creativity

in arts, science and technology

edited by
Fredricka K. Reisman, PhD
President, American Creativity Association

commentary by
James C. Kaufman, PhD
Professor of Educational Psychology,
University of Connecticut, USA

2017 International Conference on
Knowledge, Innovation and Enterprise
PHILADELPHIA, USA

Thematic Sections/Tracks:

Knowledge
Including teaching & (e-)learning in primary, secondary and higher education, knowledge-education, knowledge management, comparative knowledge, indigenous knowledge, Knowledge transfer partnerships, knowledge utilisation, intellectual property, library & information, Knowledge and technology

Innovation
Including business innovation, ICT/technology innovation including big data, analytics and deep learning, and management/organisation innovation and open innovation

Creativity
Including traditional themes/concepts of creativity—process, product, personality and environment; business/organisational creativity, arts, media & digital creativity, creative industries & enterprise, digital design & architectures, craft & animation, creativity in science and technology

Enterprise
Including entrepreneurship, marketing & strategy, HR, talent & development, servant/leadership in enterprise, SME business finance & accounting, business analytics, supply chain management, international business & management & family business/ethnic minority entrepreneurship

*There will be **opportunities to publish papers** in the KIE Conference publications—**2017 Creativity book and Research Papers In Knowledge, Innovation and Enterprise, Volume V 2017**—and selected papers will be published in the associated journal of the conference—see www.ijkie.org*

Creativity
in Arts, Science and Technology

Guest Editor
Fredricka Reisman, PhD

2016 KIE Conference Publications:

Creativity in Arts, Science and Technology
Research Papers on Knowledge, Innovation and Enterprise Volume IV

Produced and Published in London by KIE Conference Publications
Printed in Great Britain by Corporate Document Services, Leeds, England, United Kingdom

ISBN 978-1-85924-276-6

Creativity in Arts, Science and Technology

KIE Conference Publications

Contents

Contents

PREFACE

One may be able to understand creative thinking by determining the knowledge that the creative thinker brings to the situation he or she is facing.
Weisberg, 1999, p. 248

Knowledge and Creativity

When one thinks about Ellis Paul Torrance's world-acclaimed tests of divergent thinking, Torrance Tests of Creative Thinking (see Torrance, 1962, 1974), or Guilford's Alternative Uses Task (1967) or Wallas and Kogan's (1965) assessment of creativity, or a recent addition, Reisman Diagnostic Creativity Assessment (Reisman, et al., 2012), a less talk-about underpinning variable in all these creativity assessment and measuring tools is knowledge and the ability of the examinees to apply that knowledge in a variety of measurable and assessable task situations – both familiar and unfamiliar task situations.

For individuals, however, that application of knowledge could be in the fields of arts, science or technology. Artists, scientists and technologists all require some level of knowledge—mastery and immersion, sometimes deep immersion—for their creativity. In arts, evidence from studies of musicians and athletes (Bloom, 1985), chess masters (Chase and Simon, 1973) and composers, painters and poets (Haynes, 1989) showed that skills mastery and skills-horning require years of preparation. Concerning science, Weisberg (1999) makes the point that it is virtually impossible to do laboratory work without some understanding, sometimes deeper understanding, of the methods in some domains or, as evidence from Kulkarni & Simon (1988) suggests, without possessing some requisite expertise in the applicable methods.

Also, at the individual level, we know from Teresa Amabile's (1997) exposition on the componential theory of individual creativity that a prerequisite for individual and small group creativity in any given domain are 'expertise, creative-thinking skill, and intrinsic task motivation' (p. 420). Expertise and creative thinking skills are evidently characterised by knowledge.

Knowledge walks on four legs in the technology industry. The industry houses high-tech knowledge-driven companies and a significant feature of these companies is high spending on, or continuing investments in research and development (Ogunleye & Tankeh, 2013). For high-tech companies, therefore, knowledge feeds creativity which in turns feeds innovation which in turns feeds enterprise.

So, reading this book, it is obvious to me that the chain that links creativity and arts and science and technology is knowledge—and long may it be strengthened. On behalf of the KIE conference family, I say thank you to everyone who has contributed to this book; special thanks to Dr Fredricka Reisman for her sterling work in editing the book. Special thanks also to Dr James Kaufman, whose commentary on the chapters nicely rapped up the book.

James Ogunleye, PhD, FRSA
Chairman, 2016 KIE Conference
Convenor, E. Paul Torrance International Roundtable on Creative Thinking
Convenor, Reisman Diagnostic Creativity Assessment Special Interest Group

References

Amabile, T. (1997). "Motivating creativity in organizations: On doing what you love and loving what you do". *California Management Review* 40 (1) 39-58.

Guilford, J. P. (1967). The nature of human intelligence. NY: McGraw-Hill.

Haynes J. R. (1989). Cognitive processes in creativity. J. A. Glover, R.R. Ronning, & C.R. Reynolds (Eds.) Handbook of Creativity (pp. 135-145). NY: Plenum.

Kulkarni, D. & Simon, H. A. (1988). The processes of scientific discovery: The strategy of experimentation. Cognitive Science, 12, pp. 139-175.

Ogunleye, J. & Tankeh, A. (2013). Examining major contrasting risks for Knowledge-driven R&D-intensive companies, International Journal of Knowledge, Innovation and Entrepreneurship, Vol. 1 Nos. 1– 2, 2013, pp. 166—169.

Reisman, F., Keiser, L. & Oti, O. (2012) Reisman Diagnostic Creativity Assessment (RDCA). Accessible as an Apple App via iTunes (https://itunes.apple.com/us/app/reisman-diagnostic-creativity/id416033397?mt=8).

Torrance, E. P. (1962). *Guiding creative talent.* Englewood Cliffs, NJ: Prentice Hall.

Torrance, E. P. (1974). *The Torrance Tests of Creative Thinking-Norms-Technical Manual Research Edition-Verbal Tests, Forms A and B- Figural Tests, Forms A and B.* Princeton, NJ: Personnel Press.

Wallach, M., & Kogan, N. (1965). *Modes of thinking in young children*. New York, NY: Holt, Rinehart & Winston.

Weisberg R. W. (1999) Creativity and knowledge: A challenge to theories. In R. Sternberg (Ed.), *Handbook of creativity* (pp. 226-250), Cambridge: Cambridge University Press.

CHAPTER ONE

INTRODUCTION

FREDRICKA REISMAN

Chapter One constitutes both an introduction to the chapters and a call for care that expert knowledge resists harming learning. The Kapoor et al chapter, in addition to providing a historical perspective of the dark side of creativity through an exhaustive literature review, shares accounts of malevolent creativity in art (forgery), science (academic dishonesty), and technology (cybercrime). Dennett applies Bloom's taxonomy to designing a Socratic approach for organizational use. Patterson and Kerrin explore eight important individual variables that predict innovation in the workplace including the arts, science and technology. Brown and Wilson explore the notion that creativity in the arts, particularly music, benefits from constraints. Azevedo et al describe the growth of an educational program created in 1974 by Dr. E. Paul Torrance for the development of creative skills of young people globally to design and promote positive futures through problem solving using critical and creative thinking. Goff and Guzik probe the universality of creativity. Tsai investigates the nature and degree of the relationship between Chinese students' CPS styles using Puccio's FourSight model and a modified Osborn CPS model. Suss discusses the implications of global corporations creating creative environments and the affect on employees. The main goals of this study were to examine the influence that a training program has on employees' creativity and innovation competence. Pringle et al introduce empirical evidence revealing a relationship between mode shifting and creativity. Donaldson conducted a unique study to map popular creativity tools and techniques to creativity theory that resulted in a conceptual model. Patterson and Kerrin review the individual level antecedents of innovation from a psychological perspective. Lennox et al creatively structure their chapter upon fifteen hypotheses to investigate how we think about creativity, how we treat it, why we do so and whether we are behaving toward creativity to the best of our ability. Wilson and Brown explore the process and experience of creativity in the realm of music composition. Kantor's notable treatise on *Intelligence and Creativity Reconsidered* points out the importance, especially for corporations, of integrating the specialized intelligences of its human capital while promoting creativity so they are "poised for continuous reinvention and success". Dowling describes a unique program of instruction in finance at Bryant University. Kaufman's concluding chapter highlights the good work being done in the field of creativity (both in this book and elsewhere), pointing out both highlights and challenges to be faced in the future.

Too Much Knowledge by the Experts Can Be A Detriment to Learning

Sternberg (1997) suggested that "expertise" may result in rigid thinking and reduced flexibility in problem solving. He further points out:

> On the one hand, one needs to know enough about a field to move it forward. One cannot move beyond where a field is if one does not know where it is. On the other hand, knowledge about a field can result in a closed and entrenched perspective, resulting in a person's not moving beyond the way in which he or she has seen problems in the past. Knowledge thus can help, or it can hinder creativity.
> (Sternberg, 2006, p.89).

E. Paul Torrance in conversation with me also discussed the problem of experts forgetting how they learned. It appears that "experts" in teaching place value to generations of teachers have become so committed to a standard way that they have not considered alternative approaches. This phenomenon of being blinded to new possibilities by one's expertise is discussed in the creativity literature (Frensch & Sternberg, 1989; Simonton, 1984).

I like the model of Janus (Figure 1), with the two faces looking in opposite directions to represent Janusian thought. As a former mathematics teacher, I am taking the liberty of applying these thoughts to learning that occurs in elementary grades mathematics, the foundation of higher mathematics. I refer to the curtain of knowledge (represented by the vertical line) that separates the two faces as shown below. Once we learn something, we often forget what our thinking was before we learned it. I have labeled one who can re establish their awareness of their novice state—diagnostic teacher. This is a teacher, coach, mentor who can move back and forth through the curtain of knowledge (represented by the horizontal line) and thus, understands the novice learner's thinking and can creatively construct situations to foster acquisition of the new knowledge.

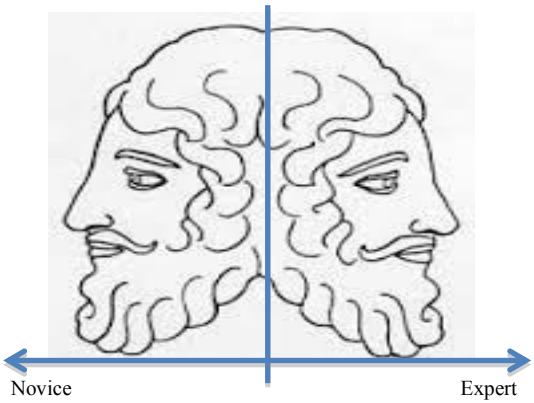


Figure 1. Janus Looking to the Past and to the Future

Following are trouble spots that are prevalent in the elementary mathematics curriculum due to a rigidity of instruction—adhering to the status quo..

Place Value

Why does place value present such a challenge to young students' constructing this knowledge, which is especially basic to whole number computation? A reason is that the universal bundling of ten sticks that are ***exchanged*** for one stick that is now worth ten is not a model for the understanding of place value where we change places after the count of nine, not ten. The exchange model is not a physical representation of our notation system. The Counting Boards shown in Appendix A represent a creative approach to teaching place value and is taken from the place value book of a trilogy on teaching mathematics creatively (Reisman and Torrance, 2002, Torrance and Reisman, 2000a, 2000b).

Carrying and Borrowing

In regard to renaming in addition and subtraction, they are merely reverse operations of the same concept as seen in the Table 1 examples: 23 + 9 = 32

23 → 20 + 3 + 9 → 20 +(3 + 9) → 20 + 12 →

+ 9

→ 20 + (10 + 2) → (20 + 10) +2 →

30 + 2 = 32

32 → (30 + 2) → (20 + 10) + 2 → 20 + (10 + 2) →

- 9

→ 20 + 12 → 20 + (12 – 9)

= 20 + 3 = 23

Table 1: Renaming in Addition and Subtraction

and 32 – 9 = 23. A physical representation of this can be explored on the counting boards in Appendix A. Exploring

> problems by combining concrete investigation in concert with symbols is a creative problem solving approach that facilitates constructive learning where the learner builds (construct) meaning.

Note that examples in Table 1 require that the learner must be aware of the following laws:

i. Numbers can be renamed and keep their equivalent values. 32 = 30+2

ii. The associative (grouping) property allows for numbers to be added in different groupings, e.g., 30+2 = (20+10) +2 = 20+ (10 + 2) without changing their value.

Why is understanding ***"carrying" and "borrowing"*** in addition and subtraction hindered when using the bundling of tens model to explain computation with digits? First, we do not *borrow* since nothing is paid back, and we do not *carry* anything-yet these terms continue to mindlessly be used. Second, there is a difference in instruction when illustrating that *exchanging* ten ones as one ten are quantitatively equivalent—or to put in little learners' language, using money we can exchange ten pennies for one dime and still have the same amount of money. When this concept shown at the concrete level is then shown with digits, the exchange of concrete objects becomes *renaming* of a number that is affected by its position in a column having the following values: ones, tens, hundreds, thousands, etc. These columns represent places, and in a multi-digit number affect the value of the digit. Thus, the value of a digit is a product - the result of face value times place value. The value of the places in a multi digit number is also a product (10 x 10, 10 x 100, 10 x 1000,…). Yet we continue to teach place value before multiplication!

These concepts are not intuitive for young learners, yet adults assume that the traditional instructional approach is correct—even in the evidence that many students do not acquire computational success and that adults often cannot explain place value. In fact, when adults are asked to explain how the bundling of objects model reflects place value in computation, they have a problem doing so. **The key is the inconsistency in the counting.** The bundling of tens model is an exchange model where indeed ten objects are exchanged for one object with a different name but equivalent value, e.g., ten pennies equal one dime. But computation depends upon place value, where the count of *nine* (not ten) triggers movement from one place value column to the next. Appendix A shows a counting boards approach that is a correct physical model for teaching place value.

Telling Time

Why is telling time such a challenge for many learners? The traditional sequence of instruction is for students first to view pictures of a clock face and identify the time shown. The sequence of times shown is time to the hour, 30 minutes after the hour, 15 minutes after the hour and 15 minutes before the next hour, five minute intervals, and finally, time to the minute. Again, we have an example of experts mindlessly repeating traditional pedagogy that ignores how children learn.

First, pictures of a clock do not relate the forward movement of time but can merely show that a student has memorized the picture in relation to a specific time. The traditional instructional sequence following time to the hour (as listed previously) violates how students learn to count, which is the underlying concept of telling time. We learn to count by ones first; not by 30s, 15s, or 5s. Further, time is a forward moving phenomenon. Therefore, we should emphasize time after the hour in the beginning instructional sequence, e.g., 35 minutes after the hour, 48 minutes after the hour, etc., and by using a real clock face with coordinated minute and hour hands, show that 60 minutes an hour is the same as zero minutes after the next hour.

Next, how to address the confusion between the 60 and 12 minute marks on the clock face. These markings represent two number lines: a 60 number line and a number line of the same length but marked by groups of five; thus, 5,10,15, etc. to 60. When these two number lines are placed side by side, the student can see the relationship and becomes aware that the 12 number line is merely marking off a counting-by-fives sequence. When these two number lines are made into circular formats, they resemble the markings on the clock face. Until students can count to 60, they are not ready to deal with the measurement of time. Also, counting by ones on the 60 number line also causes a problem if the student does not realize that they are counting jumps, not the minute marks. Some students count *one* when they are still at the 12 (or the 60) minute mark rather than moving from the 12 mark to the next mark and counting one as they jump from the beginning mark to the next. This is why children often count the 5 minute mark as six. Some would say- why not just use digital clocks? The measurement of time involves many mathematical concepts as well as relativity and the relation between speed, time and distance.

Zero

Another trouble spot for young learners is the discrepancy in representing *zero*. At the concrete level, zero is represented by nothing; but at the symbols (digital) level, zero is represented by the digit "0". This is easily shown on the Counting Boards in Appendix A.

Conclusion

A serious inhibition to enhancing creativity is the universal emphasis on obtaining the ***correct*** answer—especially, on classroom and standardized tests. This emphasis on producing a fixed answer focuses only on convergent thinking (analytical, evaluative) to the exclusion of divergent thinking (generating many ideas). Convergent thinking was designated by Guilford (1950) as the opposite of divergent thinking and refers to giving the "correct" answer to standard questions, for example, multiple-choice, matching, or true-false items. Creative thinking is the sequence of divergent, convergent, divergent, convergent, divergent,…as shown in Figure 2 (Tanner and Reisman, 2014, p.98). In addition, too much knowledge can lead to premature closure of accepting the traditional pedagogies, forgetting how difficult it was to tolerate ambiguity when not understanding something. Accepting the status quo prohibits experts from generating other ways of teaching and thus, inhibits their creative problem solving as they may not identify the *real* misunderstanding of a learner/

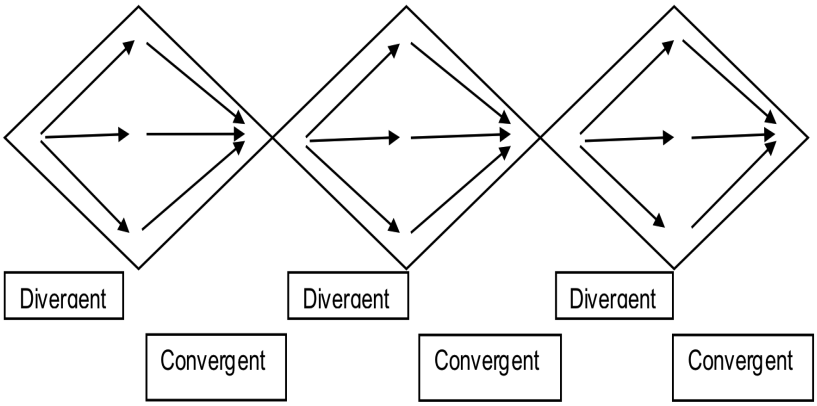


Figure 2: Creative Thinking Process

Thus, let us be knowledge rich while acknowledging that other's may be at the novice end of the Janusian diagnostic curtain and require us to be open to creative pedagogies that may go counter to what ww are used to. We must always be aware that too much knowledge by experts can be a detriment to learning.

References

Frensch, P.A. & Sternberg R.J. (1989). Expertise and Intelligent Thinking: When is it worse to know better? In R.J.Sternberg (Ed.), *Advances in the Psychology of Human Intelligence*(Vol 5, pp. 157-188). Hillsdale, NJ: Erlbaum.

Guilford, J.P. (1950) Creativity, *American Psychologist*, Volume 5, Issue 9, 444–454.

Reisman, F.K. and Torrance, E.P. (2002). *Learning mathematics creatively: Place value*. Bensenville, IL: Scholastic Testing Service.

Simonton, D.K. (1984). *Genius, creativity, and leadership.* Cambridge, MA: Harvard University Press.

Sternberg, R.J. (2006). The Nature of Creativity. *Creativity Research Journal*, Vol. 18, No. 1, 87–98.

Sternberg, R. J. (1997). *Successful intelligence: How practical and creative intelligence determine success in life*. London: Plume Books.

Torrance, E.P. and Reisman, F.K. (2000a). *Learning mathematics creatively: Word problems.* Bensenville, IL: Scholastic Testing Service.

Torrance, E.P. and Reisman, F.K. (2000b*). Learning mathematics creatively: Primes, fractions, decimals.* Bensenville, IL: Scholastic Testing Service.

Appendix A

Place Value and the Counting Boards

The following is an activity on representing numbers that lends itself well to cooperative learning about place value and its partner, face value. The counting board approach was created after many years of diagnosing why students had so much difficulty learning place value. Place value charts, Dienes Blocks, Cuisenaire Rods, the abacus, and bead charts have been used for years – and they all rely on the "exchange" model where multiples of ten are exchanged for the next higher place value. However, when we write numbers, we do not "bundle" or exchange anything. Following is a creative break-

through in place value pedagogy using *counting boards* which are a true representation of our numeration system.

An individual counting board has nine spaces with increasing values from one through nine as shown in Figures 1 and 2. An empty board has a value of zero.

A value of one is obtained by *jumping a chip onto the board,* to land on space *one*. This is important because moves that represent *counting on* as a model for addition of basic facts must start from off the board to represent the board's initial value as "zero" since no chips are on the board. This is shown in Figure 2.

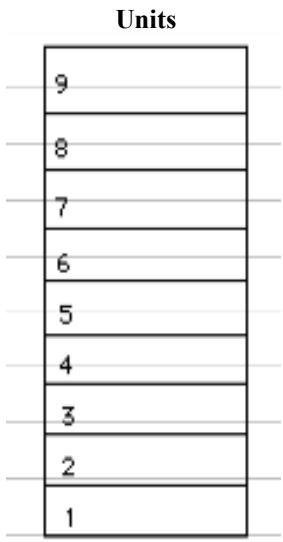


Figure 1: Counting Board

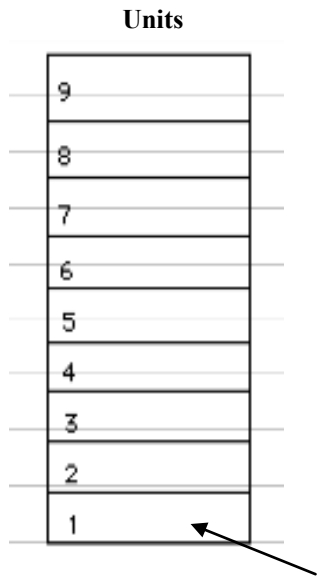


Figure 2: Counting Board

By the time students are in eighth through twelfth grade, if they still do not understand place value, which underlies the algorithms for operations on whole numbers, as well as computation with decimals, a different physical representation is needed. An analysis of place value reveals that two very different relationships are involved in understanding place value -- a *count-on -by-one model* and an *exchange model* (bundling-of-tens).

The count-on-by-one model emphasizes the fact that when recording the counting sequence, a change in thinking from units to tens occurs after the count of 9. The bundling-of-tens model, on the other hand, involves a change in thinking after the count of 10. We count ten objects and then bundle them to represent 1 ten. In fact, we count to 9 and then make our move to the tens

place; we change place values after the count of 9, not 10. Therefore, the bundling of tens model is not a good representation of our notational system.

In the beginning stages of learning, children do not think "I have ten units; that's one group of ten and no units." In fact, this is a division relationship. Until they construct some basic multiplication ideas, they should not be expected to understand a positional notation system because the values of the positions are products, i.e., 10 = 10 x 1, 100 = 10 x (10 x 1), 1,000 = 10 x (10 x 10 x 1), etc. In the numeral 5<u>3</u>9 the underlined digit has a face value of three, a place value of ten, and a total value of 30, obtained by multiplying the digit's place value by its face value: 3 x 10 = 30.

To count and write numbers through 9,999 in sequence, the counting boards are useful. The count-on place value model is prerequisite to the exchange or bundling-by-tens model as it involves a simple count-on-by-one sequence. The following suggested activities should be spaced over one to three weeks to allow enough practice time for students to understand how the value of positions in our notational system developed.

Give each student his own counting board and a counting chip. An empty board represents a value of zero; each space has the value of the space just below plus 1, thus representing an add-1 sequence.

In beginning work with a counting board, write the space values on the board. (see fig. 3) Tell the students that a rule of the game involves putting only 1 chip on the board at a time. Have students practice counting board values from zero to nine by jumping a chip onto the board to count “one”, moving the chip up 1 space to show “two”, and so on up to “nine.” Thus, a chip on a board is analogous to the face value of a digit. When only one board is used, it represents units or ones place value.

Continue counting one more beyond nine as shown in Figure 3, and call out “ten”as the chip is moved up and off the top of the counting board. Although there is now no chip on the board, set a rule that once the count starts the counting board continues to have value, especially when the count is greater than nine and the units board appears empty. Otherwise students might focus on the visual emptiness of the board and forget that they had been counting upward beyond nine to ten, with the chip now sitting in the space just above the Board.

(see fig. 4 overleaf)

Figure 3: Units Counting Board
Counting Board

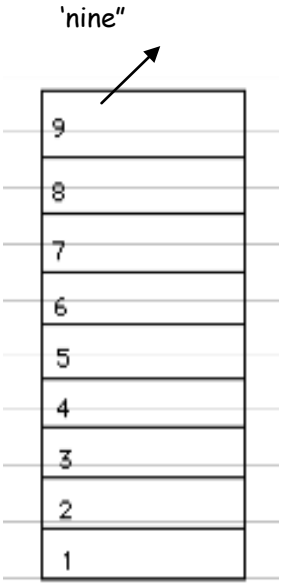
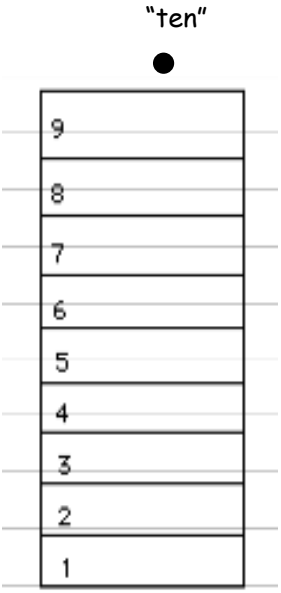
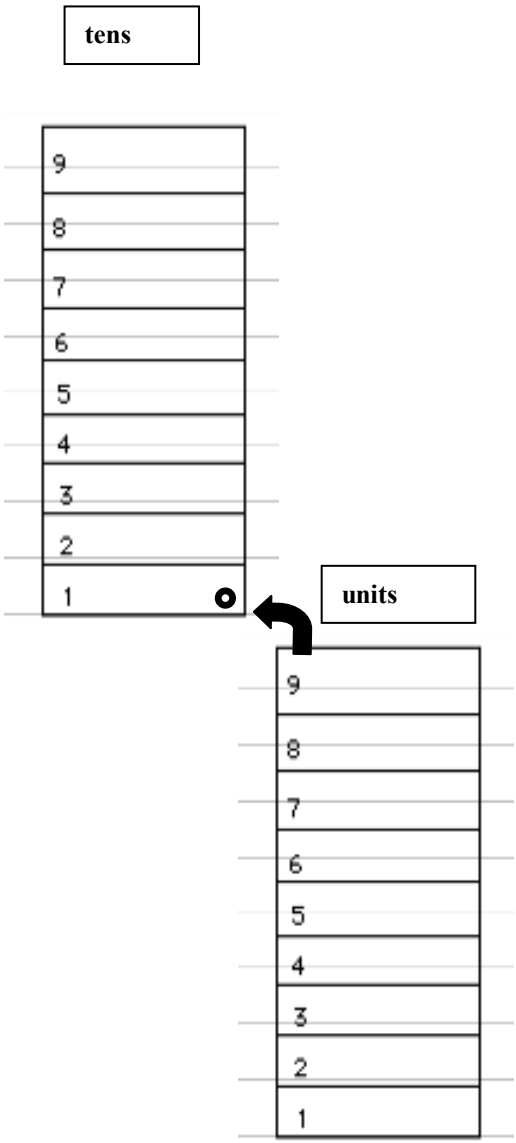


Figure 4: Units



After pupils have had practice using one board, provide a second counting board. Position the "tens board" to the upper left of the “units board” (see fig. 5) to continue the counting sequence beyond 9.

Figure 5: Tens and Units Boards



The board to the upper left represents the tens place value. Remind students that as the chip is moved up a space, the board value increases by 1. Present the problem solving situation of what the count will be if the chip is moved up 1 move beyond 9; it is now just above the units board. Move the chip horizontally to the left onto the bottom space of the board to the upper left as shown in Figure 5. Since only a horizontal move and no upper move occurred, there was no increase in value. Consequently, the value of the bottom space on the board in the tens place is ten.

For some students, it may be helpful to omit the digits on the tens board. This will emphasize the horizontal move to the left at the count of 10 rather than the idea of "1 ten." On the other hand, retaining the digits on each board highlights the idea of 1 ten and 0 units, as represented by the chip on the tens board and the empty units board. This matches the recorded form: _____ tens and _____ units (or ones).

Author's Brief Bio

Fredricka K. Reisman, PhD, is professor and founding Director of Drexel's School of Education, oversees the online Master's in Creativity and Innovation degree and certificates in the School of Education, as well as the forthcoming online EdD concentration in Creativity and Innovation. Additionally, she served as Assistant Provost for Assessment and Evaluation, Interim Associate Dean for Research of the Goodwin College, and is Director of the Drexel/Torrance Center for Creativity and Innovation. Dr. Reisman received her PhD in Mathematics Education from Syracuse University. Prior to coming to Philadelphia, Dr. Reisman served as Professor and Chair of the Division of Elementary Education at the University of Georgia and as an elementary, middle school, high school mathematics teacher in New York State, and mathematics education instructor at Syracuse University. She is the author of several books with subjects that include, diagnostic teaching, teaching mathematics to children with special needs, elementary education pedagogy, mathematics pedagogy, and application of creativity and innovation to corporate situations. She also has co-authored a trilogy of books on teaching mathematics creatively with world-renowned creativity scholar and researcher, E. Paul Torrance with whom she enjoyed a collaborative relationship for 34 years, commencing with her academic appointment at the University of Georgia and continuing until his death in 2003.

Dr. Reisman has recently published in the Handbook of Talent Management, in a text for bioscientists, and the Journal of Pharmaceutical Sciences. In addition, she has developed the Reisman Diagnostic Creativity Assessment (RDCA), which is a self-report assessment of research-based traits of creative strengths and is currently a free Apple app for the iPhone, iPad, and iTouch. Her forthcoming book with Dr. David Tanner is Creativity and Innovation: Bridging Education and Industry. Dr. Reisman was awarded the 2002

Champion of Creativity Award by the American Creativity Association (ACA), was appointed to the ACA national Board and served as ACA Treasurer. She currently is completing her Fourth year as ACA President.
Email: freddie@drexel.edu.

CHAPTER TWO

FIFTY SHADES OF CREATIVITY: CASE STUDIES OF MALEVOLENT CREATIVITY IN ART, SCIENCE, AND TECHNOLOGY

HANSIKA KAPOOR, ANIRUDH TAGAT & DAVID H. CROPLEY

Abstract

The darker shades of creativity have recently attracted great interest because negative and malevolent creativity are found in multiple domains. It is easier to conceive of creative acts that meet negative goals as uncreative, primarily because of their immoral and unethical nature. However, a complete understanding of the creativity construct may be obtained by assessing it within a valenced framework, wherein each component of creativity is positive or negative. In this qualitative account of malevolent creativity, we review manifestations of such creativities in the contexts of art, science, and technology. That is, original and subjectively useful actions taken by actors in each of these domains, which meet negative goals, with the deliberate intent to harm another individual or society at large. First, a brief review of literature in the areas of dark, negative, and malevolent creativity is presented. Second, qualitative accounts of malevolent creativity in art (forgery), science (academic dishonesty), and technology (cybercrime) are analyzed through D. H. Cropley's (2010) framework integrating valence and Rhodes' (1961) four Ps model of creativity. Each domain is first examined independently; subsequently, attempts are made to identify commonalities underlying malevolent creative behaviours across domains. Suggestions for future research in this emerging subfield of creativity are provided.

Keywords: malevolent creativity, negative creativity, moral creativity, forgery, academic dishonesty, cybercrime

Although the academic study of creativity is expanding, it continues to be typically viewed as a socially appealing concept. Creative acts, products, and persons are usually considered to be positive, and the creative process is assumed to pave the way for beneficial outcomes, that are original and valuable to society. There is, however, a growing recognition that the facets of creativity can range along the spectrum of valence, from good to bad. Recent research has examined other sides of creativity, variously referred to as the "dark side" (McLaren, 1993), "negative creativity" (James, Clark, & Cropanzano, 1999), and "malevolent creativity" (D. H. Cropley, Kaufman, &

Cropley, 2008). Although the implicit assumption is that *dark* creativity comprises at least negative and malevolent forms, nomological debates remain unresolved. Perhaps, the negative valence and accompanying immorality (Runco & Nemiro, 2003; Runco, 2009) of the creative outcomes themselves may have overshadowed the academic pursuit of the dark side of creativity. Regardless, the dark side of creativity has provoked researchers to question the restrictive assumption that "creativity is positive" (e.g., D. H. Cropley, Kaufman, White, & Chiera, 2014).

In the psychological study of creativity, the construct has commonly been defined as an outcome that is original, and effective or useful (Barron, 1955; Plucker, Beghetto, & Dow, 2004; Stein, 1953). Originality or novelty typically refer to the statistical infrequency of the act, that is, few people would be able to conceive the outcome (Wallach & Kogan, 1965), or the newness of the outcome, that is, not having been done before. Effectiveness has been described as "adaptive to reality" (Barron, 1955, p. 479), or "alternatively termed usefulness, utility, value, appropriateness, relevance, or meaningfulness" (Simonton, 2016, p. 2). Novelty and usefulness, like creativity itself, are subjective; that which may be useful to one may be useless to another. Further, Stein (1953; see also Eisenman, 2008; James et al., 1999) proposed that all creative acts required to be evaluated as such—an element of social judgment was involved. At a particular period of time, group acceptance of output was required for it to be considered creative. From a philosophical point of view, pertinent questions about the nature of creativity and its functions have been raised. In particular, whether creativity is a virtue; whether it is rational; whether it defies tradition; and whether it is associated with natural selection (Gaut, 2010). The first question is of particular importance when discussing the dark side of creativity.

At this stage, it is important to clearly delineate which aspects of creativity theoretically possess valence. In line with the doctrine of Blind Variation and Selective Retention (BVSR), proposed to be applicable to the creative process by Campbell (1960), this report does not argue that the creative process, in isolation, can have negative or positive valence. The BV process generated multiple "thought trials," of which relevant ones were retained by SR and subsequently replicated. Blindness implied not knowing which of the ideas would eventually be selected, and was not equivalent to randomness. Campbell (1960) specified that equiprobability of responses, as in the case of randomness, was not required. In fact, some alternative solutions may be prevented from being generated due to a priori constraints applied on the creative process (Simonton, 1999). These external constraints can be related to the person, the press, or the eventual product that is to be generated. Thus, "the difference is in the product or implementation, not in the capacity. That capacity for ideation is separate from the uses of the ideas, and given that one person can be both malevolent and benevolent, only the specific uses or products can be judged as benevolent or malevolent," (Runco, 2010, p. 22; see also Campbell, 1960; Simonton, 2011).

Creative Valences

Positive Creativity

Needless to say, the operationalization, measurement, and frameworks of creativity have been developed in the context of positive or benevolent creativity. In this context, the individual engages in creative processes to meet positive goals and yield beneficial outcomes (James & Taylor, 2010). The primary recipient of the benefit remains undefined; however, it was clear that the outcome was not harmful. Similarly, most methods to measure creativity were designed keeping in mind positive creativity, and thereby positive creative outcomes.

Dark, Negative, and Malevolent Creativity

Whether a creative process can produce negative and positive outcomes lies at the core of defining two strands of creativity. However, this argument is not novel. According to Rogers (1954/1976),

> Creativity is not, in my judgment, restricted to some particular content. I am assuming that there is no fundamental difference in the creative process as it is evidenced in painting a picture, composing a symphony, devising new instruments of killing, developing a scientific theory, discovering new procedures in human relationships, or creating new formings of one's own personality in psychotherapy. (pp. 296–297)

McLaren (1993) alluded to the "dark side" of creativity in various areas, and elaborated the need to study creative products in relation to their societal and moral implications (see also Runco & Nemiro, 2003). Later, James et al. (1999) conceptualized *negative creativity,* as the use of creative means to meet negative goals, which may harm others, but not deliberately. Thus, although the actor's intent was taken into consideration in negative creativity, whether the intent was deliberate or not was not explicitly stated. Given the importance of intentions in creativity, particularly in the context of morality (Gruber, 1993; Runco, 1993), D. H. Cropley et al. (2008) defined *malevolent creativity* as a creative act, with a deliberate intent to cause harm. According to D. H. Cropley (2010),

> The critical factor that differentiates malevolent creativity from negative creativity is the intent of the actor. Malevolent creativity must involve not only a harmful or damaging outcome or product but also a deliberate intent to cause harm or damage. Negative creativity, by contrast, may feature no deliberate intent. In the case of negative creativity, the harmful or damaging outcomes may be merely an unfortunate by-product, such as the discovery of microorganisms leading to germ warfare. (p. 366)

Negative creativity was empirically studied in an organizational context, where a justice manipulation was used to assess whether individuals who

perceived unfair treatment would be more likely to engage in negative creativity (Clark & James, 1999; James et al., 1999). Further, recent research associated positive creativity with negatively tinged behaviours, particularly lying. For instance, Gino and Ariely (2012) first identified how (positive) creativity can lead to dishonest behaviour, and Gino and Wiltermuth (2014) more recently showed how dishonesty can lead to (positive) creative behaviour. Similarly, an earlier study by Beaussart, Andrews, and Kaufman (2013) identified a negative relationship between behavioural integrity and (positive) creativity, and between self-reported integrity and (positive) creativity. Walczyk, Runco, Tripp, and Smith (2008) identified preliminary links between creative lying, divergent thinking, and the tendency to be ideational.

In addition to behaviours with a negative connotation, negatively shaded personality characteristics have also been studied in the context of positive and negative creativity. Kapoor (2015) investigated the relationship between the Dark Triad (subclinical narcissism, subclinical psychopathy, and Machiavellianism; Paulhus & Williams, 2002) and self-reported engagement in positive or negative creativity. Narcissism was associated with positive outcomes; psychopathy was associated with negative outcomes; and the Dark Triad as a whole predicted engagement in negatively creative behaviours. Jonason, Richardson, and Potter (2015) found that narcissism was associated with greater self-reported creativity, while Machiavellianism was marginally related to creativity.

Recent research has found associations between malevolent creativity and trait physical aggression and low conscientiousness (Lee & Dow, 2011); implicit aggression; low premediation (Harris & Reiter-Palmon, 2015); and low emotional intelligence (Harris, Reiter-Palmon, & Kaufman, 2013). Malevolent creativity has also been studied in the contexts of terrorism and crime (A. J. Cropley & Cropley, 2011; D. H. Cropley & Cropley, 2013; D. H. Cropley et al., 2008; Eisenman, 1999; Gill, Horgan, Hunter, & Cushenbery, 2013; Gill, Horgan, & Lovelace, 2011). D. H. Cropley et al. (2008) suggested that benevolent and malevolent creative products could be analyzed via a hierarchy of four parameters: relevance and effectiveness, novelty, elegance, and generalizability. They also proposed viewing terrorism through the lens of functional creativity, where a parallel was drawn between businesses competing for market share, and between terrorists and counter-terrorists. Thus, creative ways could be used to engineer products that served malevolent intentions.

Eisenman (2008) provided several examples of malevolent creativity in criminal populations, such as using gruesome torture techniques to coerce someone to provide sensitive information. Gill, Horgan, and Lovelace (2011) mentioned the use of malevolent creativity by terrorist organizations and individuals to produce specialized, improvised explosive devices, which would cause the most societal harm. Similar to James et al.'s (1999) initial paper which applied negative creativity in an organizational context, Gill, Horgan, Hunter, and Cushenbery (2013) assessed malevolent creativity in terrorist

organizations. They identified several facilitators of malevolent creativity, such as an environment for innovation; they emphasized the importance of its study, especially for counter-terrorism groups.

Thus, the study of negative and malevolent creativity can progress from nomological concerns and debates, to operationalization of relevant variables, to assessing different behavioural and psychological correlates of the construct, to studying contextual and situational (press) factors that promote or restrict engagement in negative and malevolent creativity (e.g., Clark & James, 1999; Harris et al., 2013). The costs of not examining the dark side of creativity will amount to more variants of novel, yet harmful, behaviours that can have a detrimental impact on individuals and society as a whole. In this context, D.H. Cropley and Cropley (2013) analyzed examples of creativity in terrorism and fraud, and proposed strategies that might be employed by organisations seeking to prevent or mitigate these acts. Earlier, McLaren (1993) illustrated the dark side of creativity with examples from artistic, scientific, and technological areas; the current chapter attempts to do the same with contemporary examples, and by applying a valence-based model of creativity (D. H. Cropley, 2010).

Relevant Models of Creativity

To simplify the framework within which creativity was studied, Rhodes (1961) argued that the construct comprised four strands, which were not necessarily mutually exclusive. "One of these strands pertains essentially to the person as a human being. Another strand pertains to the mental processes that are operative in creating ideas. A third strand pertains to the influence of the ecological press on the person and upon his mental processes. And the fourth strand pertains to ideas," (Rhodes, 1961, p. 307). This came to be identified as the four Ps model of creativity, consisting of the Person, Process, Product and Press:

(a) Person included traits, temperament, and attitudes of the individual creator,

(b) Process referred to the creative process, mental and otherwise, including motivation and cognition,

(c) Product was the tangible and intangible (ideational) outcome of the creative process,

(d) Press included environmental and contextual factors that may have prompted the creator to create.

D. H. Cropley's (2010) model of malevolent creativity integrated Rhodes' (1961) four Ps model with valences. In the model, person represented the actor's intent (benevolent or malevolent); product represented the outcome of the creative process (good or bad); and press/process represented environmental and social factors (supportive or obstructive). This led to eight types of creativity based on the 2 x 2 x 2 interaction. For instance, D. H. Cropley's (2010) model described *failed malevolence* as the state when an

individual's malevolent intent is hindered due to the (unintended) generation of a positive outcome. This implies that unintentional consequences are possible in such a valence-based model. Similarly, *resilient malevolence* is a state in which an individual's malevolent intent generates a bad outcome, despite obstructive presses. Although D. H. Cropley (2010) grouped press and process together to represent creative aspects occurring between the intent (person) and outcome (product), we reiterate that the creative process in isolation is not theoretically valenced. According to the model, the creative process can be manipulated as supportive or not, possibly by providing creativity training. No doubt, the process can *facilitate* or *not facilitate* creativity, but attributing valence solely to the creative process is incompatible with BVSR. However, as the valence-based model represents a systems view of the facets of creativity, it emphasizes the interactionist nature of the four Ps. That is, valences in intents and outcomes may interact with valences in presses. Thus, whether valence applies to specific Ps or to the entire system of interactive Ps remains open-ended.

This growing interest in the dark side of creativity is a stimulus for developing a deeper understanding of not only the variables embedded in any one of the four Ps, but also a broader understanding of the relationships between variables and their interaction across those four Ps. Therefore, the current chapter describes three instances of malevolent creativity in recent times, in the areas of art, science, and technology. We apply D. H. Cropley's (2010) model to illustrate the four Ps of creativity in the context of malevolent intent, societal harm, and economic consequences, and delineate the commonalities and differences between the three anecdotes. Each illustration is reasoned to fall within the category of *conscious malevolence* (malevolent intent–bad product–supportive press), and implications are discussed. The purpose of this analysis derives from a need to assess qualitatively the construct of malevolent creativity to yield future directions in research related to the dark side of creativity. By identifying variables of relevance in malevolent creativity, as well as how relationships among these variables are organically developed, represented, and sustained, future research in this area can be informed.

Art: Wolfgang Beltracchi

The art market thrives on authenticity. Genuine and original artwork is sought and forgeries, no matter how technically sound, are frowned upon. Art forgery distorts the history of art, and meddles with the timelines of artists and art movements. Yet, the art market has a limited number of artwork from classic artists, with an increasing demand and finite supply. In such a context, when novel artworks, painted in the style of their original creators emerge, the market and its stakeholders are bound to take notice. In this context, Wolfgang Beltracchi is considered to be one of the greatest art forgers, who was able to deceive several in the art industry by creating about 300 fake

paintings in the styles of famous artists like Heinrich Campendonk and Max Ernst (McCamley, 2015).

How is art forgery related to malevolent creativity? Beltracchi's methods of forgery, the painstaking detail with which he created paintings from a previous era, and the ability to trick art historians and connoisseurs alike makes this anecdote particularly relevant. Beltracchi forged about 50 artists in a methodical manner; rather than copying existing works, he sought to complete artists' collections by inventing paintings that art historians noted as missing. For instance, he created original works, which were believed to be lost, but appeared in an artist's list of works ("Spiegel interview with Wolfgang Beltracchi: Confessions of a genius art forger," 2012). Thus, Beltracchi produced forgeries by dwelling into the minds of artists, and adopting their technical style, along with their conception of art itself (Birkenstock, 2014). After having used an incorrect pigment in a supposedly 1915 Campendonk, Beltracchi was tried and sentenced to six years in prison in 2011.

From the lens of D. H. Cropley's (2010) model, Beltracchi's intent was clearly malevolent. He produced forgeries intentionally, with a deliberate intent to harm and trick various persons in the art sector, for primarily personal monetary gains. His forgeries sold for millions, and once he was convicted, he owed millions in debt. Beltracchi's personality, as inferred through interviews and a documentary (Birkenstock, 2014; "Spiegel interview with Wolfgang Beltracchi: Confessions of a genius art forger," 2012), revealed narcissistic, nonchalant, and omnipotent traits. He asserted that he often took classic paintings and improved them, and that his adaptations of classic artists' styles were better than the originals. He showed little remorse for his actions, and when asked what he would change about his past, replied that he would never use the pigment titanium white (McCamley, 2015). He blatantly capitalized on the greed prevalent in the art market, which demanded classic works. When a lost original appears in the market, art historians want to have found the missing painting from an artist's collection; auction houses want to be able to value the artwork highly; and collectors seek to make high bids to secure the piece. Unfortunately, no one in this nexus wants the painting to be a fake, and this is what Beltracchi took advantage of ("Spiegel interview with Wolfgang Beltracchi: Confessions of a genius art forger," 2012). From the perspective of personal abilities, Beltracchi undoubtedly had immense artistic talent, was knowledgeable of art history and science, and had minute attention to detail. However, he chose to produce fakes rather than originals, because in his words "it's easier to sell a painting for half a million than for ten thousand dollars," (Birkenstock, 2014).

The creative process adopted by Beltracchi was a combination of original and deceptive processes. He generated novel art, which was useful to him and the market, while utilizing the art of forgery to trick potential buyers and stakeholders. Deception and positive creativity have a bi-directional relationship (Gino & Ariely, 2012; Gino & Wiltermuth, 2014), and research is yet to examine whether malevolent creativity has a qualitatively different associa-

tion with deception. With respect to the creative product generated, Beltracchi was creating art, which in itself is a 'good' product, leading to a categorization of *failed malevolence*. Although he produced novel artwork, which required a great deal of originality and ingenuity, he did not sign his name to the paintings and misattributed the source of the works (McCamley, 2015). Thus, although art was a 'good' creative product, a forgery was a 'bad' product. This is not to say that Beltracchi was not creative—he was possibly one of the most creative artists of all time. However, by co-opting the stylistic ways of famous artists and misrepresenting their work, Beltracchi was more malevolent than benevolent.

The fourth P, press, was highly supportive in Beltracchi's case. His father was a church painter and painted copies of earlier works. At age 14, Beltracchi painted a copy of a Picasso for his father, but improved on the original by omitting elements that he felt were unnecessary. Early experiences such as these prompted Beltracchi to emerge as an artist, and he showcased his original works in the 1970s. He began painting forgeries, in part due to his desire to paint, and perhaps in part due to the skills that he honed. In collaboration with his wife (who was sentenced to four years in prison in 2011) and a colleague, Beltracchi deceived interested parties by creating fictional familial art collections ("Knops" and "Jägers"). Further, his wife Helene, dressed up in vintage clothes, pretended to be her grandmother, and posed with the paintings on the walls to yield photographic evidence (McCamley, 2015). Beltracchi went to great lengths to procure the correct materials to produce forgeries. For instance, he searched flea markets for old canvasses and frames, removed the painting on them, and repainted on such canvasses. He ensured that dust mites that may have gathered over the years in the frame were present when attempting to sell a lost treasure to a potential collector (Birkenstock, 2014). He mixed the colors himself, using only those pigments that were available to artists in that era. Thus, both affordances (material presses) and audiences (social presses) in his milieu (Glăveanu, 2013) were conducive to generating forgeries.

Beltracchi's anecdote is one of conscious malevolence, where his malevolent intent (person) produced fake art (product) in an encouraging environment (press). Regardless of his artistic prowess, he would still be considered a malevolently creative individual, as his actions caused deliberate harm to several in society. However, this should not detract from the fact that he is immensely creative, whose valuation in the art market is only increasing (Kolb, 2015). However, art forgery has enormous and lasting economic and social consequences. Beltracchi has admitted to being unaware of where several of his forgeries continue to adorn the walls of collections and galleries. Some have called Beltracchi a concept artist as his art uncovered the arbitrary and flawed workings of the art market ("Spiegel interview with Wolfgang Beltracchi: Confessions of a genius art forger," 2012). Over a period of time, perhaps the intent of art forgers like Beltracchi would be reinterpreted as benevolent for helping identify faulty mechanisms of art exchange. However, in

the current context, Beltracchi remains a malevolent, albeit creative individual.

Science: Michael LaCour

In LaCour and Green (2014), the authors presented findings from a randomized control trial that showed how gay canvassers were more successful than their heterosexual counterparts at changing voter attitudes towards same-sex marriage. The study also found significant cascade effects of attitude change, thereby concluding that the sexuality of the person bringing about attitude change was a significant determinant in whether or not attitudes toward same-sex unions can be changed. Given the significance of this finding, Broockman, Aronow, and Kalla (2015) set out to replicate and extend the study due to their interest in this area. In the course of their study, the authors found several irregularities in LaCour and Green (2014), initially motivated by unusually high reliabilities as the survey involved follow-ups with voters over a 12-month period. During the course of their own pilot study, Broockman et al. (2015) were unable to attain a similar (high) response rate, leading to the authors approaching the same survey agency that carried out the study for LaCour. At this stage, Broockman et al. (2015) discovered that this survey agency claimed to have no connection to LaCour and Green (2014) while also suggesting that they had no capabilities to carry out such a survey for Broockman and his colleagues. Apart from this operational irregularity, closer statistical analysis of the data (that was made publicly available as part of *Science*'s publication policy) revealed an abnormally high statistical reliability for a "notoriously" unreliable survey instrument (the feeling thermometer); a perfect normal distribution of scores on the thermometer; and lack of non-random measurement error in the panel data.

Eventually, with support from the study's co-author Donald Green, Broockman et al. (2015) were able to identify that much of the data used in the original study was derived from modifications to the Cooperative Campaign Analysis Project (CCAP), to which only few scientists had access. This led to the conclusion that much of the analysis relied on genuine data from CCAP (and was not collected via primary surveys), but was modified to fit a set of pre-conceived results. This meant that the data was fabricated to yield specific results, leading to Green retracting the study publicly on his website (Oransky, 2015a), followed by an official retraction by *Science* (McNutt, 2015). In the course of events leading up to the retraction, the study's lead author, Michael LaCour, did not admit to scientific fraud or academic dishonesty publicly, or in private to his graduate advisors at the University of California at Los Angeles (UCLA), his co-author, or editors at *Science*.

This episode brings to the fore a persistent problem that has plagued science and scientific writing: academic dishonesty. Such dishonesty is most commonly manifested in data fabrication/falsification, plagiarism/duplication,

or undisclosed conflicts of interest. Although plagiarism is considered qualitatively different from the other two, its consequences for scientific progress are similarly dire (Steneck, 2006). Academic dishonesty is malevolent, in that in detracts from the progress of science, for the selfish benefit of a few and overall harm for others in academia. Yet, to carry out an elaborate fraud in data collection and analysis requires genius and creativity, especially when published in a high-impact journal such as *Science*, which has rigorous peer-review standards.

The scientific community has often been accused of reacting ambiguously to dishonest science or instances of data fabrication (Van Noorden, 2011). In most cases, the publication publicly announces a retraction of the manipulated paper(s), but there is little evidence that academic fraud has adverse impacts on the future career path of researchers (Karabag & Berggren, 2012). For Michael LaCour, revelations of data fabrication led Princeton University to rescind their offer of employment to him (Singal, 2015b). Since the retraction, not only has LaCour failed to publish, but also his co-author's credibility has faced doubt. In his defense, LaCour published a 27-page response to the allegations in Broockman et al. (2015; LaCour, 2015) defending the destruction of data citing institutional requirements and UCLA Institutional Review Board (IRB) protocol. In attributing funding support to other credible organizations, LaCour felt that it would bolster the outreach of his research. LaCour's argument that IRB regulations required destruction of data could not be held up to scrutiny since UCLA IRB regulations only require that personal identifiers be deleted, and not the entire dataset. His response also contained detailed statistical code that purported to show Broockman et al. (2015) had manipulated CCAP data to match that of LaCour, in order to make their case. Notably, LaCour did admit that he was dishonest about the role of the funding source, stating that he claimed funding from such sources to gain plausibility to his results (Carey, 2015).

In the case of LaCour, the author's attempts to fabricate data were creative in that he did not generate completely new data, but rather relied on a simple data-generating process adapted to an existing well-known (albeit somewhat exclusive) dataset such as the CCAP (Broockman et al., 2015). LaCour's intent was malevolent since he wanted to establish a fictitious finding without the backing of any genuine data, leading other academics (and the general public) to believe a false result. Since the retraction, co-authors have suggested that LaCour was not averse to data manipulation in order to advance his academic career (Oransky, 2015b). LaCour was also especially persuasive in communicating his research findings to colleagues (Singal, 2015a). He also exhibited narcissistic tendencies, and was not averse to associating with well-established researchers (such as co-author Donald Green) to maintain his own credibility. In remaining vague and unhelpful when dealing with Broockman's efforts to extend the study, LaCour further showed malevolent intent.

While fabricating data itself may require creative analyzing, the process that LaCour followed to ensure that fabricated data would appear genuine was one that required special skill. In using an existing and credible dataset, LaCour ensured that the data for his study would remain unquestioned since it closely resembled survey data. LaCour's creativity generated a unique dataset that he used to reinforce a false result (product): that gay individuals were able to change attitudes of voters toward same-sex marriages. This finding, had it been proven with verifiable data, might have resulted in a significant scientific finding related to attitude change in political science. However, since the data was fabricated, the eventual product was 'bad'.

Fanelli, Costas, and Larivière (2015) showed that there were specific factors within a country or a culture's academic environment that might enable scientific fraud, regardless of the pressure to publish that has become commonplace in modern academia. One of the key contributors complicit in enabling publication of this study was LaCour's co-author, Donald Green. As a tenured professor and established researcher, Green's involvement in the project lent it considerable credibility—so much so that other academics were not compelled to question its findings (Singal, 2015a). Furthermore, Green did not check the primary data as collected by LaCour, neglecting his responsibility as co-author. By accepting the paper for publication, *Science* also enabled LaCour's malevolent creativity. In not holding the data supplied by LaCour to greater scrutiny, *Science* implicitly granted credibility to the study. Not raising any questions about the data also meant that LaCour was less likely to admit in the future that his data was fabricated.

Like Beltracchi, LaCour's case was one of conscious malevolence, where a bad creative product emerged in an enabling environment, driven by malevolent intent. Unlike Beltracchi, LaCour's fraud had fewer, yet concentrated, economic consequences. Most prominently, LaCour's actions affected his scope for future employment and ability to raise grants. In the anecdotes on art and science, when the malevolently creative actions were uncovered, the actor faced dire repercussions. However, this may not be a feature of all forms of malevolent creativity, as seen in the anecdote on cybercrime.

Technology: The Impact Team

Ashley Madison is a service offered by Avid Life Media (ALM) that facilitates extramarital relationships between various individuals in more than 50 countries. Given that user privacy was a key concern for potential clients, ALM put in place a secure mechanism by which all user data could be "permanently" deleted for a nominal fee (Newcomb, 2015a). As of 2015, Ashley Madison had nearly 40 million registered users, although the precise number of active users is not publicly known.

On July 12, 2015, ALM employees received messages from anonymous hackers threatening to release confidential company and client data unless Ashley Madison and an affiliated service were shut down (Lord, 2015). In the

following week, cyber security experts reported that sensitive user information from Ashley Madison had indeed been compromised, with a potential risk to all registered users and employees (Krebs, 2015). An anonymous hacking group, The Impact Team, claimed responsibility for the hack and were largely motivated by two reasons. First, the Impact Team cited Ashley Madison's "full delete" feature to be a fraudulent business practice—that ALM had no mechanism by which they could guarantee that such users' data would be wiped off their online records. Second, the Impact Team also took issue with the premise of services offered by Ashley Madison, reasoning "Too bad for those men, they're cheating dirtbags and deserve no such discretion...Too bad for ALM, you promised secrecy but didn't deliver," (Newcomb, 2015b). This message was accompanied by a 30-day deadline to ALM to shut down Ashley Madison and an affiliated website, failing which confidential user records (including credit card information, names, and addresses) would be released to the public. Treating the hack as a crime, local cyber law enforcement agencies were involved but could not trace the group or individual under the name of the Impact Team. On August 18, 2015, The Impact Team released the first tranche of user data, detailing login credentials and seven years' credit card information of registered users, along with a note that urged the public to claim legal compensation from ALM for false promises (Zetter, 2015). Later in the week, a second data leak contained emails of ALM's Chief Executive Officer (CEO), followed by staggered releases of user data categorized by state of origin from the United States. Even as law enforcement officials attempted to trace the hacking back to individuals, ALM faced legal action in Canada.

Unlike the earlier anecdotes, the Impact Team appears to be a collective of persons, although this information is not known. While analyzing the event, it was difficult to identify whether Ashley Madison or the Impact Team was classifiable as the "Person." This is because Ashley Madison too engaged in dark creativity by falsely promising clients that they would delete identifiable data for a fee. However, in the absence of a deliberate intent to harm others, their actions may at best be categorized as negative creativity, since they found an original way to generate revenue, without being held accountable for their assurance. On the other hand, the Impact Team's intent was clearly malevolent, not only toward Ashley Madison and its parent company, but also toward the millions of individuals who chose to have extramarital affairs via their participation in the site, prompting the release of confidential data (Krebs, 2015). Although personal attributes are difficult to delineate in such an anecdote given the anonymity of the Impact Team, it can be inferred through interviews that they engaged in hacktivism with the intention of exposing a corrupt organization and its adulterous customers (Cox, 2015). The Impact Team was motivated by righteous ideals and moral absolutism, and condemned the basic operations of Ashley Madison in facilitating clandestine encounters.

Hacking requires considerable skill and although the process of hacking may not seem novel anymore, the methods and motivations surrounding cybercrime are often original. The Impact Team's actions led to a massive data breach, in the form of a 'bad' creative product. Unlike the former two examples, the creative product was not generated by the persons involved, but was accessed by the Impact Team in a novel manner, and for a novel purpose; they threatened to release customer information if ALM failed to cease its operations. Thus, the methods and reasoning adopted by the Impact Team to carry out the hack were considered to be a manifestation of the creative process and product. Further, unlike Beltracchi and LaCour, the Impact Team did not resort to deception in the process of creativity, suggesting that deception may be a useful, yet insufficient, characteristic of malevolent creativity. In this case, person variables had a greater contribution to the malevolent act.

Last, press variables in this anecdote were very supportive of the Impact Team's actions. Ashley Madison's data security was incredibly weak, and the Impact Team clearly took advantage of this (Krebs, 2015). Second, the passwords used by customers were even weaker and vulnerable to access by third parties (Goodin, 2015). Third, the Impact Team released the data on the "dark web," a portion of the Internet that requires specialized means to access its contents (Newcomb, 2015b). Thus, their identities were secure, anonymous, and less likely to be revealed. Last, although there are means to legally prosecute cybercriminals, the means to trace them remain unsophisticated. Thus, the Impact Team functioned within an environment that was well-suited for their malevolent intentions. From an economic point of view, the Impact Team had little at stake, unlike Beltracchi and LaCour. However, Ashley Madison and ALM faced severe financial liabilities for failing to safeguard confidential information as per user agreements. Further, users registered on Ashley Madison who were affected by the leak became subject to blackmail and extortion from anonymous individuals who threatened to expose their indiscretions. Detrimental social impacts included individuals who committed suicide as a result of their details being made public (Brown, 2015). Thus, the Impact Team enabled malevolently creative means to harm multiple stakeholders associated with Ashley Madison.

Future Directions and Conclusion

The three instances of malevolent creativity discussed are argued to be examples of conscious malevolence, although over time they may adopt another classification in D. H. Cropley's (2010) model. For instance, if Ashley Madison's cyber security improves tremendously, and the Impact Team hacks it in the future, this would be an example of *resilient malevolence* in the face of obstructive presses. In the art and science examples, deceptive processes were combined with creative processes to yield malevolently creative output; the persons' creative work would guarantee a future source of income; and therefore, economic consequences would accrue only to the individuals them-

selves. The three examples were evidently malevolent, with high stakes, in the specific domains of art, science, and technology; the creative acts were clearly useful to the actors; and the persons harmed others in society, including themselves at times, in monetary, professional, and social ways. All anecdotes were driven by strong person and press variables, in the absence of which the creative process itself could have generated benevolent works instead.

This qualitative analysis yielded information regarding factors that may motivate individuals in such domains to pursue goals through malevolently creative means. Economic (Beltracchi), status and esteem-related factors (LaCour), and moral motives (the Impact Team) played a role in shaping the actors' malevolent intents. However, such motivations are more likely to be shared by benevolent and malevolent forms of creativity, than to be unique to the latter. Yet, exploring the antecedents of malevolent intent can be a line of enquiry worth pursuing. Such analyses may guide the selection of potential variables of interest in subsequent empirical investigations.

Malevolent creativity in the product also emerged in a unique manner across the examples. For instance, conventionally, the consensus of what characterizes 'good art' is subjective. In contrast, 'good science' is backed by objective data or by strict adherence to the scientific method. Similarly, in the case of technology, any advancement that may improve (either via simplification or otherwise) current understanding of technological devices is deemed creative in nature. The examples showed that the manifestations and repercussions of malevolent creativity in different areas differed, possibly because the appreciation and recognition of what is creative differed in each domain. Moreover, the response (or judgment) of the creative product relies largely on the nature of the immediate environment (press). There were clear differences in the latitude of responses each domain offered to a malevolently creative person. For instance, given the rapid advancement in science and technology at a growing rate, opportunities to be malevolently creative are likely to similarly grow. However, in domains like art, which remains relatively static compared to the former domains, the ways in which one can produce a malevolently creative product may be restricted. Thus, it may be beneficial to examine malevolent creativity in specific domains initially, before generalizing its elements across various domains.

Further, the importance of technical skills and sophisticated know-how across the examples cannot be overstated. Persons in each domain were skilled and perhaps trained in their respective disciplines; they were well-versed with the rules and norms of their domains, making it easier for them to flout the same rules. Moreover, in the contemporary examples presented, technology played a significant role in permitting the expression of malevolent creativity. For instance, with access to a specialized database and data manipulation skills, LaCour was able to misrepresent results in a novel manner. Thus, expertise is another variable to be considered while examining malevolent creativity, which can be operationalized as a form of problem-

solving. Last, the systems perspective applied to the three anecdotes in this chapter suggested that making sense of the creative Ps in isolation provides an incomplete image of malevolent creativity. Taking the example of Beltracchi, if the art he produced (product) was analyzed independently, it would have represented a positive creative outcome. However, when Beltracchi's art was contextualized in light of his deception and prior forgeries, it came to represent a malevolent creative outcome. Further, the Ps are likely to be facilitative of each other, in a synchronous rather than sequential manner. This yields impetus to exploring the nature in which Ps interact with each other, as well as to alter the valences of Ps along a continuum to identify when malevolent creativity is most likely to emerge.

In conclusion, while theoretical and empirical work in the dark side of creativity progresses at an increasing pace, it may be beneficial to concurrently examine specific cases of malevolent creativity through a valence-based model. Such investigations can lead to identifying (a) how current models and definitions of creative behavior can be adapted to accommodate the dark side; (b) how tools can be developed to measure the dark side; and (c) which variables within the four Ps can be examined in a methodical manner. Case studies such as Beltracchi, LaCour, and the Impact Team reiterate the tremendous societal harm caused by such individuals, as a combination of their products, presses, and processes; such anecdotes thereby highlight the necessity of comprehending all aspects of the construct of malevolent creativity.

References

Barron, F. (1955). The disposition toward originality. *Journal of Abnormal and Social Psychology*, *51*, 478–485. doi:10.1037/h0048073

Beaussart, M. L., Andrews, C. J., & Kaufman, J. C. (2013). Creative liars: The relationship between creativity and integrity. *Thinking Skills and Creativity*, *9*, 129–134. doi:10.1016/j.tsc.2012.10.003

Birkenstock, A., Springer, T., & Weber, H. G.(Producers) & Birkenstock, A. (Director). (2014). *Beltracchi: The art of forgery* [Motion picture]. Germany: Fruitmarket Kultur und Medien.

Broockman, D., Aronow, P., & Kalla, J. (2015). *Irregularities in LaCour (2014)*. Retrieved from http://www.drscompany.com/

Brown, K. (2015). Scared, dead, relieved: How the Ashley Madison hack changed its victims' lives. *Fusion*. Retrieved February 5, 2016, from http://www.fusion.net/

Campbell, D. T. (1960). Blind variation and selective retentions in creative thought as in other knowledge processes. *Psychological Review*, *67*(6), 380–400. doi:10.1037/h0040373

Carey, B. (2015, May 29). Study using gay canvassers erred in methods, not results, author says. *The New York Times*. New York, NY. Retrieved from http://www.nytimes.com/

Clark, K., & James, K. (1999). Justice and positive and negative creativity. *Creativity Research Journal*, *12*(4), 311–320. doi:10.1207/s15326934crj1204_9

Cox, J. (2015). Ashley Madison hackers speak out: "Nobody was watching." *Motherboard*. Retrieved February 5, 2016, from http://www.motherboard.vice.com/

Cropley, A. J., & Cropley, D. H. (2011). Creativity and lawbreaking. *Creativity Research Journal*, *23*(4), 313–320. doi:10.1080/10400419.2011.621817

Cropley, D. H. (2010). Summary - The dark side of creativity: A differentiated model. In D. H. Cropley, A. J. Cropley, J. C. Kaufman, & M. A. Runco (Eds.), *The dark side of creativity* (pp. 360–373). New York: Cambridge University Press.

Cropley, D. H., & Cropley, A. J. (2013). *Creativity and crime: A psychological analysis*. New York, NY: Cambridge University Press.

Cropley, D. H., Kaufman, J. C., & Cropley, A. J. (2008). Malevolent creativity: A functional model of creativity in terrorism and crime. *Creativity Research Journal*, *20*(2), 105–115. doi:10.1080/10400410802059424

Cropley, D. H., Kaufman, J. C., White, A. E., & Chiera, B. A. (2014). Layperson perceptions of malevolnt creativity: The good, the bad, and the ambiguous. *Psychology of Aesthetics, Creativity, and the Arts*, *8*(4), 400–412. doi:10.1037/a0037792

Eisenman, R. (1999). Creative prisoners: Do they exist? *Creativity Research Journal*, *12*(3), 205–210. doi:10.1207/s15326934crj1203

Eisenman, R. (2008). Malevolent creativity in criminals. *Creativity Research Journal*, *20*(2), 116–119. doi:10.1080/10400410802059465

Fanelli, D., Costas, R., & Larivière, V. (2015). Misconduct policies, academic culture and career stage, not gender or pressures to publish, affect scientific integrity. *PLoS ONE*, *10*(6), e0127556. doi:10.1371/journal.pone.0127556

Gaut, B. (2010). The philosophy of creativity. *Philosophy Compass*, *12*(5), 1034–1046. doi:10.1111/j.1747-9991.2010.00351.x The

Gill, P., Horgan, J., Hunter, S. T., & Cushenbery, L. D. (2013). Malevolent creativity in terrorist organizations. *The Journal of Creative Behavior*, *47* (2), 125–151. doi:10.1002/jocb.28

Gill, P., Horgan, J., & Lovelace, J. (2011). Improvised Explosive Device: The problem of definition. *Studies in Conflict & Terrorism*, *34*(9), 732–748. doi:10.1080/1057610X.2011.594946

Gino, F., & Ariely, D. (2012). The dark side of creativity: Original thinkers can be more dishonest. *Journal of Personality and Social Psychology*, *102*(3), 445–59. doi:10.1037/a0026406

Gino, F., & Wiltermuth, S. S. (2014). Evil genius? How dishonesty can lead to greater creativity. *Psychological Science*, *25*(4), 973–81. doi:10.1177/0956797614520714

Glăveanu, V. P. (2013). Rewriting the language of creativity: The Five A's framework. *Review of General Psychology*, *17*(1), 69–81. doi:10.1037/a0029528

Goodin, D. (2015). Top 100 list shows Ashley Madison passwords are just as weak as all the rest. *Ars Technica*. Retrieved February 5, 2016, from http://www.arstechnica.com/

Gruber, H. E. (1993). Creativity in the moral domain: Ought implies can implies create. *Creativity Research Journal*, *6*(1-2), 3–15. doi:10.1080/10400419309534462

Harris, D. J., & Reiter-Palmon, R. (2015). Fast and furious: The influence of implicit aggression, premeditation, and provoking situations on malevolent creativity. *Psychology of Aesthetics, Creativity, and the Arts*, *9*(1), 54–64. doi:10.1037/a0038499

Harris, D. J., Reiter-Palmon, R., & Kaufman, J. C. (2013). The effect of emotional intelligence and task type on malevolent creativity. *Psychology of Aesthetics, Creativity, and the Arts*, *7*(3), 237–244. doi:10.1037/a0032139

James, K., Clark, K., & Cropanzano, R. (1999). Positive and negative creativity in groups, institutions, and organizations: A model and theoretical extension. *Creativity Research Journal*, *12*(3), 211–226. doi:10.1207/s15326934crj1203

James, K., & Taylor, A. (2010). Positive creativity and negative creativity (and unintended consequences). In D. H. Cropley, A. J. Cropley, J. C. Kaufman, & M. A. Runco (Eds.), *The dark side of creativity* (pp. 33–56). New York: Cambridge University Press.

Jonason, P. K., Richardson, E. N., & Potter, L. (2015). Self-reported creative ability and the Dark Triad traits: An exploratory study. *Psychology of Aesthetics, Creativity, and the Arts*, *9*(4), 488–494. doi:10.1037/aca0000037

Kapoor, H. (2015). The creative side of the Dark Triad. *Creativity Research Journal*, *27*(1), 58–67. doi:10.1080/10400419.2014.961775

Karabag, S. F., & Berggren, C. (2012). Retraction, dishonesty and plagiarism: Analysis of a crucial issue for academic publishing, and the inadequate responses from leading journals in economics and management disciplines. *Journal of Applied Economics and Business Research*, *2*(3), 172–183. Retrieved from http://papers.ssrn.com/abstract=2190694

Kolb, B. (2015, August 19). How Beltracchi, the world's most famous art forger, plays with the market. *DW Arts*. Retrieved from http://www.dw.com/en/

Krebs, B. (2015). Online cheating site Ashley Madison hacked. *KrebsOnSecurity*. Retrieved February 5, 2016, from http://www.krebsonsecurity.com/

LaCour, M. J. (2015). *Response to irregularities in Lacour and Green (2014)*. Los Angeles. Retrieved from http://www.retractionwatch.com/

LaCour, M. J., & Green, D. P. (2014). Political science. When contact changes minds: an experiment on transmission of support for gay equality. *Science*, *346*(6215), 1366–9. doi:10.1126/science.1256151

Lee, S. A., & Dow, G. T. (2011). Malevolent creativity: Does personality influence malicious divergent thinking? *Creativity Research Journal*, *23* (2), 73–82. doi:10.1080/10400419.2011.571179

Lord, N. (2015). A timeline of the Ashley Madison hack. *Digital Guardian*. Retrieved February 5, 2016, from https://www.digitalguardian.com/

McCamley, F. (2015, May 10). Art forger freed and making millions. *BBC Arts*. Retrieved from http://www.bbc.co.uk/arts/0/32608939

McLaren, R. B. (1993). The dark side of creativity. *Creativity Research Journal*, *6*(1-2), 137–144. doi:10.1080/10400419309534472

McNutt, M. (2015). Retraction. When contact changes minds: an experiment on transmission of support for gay equality. *Science*, *348*(6239), 1100. doi:10.1126/science.aac6638

Newcomb, A. (2015a, July 21). Ashley Madison: What the site says hackers got wrong. *ABC News*. Retrieved from http://www.abcnews.go.com/

Newcomb, A. (2015b, August 19). Ashley Madison hack: What's included in the data dump. *ABC News*. Retrieved from http://abcnews.go.com/Technology/ashley-madison-hack-included-data-dump/story?id=33176238

Oransky, I. (2015a). Author retracts study of changing minds on same-sex marriage after colleague admits data were faked. *Retraction Watch*. Retrieved February 4, 2016, from http://www.retractionwatch.com/

Oransky, I. (2015b). Data "were destroyed due to privacy/confidentiality requirements," says co-author of retracted gay canvassing study. *Retraction Watch*. Retrieved February 4, 2016, from http://www.retractionwatch.com/

Paulhus, D. L., & Williams, K. M. (2002). The Dark Triad of personality: Narcissism, Machiavellianism, and psychopathy. *Journal of Research in Personality*, *36*(6), 556–563. doi:10.1016/S0092-6566(02)00505-6

Plucker, J. A., Beghetto, R. A., & Dow, G. T. (2004). Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research. *Educational Psychologist*, *39*(2), 83–96. doi:10.1207/s15326985ep3902_1

Rhodes, M. (1961). An analysis of creativity. *The Phi Delta Kappan*, *42*(7), 305–310. Retrieved from http://www.jstor.org/stable/20342603

Rogers, C. R. (1976). Toward a theory of creativity. In A. Rothenberg & C. R. Hausman (Eds.), *The Creativity Question* (pp. 296–305). Duke University Press.

Runco, M. A. (1993). Creative morality: Intentional and unconventional. *Creativity Research Journal*, *6*(1-2), 17–28. doi:10.1080/10400419309534463

Runco, M. A. (2009). The continuous nature of moral creativity. In T. Cross & D. Ambrose (Eds.), *Morality, ethics, and gifted minds* (pp. 105–115). Springer US. doi:10.1007/978-0-387-89368-6_7

Runco, M. A. (2010). Creativity has no dark side. In D. H. Cropley, A. J. Cropley, J. C. Kaufman, & M. A. Runco (Eds.), *The dark side of creativity* (pp. 15–32). New York: Cambridge University Press.

Runco, M. A., & Nemiro, J. (2003). Creativity in the moral domain: Integration and implications. *Creativity Research Journal*, *15*(1), 91–105. doi:10.1207/S15326934CRJ1501

Simonton, D. K. (1999). Creativity as Blind Variation and Selective Retention: Is the creative process Darwinian? *Psychological Inquiry*, *10*(4), 309–328. doi:10.1207/S15327965PLI1004_4

Simonton, D. K. (2011). Creativity and discovery as blind variation: Campbell's (1960) BVSR model after the half-century mark. *Review of General Psychology*, *15*(2), 158–174. doi:10.1037/a0022912

Simonton, D. K. (2016). Defining creativity: Don't we also need to define what is not creative? *Journal of Creative Behavior*, 1–15. doi:10.1002/jocb.137

Singal, J. (2015a, May 29). How a grad student uncovered a huge fraud -- Science of us. *New York Magazine*. Retrieved from http://www.nymag.com/

Singal, J. (2015b, June 22). Princeton rescinded its offer to Michael LaCour -- Science of us. *New York Magazine*. Retrieved from http://www.nymag.com/

Spiegel interview with Wolfgang Beltracchi: Confessions of a genius art forger. (2012, March 9). *Der Spiegel*. Retrieved from http://www.spiegel.de/

Stein, M. I. (1953). Creativity and Culture. *The Journal of Psychology: Interdisciplinary and Applied*, *36*(2), 311–322. doi:10.1080/00223980.1953.9712897

Steneck, N. H. (2006). Fostering integrity in research: Definitions, current knowledge, and future directions. *Science and Engineering Ethics*, *12*(1), 53–74. doi:10.1007/PL00022268

Van Noorden, R. (2011). Science publishing: The trouble with retractions. *Nature*, *478*(7367), 26–28. doi:10.1038/478026a

Walczyk, J. J., Runco, M. A., Tripp, S. M., & Smith, C. E. (2008). The creativity of lying: Divergent thinking and ideational correlates of the resolution of social dilemmas. *Creativity Research Journal*, *20*(3), 328–342. doi:10.1080/10400410802355152

Wallach, M., & Kogan, N. (1965). *Modes of thinking in young children: A study of the creativity-intelligence distinction.* New York, NY: Holt, Rinehart, and Winston, Inc. doi:10.1002/1520-6807(196604)3:2<190::AID-PITS2310030226>3.0.CO;2-C

Zetter, K. (2015). Hackers finally post stolen Ashley Madison data. *Wired Magazine*. Retrieved February 5, 2016, from http://www.wired.com/

Correspondence
Ms Hansika Kapoor, Department of Psychology, Monk Prayogshala, Mumbai, India. hk@monkprayogshala.in

Mr Anirudh Tagat, Department of Economics, Monk Prayogshala, Mumbai, India. at@monkprayogshala.in

Dr David H. Cropley, School of Engineering, University of South Australia, Australia. David.Cropley@unisa.edu.au

Authors' Brief Bios

Hansika Kapoor is currently pursuing her PhD at IIT, Bombay in the area of creativity. She is a published author, practising psychologist, and a passionate researcher, striving to improve the academic environment in India. Her research interests lie in psychology, linguistics, and economics.

Anirudh Tagat holds an MSc in Economics from the University of Warwick and consults with the World Resources Institute (WRI) India and Institute of Rural Management, Anand (IRMA). His research interests include cross-cultural differences in decision-making, intra-household bargaining, and experimental economics.

David Cropley is an internationally recognised expert on creativity and innovation. His teaching interests focus on systems engineering and related concepts, and his research examines a range of aspects of creativity and innovation, both in the field of engineering, and more broadly.

CHAPTER THREE

THE 4E'S SOCRATIC MODEL—A FRAMEWORK TO FOSTER CREATIVITY IN TEAMS

PHILIP DENNETT

Abstract

It has been suggested that using the Socratic Method (a directed questioning technique to encourage critical thinking) to create a learning environment within an organization is a way to foster creativity in an uncertain environment. This article describes the development of a grounded theory to empirically test and refine a model to manage a Socratic dialogue within organizational teams. The resulting *4E's Socratic Model* produced concrete creative outcomes in real-world application in a range of organisations.

Keywords: Socratic method, creativity in business, critical thinking, managing teams

Introduction

This article presents the 4E's Socratic Model which was developed using a grounded theory methodology to investigate the use of the Socratic method as a means of encouraging creativity in an organisational context.

While there has been considerable research into both individual and organizational creativity, the use of a Socratic approach to managing creativity in organizations has not been comprehensively explored. The objective of the investigation was to develop a new theory grounded in data to provide a base for further examination.

Seven participating organisations were self-selected based on their response to a message sent to 311 business contacts on Linkedin. This method of selecting was chosen because of the level of trust required of organisations in sharing confidential data. Multiple organisations were selected to ensure that results were transferable which is preferable when dealing with a broad-based phenomenon (Yin, 1981). It is also appropriate in building a grounded theory that will be extended as the study proceeds (Benbasat, Goldstein & Mead, 1987).

Data was gathered through a series of workshops conducted in a real-world setting that examined a question of interest to the subject organisation using the proposed Socratic model (Figure 1). During the workshops, questionnaires were given to each participant to explore their perceptions of creativity as it relates to themselves and their organisation, answers to these questions were used to create a benchmark creativity index for the organisation. At each stage of the data gathering process a series of memos were written to record insights gained and to interpret phenomena that arose.

Through this process 11 themes were identified and then further examined using axial coding resulting in 5 major categories. These categories were: Open dialogue; Internal championing; Organisational environment; Questioning techniques; and Outcomes.

Figure 1: Socratic Model as tested

Open dialogue

"Yes, we were able to have a more open and constructive conversation which helped us to nail down what we wanted to do and what was realistic/ feasible. This approach increased the level of input non-Board staff had, which in turn would increase their buy-in and feelings of being valued. Specifically, the process allowed us to plan and reach a realistic goal without being directed to achieve an outcome which wasn't realistic." (Field note excerpt)

This excerpt is an illustration of the importance of encouraging all members of the group to participate. By creating a non-threatening environment, as facilitator I was able to engage with each member of the various groups encouraging them to share concrete examples of what they knew, rather than merely canvassing opinions. It became obvious early in the process that without this more in-depth approach certain team members discouraged others from contributing because of the forcefulness of their opinions.

Internal championing

While all workshop sessions concluded with agreement on future direction, in the first session agreement wasn't reached on specific timeframes or responsibilities. Later feedback suggested that it is easy for deadlines to be missed if there is no champion of the process. In working with the process in

a company making sure that there is an internal champion that continues the process in place of the facilitator means it is less likely that progress will stall.

In one of the groups 5 of the 8 participants reported that they would not change their responses to the creativity index questions as a result of the session. One participant identified organizational rigidity as a barrier to change, and two participants felt that the process would be effective as a change agent if senior management were facilitating change via this process.

To be effective in an organization the process should not only gain acceptance within the team but also must be sold to senior management so that it may be viewed as an effective management tool.

"…depends on clearly signalling change. We tend to self-serve in first 2 stages resulting in frustration and disinterest. Need to focus change on what we can achieve." (Field note excerpt).

During the session this team made it clear that while they had confidence in both their creativity and the support of their team manager there was a sense that they were wasting their time due to the bureaucratic nature of the organization and the conservative nature of senior management. It seems that it is not enough to have the support of a team manager – it is also important to have this process recognized as a legitimate part of the overall management philosophy.

The Socratic Model as a management tool therefore needs to be championed by leaders within the organization in order for it to be successful, as conflicting contextual influences could negate any value gained. The role of a leader (of an organization or a group within that organization) is to create an environment where uncertainty and risk are tolerated and personal consequences in a creative environment are positive (Andriopoulus (2001).

Organisational environment

"It is difficult to change because it needs to be approved by too many people up the line. The organisation is rigid but our manager encourages creativity which makes it less frustrating." (Field note excerpt).

This comment highlights the need for ownership from within the team. The problems of a rigid hierarchical organization have been well documented as a barrier to creativity—an important outcome of the Socratic process should be to get group ownership of the process to help counteract organizational rigidity. The result of such ownership is apparent from the comment below:

"The open question forum led to exact discussion and specific goals being reached on ideas that have been circulating for quite some time. Project planning - being accountable immediately will make the process more likely to succeed than in the past." (Field note excerpt).

Sometimes group cohesiveness will assist in creating change from the bottom up as the following comment states:

"This process enabled an open dialogue in which thoughts and ideas could be tabled and challenged. The outcome was better than expected! Having buy-in from all participants was important—this guided the discussion to keep on track (historically a challenge for us). Using this process would definitely help immediate supervisors/Board to understand internal resource challenges." (Field note excerpt).

In a briefing prior to the session, this team identified a conflict between the management team and the Board (not for profit organization) in terms of expectations being unrealistic. The session, which included the Board Chairman, provided a structure whereby everyone felt comfortable that they would be accountable for the outcomes agreed. This came from having in the same session, all the people that had opinions about and were affected by the topic under discussion. The neutrality provided by the Socratic process helped to remove personalities from the debate.

Questioning techniques

While the first workshop concluded successfully it became apparent early that the facilitator should be prepared to actively seek clarification of concepts that were raised. During the Evidence stage, a concept was agreed on by participants, but it appeared to have different meanings or implications to each of them. By asking a series of qualifying questions, before moving onto the next stage, I was able to draw these views out and thus provide a platform for further development.

While I am experienced in facilitating this type of discussion, in a real-world situation specific questioning strategies should be explored prior to a session to avoid stalling the process or ending with a fuzzy outcome that is hard to action. In reviewing data on the application of the Socratic method it became apparent that the Model needed to be more than a single dimension and should be overlaid with a questioning process that identifies the most appropriate approach to questioning at each stage of the Model. The questioning approach should align with the stages of the model as it moves from the known to the unknown.

Outcomes

The initial workshop was the first time the process was tested in a real world setting. The setting was a planning meeting to discuss the firm's capabilities and to provide direction for future expression of those capabilities in business pitches.

The first step in the process is to put the question under consideration to the group. In this case the question was: "What are the distinct competencies we have over our competitors?" This question was determined in advance in a separate discussion I had with the Chief Executive. It quickly became apparent that before discussing the question, participants wanted to debate the rea-

sons behind the question and the relevance of it in terms of their business. Their main interest related to outcomes, in other words "how will the answer to this question help us to achieve our goals?"

In subsequent workshops, in discussing the question I made sure that each group also agreed on outcomes they wanted to achieve. In one group this made it easier for them to focus on specific actions to take:

"We have spent this week following up on actions from our meeting and have introduced this concept across other areas of our business and are very happy and impressed by the results we were able to achieve." (Field note excerpt).

Theory development

This project started as an exploration of the use of the Socratic Method as a means of enhancing team-based creativity in an organisational context. The desired outcome was a grounded theory that would provide a documented and tested model that could be used by managers in a real world context. The four steps in the Model (Figure 1) provided an effective linear progression for a dialogue resulting in creative outcomes in the teams studied. However, the Model as it stands is not comprehensive enough to document a process that can be followed without the input of a trained facilitator. Therefore an additional stage of theory development was required with the objective of adding additional guiding layers suggested by feedback identified in the themes described previously.

Open dialogue

In order to facilitate open dialogue there were two ideas that emerged:

Engagement of all participants

Ownership of the question

The first can be facilitated through the use of concrete questions that explore what people know rather than opinions. The ideal place to start is a discussion on the question itself with input from all participants so that the process starts with an agreement and thus creates ownership of the question.

This approach is supported by Boswell (2006) who, in discussing the use of questions to encourage critical thinking, identifies three question types: concrete, abstract and creative that progressively move from lower level enquiry to higher level abstract and creative thinking. As an aid to implementing the Model, a baseline questioning layer can be added that maps an appropriate question type to specific stages of the process (see Figure 2).

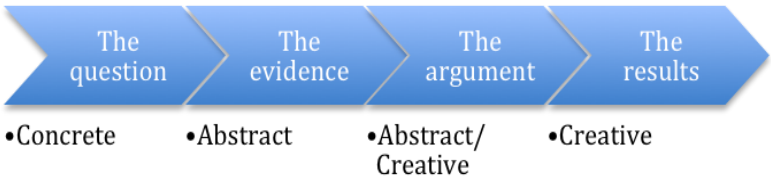


Figure 2: Model with appended question types

Internal Championing and Organisational Environment

Organisational rigidity was identified as a barrier to creativity. This is supported in the literature by Boswell (2006) and others who identify a range of 'cultural' issues that inhibit creativity and innovation. Therefore it will be important to identify a champion from within the organisation who is at a high enough level to influence culture and effect change. The role of this person is to be a creative leader, encouraging creativity in teams and removing potential barriers to provide a supportive creative environment (see Figure 3).

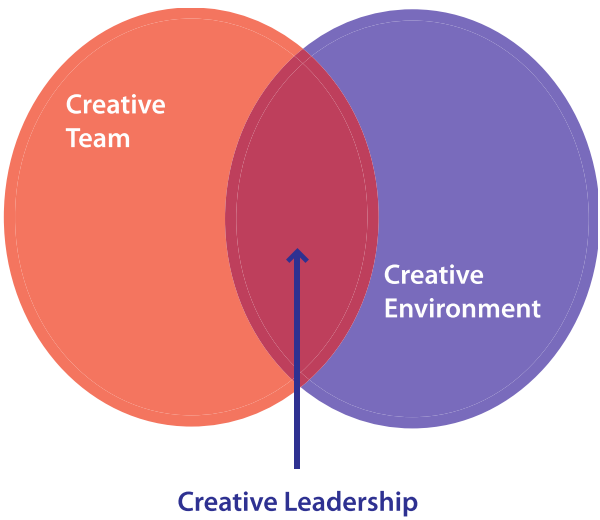


Figure 3: Role of the creative leader

Questioning techniques

In Figure 2 a second layer of questioning types was added to the model. However, this by itself does not provide enough insight for someone to work with the model without training and/or experience. Neenan (2009) highlights the danger in relying on intuition when it comes to facilitating a Socratic Dialogue. This is an issue I found in conducting this research. Even though I had prepared a range of questions in advance these only formed a relatively small

part of the questioning process. Therefore, I undertook a critical review of questioning techniques that could be synthesised to provide a third layer that provides specific guidance for each stage of the process.

The key to a successful Socratic dialogue is that it should be a co-operative investigation (van Hooft, 1999) that ends with a consensus rather than an interrogation. To achieve this the role of Socrates is not just to question he must also recognise and react to the dynamics of the group (Gose, 2009) by reining some participants in and encouraging others. So the role of questioning is two-fold—on the one hand to stimulate discussion and on the other to stimulate ownership of both problem and solution.

A number of authors (Paul & Elder, 1996; Boswell, 2006; Oyler & Romanelli, 2014) suggest categories of questions to consider. Boswell focuses on a top-level progression (concrete, abstract, creative) which has been integrated into a second layer of the Model and is supported by Oyler and Romanelli (2014) who propose procedural (concrete facts), preferential (abstract opinions), and judgemental (synthesis or creative) questions.

However, it is important to remember that questions are not asked in isolation as each person will apply their own contextual filtering process before answering. It follows then, that cognition must also be considered.

The most widely accepted theory of cognition is that of Bloom, Engelhart, Furst, Hill and Krathwol (1956). Their taxonomy identifies six levels of cognition: knowledge, comprehension, application, analysis, synthesis and evaluation which according to Krathwohl (2002) represent a cumulative hierarchy which fits neatly into the hierarchy present in the Socratic Dialogue Model. By understanding people's different levels of cognition we can avoid asking a complex question too early and therefore avoid confusing participants and ultimately frustrating the process.

This leads to a model (Figure 4) with three dimensions (to aid integration of the dimensions the 4 steps of the process have been renamed using a single descriptive word):

Stage	Question type	Cognition
Exploration stage	Concrete: what, where, when, why, who, explain, compare, give examples	Knowledge and comprehension
Examination stage	Abstract: consider, solve, apply (to a new situation) What are the pros and cons? What is missing?	Application and analysis
Evaluation stage	Abstract and Creative: What are the links between…. and …..? defend your choice, justify.	Synthesis and evaluation
Election stage	Decision and resolution	

Figure 4: Model with question types and cognition levels

Discussion

The addition of the two extra layers in the Model made it much easier to keep focused as the facilitator. Firstly, in terms of preparation, it suggested consideration of not only questions that might be asked but also staging them at the appropriate level in both type and cognition. Secondly, having a visual of the Model available during the discussion gave immediate guidance for the type of question required at different times in order to stimulate discussion or tease out linkages in the evaluation stage that resulted in more creative thought.

In a final session to test the final iteration of the Model (Figure 5), participants expressed surprise at how quickly they were able to come to a conclusion and also one they felt gave critical direction to their project. This was something as facilitator I also noticed and was surprised to note later that the total time taken in this session was just over 60 minutes compared with similar sessions during the initial data gathering stage that lasted over 90 minutes.

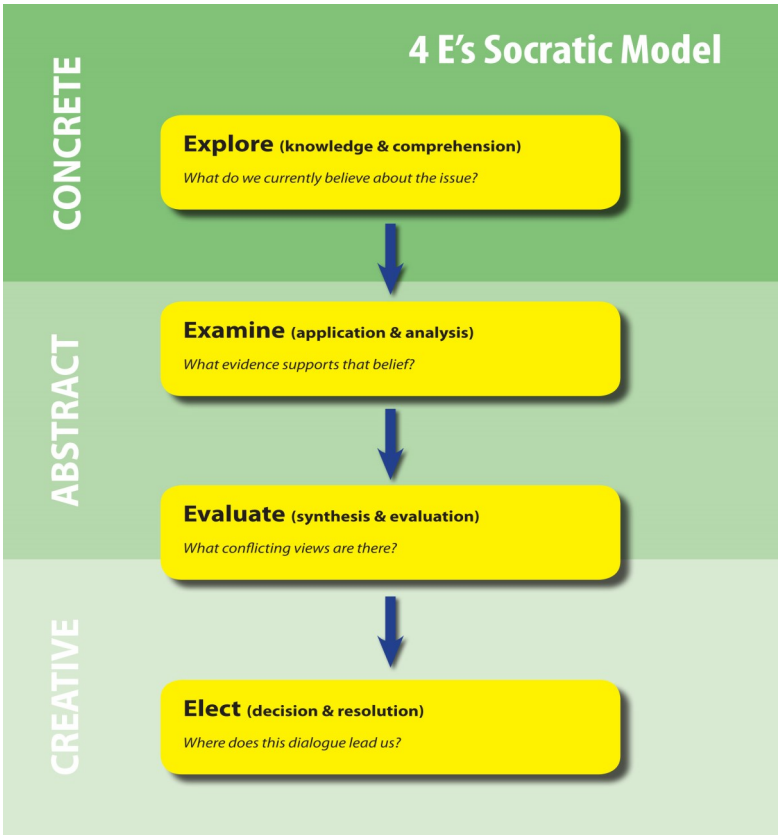


Figure 5: 4E's Socratic Model

Theory justification

The purpose of this research was to test the viability of a Socratic approach as a tool to champion creativity in an organizational context. The 4E's Socratic Model (Figure 5) was found to be an effective tool in producing creative outcomes in the context of an organizational team. It achieved this through:

- Producing a creative, actionable outcome in all seven organizations studied.
- Creating an environment where creativity is encouraged by producing conditions that are conducive to creativity; namely,
    - personal freedom—to provide an opinion in a non-threatening environment,
    - encouragement—to think creatively outside normal operating constraints,

  - recognition—that each team member's opinion is valid and valued,
  - challenge—to go beyond the common wisdom and create something new and innovative.
- Modeling a culture that encourages creativity and tolerance.

Delimitation

As this research is a phenomenological study, the results may not be applicable outside of the organizations studied (Bonoma, 1985). However, this study should be thought of as a starting point for companies wishing to promote creativity rather than a prepackaged solution.

Limitations

As participating organizations were self-selected this may indicate potential bias in that they may have a greater acceptance of the need for creativity in their organizations. However the wide range in levels of creativity measured by the creativity index of each group, means that it would be difficult to state that there were sufficient commonalities that were likely to produce a bias.

Another limitation is that the results are not quantifiable – this could be considered as an opportunity for future research to measure the results of implementing the Model over time.

This study used an external facilitator (the author). This was done to concentrate on the applicability of the model itself and remove any bias that might have come from using different facilitators.

Recommendations

In developing the 4E's Socratic Model in response to the data collected the aim has been to produce a management tool that reflects the experience of taking a Socratic approach to enhancing creativity in a team environment. However, prior to implementation it is important to consider the legitimacy of creativity in the organization and what organizational impediments might need to be removed.

Secondly, pick a project and a team to pilot the use of the model. A successful outcome will prove the value of institutionalizing the model and it will also give insights into how best to apply the process.

References

Andriopoulos, C. (2001). Determinants of organisational creativity: A literature review. *Management Decision, 39*(10), 834-840.

Benbasat, I., Goldstein, D. K., & and Mead, M. (1987). The case research strategy in studies of information systems. *MIS Quarterly, 11*(3), 369-386.

Bloom, B., Engelhart, M., Furst, E., Hill, W., & Krathwol, D. (1956). *Taxonomy of educational objectives: The classification of educational goals. handbook 1: Cognitive domain*. New York: David McKay Company.

Bonoma, T. (1985). Case research in marketing: Opportunities, problems, and a process. *Journal of Marketing Research, 22*(May), 199-208.

Boswell, C. (2006). The art of questioning: Improving critical thinking. *Annual review of nursing education* (pp. 291-304) Springer.

Gose, M. (2009). When Socratic dialogue is flagging: Questions and strategies for engaging students. *College Teaching, 57*(1), 45-50.

Krathwol, D. (2002). A revision of bloom's taxonomy: An overview. *Theory into Practice, 41*(4), 212-218.

Neenan, M. (2009). Using socratic questioning in coaching. *Journal of Rational-Emotional Cognitive Behavioural Therapies, 27*, 249-264.

Oyler, D., & Romanelli, F. (2014). The fact of ignorance revisiting the socratic method as a tool for teaching critical thinking. *American Journal of Pharmaceutical Education, 78*(7), 1-9.

Paul, R., & Elder, L. (2006). *The thinkers guide to the art of socratic questioning* The Foundation for Critical Thinking.

van Hooft, S. (1999). What can philosophy offer enterprise?: A dialogue. *Business & Professional Ethics Journal, 18*(3/4), 113-124.

Yin, R. K. (1981). The case study as a serious research strategy. *Knowledge: Creation, Diffusion, Utilization, 3*(1), 97-114.

Correspondence

Philip Dennett, MMgmt; DipBus Mktg, University of Notre Dame Sydney, Australia, philip.dennett@nd.edu.au

Author's Brief Bio

Philip Dennett is a lecturer in Advertising at The University of Notre Dame Australia (Sydney). He has a broad business experience at senior executive level in advertising, publishing and marketing. In addition to teaching, Philip runs a successful consulting business specialising in business communications. He is currently completing his PhD thesis on creativity in an organisational context.

CHAPTER FOUR

GREAT MINDS DON'T THINK ALIKE: PERSON-LEVEL PREDICTORS OF INNOVATION IN THE WORKPLACE

FIONA PATTERSON & MAIRE KERRIN

Abstract

In this chapter, we explore eight important individual variables that predict innovation in the workplace including the arts, science and technology. The propensity to innovate is fundamentally determined by the knowledge, skills, abilities and attributes of individuals. This chapter builds on an original paper by Patterson (2002) and reviews more recent research literature relating to these key variables and their relation to innovation: (1) intelligence, (2) knowledge, (3) motivation, (4) personality, (5) emotional intelligence, (6) mood states, (7) behaviours, and (8) values. In addition, theoretical models encompassing innovation resources are discussed, and significantly which stages of the innovation process individual-level factors are likely to have the most impact. Implications for increasing innovation in the workplace are presented, particularly focusing on selection assessment and employee development. We also present a measure that is used to assess for innovation potential, the Innovation Potential Indicator (IPI). As face validity of psychometric measures of innovation potential for selection can be low, assessment for development of innovation potential, as well as other approaches to promoting innovation, are also considered.

Keywords: Innovation potential, intelligence, knowledge, motivation, personality, emotional intelligence, mood states, behaviours, values

Introduction

This chapter builds on an original paper by Patterson (2002) reviewing the individual level antecedents of innovation from a psychological perspective. The tendency to innovate is one of the most important aspects of human behaviour in the workplace and a key factor for organisational success in today's economic climate (Anderson, Potočnik & Zhou, 2014); yet there remain

gaps in our understanding that need to be filled. Since innovation ultimately involves human behaviour, examining it from a psychological perspective is important for gaining a unique insight into the determinants of innovation and offering guidance on how to harness innovation in practice (Patterson & Kerrin, 2013). Whilst scholars are generally agreed that employees need a supportive organisational context to encourage, reinforce, and facilitate innovation (e.g. Patterson, Kerrin & Gatto-Roissard, 2009; Sears & Baba, 2011), the propensity to innovate is fundamentally determined by the knowledge, skills, abilities and attributes of individuals (Patterson et al., 2009). These can be regarded as the necessary foundations upon which to investigate innovation at any other level (e.g. group-, organisation-, or societal-level; Patterson, Kerrin & Zibarras, 2013), and thus will be the focus of this chapter.

Much of the early innovation literature has concurred that innovation involves multiple components at the individual level; as such, Patterson's (2002) original review classified the literature into the associations between innovation and four key components: (i) intelligence and cognition, (ii) knowledge, (iii) personality, and (iv) motivation. Later research has since indicated a role for factors such as emotional intelligence (e.g. Suliman & Al-Shaikh, 2007), mood states (e.g. Baas, Carsten, De Dreu & Nijstad, 2008), behaviours (e.g. Rank, Pace & Frese, 2004), and values (Dollinger, Burke & Gump, 2007). Despite the general acceptance that innovation is vital in today's market, many organisations are not clear on how to successfully identify and measure innovative individuals; how to translate their knowledge on innovation into processes such as selection and assessment and employee development; or how to manage individuals who are not as naturally predisposed to innovate as others. Therefore, this chapter will explore the key individual-level variables that influence innovation and outline ways of appropriately measuring innovation potential. Implications for selection and assessment and employee development will be discussed, with a case example to illustrate.

Theoretical perspectives

It is important at this point to acknowledge that although not the focus of this chapter, other resources aside from individual-level resources can also influence innovation. Broadly, these can be divided into resources from the work environment (at both the group- and organisational-level) and external societal influences; and include things like teamwork, group norms, organisational culture, strategy, market, and global climate. Researchers have recently aimed to synthesise the typically fragmented and level-specific literature and present cross-level theories that are concerned with the factors that drive the generation of innovation at the individual level, as well as those that facilitate implementation at the group-, organisational- and societal-levels (see Patterson et al., 2009; Sears & Baba, 2011). This represents a response to a call

from a number of innovation scholars (e.g. Anderson, De Dreu & Nijstad, 2004; Janssen, Van de Vliert & West, 2004; Wejnert, 2002; West, 2002; Zhou & Shalley, 2003) for more cross-level theory building. Figure 1 presents a model by Patterson et al. (2009) outlining the relevant resources for innovation at various levels of influence.

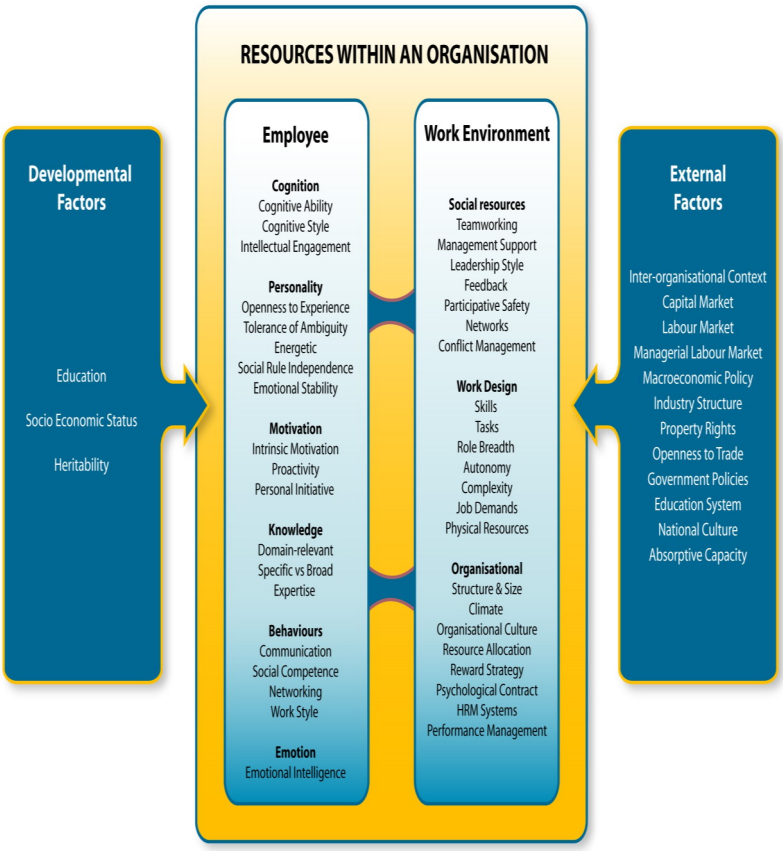


Figure 1: Resources for innovation in organisations (Patterson et al., 2009)

An examination of innovation at the group-, individual-, and societal-levels are covered elsewhere in the literature and will therefore not be the focus of this chapter. We instead look in detail at some of the individual-level determinants of innovation (referred to as *employee resources* in Figure 1). Before delving into these, however, it is useful to first outline the relevant

innovation theory to explain how and why individual differences in innovation might come about.

One such theory, proposed by Sternberg and Lubart (1991), is the *investment theory.* The premise of this theory is that innovative individuals differ from others in that they "buy low and sell high" when it comes to ideas. What this means is that they are prepared to defy the crowd and pursue "low" ideas that are unknown, out of favour, or have perhaps never been applied to a particular context before, but that they believe have growth potential. Innovative individuals will persist with these ideas, even in the face of resistance, and eventually "sell high" once they have convinced others of the value of their ideas. The ability to do this requires six key resources: 1) intellectual ability, 2) knowledge, 3) styles of thinking, 4) personality, 5) motivation, 6) environment. However, it is important to note that a simple sum of these resources is not enough to guarantee innovation: there may be thresholds on some components (e.g. knowledge) below which innovation is not possible. Further, interactions may occur between components that *together* enhance innovation. According to Sternberg and Lubart (1996), some components, e.g. knowledge, will be domain-specific, whilst others, e.g. motivation, can be relevant across all domains.

Ford (1996) proposes a *model of individual creative action,* which attributes the occurrence of innovation to a *decision* made on the part of the individual to be creative rather than undertake routine, habitual actions. The decision to choose one way over the other is determined by three factors: sense making processes, motivation, and knowledge and skills (Anderson et al., 2014; Ford, 1996). Sense making processes elicit intentions and expectations regarding the appropriateness and likely effectiveness of future actions, whilst motivation is determined by an interaction between one's goals, expectations and emotions. Knowledge and skills reflect domain-specific knowledge, behavioural abilities, and creative thinking abilities. If all three factors align – that is, if one expects their creative action to be successful, is motivated to take action, and has the necessary knowledge to inform that action – then they will make the decision to choose innovation over routine. Additionally, innovative actions must hold an advantage over habitual actions if one is to be motivated to pursue them (Ford, 1996). The motivation factor will be explored in detail later in this chapter.

Two additional models that reflect key areas of research at the individual level are the *geneplore model* (Finke, Ward & Smith, 1992), and the *componential model* (Amabile, 1996). The geneplore model characterises innovation as a result of the interplay between *generative processes*, which are responsible for the production of innovative ideas, and *exploratory processes*, which define how ideas are implemented. Innovation, then, can be thought of as a continual iteration of generative and exploratory steps (Ward, 2001). The componential model (Amabile, 1996) suggests that innovation is influenced by three factors: expertise, creative thinking skills, and intrinsic motivation, and that factors can become more or less important at varying stages of the

innovation process. Both theories point to the idea of a stage-based approach to innovation. Indeed, within the literature it is generally agreed that innovation consists of at least two stages – an idea generation phase followed by an idea implementation phase (Axtell, Holman, Unsworth, Wall, Waterson & Harrington, 2000; Puccio & Cabra, 2012; Patterson et al,. 2013). The inclusion of a middle step – idea dissemination/idea promotion – has also been suggested, which involves assessing the domain relevance of ideas, sharing them, and finding support for them from the right people (De Jong & Hartog, 2010; Howell, Shea & Higgins, 2005). It is noted that these steps do not tend to progress in a linear sequence, they are largely iterative and overlapping.

In light of Amabile's (1996) suggestion that different factors can become important at different stages of innovation, where relevant, this chapter will comment on which stage/s of the innovation process the individual-level factors presented are likely to have the most impact.

Individual-level predictors of innovation

The majority of innovation research published in psychological literature has focused on identifying the various traits and personal characteristics that facilitate innovation. In the following sections, we review the relationship between innovation potential and eight key personal resources: (1) intelligence, (2) knowledge, (3) motivation, (4) personality, (5) emotional intelligence, (6) mood states, (7) behaviours, and (8) values.

1. Intelligence

The relationship between innovation and intelligence has been explored by numerous researchers; however, results are generally inconclusive in this area, with the exact nature of the association remaining unclear. Various researchers (e.g. Patterson, 2002; Patterson et al., 2009) have suggested that the research literature can be subdivided into four areas that conceive human innovation to be: i) a subset of general intelligence; ii) an aspect of genius; iii) a set of cognitive abilities and mental processes; iv) related to observer judgements of intelligence (or perceived intelligence). A brief overview of each is provided below.

i. General intelligence

Early research suggested that creativity was equal to high intelligence; however, several authors have questioned this view since innovators may be intelligent, but high intelligence does not guarantee innovation. In his theory of the *structure of intellect*, Guilford (1950; 1988) claimed that creative thinking was a mental ability involving divergent production (that is, the ability to generate a variety of information from the same source). Stemming from

this, the notion of 'divergent thinking' emerged, and divergent thinking tests were viewed as a way to measure creative abilities. More recently, however, divergent thinking tests have been criticised on the basis that it is the quantity, not quality, of ideas that are considered. This is problematic because innovation can only be useful if it adds value to an organisation (Wycoff, 2004), and therefore it is idea *quality* that is of the highest importance. Furthermore, it has been suggested that divergent *and* convergent thinking may work together to produce innovative thought, and as such, divergent thinking tests are inevitably ill-equipped to measure creative thinking as a whole (Runco, 2007). Indeed, Jones and Estes (2015) found support for this argument (i.e. the independent effects of convergent and divergent thinking on innovative thought); since convergent and divergent thinking predicted innovative thought over and above individuals' creative behaviours and crystallised intelligence.

ii. Genius

Early researchers (e.g. Eysenck, 1979) have suggested that genius – the most obvious manifestation of high intelligence – is closely linked to the propensity to innovate. Whilst recent research has supported this suggestion with the finding that high IQ populations are more innovative (Squalli & Wilson, 2014), this is the exception rather than the rule when it comes to evidence supporting a direct relationship between innovation and high intelligence. Indeed, a recent meta-analysis (Kim, 2005) reported an almost negligible relationship between innovation and IQ, and researchers have concluded that intelligence is probably a necessary, but not a sufficient, condition for innovation. The possibility of a curvilinear relationship between intelligence and innovation has also been tested, where intelligence may become less influential as it increases beyond a certain level (Gilhooly, Wynn & Osman, 2004). For example, Feist and Barron (2003) suggest that there is generally a moderate relationship between intelligence and innovation, but when IQ scores are beyond 115 the relationship is near zero. This has been termed the '*threshold theory*'. By contrast, other authors (e.g. Preckel, Holling & Wiese, 2006) dispute the idea of a threshold theory since their school-based research showed similar associations between innovation and intelligence across different ranges of ability, including students who attended specialised schools for the gifted and would therefore have especially high IQs.

iii. Cognitive ability

Perhaps the most promising account of the role of cognitive abilities in the innovation process is that of Finke, Ward and Smith (1992), who suggest that in order to understand the role of cognitive abilities in idea generation, we must draw upon models from cognitive psychology. As touched upon earlier in this chapter, the *geneplore model* proposes a framework that out-

lines the cognitive processes involved in creative activities. This framework suggests that creative activities can be described in terms of an initial generation of ideas/solutions, followed by an extensive exploration of those ideas. Capacity for creative cognition has been found to be normally distributed, implying that a highly creative person's mind does not operate in any fundamentally different way to other people (Nicholls, 1972; Runco, 2005). Individual differences only occur due to variations in the use and application of these generative and exploratory processes (e.g. retrieval of existing structures from memory, forming associations, mental synthesis, transformation from one domain to another), together with the sophistication of an individual's memory and knowledge in the relevant domain. This suggests that assessment techniques could potentially be devised to assess an employee's capacity for generative thinking (Patterson et al., 2013). The intricacies of the interactions between generative and exploratory processes are not clear, though, and merit further research (Puccio & Cabra, 2012). Researchers have also called for studies that investigate the specific cognitive abilities involved in the implementation phase of the innovation process (Mumford, 2003).

iv. Perceived intelligence

Much of the early literature suggested that innovative individuals are perceived and rated by others as more intelligent than less innovative people. For example, in a study of architects (MacKinnon, 1960), innovative architects were rated as more 'intelligent' than less innovative architects by their supervisors. The author described these architects as having high 'effective intelligence', arguing that traditional measures of intelligence (that is, IQ) do not fully explain 'real-world' intelligence. Part of the issue here has been that intelligence (similar to innovation), is often viewed as a unitary concept. Previous theories of intelligence have tended to overemphasise cognitive abilities and underestimate the role of knowledge-based intelligence (Silvia, 2008). We discuss the role of knowledge in more detail next.

2. Knowledge

Researchers in the field, regardless of their theoretical viewpoint, have tended to suggest that knowledge is a core component of innovation. Immersion in domain-specific knowledge is a prerequisite for innovation, as one must have an accurate sense of a domain (i.e. contextual relevance) before one can hope to change it for the better. However, the literature also highlights that too much expertise in a particular area can be a *block* to innovation (Sternberg, 1982). Thus, it is suggested that an inverted U relationship exists between knowledge and innovation, where too much or too little knowledge hampers the innovative process. This is illustrated by findings from a widely cited study (Simonton, 1984), where findings suggested that both a lack of

and an excess of familiarity within a particular subject domain could be detrimental to innovation. Sternberg (1997) suggests that "expertise" may result in rigid thinking and reduced flexibility in problem solving. The research literature suggests that domain-relevant knowledge may be broad, and that highly complex or detailed knowledge is not required (Mascitelli, 2000). Personal mastery and an accurate sense of contextual relevance are also necessary antecedents of innovation. (Csikszentmihayli, 1988).

3. Motivation

In order to investigate the relationship between motivation and innovation, scholars began to research the motives of individuals willing to spend time and effort in a process of collective invention. Most studies rely on the well-established typology of human motivation, which differentiates between intrinsic and extrinsic motivation. Motivation is said to be intrinsic if an activity is valued and performed for its own sake and the individual has a genuine passion and interest in innovation itself. By contrast, a person performing a task with the aim of obtaining a reward separable from the task is said to be extrinsically motivated. High levels of motivation are required for innovation (Eysenck, 1994).

Although theories on innovation and creativity consistently refer to intrinsic motivation as one of the most important antecedents of creativity and innovation (and recent research has supported this, e.g. Xhang & Bartol, 2010), empirical studies of the association between intrinsic motivation and innovation remain limited. One exception is a study by Shin and Zhou (2003), who reported that a transformational style of leadership promoted employees' intrinsic motivation, which was conducive to creative performance. Similarly, in a laboratory based study, Sosik, Kahai and Avolio (1999) found that a transformational leadership style was conducive to '*flow*', a psychological state characterised by intrinsic motivation, concentration, and enjoyment, which encourages idea generation. Further, a recent study by Yidong and Xinxin (2013) showed that individual innovative work behaviour was positively related to the perception of ethical leadership, and intrinsic motivation mediated this relationship. These studies provide support for the notion that motivation may be an important mediator between leadership style and creative performance.

Intrinsic motivation has also been found to be a mediator in other relationships. For example, the relationships between innovation and openness to experience and self-efficacy is mediated by intrinsic motivation (Prabhu, Sutton & Sauser, 2008), and intrinsic motivation mediated the relationship between basic need satisfaction and innovative work behaviours (Deyloo et al, 2015).

Whilst intrinsic motivation is clearly a pre-requisite for innovation, the role of extrinsic motivators is less clear. Although some studies have found

significant effects of extrinsic motivation on creativity (Sung & Choi, 2009), research generally suggests that this is context-dependent. For example, it has been suggested (Ford, 1996) that innovative actions must hold an advantage over habitual actions if one is to be motivated to pursue them. This can be explained using the *learned industriousness theory* (Eisenberger, 1992), which suggests that individuals learn which performance dimensions (i.e. innovation) lead to rewards and are motivated to perform them accordingly. Indeed, research has indicated that if submitting new suggestions or implementing innovative work processes is rewarded by an organisation, individuals may be more motivated to be actively involved in such processes - but will not in the absence of rewards. However, some researchers have posited a *paradox of rewards* in which extrinsic motivation may undermine intrinsic motivation over time. In exploring external influences on motivation, the evidence suggests that constructive evaluation (i.e. informative, supportive, and recognising of accomplishment) can enhance innovation. Any extrinsic motivator that enhances an employee's sense of competence without undermining self-determination should enhance intrinsic motivation and thus, increase the propensity for innovation. Since it seems that extrinsic motivators are related to innovation only under certain circumstances, intrinsic motivators can be said to have a stronger and more consistent relationship with innovation (Hammond, Neff, Farr, Schwall & Zhao, 2011).

It has also been suggested that there may be motivators that are neither wholly intrinsic nor extrinsic, but that lie between the two ends of the continuum (Frey, Lüthje & Haag, 2011). For example, engaging in innovative endeavours in order to increase one's status within a community can be regarded as extrinsic at the outset because the motivation is to enhance the personal benefit of the individual. As this aim is not related to the task itself, the outcome can be considered an extrinsic reward. However, individuals aiming to build their reputation within a group often do so in order to gain feelings of self-esteem, and therefore the innovative action leads to sensations of enjoyment and satisfaction – which are intrinsic motivators. Such motivations can therefore be considered both intrinsic *and* extrinsic in nature.

It is also possible that intrinsic and extrinsic motivators may be important at different stages of the innovation process. In the 1980s, Amabile suggested a componential model of innovation that involves three components: intrinsic task motivation, domain-relevant skills (i.e. expertise) and innovation relevant process skills (cognitive skills and work styles conducive to novelty). The model includes a five-stage description of the innovation process: task presentation, preparation, idea generation, idea validation, and outcome assessment, where the roles of the three components vary at each of the stages. Amabile's (1988) model suggests how and where individual skills and motivation affect the progress of the innovation process. According to Amabile (1988), intrinsic motivation is particularly important in tasks that require novelty, and extrinsic motivators may be a distraction during the early stages of the innovation process. Later in the innovation process, where persistence and

evaluation of ideas is required, synergistic extrinsic motivators may help innovators persist in solving the problem within the domain.

Sauermann and Cohen (2008) recently analysed the impact of individual motivation on organisational innovation and performance. They found that intrinsic and extrinsic motivation affected both individual effort and the overall quality of the innovative endeavours. The study confirmed that extrinsic rewards, such as pay, were not as important as certain aspects of intrinsic motivation, such as the desire for intellectual change, in enhancing innovation. These findings have been replicated in later studies (e.g. Frey et al., 2011; Sauermann & Cohen, 2010) that have concluded that intrinsic rather than extrinsic motivations have strong effects in explaining innovative effort and performance. This has obvious implications for how to best nurture innovation within the workplace. Further research could investigate the part that different aspects of intrinsic motivation, such as curiosity, improving feelings of mastery, self-expression potential, and the resolution of conflicts, play in innovation.

4. Personality

Psychological literature on the association between innovation and personality has generally agreed that personality plays a role in an individual's tendency to innovate. Over several decades of research, a set of characteristics has consistently emerged as being beneficial for innovation, including: imagination, inquisitiveness, high energy, autonomy, social rule independence, toleration of ambiguity, and high self-confidence (Patterson, 2002). Self -efficacy and resilience have also been associated with innovative outputs and found to be important in predicting innovative outputs at work (Ziyae et al., 2015; Jaussi, Randel & Dionne, 2007). Additionally, psychoticism (Eysenck, 1993; Patterson, 2002) and the "creative schizotype" (Burch, 2006) have been linked to innovation. It is thought that the strange beliefs, thinking, and odd behaviour associated with these personality types may facilitate the generation of original ideas, and are therefore particularly important at the idea generation stage of the innovation process.

Many early studies examined single personality traits in order to establish relationships between specific characteristics and creative outcomes. However, in order to integrate these findings, it is useful to categorise the characteristics found in the innovation literature using models of personality. The Five-Factor Model (FFM) has become a near-universal model with which to understand the structure of personality, and thus will be used as a template within which to review the literature on personality and innovation.

The Five-Factor Model (FFM)

The FFM of personality (Goldberg, 1990; McCrae & Costa, 1999) has led to a better understanding of how creativity and innovation relate to broad

personality domains. Common labels for the five factors are: (1) Openness to Experience, (2) Conscientiousness, (3) Extraversion, (4) Agreeableness, (5) Neuroticism.

Openness to Experience

Openness to Experience is concerned with the degree to which a person is willing to consider new ideas and opportunities. It is characterised by six lower-level facets, including: active imagination (fantasy), aesthetic sensitivity, attentiveness to inner feelings, intellectual curiosity (ideas), values and preference for variety (actions). Of all the FFM factors, openness to experience has most often been found to be positively related to innovation (Hammond et al., 2011); a likely result of all of the openness facets sharing an interest in varied experience for its own sake – a key aspect of innovation (McCrae, 1987; Steel, Rinne & Fairweather, 2011). Furthermore, the word 'innovation' itself has been used throughout literature to define the concept of openness (e.g. Connelly, Ones, Davies & Birkland, 2014; Williamson, Lounsbury & Han, 2013). Parallels have been drawn between characteristics associated with both innovation and openness, such as being imaginative, flexible, original, and having wide interests. Additionally, open individuals tend to be more curious about the world, more flexible, and more accepting of various perspectives, even when ideas may seem unfamiliar or underdeveloped. By definition, then, individuals high on openness are likely to be more suited to innovation. Indeed, openness has been regarded an important trait for professional roles that involve the ability to continually acquire new knowledge and ideas (Williamson et al., 2013). It has therefore been suggested that openness may be more important at the idea generation stage of innovation (Steel et al., 2011). This is supported by the finding that having leaders high on openness benefitted radical innovations, i.e. those concerned with the generation of novel ideas (Aronson, Reilly & Lynn, 2008). Although recent findings suggest that the relationship might be moderated by contextual factors, researchers tend to agree that it is likely to be the most important personality dimension in predicting innovation potential (Patterson, 2002; Patterson & Zibarras, in press; Yesil & Sozbilir, 2013). Research has also suggested that openness enhances an individual's intrinsic motivation towards novelty and, therefore, works in a multiplicative way to produce innovation (King, Walter & Broyles, 1996).

Conscientiousness

Conscientiousness is concerned with the degree to which a person is thorough, careful, and vigilant. Being conscientious implies a desire to do a task well, and conscientious people are usually efficient, organised and dependable as opposed to easy going and disorderly. Conscientiousness is character-

ised by lower-level facets including competence, order, dutifulness, achievement striving, self-discipline, and deliberation. The majority of research demonstrates that a lack of conscientiousness is related to innovation (e.g. Harrison et al., 2006), and evidence shows that individuals high on conscientiousness do not challenge authority and are more likely to resist change (Costa & McCrae, 1992). This can be problematic since a key feature of innovation is challenging the status quo (Patterson, 2002).

So, at first glance, conscientiousness may appear to be negatively related to innovation. However, conscientiousness entails a number of distinct facets, which each have different relationships with innovation. Innovation is known to be positively associated with the achievement striving and persistence facets but negatively associated with being systematic, dependable, methodical, ordered, and dutiful (Patterson, 1999; Robertson, Baron, Gibbons, MacIver, and Nyfield, 2000). For example, Patterson and Zibarras (in Press) found that achievement striving, competence and self-discipline facets of conscientiousness were positively related to innovation, whereas dutifulness, deliberation and order were not. One recent study, however, yielded findings that are contradictory to the trend of the rest of the literature on conscientiousness and innovation. Moon, Kamdar, Mayer, and Takeuchi (2008) found that dutiful individuals were more likely to be rated by their peers as likely to provide innovative suggestions, whilst achievement strivers were rated less likely to do so. This has been explained using the logic that two of the major facets of conscientiousness—duty and achievement striving – are inherently opposed, as duty is other-centred, whilst achievement-striving is self-centred. Therefore, dutiful individuals engage in innovative citizenship because their focus is on the welfare of the organisation, whereas achievement strivers are more likely to attend to their own welfare and performance. Evidently, the broad bandwidth of conscientiousness may make it hard to determine its relationship with innovation, but what is clear is that conscientiousness measured broadly might forego important information. Since it is generally accepted that organisations should hire individuals that are high on conscientiousness (Moon, Livne & Marinova, 2013), significant implications for selection and assessment are implied in that placing a high value on conscientiousness may not be as beneficial as traditionally thought (Patterson & Kerrin, 2013). Clearly, more research at the facet level is needed to more fully understand the influence of each distinct facet.

Extraversion

Extraversion is a personality dimension characterised by concentration of interest on the outside world. It contains six lower-level facets, including: warmth, gregariousness, assertiveness, activity, excitement-seeking, and positive emotions. Extraversion is typically viewed as being one end of a continuum, with introversion on the opposite end. Unlike extraverts, introverts tend

to be more concerned with their own inner world than with outside activities. Empirical studies have revealed conflicting findings with regards to the relationship between innovation and extraversion. Although many researchers report a negative relationship, other studies have found a positive association.

However, different facets of extraversion are linked to innovation in different ways. Feist (1998) notes two distinct sub-dimensions of extraversion: assertiveness and sociability, which although related to each other, are not synonymous since one can be assertive without being sociable and vice versa. Findings suggested that assertiveness had a small relation to innovation, while sociability had none. However, Feist's review focused on artists and scientists, with no evidence from general working population contexts. Additionally, in meta-analytic studies of general occupational work performance (e.g. Barrick & Mount, 2001) extraversion is a positive predictor for many occupations. This is particularly the case for jobs where interpersonal factors are important for effective job performance (e.g. sales). Thus, it can be inferred that the association between extraversion and innovation may be context dependent. Introversion is likely to be important to real-life artistic endeavors, whereas extraversion may predict performance measures of creativity and innovation (Patterson, 2002; Batey & Furnham, 2006).

Research has also indicated that extraversion may have differing effects at different stages of the of the innovation process. Williamson et al. (2013) reported lower extraversion among professions that require the ability to consistently produce new ideas (i.e. the idea generation phase), and attributed success in such professions to concentrating on work in a quiet, attentive and thoughtful manner. Similarly, Stam, de Vet, Barkema & Dreu (2014) found that suspending group debate—i.e. inhibiting behaviours associated with extraversion – at the idea generation phase allowed individuals to gather and process thoughts and work on problems effectively before sharing and discussing their ideas; the result was a 53% increase in idea generation. This may be explained by the fact that idea generation can be achieved alone, and indeed the stereotypical "solitary innovator" has been iconic in the Western world (Steel et al., 2011). However, whilst individuals may *generate* ideas alone, their social context frequently facilitates or hinders the *implementation* of innovation. Since for an idea to be successfully implemented it must first be successfully sold to others (Bain & Tran, 2006), extraversion may lend itself more to the implementation stage where social exchanges are essential. In line with this, it has been suggested that expressed or social forms of creativity may have a set of predictors that are different from unexpressed forms (Choi, 2004), as extraverts are likely to be more comfortable presenting their creative thoughts to others than introverts. Additional empirical research is still needed to further explore the association between extraversion and innovation, however on balance, it seems that introversion may be more suited to the idea generation phase and extraversion to the implementation phase of innovation. Future research may also wish to explore the association between extraversion and innovation in different occupational sectors and contexts.

Agreeableness

Agreeableness typically manifests itself in behavioural characteristics that are seen as kind, sympathetic and cooperative. It is characterised by lower-level facets that include: trust, compliance, altruism, straightforwardness, modesty and tender-mindedness. Several studies have shown a negative association between agreeableness and innovation (Patterson, 1999); that is, being disagreeable and defying order is linked to innovation. Others have shown no link between agreeableness and innovation (Tehran & Khaledi, 2014). This can be explained by the fact that agreeableness leads to conformity but innovation requires independence of thought and action (Patterson, 2002). Therefore, agreeable individuals are likely to opt out of engaging in processes that may cause conflict or tension. Findings are consistent with Eysenk's emphasis on the potentially negative dispositional characteristics of innovators, where innovators are often outspoken, uninhibited, quarrelsome, and sometimes asocial (Zibarras, Port & Woods, 2008). Findings also show that agreeableness is negatively associated with creative achievement but not with creative thinking. This may indicate that lack of agreeableness is important in the implementation stage of innovation but not for idea generation. This affords intuitive sense because implementation of new ideas is likely to be a group effort involving social processes and activities.

Neuroticism

Neuroticism (also known as *low emotional stability*) is associated with the frequent experience of negative emotions, increased reactivity to stressors, and predisposition to a range of emotional psychopathologies (Costa & McCrae, 1992). It is characterised by six facets: anxiety, hostility, depression, self-consciousness, impulsiveness, and vulnerability. There is relatively little research examining an association between neuroticism and innovation. Of the literature that is available, there appears to be some inconsistencies depending on the domain of interest. For example, some researchers have found no association between neuroticism and creative thinking or innovation, whilst other research literature suggests a positive association with neuroticism. Conversely, negative associations between neuroticism and innovation have been found, where neurotic individuals perceive a reduction in innovative interactions in conjunction with increased anxiety (Chen & Chen, 2013) – although this can be improved by managers who demonstrate visionary leadership (based on core values, clear vision, empowering relationships, intellectual stimulation, and innovative action). An explanation for these inconsistencies is likely to be that the association between neuroticism and innovation is domain-dependent. For example in a meta-analytic review, Feist (1998) observed that artists appear to be more anxious, less emotionally stable and impulsive than scientists. A more thorough investigation in organisa-

tional settings is necessary, with a broader range of occupations. Meta-analytic studies of personality and work performance generally suggest a curvilinear association between emotional stability and performance, where too much or too little anxiety is detrimental; this could be tested in the innovation arena. Perhaps a first step could be to examine possible links at the facet level. The innovation literature shows different associations with these facets: for example innovation is associated with moderate levels of anxiety; hostility, impulsiveness and volatility.

Summary

In summary, it is possible to broadly conclude that innovation is positively associated with openness and a lack of agreeableness and conscientiousness. The associations with extraversion and neuroticism are less certain and information is lacking from organisational research. The literature suggests that the relationships between the five personality domains and innovation are more complex at the facet level, and although this requires further research, it seems that assessing personality at the facet level could prove more useful than assessing at the domain-level in terms of predicting innovation. This has implications for selection and assessment and employee development.

5. Emotional Intelligence

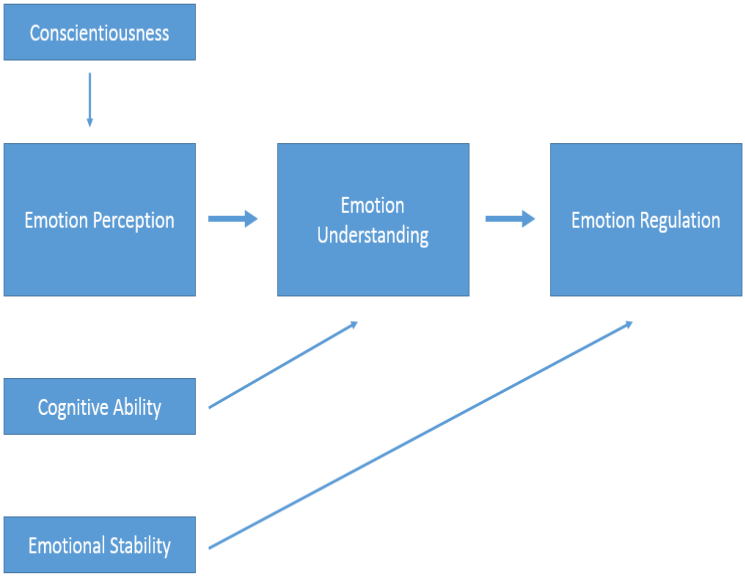
The concept of emotional intelligence (EI) has become popular in recent years, attracting a large amount of interest from academics. EI can be defined as "*a set of abilities that enable a person to generate, recognise, express, understand, and evaluate their own, and others', emotions in order to guide thinking and action"* (Van Rooy & Viswesvaran, 2004, p 72). In relation to innovation, some authors suggest that EI has a positive influence on organisational innovation, for leaders, teams, and individual employees. For example, in a review of the role emotions have in transformational leadership, Ashkanasy and Tse (2000) suggested that EI involves the ability to utilise emotions in a way that allows flexible planning and creative thinking. Similarly, leaders' levels of EI are likely to accentuate the employees' inclination to engage in the innovation process (Castro, Gomes & de Sousa, 2012). From a team perspective, Barczak, Lassk and Mulki (2010) found that emotionally intelligent teams create both cognitive and affective team trust, which in turn builds a collaborative culture and facilitates higher levels of creativity and innovation. For individual employees, it has been found that those who show high levels of EI also display higher levels of readiness to create and innovate (Suliman & Al-Shaikh, 2007), and are likely to benefit more from both positive and negative creativity-related feedback. Furthermore, it is thought that EI may be beneficial when innovative employees have to persuade others to support them in during the implementation phase of innovation. Specifically,

being able to perceive others' emotions and to regulate them appears to be important. A recent study by Carmeli, McKay and Kaufman (2014) found support for an indirect effect of EI on creative behaviours, whereby individuals with higher EI tended to be more generous towards colleagues; this generosity led to increased vigour and consequently more creative behaviours. Future research may wish to investigate this further, as whilst early psychologists in the area tended to conceive of EI as being a single concept, it is now appreciated that it is more complex and comprises multiple capabilities.

Although conceptualisations of EI exist that explore its underlying dimensions specifically in relation to work behaviours (see Goleman, 1998, for example), they have been critiqued for simply repackaging previous literature without identifying anything new or important. A recent meta-analysis by Joseph and Newman (2010), however, aimed to clarify the theoretical basis for EI. The authors propose a *cascading model of emotional intelligence* (see Figure 2), in which a causal chain exists between three subfacets of EI: emotion perception, emotion understanding, and emotion regulation; and includes personality (specifically, conscientiousness and emotional stability) and cognitive ability as antecedents of various stages of the EI process. Emotion perception refers to *the ability to identify emotions in oneself and others*; emotion understanding refers to *understanding how emotions evolve over time, how emotions differ from each other, and which emotion is most appropriate for a given context*; and emotion regulation refers to *the process by which individuals influence which emotions they have, when they have them, and how they experience and express these emotions*. Joseph and Newman (2010) suggest that conscientiousness is positively related to emotion perception since conscientious individuals (described as methodical, cautious and careful) have shown above average levels of interpersonal functioning and an increased capacity for self-conscious emotions. This should enable conscientious individuals to use emotional cues to guide their need for controlled behaviour—that is, they will be able to determine when a behaviour is appropriate or inappropriate. Cognitive ability has been linked to the emotion understanding phase, since those high on cognitive ability would acquire a stronger knowledge-base associated with understanding one's emotions. Finally, emotional stability is proposed as an antecedent of emotion regulation, since neurotic individuals have been found to lack the ability to regulate their emotions effectively—a result of using ineffective emotion regulation strategies such as surface acting, which cover up rather than actually change a negative emotional state. Gross and John (2003) concur that neurotic individuals do not engage in effective emotion regulation strategies (e.g. reappraisal) as often as emotionally stable individuals. Meta-analytic data showed good fit with the cascading model. Future research may therefore wish to test the relationships between the subfacets of EI and innovation in order to shed light on which might be important for innovation. There is burgeoning research in this arena where some researchers have explored the differential influences of the EI dimensions, for example Kaur (2014) found that the *emotional regulation*

scale had the strongest correlation with role innovation in a sample of bank managers; and higher *self-emotion appraisal* predicted increased innovative work behaviours for employees in Mass Service roles that offer low "customisability" (Othman, 2011). Nevertheless, further research is needed in this area, particularly around the stages of the innovation process; Emotion perception, for example, may be more important at the idea generation phase, whilst emotion understanding and emotion regulation are perhaps more likely to affect the implementation stage.

Figure 2: Cascading model of emotional intelligence (adapted from Joseph &



Newman, 2010)

6. Mood states

Examining the relationship between emotions, mood states, and innovation is a new but rapidly growing research area. When referring to emotions and mood states, the most commonly used terms are *affect*, *mood*, and *emotion*. Affect refers to a subjective feeling that involves both general (and long-lasting) states such as cheerfulness or depression, and more specific ones such as happiness or anger. Mood and emotion can then be seen as subtypes of affect, with emotions typically being directed toward a specific stimulus (e.g. a person, object, or event) and moods tending to lack this directedness. This

distinction can be illustrated with the following: "*a person in an irritable mood is not necessarily angry about anything in particular— he or she is just generally grumpy*" (Parrot, 2001, p. 3).

Moods can be characterised by two dimensions; either positive or negative. A wide range of empirical studies have found links between positive mood states and aspects of innovation. For example, George and Brief (1992) proposed that positive mood facilitates voluntary behaviours relevant to both initiative and innovation, including making constructive suggestions, developing oneself and helping co-workers. That is, individuals in positive moods are more likely to continue in self-development since they have more favourable self-perceptions, increased self-efficacy and higher aspirations. Additionally, people in a positive mood are more likely to have richer associations within existing knowledge structures and thus are likely to be more flexible and original. Support for this suggestion comes from research by Schei (2013) who found that active, positive moods (e.g. enthusiastic) enhanced the effect of innovative thinking on successful negotiation outcomes, compared to passive positive moods (e.g. glad). It has also been suggested that the relationship between positive mood states and creativity might be dependent on task-motivation. For example, Baas, Carsten, De Dreu and Nijstad (2008) found that positive moods influence creativity more when tasks are framed as enjoyable and intrinsically rewarding than when they are framed as serious and extrinsically rewarding.

Other studies point out relationships between *negative* affect and creativity. For example a higher incidence of affective disorders (e.g. depression, bipolar disorder) have been identified among innovative individuals and their relations compared to the general population (e.g. Heston, 1966). In relation to creativity, authors have acknowledged that "*negative emotions may be necessary to break down old expectations and paradigms*", and Madjar and colleagues argue that tension and dissatisfaction may be important for creative problem-solving (Madjar, Oldham & Pratt, 2002), and field studies have indicated that negative mood may sometimes facilitate innovative behaviour.

Interestingly, it has also been suggested that neither positive nor negative emotion influence innovation. Fong (2006) found that as opposed to either positive or negative emotion, emotional ambivalence (the simultaneous experience of positive and negative emotions) facilitated creativity. This is consistent with George and Zhou's (2007) '*dual-tuning' theory*, and also the Dual Pathway to Creativity Model (DPCM) (see De Dreu et al., 2012), where positive mood enhances cognitive flexibility, and negative mood sustains the effort required for innovation.

A meta-analysis of 102 independent samples and over 7,000 research participants (Baas et al., 2008) aimed to alleviate some of the inconsistency found in the literature on the association between mood states and innovation. With regard to causality, it was concluded that when compared with neutral moods, positive moods generally produce more creativity. Further, whilst negative moods are not inclined to produce creativity over and above neutral

moods, they do not tend to produce *less*. In the case of positive vs negative moods, no statistically significant differences were found between the two in relation to creativity, suggesting that one is no more important than the other in influencing innovative behaviour overall. Since empirical studies have showed support for the involvement of both positive and negative mood states in creativity and innovation, yet they both seem to be as important (or indeed unimportant) as one another in influencing creativity, it might be that different mood states are relevant to different stages of the innovation process. This may account for the diversity of findings found in the literature on mood states and innovation to date, and deserves more emphasis in future research.

7. Behaviours

The role of discretionary employee behaviours in enhancing innovation has traditionally been vastly underestimated. Contemporary research, however, has suggested that concepts such as *personal initiative* and *voice behaviour* may provide valuable insights into our understanding of human innovation.

Personal initiative

Personal initiative (PI) is defined as "self-starting, long-term proactivity, and persistence in the face of barriers that need to be overcome" (Frese, 2009, p. 444). This definition represents the three facets of PI: 1) self-starting, 2) proactivity, and 3) persistence; all have been positively linked to innovation. *Self-starting* individuals do things without being told and without explicit instruction. They set their own goals as opposed to responding to assigned goals, and will go outside the remit of their job description to do what needs to get done. *Proactive* individuals have a long-term focus – they do not wait until they must respond to a demand, they plan ahead and anticipate problems and opportunities so that they are prepared to deal with them when they arise. *Persistent* individuals are key to implementing innovation. With new ideas comes change, whether in the form of new procedures, processes, or tasks being implemented or modified. However, change does not usually work out perfectly from the outset—there are setbacks, failures, and adjustment periods where people must adapt to the new and abandon their routines. Since people do not generally respond well to this, they push back with resistance, and this is where persistence is required on the part of the individual taking initiative to get past these barriers. Indeed, it has been found that in order to reach innovative performance, people need to take the initiative in promoting their ideas (Miron, Erez & Naven, 2004). Frese and colleagues suggest that the three PI facets reinforce each other and tend to co-occur.

There is a growing body of research examining the association between PI and innovation. For example, Rank, Pace, and Frese (2004) suggest that personal initiative plays an important moderating role in the innovation process. Studies have found that personal initiative positively predicts employee and team-level innovation and innovative ideas are more often implemented when personal initiative is high. A recent longitudinal study examined the effects of PI at each stage of the innovation process (Binnewies & Gromer, 2012). It was found that whilst PI was not a significant predictor of early stages of the innovation process such as idea generation (the development of novel and potentially useful ideas) and idea promotion (selling ideas to others and finding supporters), it was important at the idea implementation stage. This stage consists of behaviours directed at the realisation of innovative ideas in the work context, and therefore self-starting, proactive, and persistent behaviours are important here. Other studies have reported similar results. For example, Parker, Williams and Turner (2006) examined several predictors of innovation and it was found that that being proactive, actively involved in one's work environment and confident that one is capable of generating good ideas were the most important predictors of innovation. A recent meta-analysis of innovative behaviour in teachers contributed further support for two PI facets: self-efficacy and persistence both independently predicted innovative behaviour in teachers (Thurlings et al., 2015). Further, self-efficacy fully mediated direct effects of demographic variables (e.g. income, age, education level).

Organisational factors were also important, indicating that innovation is maximised when organisational climates promote an active approach towards work and interpersonal risk-taking. Interestingly, a study by Herrmann and Felfe (2014) found that transactional and transformational leadership styles predicted differentially increased types of innovative employee behaviours (quantitative i.e. number of solutions, and qualitative i.e. originality of solutions, respectively), but that personal initiative independently predicted both quantitative and qualitative measures of innovative behaviours.

Recent work (Zibarras, Patterson & Judson, in press) has also indicated a role for one of the PI facets—proactivity—at the early stages of the innovation process. Having a proactive personality was found to significantly and positively influence the generation and suggestion of new ideas in the workplace; accounting for significant variance over and above other employee factors such as motivation towards change. Further research into the role of PI at each stage of the innovation process is necessary to establish the exact nature of the relationship between PI and the innovation process.

Voice Behaviour

Voice behaviour refers to behaviour that proactively challenges the status quo (Liu, Zhu & Yang, 2010), and is related to an individual's willingness to

speak up with suggestions for change. This behaviour may play an important role in enabling the implementation of creative ideas.

There has been a recent surge of interest in the transferrable skills— such as communication skills—that are important for innovation, especially during the implementation phase of innovation. Although employees are the source of innovations, innovation rarely occurs in isolation. In order to innovate, employees are likely to have to relate and interact with other individuals, inside or outside the organisation; hence the importance of communication, articulation, and social networking skills. Indeed, voice behaviour is a communicative form of behaviour that is important for innovation since if new ideas are not articulated they cannot be implemented (Rank et al., 2004). A meta-analysis by Ng and Feldman (2012) reflected this line of argument: individuals' voice behaviour positively correlated with self- and other- rated innovation, and self-rated implementation of new ideas. Other important skills may include conflict resolution, and collaborative problem solving. Recent research has suggested that individuals' voice behaviour and subsequently, innovative behaviour, can be influenced by their perceptions of ethical leadership (Chen & Hou, 2016). Further research is needed in order to shed light on how innovative employees manage social interactions and on how they integrate social and intellectual demands.

8. Values

Values are learned beliefs that serve as guiding principles about how individuals ought to behave (Parks & Guay, 2009). They provide directions for action and serve as standards for judging and justifying action; therefore they may provide a basis for innovative actions. Indeed, recent research (Dollinger, Burke & Gump, 2007) has suggested that a central element in innovation is the desire to be creative, implying creativity as a core value. It therefore follows that innovative individuals should have a different value system than their less creative counterparts. Dollinger and colleagues investigated this and found that creative accomplishments correlated with the values of: self-direction—independent thought and action choosing, creating, and exploring; universalism – understanding, appreciation, tolerance, and protection for the welfare of all people; and stimulation—excitement, novelty, and challenge in life. Conversely, innovation was negatively correlated with tradition, security, and power. This provides support for the view that innovation is grounded in values and that innovative individuals may place more importance on certain values than non-innovative individuals. Other research has highlighted relationships between values such as conservation—the respect for tradition, conformity, security, and harmony in interpersonal relations— and increased innovation. For example, Shin and Zhou (2003) found that employees high on conservation exhibited greater creativity as a result of

their positive reaction to transformational leadership. This was explained by the fact that individuals high on conservation are likely to conform to expectations and less likely to upset others or violate social norms; as a result, they are more willing to try hard, use their imagination, and become excited about their tasks if stimulated by a transformational leader. Whilst both Dollinger and colleagues and Shin and Zhou (2003) support the idea of value-based innovation, their findings are contradictory in terms of the specific values that facilitate innovation. It seems that contextual factors (e.g. leadership style) may be mediating this relationship. Additionally, individual factors such as organisational commitment have been suggested to mediate the impact of conservation values on employee creativity (Sousa & Coelho, 2009). Indeed, it has been found that values may change as a result of experiences in the workplace, such that values that are favoured by an organisation become internalised by employees and may affect their behaviour. The influence of managers and leaders is likely to be significant due to their status as role models (Maierhofer, Griffin & Sheehan, 2000).

There is no research currently examining the role of values at varying stages of the innovation process. Since values are guiding principles in people's lives and affect their goals and behaviour, it would be valuable for future research to examine the role of values in idea generation and implementation, as well as the effect of contextual factors on the values that most influence innovation.

Individual-level predictors of innovation: A summary

This section has discussed the role of eight individual-level predictors of innovation. Generally, research has tended to examine the relationship between innovation and one predictor at a time (i.e. intelligence, or personality, or motivation etc.), but hasn't looked comprehensively at the relationships between predictors and innovation. An exception is a review by Hammond, Neff, Farr, Schwall, and Zhao (2011). In one of the first comprehensive reviews of individual-level innovation in the workplace, Hammond and colleagues explored the relationships between four predictor types (individual differences, motivation, job characteristics, and contextual influences) and individual-level innovation. They concluded that personality has a small effect in the prediction of innovative performance; however, a *creative personality* was not consistently related to innovation. This suggests that innovation may not be solely trait driven, and environmental factors may also be important (Zhou, 2003; Zhou & Oldham, 2001). Additionally, it was found that having a driving force (i.e. motivation) is necessary for innovation—motivation was the factor that had the most consistent and positive relationship with innovative behaviour. Additional external factors found to influence innovation included job characteristics, environmental support, and leadership. Finally, it was found that the stage of the innovation process had an ef-

fect on the strength of the relationships between innovation and its correlates; as such, it was suggested that relationships between predictors and outcomes may be specific to various stages of the innovation process as they may represent different psychological processes. Evidently, further research is needed to substantiate these findings and incorporate other predictors in addition to the four reviewed by Hammond and colleagues.

Measuring innovation potential

A long-standing problem for HR managers has been how to select and develop innovative individuals effectively. Although the propensity to innovate has often been referred to as a desirable competency for a range of job roles, there has traditionally been a lack of reliable methods of assessing it (Arnold & Randall *et al*., 2010). This can be attributed, in part, to the continued confusion within innovation literature over defining the concepts of creativity and innovation; if we cannot define it, then how can we effectively measure it? Traditionally, measures of creativity and innovation have been concerned with measuring an individual's ability to generate novel ideas, i.e. their divergent thinking skill. However, this method of assessment is not as useful as originally thought, since essentially it is concerned with "How many uses of a paperclip can you think of?" type questions. The issue here is that whilst an individual may be able to come up with numerous ideas to answer these questions, how many of them will be quality ideas that can add value to a given situation? Furthermore, divergent thinking tests (see Guilford, 1967; Mednick & Mednick, 1967; Torrance, 1966 for example tests) only measure one aspect of the innovation process: the idea generation phase. They cannot determine whether an individual will be likely to share or implement any of the creative ideas they come up with, and therefore divergent thinking tests cannot predict innovation as a whole. Moreover, they can be influenced by training and practice, and thus are likely to lack reliability.

This chapter has explored in depth some of the individual-level predictors of innovation, and highlighted the relationships between factors such as personality, for example, and innovation. Since certain factors have been found to predict innovation, assessing these factors may reveal one's innovation potential. For example, it is generally accepted that those high on the FFM dimension 'Openness to Experience' will tend to have a higher propensity for innovation (e.g. Hammond et al., 2011; Sung & Choi, 2009). Therefore, using FFM measures such as the International Personality Item Pool (IPIP; Goldberg, 1999) or the NEO Personality Inventory (Costa & McCrae, 1992) to assess this dimension (and its related facets) may help predict innovation potential—those high on Openness to Experience should also have high innovation potential. Similarly, the other four personality dimensions could also be assessed; although it should be noted that the relationships between these dimensions and innovation are more complex than that of Open-

ness and innovation, particularly at the facet level. Additionally, measures of a 'creative personality' (e.g. the Creative Personality Scale; Gough, 1979) can be used to assess innovation potential on the basis of personality, although it should be noted that this has not been consistently related to innovation.

Other measures have more recently been developed that take a more integrative approach and are aimed directly at assessing innovation potential (e.g. Patterson, 1999). The Innovation Potential Indicator (IPI) was developed as a multi-dimensional, trait-based measure of innovative behaviour; encompassing aspects of work style, motivation, personality and intellect. It captures self-reports of important behaviours associated with both the idea generation and idea implementation phases of the innovation process, and is therefore a more comprehensive measure than assessment tools like divergent thinking, intelligence, or personality tests. Specifically, one aspect of the IPI measures 'motivation to change' which has been found by independent researchers to be the best predictor of innovation outcomes for employees and teams (Burch, Pavelis & Port, 2008).

The validity and reliability of measures of innovation potential (e.g. the IPI) and predictors of innovation, such as personality (e.g. the NEO-PI-R and the IPIP), have been widely demonstrated. As such, they can be considered psychometrically fit for assessing innovation potential. However, a common issue with using these measures is that individuals do not generally like the idea that their creativity can be assessed psychometrically, and often feel like they are being 'put in a box'. So, how can we increase the face validity of these methods and engage individuals with the concept of assessing innovation potential? One way is by using methods of assessing innovation for employee development purposes. This will be explored in the next section.

Practical implications

Thus far, this chapter has explored some of the most important predictors of individual-level innovation, and provided an overview of how innovation potential can be measured in order to appropriately identify individuals with a high propensity to innovate. However, what does having 'innovation potential' mean for organisational practice? And what can we do for those with low innovation potential in a climate that places so much emphasis on the need to innovate? We discuss this in the context of a) selection and assessment, and b) employee development.

a) Selection and Assessment

Having identified the key resources for innovation, this knowledge could be used to inform selection and assessment. For example, since the literature suggests that there are individual differences in the capacity for generative thinking (e.g. Ward, Smith & Finke, 1999), assessments of this nature may be

used in selection scenarios—although it is noted that this should be with caution and not as the sole selection instrument. Similarly, in relation to personality, organisations may choose to select individuals high on Openness to Experience as a predictor of innovation. Extraversion has been found to be particularly important for the implementation stage of innovation, where social interaction is essential. Therefore, it may be useful to select those high on extraversion for professions that require high levels of social interaction (e.g. sales), whilst those low on extraversion might be more suited to roles that are more concerned with idea generation (e.g. artistic professions).

Values-based recruitment (incorporating a method of assessing values into a recruitment process in order to increase the likelihood of selecting individuals with appropriate values) could also be implemented based on the finding that a central element in innovation is the desire to be creative, implying creativity as a core value (Dollinger et al., 2007). Selection methods such as Situational Judgement Tests (SJTs) have been found to be reliable and valid methods with which to measure values important for innovation; introducing these into selection processes may therefore be beneficial. It is worth noting, however, that no measure of innovation should be used in isolation for selection purposes, as although creative achievement depends on individuals to generate ideas and turn them into a reality (Hammond et al., 2011), creative achievement is also dependent on contextual factors. Furthermore, more research is needed in order to establish the exact role each aspect of the factors discussed plays in innovation, as thus far, research findings have been somewhat inconsistent. A case study of a global organisation that has successfully incorporated the assessment of innovation potential into their recruitment and selection process is outlined in Box 1.

Box 1: Case Example of Innovation in Selection and Assessment

'Teach for All' is a global organisation aiming to expand educational opportunities in countries around the world. It was founded in 2007 by Wendy Kopp,the CEO of Teach for America, and Brett Wigdortz,the CEO of Teach First. One of their unifying principles is to recruit and select as many as possible of the world's most promising future leaders who have the potential to create change.

'Teach for All' work by a model that involves recruiting and training young leaders who will have a positive influence on students in both the short and long term. In the short term, they will inspire students to break the mould, defy expectations, and strive for formerly unimaginable goals. In the long term, they will create systemic change in their national education systems. Evidently, the ability to innovate is at the core of their model and a key quality in all of their employees.

Along with seven other competencies, all 'Teach for All' employees are assessed according to their creativity and innovation potential during the selection process., This model has proved so impactful and effective that it has been employed in 34 countries over the last 7 years; this illustrates the positive impact selecting based on innovation potential (as one part of the selection process) has had.

b) Employee development

As mentioned earlier in this chapter, whilst various measures of innovation potential have proved to be psychometrically sound, they may lack face validity among individuals who do not wish to be pigeonholed based on psychometric profiling. For this reason, it may be useful to re-frame the use of measures of innovation potential as development tools. Profiling employees in terms of factors such as personality, values, motivation, behaviour, etc. can afford them a greater understanding of their own drivers and behaviours and enable them to modify these accordingly in order to increase their own innovation potential, as opposed to feeling that they are being judged on their results. Take an individual that is low on Openness to Experience (a key predictor of innovation), for example. After being assessed using a personality measure such as the IPIP (Goldberg, 1999), they would have a greater awareness of this and perhaps try harder to be more open to innovative ideas if this is essential for success in their organisation. Alternatively, an individual that does not place much importance on the values of self-direction and stimulation, for example—which have been found by Dollinger et al. (2007) to be important for innovation—can *learn* to put more emphasis on these values whilst at work if they wish to develop their innovation potential, which can eventually facilitate changes in their own value structure. Thus, it is possible to nurture and promote creativity in those who are not naturally predisposed towards innovation. Indeed, Madjar et al.(2002) found that under certain contextual conditions, employees with fewer creative personality traits exhibited greater creativity when provided with co-worker and supervisor support, as well as non-work support from family members.

Research shows that the motivational component of innovation explains a large proportion of the variance in innovative behaviours (Patterson, 1999). In terms of increasing innovation potential amongst those that do not see themselves as innovators, the evidence suggests that managers are likely to significantly influence an employee's motivation to innovate. Patterson and Kerrin (2009) suggest that the relationship an employee has with their immediate line manager is directly related to how the employee perceives and describes the working culture. Therefore, managers play an important 'gatekeeper' role in influencing innovation, such that specific development interventions can be used to enhance a manager's competence in enhancing employee innovation (e.g. how best to provide feedback to employees to promote innovation; see Tierney, 2009). Contextual factors such as these that are important to innovation are explored in detail elsewhere in this book; using them effectively can facilitate innovation in all employees—not just those with high innovation potential.

References

Amabile, T. M. (1988). A model of creativity and innovation in organizations. Research in Organizational Behaviour, 10, 123–167.

Amabile, T. M. (1996). Creativity in context. Westview Press.

Anderson, N., De Dreu, C. K., & Nijstad, B. A. (2004). The routinization of innovation research: A constructively critical review of the state-of-the-science.*Journal of organizational Behavior*, *25*(2), 147-173.

Anderson, N., Potočnik, K., & Zhou, J. (2014). Innovation and Creativity in Organizations A State-of-the-Science Review, Prospective Commentary, and Guiding Framework. *Journal of Management*, *40*(5), 1297-1333.

Arnold, J., Randall, R., Patterson, F., Silvester, J., Robertson, I., Cooper, C., Burnes, B., Swailes, S., Harris, D., Axtell, C. & Den Hartog, D. (2010) *Work Psychology: Understanding Human Behaviour in the Workplace* (5th ed). Prentice Hall.

Aronson, Z. H., Reilly, R. R., & Lynn, G. S. (2008). The role of leader personality in new product development success: an examination of teams developing radical and incremental innovations. *International Journal of Technology Management*, *44*(1), 5-27.

Ashkanasy, N. M., & Tse, B. (2000). Transformational leadership as management of emotion: A conceptual review.

Axtell, C. M., Holman, D., Unsworth, K., Wall, T., Waterson, P., & Harrington, E. (2000). Shopfloor innovation: Facilitating the suggestion and implementation of ideas. *Journal of Occupational and Organizational Psychology, 73*(3), 265-285.

Baas, M., De Dreu, C. K., & Nijstad, B. A. (2008). A meta-analysis of 25 years of mood-creativity research: Hedonic tone, activation, or regulatory focus?.*Psychological bulletin*, *134*(6), 779.

Bain & Train (2006), cited in Hammond, M. M., Neff, N. L., Farr, J. L., Schwall, A. R., & Zhao, X. Predictors of individual-level innovation at work: A meta-analysis. *Psychology of Aesthetics, Creativity, and the Arts*, *5*(1), 90.

Barczak, G., Lassk, F., & Mulki, J. (2010). Antecedents of team creativity: An examination of team emotional intelligence, team trust and collaborative culture. *Creativity and Innovation Management*, *19*(4), 332-345.

Barrick, M. R., Mount, M. K., & Judge, T. A. (2001). Personality and performance at the beginning of the new millennium: What do we know and where do we go next?. *International Journal of Selection and Assessment*, *9*(1 -2), 9-30.

Batey, M., & Furnham, A. (2006). Creativity, intelligence, and personality: A critical review of the scattered literature. *Genetic, Social, and General Psychology Monographs, 132*(4), 355-429.

Binnewies, C., & Gromer, M. (2012). Creativity and innovation at work: the role of work characteristics and personal initiative. *Psicothema*, *24*(1), 100-105.

Burch, G. S. J. (2006). The "creative-schizotype": Help or hindrance to team-level innovation? *The University of Auckland Business Review, 8*(1), 43 -50.

Burch, G. S. J., Pavelis, C., & Port, R. L. (2008). Selecting for creativity and innovation: The relationship between the innovation potential indicator and the team selection inventory. *International Journal of Selection and Assessment*,*16*(2), 177-181.

Castro, F., Gomes, J., & de Sousa, F. C. (2012). Do intelligent leaders make a difference? The effect of a leader's emotional intelligence on followers' creativity. *Creativity and Innovation Management*, *21*(2), 171-182.

Chen, J. K., & Chen, I. S. (2013). Don't worry, I'm with you: Can visionary leadership release neurotic employees for more perceived innovative interactions?. *Innovation: Management, Policy & Practice*, *15*(2), 215-223.

Choi, J. N. (2004). Individual and contextual predictors of creative performance: The mediating role of psychological processes. *Creativity Research Journal*,*16*(2-3), 187-199.

Connelly, B. S., Ones, D. S., Davies, S. E., & Birkland, A. (2014). Opening up Openness: A theoretical sort following critical incidents methodology and a meta-analytic investigation of the trait family measures. *Journal of personality assessment*, *96*(1), 17-28.

Costa Jr, P. T., & McCrae, R. R. (1992). Four ways five factors are basic. *Personality and Individual differences*, *13*(6), 653-665.

Csikszentmihayli, M. (1988). Society, culture and person: A systems view of creativity. R. J. Sternberg (Ed.) The Nature of Creativity New York: Cambridge University Press.

De Jong, J., & Den Hartog, D. (2010). Measuring innovative work behaviour. *Creativity and Innovation Management*, *19*(1), 23-36.

Dollinger, S. J., Burke, P. A., & Gump, N. W. (2007). Creativity and values.*Creativity Research Journal*, *19*(2-3), 91-103.

Dollinger, S. J., Burke, P. A., & Gump, N. W. (2007). Creativity and values. *Creativity Research Journal*, *19*(2-3), 91-103.

Eisenberger, R. (1992). Learned industriousness. *Psychological review*, *99*(2), 248.

Eysenck, H. (Ed.). (1979). *The structure and measure of intelligence*. New York: Springer Link.

Eysenck, H. J. (1993). Target article: Creativity and personality: Suggestions for a theory. *Psychological Inquiry, 4*(3), 147-178.

Eysenck, H. J. (1994). Personality and intelligence: Psychometric and experimental approaches. In R. J. Sternberg, & P. Ruzgis (Eds.), *Personality and intelligence* (pp. 3-31). Cambridge: Cambridge University Press.

Eysenck, H. J. (1994). Personality and intelligence: Psychometric and experimental approaches. In R. J. Sternberg, & P. Ruzgis (Eds.), *Personality and intelligence* (pp. 3-31). Cambridge: Cambridge University Press.

Feist, G. J. (1998). A meta-analysis of personality in scientific and artistic creativity. *Personality and Social Psychology Review, 2*(4), 290-309.

Feist, G. J., & Barron, F. X. (2003). Predicting creativity from early to late adulthood: Intellect, potential, and personality. *Journal of Research in Personality, 37*(2), 62-88.

Finke, R. A., Ward, T. B., & Smith, S. M. (1992). Creative cognition: Theory, research, and applications.

Fong, C. T. (2006). The effects of emotional ambivalence on creativity. *Academy of Management Journal*, *49*(5), 1016-1030.

Ford, C. M. (1996). A theory of individual creative action in multiple social domains. *Academy of Management review*, *21*(4), 1112-1142.

Frese, M. (2009). *Toward a psychology of entrepreneurship: An action theory perspective*. Now Publishers Inc.

Frey, K., Lüthje, C., & Haag, S. (2011). Whom should firms attract to open innovation platforms? The role of knowledge diversity and motivation. *Long Range Planning*, *44*(5), 397-420.

George, J. M., & Brief, A. P. (1992). Feeling good-doing good: A conceptual analysis of the mood at work-organizational spontaneity relationship. *Psychological Bulletin, 112*(2), 310-329.

George, J. M., & Zhou, J. (2007). Dual tuning in a supportive context: Joint contributions of positive mood, negative mood, and supervisory behaviors to employee creativity. *Academy of Management Journal*, *50*(3), 605-622.

Gilhooly, K., Wynn, V., & Osman, M. (2004). Studies of divergent thinking. *Proceedings of the British Psychological Society,* London. *, 12*(2) 146.

Goldberg, L. R. (1990). An alternative" description of personality": The big-five factor structure. *Journal of Personality and Social Psychology, 59*(6), 1216-1229.

Goldberg, L. R. (1999). A broad-bandwidth, public domain, personality inventory measuring the lower-level facets of several five-factor models. *Personality psychology in Europe*, *7*, 7-28.

Goleman, D. (1998). *Working with emotional intelligence*. Random House LLC.

Gough, H. G. (1979). A creative personality scale for the Adjective Check List. *Journal of personality and social psychology*, *37*(8), 1398.

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. *Journal of personality and social psychology*, *85*(2), 348.

Guilford, J. (1988). Some changes in the structure-of-intellect model. *Educational and Psychological Measurement, 48*(1), 1-4.

Guilford, J. P. (1950). Creativity research: Past, present and future. *American Psychologist, 5*(1), 444-454.

Guilford, J. P. (1967). The nature of human intelligence. New York: McGraw-Hill.

Hammond, M. M., Neff, N. L., Farr, J. L., Schwall, A. R., & Zhao, X. (2011). Predictors of individual-level innovation at work: A meta-analysis. *Psychology of Aesthetics, Creativity, and the Arts*, *5*(1), 90.

Hammond, M. M., Neff, N. L., Farr, J. L., Schwall, A. R., & Zhao, X. (2011). Predictors of individual-level innovation at work: A meta-analysis. *Psychology of Aesthetics, Creativity, and the Arts*, *5*(1), 90.

Harrison, M. M., Neff, N. L., Schwall A.R., & X. Zhao. (2006). A meta-analytic investigation of individual creativity and innovation. *Paper Presented at the 21st Annual Conference for the Society for Industrial and Organizational Psychology,* Dallas, Texas.

Howell, J. M., Shea, C. M., & Higgins, C. A. (2005). Champions of product innovations: defining, developing, and validating a measure of champion behavior. *Journal of Business Venturing*, *20*(5), 641-661.

Janssen, O., Van de Vliert, E., & West, M. (2004). The bright and dark sides of individual and group innovation: A special issue introduction. *Journal of Organizational Behavior*, *25*(2), 129-145.

Jaussi, K. S., Randel, A. E., & Dionne, S. D. (2007). I am, I think I can, and I do: The role of personal identity, self-efficacy, and cross-application of experiences in creativity at work. *Creativity Research Journal*, *19*(2-3), 247-258.

Joseph, D. L., & Newman, D. A. (2010). Emotional intelligence: an integrative meta-analysis and cascading model. *Journal of Applied Psychology*, *95*(1), 54.

Kim, W. C., & Mauborgne, R. (2005). Value innovation: a leap into the blue ocean. *Journal of business strategy*, *26*(4), 22-28.

King, L. A., Walker, L. M., & Broyles, S. J. (1996). Creativity and the five-factor model. *Journal of Research in Personality*, *30*(2), 189-203.

Liu, W., Zhu, R., & Yang, Y. (2010). I warn you because I like you: Voice behavior, employee identifications, and transformational leadership. *The Leadership Quarterly*, *21*(1), 189-202.

MacKinnon, D. W. (1962). The nature and nurture of creative talent. *American Psychologist, 17*(7), 484-495.

Madjar, N., Oldham, G. R., & Pratt, M. G. (2002). There's no place like home? The contributions of work and nonwork creativity support to employees' creative performance. *Academy of Management Journal*, *45*(4), 757-767.

Maierhofer, N. I., Griffin, M. A., & Sheehan, M. (2000). Linking manager values and behavior with employee values and behavior: a study of values and safety in the hairdressing industry. *Journal of occupational health psychology*, *5*(4), 417.

Masticelli, R. (2000). "From experience: Harnessing tacit knowledge to achieve breakthrough innovation." Journal of Product Innovation Management 17(3): 179-193.

McCrae, R. R., & Costa Jr, P. T. (1999). A five-factor theory of personality. In L. A. Pervin, & O. P. John (Eds.), *Handbook of personality* (2nd Ed.). London: The Guilford Press.

Mednick, S.A., and Mednick, M.T. (1967). 'Remote Associates Tests examiner's manual.' Boston: Houghton Mifflin.

Miron, E., Erez, M., & Naveh, E. (2004). Do personal characteristics and cultural values that promote innovation, quality, and efficiency compete or complement each other?. *Journal of Organizational Behavior*, *25*(2), 175-199.

Moon, H., Kamdar, D., Mayer, D. M., & Takeuchi, R. (2008). Me or we? The role of personality and justice as other-centered antecedents to innovative citizenship behaviors within organizations. *Journal of Applied Psychology*,*93* (1), 84.

Moon, H., Livne, E., & Marinova, S. (2013). Understanding the independent influence of duty and achievement striving when predicting the relationship between conscientiousness and organizational cultural profiles and helping behaviors. *Journal of personality assessment*, *95*(2), 225-232.

Nicholls J. G. (1972). Creativity in the person who will never produce anything original and useful: The concept of creativity as a normally distributed trait. American Psycho- logist, 27, 717–727.

Parker, S. K., Williams, H. M., & Turner, N. (2006). Modeling the antecedents of proactive behavior at work. *Journal of applied psychology*, *91*(3), 636.

Parks, L., & Guay, R. P. (2009). Personality, values, and motivation.*Personality and Individual Differences*, *47*(7), 675-684.

Parrott, W. G. (Ed.). (2001). *Emotions in social psychology: Essential readings*. Psychology Press.

Patterson F, Kerrin M, Gatto-Roissard, G. (2009). *Characteristics and behaviours associated with innovative working in organisations. NESTA research reports.* London: NESTA.

Patterson, F. (2002). Great minds don't think alike? Person level predictors of innovation at work. '*International Review of Industrial and Organisational Psychology'*. 17, pp. 115-144.

Patterson, F. (1999). *The innovation potential indicator. manual and User's guide*. Oxford: OPP Ltd.

Prabhu, V., Sutton, C., & Sauser, W. (2008). Creativity and certain personality traits: Understanding the mediating effect of intrinsic motivation. *Creativity Research Journal*, *20*(1), 53-66.

Preckel, F., Holling, H., & Wiese, M. (2006). Relationship of intelligence and creativity in gifted and non-gifted students: An investigation of threshold theory. *Personality and Individual Differences, 40*(1), 159-170.

Puccio, G. J., & Cabra, J. F. (2012) Idea Generation and Idea Evaluation: Cognitive Skills and Deliberate Practices. In M. D. Mumford (Ed.), *Handbook of Organisational Creativity.* (pp. 189-215) Norman, OK: Elsevier Academic Press

Rank, J., Pace, V. L., & Frese, M. (2004). Three avenues for future research on creativity, innovation, and initiative. *Applied Psychology, 53*(4), 518-528.

Rank, J., Pace, V.L., and Frese, M. (2004). Three avenues for future research on creativity, innovation, and initiative. '*Applied Psychology: An International Review.*' 53 (4), pp.518-528.

Robertson, I. T., Baron, H., Gibbons, P., MacIver, R., & Nyfield, G. (2000). Conscientiousness and managerial performance. *Journal of Occupational and Organizational Psychology*, *73*(2), 171-180.

Runco, M. (2007). Creativity theories and themes: Research, development and practice. Burlington, MA: Elsevier Academic Press

Runco, M. A., Illies, J. J., & Eisenman, R. (2005). Creativity, originality, and appropriateness: What do explicit instructions tell us about their relationships?.*The Journal of Creative Behavior*, *39*(2), 137-148.

Sauermann, H., & Cohen, W. M. (2008). *What makes them tick? Employee motives and firm innovation* (No. w14443). National Bureau of Economic Research.

Sauermann, H., & Cohen, W. M. (2010). What makes them tick? Employee motives and firm innovation. *Management Science*, *56*(12), 2134-2153.

Shin, S. J., & Zhou, J. (2003). Transformational leadership, conservation, and creativity: Evidence from Korea. *Academy of Management Journal*, *46* (6), 703-714.

Silvia, P. J. (2008). Another look at creativity and intelligence: Exploring higher-order models and probable confounds. *Personality and Individual Differences, 44*(4), 1012-1021.

Simonton, D.K. (1984). Artistic creativity and interpersonal relationships across and within generations. '*Journal of Personality and Social Psychology*.' 46, pp.1268-1273.

Sosik, J. J., Kahai, S. S., & Avolio, B. J. (1999). Leadership style, anonymity, and creativity in group decision support systems: The mediating role of optimal flow. *The Journal of Creative Behavior, 33*(4), 227-256.

Squalli, J., & Wilson, K. (2014). Intelligence, creativity, and innovation.*Intelligence*, *46*, 250-257.

Stam, D. A., de Vet, A., Barkema, H. G., & Dreu, C. K. W. (2014). Why quiet reflection improves development performance. *RSM insight*, *17*(1), 14-15.

Steel, G. D., Rinne, T., & Fairweather, J. (2011). Personality, nations, and innovation: Relationships between personality traits and national innovation scores. *Cross-Cultural Research*.

Sternberg, R. J. & Lubart, T. I. (1991). An investment theory of creativity and its development. Human Development, 34, 1–32

Sternberg, R. J. (1982). Nonentrenchment in the assessment of intellectual giftedness. *Gifted Child Quarterly, 26*(2), 63-67.

Sternberg, R. J. (1997). *Successful intelligence: How practical and creative intelligence determine success in life*. London: Plume Books.

Sternberg, R. J., & Lubart, T. I. (1996). Investing in creativity. *American psychologist*, *51*(7), 677.

Suliman, A. M., & Al-Shaikh, F. N. (2007). Emotional intelligence at work: links to conflict and innovation. *Employee Relations*, *29*(2), 208-220.

Sung, S. Y., & Choi, J. N. (2009). Do big five personality factors affect individual creativity? The moderating role of extrinsic motivation. *Social Behavior and Personality: an international journal*, *37*(7), 941-956.

Sung, S. Y., & Choi, J. N. (2009). Do big five personality factors affect individual creativity? The moderating role of extrinsic motivation. *Social Behavior and Personality: an international journal*, *37*(7), 941-956.

Tehran, M. & Khaledi, F. (2014). An investigation on the effects of personal characteristics on creativity and innovation. *Management Science Letters*, *4*(7), 1495-1498.

Torrance, E.P. (1966). The cooperative and competitive goal approach to conflict: Accomplishments and challenges; 'The Torrance test of creative thinking: Norms-technical manual.' Lexington, MA: Personnel Press.

Van Rooy, D. L., & Viswesvaran, C. (2004). Emotional intelligence: A meta-analytic investigation of predictive validity and nomological net. *Journal of Vocational Behavior*, *65*(1), 71-95.

Ward, T. B., Smith, S. M., & Finke, R. A. (1999). Creative cognition.

Wejnert, B. (2002). Integrating models of diffusion of innovations: A conceptual framework. *Annual review of sociology*, 297-326.

West, M. A. (2002). Sparkling fountains or stagnant ponds: An integrative model of creativity and innovation implementation in work groups. *Applied Psychology*, *51*(3), 355-387.

Williamson, J. M., Lounsbury, J. W., & Han, L. D. (2013). Key personality traits of engineers for innovation and technology development. *Journal of Engineering and Technology Management*, *30*(2), 157-168.

Wycoff, J. (2004). The Big Ten Innovation Killers. Innovation Network, CA.

Yidong, T., & Xinxin, L. (2013). How ethical leadership influence employees' innovative work behavior: A perspective of intrinsic motivation. *Journal of business ethics*, *116*(2), 441-455.

Zhang, X., & Bartol, K. M. (2010). Linking empowering leadership and employee creativity: The influence of psychological empowerment, intrinsic motivation, and creative process engagement. *Academy of Management Journal*, *53*(1), 107-128.

Zhou, J., & Shalley, C. E. (2003). Research on employee creativity: A critical review and directions for future research. *Research in personnel and human resources management*, *22*, 165-217.

Zibarras, L. D., Port, R. L., & Woods, S. A. (2008). Innovation and the 'Dark Side'of Personality: Dysfunctional Traits and their Relation to Self-Reported Innovative Characteristics. *The Journal of Creative Behavior*, *42* (3), 201-215.

Zibarras, L. D., Patterson, F. & Judson, H.C. (in press). The differential influence of traits and manager behaviour on employee innovation. *Business Creativity and the Creative Economy*.

Correspondence
Professor Fiona Patterson Work Psychology Group & University of Cambridge, UK, f.patterson@workpsychologygroup.com.

Dr Máire Kerrin, Work Psychology Group & City University London, UK, m.kerrin@workpsychologygroup.com

Authors' Brief Bios

Professor Fiona Patterson is a Principal Researcher at the University of Cambridge & founding Director for the Work Psychology Group, an international research-led organisational psychology consulting practice. Fiona has published widely in assessment, especially in relation to selection, innovation and change in organisations.

Dr Máire Kerrin is a founding Director of Work Psychology Group and Visiting lecturer in Organisational Psychology at Cass Business School, City University. She specialises in assessment, innovation and organisational change and development.

CHAPTER FIVE

A CAGE FOR THE MUSE AND THE LIMITS OF INVENTION

MICHAEL BROWN & CHRIS WILSON

Abstract

This paper explores the notion that creativity in the arts, particularly music, benefits from constraints. Expressive freedom is often fostered within education to encourage the pursuit of artistic individualism, but straying too far from stylistic norms can often engender incoherence. This paper does not challenge the breaking of rules that define a style nor does it denigrate the benefits that may arise from conflicting ideas and unusual combinations, but explores the virtue and benefits of boundaries and suggests that freedom, from a creative perspective, is often an illusory construct; strong creative identities are achievable through and often defined by creative constraints. Conclusions focus on the potential profits of constraints that bind expressive ideas and the function and virtue of intuition within the creative process; theorizing upon whether creative confinement, or the awareness thereof, is ultimately a liberating or inhibiting experience. We determine that artistic creative freedom as a concept may indeed be illusory, but the perception of freedom for some is a necessary ingredient in the creative act.

> *"...my freedom will be so much the greater and more meaningful the more narrowly I limit my field of action and the more I surround myself with obstacles.....The more constraints one imposes, the more one frees one's self of the chains that shackle the spirit."*
> —Igor Stravinsky (1942), Poetics of Music, Harvard University Press.

Keywords: creativity, constraint, inspiration, music, art, education

Prelude

Whilst there are certainly exceptions, generally profound works of art and our most revered artists often appear at the epoch of a stylistic period, not the beginning. Innovations in *art* are not necessarily the best examples of the form, some refinement of structure normally ensues which is, to some extent, inevitable.

Constant innovation in the arts is also not typical or desirable, forms of individual expression often need time to mature. Consider the formative works by key artists and early examples or stylistic structures, for example: the 18th century innovations introduced by Johann Stamitz (1717-1757) to the *symphony*, expanding not only the orchestral structure but incorporating thematic traits from other forms, exploring new dynamic devices, and introducing the four-movement form that became the norm for later composers. Despite this Stamitz is not a popular name in modern programs of concert music even though he composed near sixty symphonies. Why also is the work of French painter Francis Picabia (1879-1953) not more significantly within the public consciousness? As a key figure influencing early 20th century progression of Modern Art, contributing to multiple stylistic definitions most significantly Dadaism; he was also particularly pivotal in introducing modern European ideas to America and yet is infrequently discussed in modern art textbooks.

The word *style* itself constitutes a set of formal preconceptions; to work within a style one must consistently repeat characteristic features within the acceptable boundaries that circumvent the form. Style may be identified and considered at a number of hierarchical levels as illustrated in figure 1 below. At the level of a *period of history* we can observe generalized patterns of behavior which typically define broad syntactic paradigms. We can consider the prevalent behaviors within a period of time; we can then consider the forms that constitute these behaviors and we can further consider individual characteristics of particular artists.

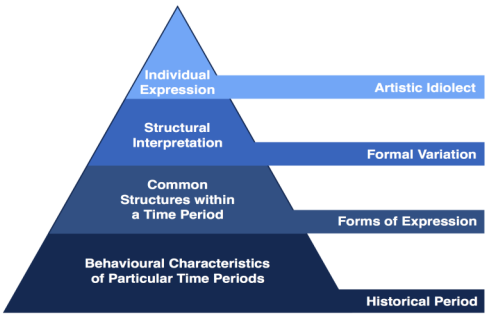


Figure 1: Hierarchies of Style

We comprehend the new with respect to the old, we make comparisons to serve our conceptual frameworks. History often provides a foundational structure upon which to develop new ideas and these ideas may also be the result of multi-modal cross-fertilization, but all art may ultimately have to be considered a product of its time, as Kandinsky succinctly expressed it:

> *"The various arts of today learn from each other and often resemble each other… The greatest freedom of all, the freedom of an unfettered art, can never be absolute. Every age achieves a certain measure of this freedom, but beyond the boundaries of its freedom the mightiest genius can never go. But the measure of freedom of each age must be constantly enlarged."*
> —Wassily Kandinsky, W. (1910) *Concerning the Spiritual in Art*

There may be multiple reasons, see figure 2 below, why artists might be motivated to create something new. Whatever the reasons, freedom of expression is a common expectation but are there limits to original invention? When the familiar yields little novelty, may we then justifiably supplant old constraints with new semantic designs, recover and revisit lost avenues from foreign landscapes or invite the *Muse* to roll the dice?

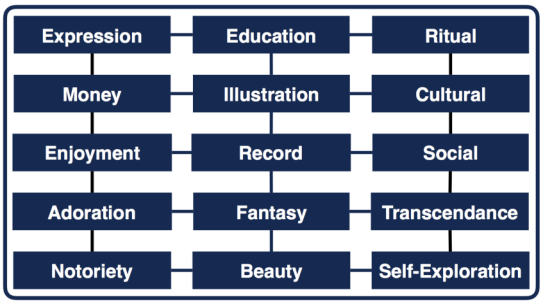


Figure 2: Creative Motivations

This chapter begins by exploring the fundamental idea of creative and expressive freedom within the arts and discusses approaches to education challenging existing pedagogic philosophies. We will develop the discussion by offering theoretical insights outlined in key texts and incorporating observations drawn from the authors experience as an undergraduate student of music and art, incorporating illustrations from professional teaching experience as a lecturer within a UK university.

Free as a Bird

Artists may wish to consider their work a free and individual expression unfettered by audience expectation or priori considerations; this is for some a significant motivator; artists are inspired by great works and successful creative minds of the past, but ultimately seek to express a personal, unique and resonant message.

> *"Artists talk a lot about freedom. So, recalling the expression: 'free as a bird,' Morton Feldman went to a park one day and spent some time watching our feathered friends. When he came back, he said, 'You know? They're not free: they're fighting over bits of food.' "*
> —John Cage (1969) from the lecture "Indeterminacy" given in Brussels in 1959 (published in *Silence* p. 265).

It is not an uncommon perception that as artists we are *free* and empowered to express ourselves in any medium we desire, that we are not bounded by *rules*, in fact *rule-breaking* is what we do! Bill Bernbach, copywriter and founder of advertising agency *DDB Worldwide*, said "*Rules are what the artist breaks; the memorable never emerged from a formula*." (Eadie, W.F. 2009).

A key motivational characteristic of the artistic creative act may indeed be the persistent believe that we are uniquely positioned to explore with conviction and assuredness any means that we wish, and that works that are the result of *inspiration*, or involuntary intuitive creativity, are a pure expression of the artist; as though the paint, the form, the sonic organization in the music is semantically manipulated to represent a direct connection to, and expression of, the *heart* or *soul* of the artist. This paper does not seek to dismantle this perception, it acknowledges it as a potentially needful aspect of the creative act, without which the necessary mystery surrounding the artifact or performance for the artist, and audience, would be perhaps absent and bereft of coherence.

The connection that an artist makes with their chosen medium may absolutely be a wonderful experience from both perspectives, but as educators it may not be particularly insightful for students of an art-form to learn that in order to be creative one must wait for inspiration which may or may not appear, or that you are either *creative* or you are *not.* The writings of 18th century theorist Edward Young support this rather unhelpful view:

> *"An original may be said to be of a vegetable nature, it rises spontaneously from the vital root of genius; it grows, it is not made…"*
> —Young (1759) *Conjectures on Original Composition* taken from Kivy, P. (2001) *The Possessor and the Possessed*

It is also a common belief, certainly amongst students of popular music informed perhaps by psychedelic anecdotes, that if you are already defined by *creativity* that you may become more creative by attending to *states-of-mind* rather than furthering knowledge and developing technique. There is perhaps for some a mistrust of the role education might play in the development of artists, as though instilling stylistic *rules* might limit imaginations to well trodden paths, elevating coherence above expressive needs; as Gaut (Paul, E.S and Kaufman, S.B., 2014) puts it, *"...learning cannot advance our originality, although it may destroy it."* There may be a reluctance to understand how it, creativity, works, especially if it is currently functional since this might *spoil the magic* and the capacity to create may be lost. Can creativity actually be taught? Are there universal lessons in *creativity* that transcend the different creative domains, the understanding of which might increase our capacity for original thought? *"...coming up with an idea is a process, not an accident"* said DBB chairman Keith Reinhard (Young, 2003); if this is the case might the creative act be demystified and reduced to a series of predictable algorithmic steps, could we program art? Is the *humanity* in the process so important that we should dismiss such considerations or *forbid* them as modern-day binary *Luddites*?

Perhaps as art director George Lois (2012) believes that new ideas may be formed as a product of experimental discovery to find novel combinational products, *"I don't think I create anything. I'm really serious — I discover the ideas."* It is easy to see from the perspective of a composing pianist with a limited palette of sounds how this might be the case, where there are physical constraints of pitch (eighty-eight discrete notes, with a fixed tuning), limited polyphony (barring the use of forearms, equivalent to the number of fingers), limited dynamics and constraints of acceptable combinations (determined by *style* and performer *technical ability*). Are the number of original ideas, at least in this case, finite? And how do we know when we have created or discovered something of value? What criteria determine this assuming this can be measured? Would the idea need to be compared with all other creative work for validation and does it need to be determined to reflect the *zeitgeist* or is this inevitable? Can we be certain that the obsession we have with a particular expression is novel and interesting enough to be of lasting significance? Should that even concern the artist?

The Girl from Ipanema

What role does *beauty* play in the creative process and is this aesthetic sense free or bounded by cultural or personal conditions; should this too be mistrusted as Grayson Perry (2013) said *"beauty is very much about familiarity and it's reinforcing an idea we have already…. Because our idea of beauty is constructed, by family, friends, education, nationality, race, religion, politics, all these things"*. Are aesthetic qualities even necessary for the creation or appreciation of Art? What did Marcel Duchamp actually mean when he said (Danto, 1983) *"Aesthetic delectation is the danger to be avoided"*? Despite this it is very counter intuitive to regard creativity as a process in which the consideration of aesthetics is not a key motivational characteristic. Conceptual artists Vitaly Komar and Alex Melamid were certainly being mischievous when they commissioned their market research to democratically determine aesthetic preferences correlated across eleven different countries, but it does provoke some interesting perspectives concerning artistic free-will against predetermination (see Komar & Melamid, 1995). In commenting upon the rather banal results Komar said (Wypijewski, 1997):

> *"In our early work, we arrived at [the] definition of freedom that entailed being free from individual clichés, being free to change intonations and styles. Individuality lost its stability and its uniqueness. Now we are searching for a new freedom …..Looking for freedom, we found slavery."*

We can be equally fascinated and interested with things that we do not find aesthetically ideal but this does imply that we know what we do; as cinematographer Conrad Hall said, *"There is a kind of beauty in imperfection"*. Novelty itself is perhaps quite easily achievable, providing we have amassed significant knowledge or can access a database in the form of expertise, artificial or otherwise; but is there something other than novelty that is sought in the creative process? Original work clearly does need to have value and a context within which the value is to be judged but is this necessary at the time of conception? There are numerous instances of artists working outside of contextual frameworks individually pursuing creative apparently disconnected from their societal origins.

As educators should we be seeking ways to assist the student to experimentally *discover* something that is characteristically novel, that others then may elevate to the position of *Art*? Or leave inspiration to chance, favoring the privileged few or ignore the idea of creative training and simply focus upon the craft in the hope that the student finds a unique enough voice to secure creative survival and function. It is very natural for students to seek early validation and guidance, as they frequently negotiate for optimal grades

through attempts to establish tutor preferences. This brings into question the value of judgmentally awarding qualitative grades to a creative work, and how detrimental this might prove to be for the development of an individual expressive voice that may consequently struggle to escape the constrictive ideals of the tutor. Perhaps complete freedom is not always what artists, or students of art, require; if art is an expression then on some level it must be communicable and coherent to the audience, which means there will be presumably a familiar framework for appreciation. For an artist to be known to be of a particular species then he/she must be re-creating on some level, repeating past success wherein authorial identity lies.

Creativity can also be understood to function at a number of qualitative levels as defined by Kaufman's and Beghetto's 'Four C model' (2013) and Sternberg's creativity types (2006). Does this impose an unwelcome pressure to function at the highest levels and inviting the perception that the lower forms are less significant? How many *innovative* artists do we actually need?

Across The Universe

The role of *inspiration* in the creative process does need quantifying; if creativity is a process then should inspiration be regarded as a requirement for the production of art or the validation of the artist? Composer Aaron Copland (Maisel, 2000) suggested that inspiration should not be regarded as a self-obsessed condition when he said of it: *"Inspiration may be a form of a super-consciousness, or perhaps of sub-consciousness - I wouldn't know. But I am sure it is the antithesis of self-consciousness"*. Should we regard the work produced mechanically as in some way invalid? If it is deemed necessary, how long should we wait for inspiration until we determine that we do not have the capacity to be creative at all?

> *"Someone once asked me.., whether I waited for inspiration. My answer was: "Every day!" But that does not imply a passive waiting around. That is exactly what separates the professional from the dilettante. The professional can sit down day after day and turn out some kind of music. On some days it will be undoubtedly better than others; but the primary fact is the ability to compose. Inspiration is often only by-product."*
> —Aaron Copland (1939) - *What to Listen for in Music*

As artists should we stop ideating about the *muse* and just get on with the work as author Frank Tibolt suggests? *"We should be taught not to wait for inspiration to start a thing. Action always generates inspiration. Inspiration*

seldom generates action". Painter Chuck Close dismisses it all together (Fig, 2009) *"I don't work with inspiration. Inspiration is for amateurs. I just get to work."* Leonard Bernstein was, like Copland, very pragmatic in his attitude towards it (Tharp, 2003), *"Inspiration is wonderful when it happens, but the writer must develop an approach for the rest of the time… The wait is simply too long."* Picasso said (Villasante, 1994) *"Inspiration does exist, but it must find you working."* this is also echoed by Stravinsky (Graf, 2013) *"Just as appetite comes by eating, so work brings inspiration, if inspiration is not discernible at the beginning."* Why is inspiration, involuntary creativity, regarded at all as a significantly special part of the creative process? Composer Pyotr Ilyich Tchaikovsky was very clear about the significance of inspiration (Tchaikovsky, 2004), *"Do not believe those who try to persuade you that composition is only a cold exercise of the intellect. The only music capable of moving and touching us is that which flows from the depths of a composer's soul when he is stirred by inspiration."* To what extent are artists bound by prior structural conditions, expressive, technical or otherwise? And is there any virtue in raising awareness of these features? How does one learn to create art? Should we focus upon the nurturing of the conditions of creativity? To accept the role inspiration might have to play in the process. Painter Agnes Martin described this phenomenon (Glimcher, 2012) as a result of a relaxed contemplative mind:

> *"An inspiration is a happy moment that takes us by surprise. Many people are so startled by an inspiration or a condition of inspiration, which is so different from daily care that they think that they are unique in having had it. Nothing could be further from the truth. Inspiration is there all the time for anyone whose mind is not covered over with thoughts and concerns, and [it is] used by everyone whether they realize it or not. […] It is an untroubled state of mind. Of course, we know that an untroubled state of mind cannot last, so we say that inspiration comes and goes, but it is there all the time waiting for us to be untroubled again. We can therefore say that it is pervasive."*

Within artistic educational institutions students are indoctrinated through studying the work of past masters, to develop technique and absorb philosophies; this is initially achieved through, environmental exposure, structured observing/listening and technical imitation, encouraging the students to secure identity and ownership in the pursuit of increasingly idiosyncratic approaches developing a personal expressive voice. How does this work in

practical terms? It may involve, in particularly enlightened institutions, the consideration of the creative space within which play and experimentation is encouraged or the development of a creative mind-set involving attention to meditative states laying the foundations for that special romantic notion, that the *muse* may deliver an inspirational idea but this is understood to usually be reserved for a select number of chosen individuals, as is often illustrated by the following insightful text derived from an account given by 19th century publisher Friedrich Rochlitz originally in 1815 within Germany's *General Music Journal* and cited in numerous publications such as: *The Life of Mozart, Including his Correspondence* by E. Holmes (2009), *The Emperor's New Mind* by R. Penrose (1999), and *Creativity: Selected Readings*, edited by Vernon. P (1970).

> *"...All this fires my soul, and provided I am not disturbed, my subject enlarges itself, becomes methodized and defined, and the whole, though it be long, stands almost finished and complete in my mind, so that I can survey it, like a fine picture or a beautiful statue, at a glance. Nor do I hear in my imagination the parts successively, but I hear them, as it were, all at once.... When I proceed to write down my ideas, I take out of the bag of my memory, if I may use that phrase, what has previously been collected into it, in the way I have mentioned. For this reason, the committing to paper is done quickly enough, for everything is, as I said before, already finished; and it rarely differs on paper from what it was in my imagination."*
> —Wolfgang Amadeus Mozart.

This describes composition as a passive mental process, the complete product being channeled through the *inspired* composer as though the music was subconsciously discovered rather than composed. Unfortunately, although originally attributed to a letter written by Mozart himself, as Ashton (2015) reveals, this is now considered a forgery. This is not to say that inspiration as a phenomenon does not exist, but that it may not form a complete picture of process; it may not be entirely helpful to consider completely a mystical involuntary process to which only particular artists are privileged to experience. There may be evidence to suggest that, whereas some people exhibit the potential for multi-modal creativity, artists that play instruments or compose, musicians that paint, sculpt or take photographs etc., or artists that exist between two domains perhaps in a new emerging forms, or develop cross-fertilized ideas drawing upon multiple influence, creativity will general-

ly manifest itself maturely within a single domain, that is familiar to the artist in which the artist has invested significant interest, time and effort, see Kaufman and Sternberg (2010). If this is the case, are large scale theories of creativity truly meaningful? Are measures for creativity or general creative exercises even applicable?

Introducing aspects of the *Torrance Tests of Creative Thinking* to music students, administered by the authors on multiple occasions, seemed to yield little insight into the creative potential of musicians despite very clear creative attributes being present, but perhaps this is the wrong test. The process of creativity has been investigated from a number of perspectives offering some speculative insight into the mechanism and characteristics of creative individuals, but this knowledge is seemingly not often applied in any tangible form within arts-based institutions of learning. The most common response from students when asking the question about whether creativity can be taught is a resounding *no*. Trends in educational philosophies similarly may feature in pedagogical approaches providing shifting frameworks upon which to structure a creative curriculum, but generally this is not transparent to students or necessarily of interest to them. The syllabus will probably will not include an involved study of great creative failures although the developmental decisions of artists may provide significant insights into creative reasoning; it also will likely not coerce students into producing poor art or directly consider failure as a viable process outcome or something that may be of interest in another context; and yet in other aspects of society we learn what is *right* by also appreciating what is *wrong* even if we generally do not challenge these concepts irrespective of the moral origins. Should artists also be encouraged to be cognizant of issues above and beyond their own field of expression?

> *"Originality depends on new and striking combinations of ideas. It is obvious therefore that the more a man knows the greater scope he has for arriving at striking combinations. And not only the more he knows about his own subject but the more he knows beyond it of other subjects. It is a fact that has not yet been sufficiently stressed that those persons who have risen to eminence in arts, letters or sciences have frequently possessed considerable knowledge of subjects outside their own sphere of activity."*
> —Rosamund E. M. Harding (1939) *An Anatomy of Inspiration*

At least within the arts, there are some obvious and some less obvious constraints that limit the nature and expressive qualities of creative perfor-

mance and artifact production, and that these constraints are considered by some as a necessary and conscious requirement.

We Don't Need No Education

Education within the arts will likely involve, at least initially, the systematic analysis, and possibly re-creation of key works, or features of, to understand the respective *craft* involved, learn technique through directed simulated commissions, and with respect to music, to develop appropriate communication and symbolic representation. New ideas are contextualized, sometimes retrospectively if the compositional process is intuitively conceived; this is to allow comparative evaluations to be effectively made.

> *"Here's a new design, the cut and style you know so well."*
> —David Sylvian (1980). Lyrics from the song
> *Methods of Dance*, Japan.

There is only so much that can be intuitively absorbed technically through passive observation and listening but this also has to form part of the development of an *aesthetic sensibility* to learn to *know* and appreciate what is right, what is appropriate, and what is wrong, what is inappropriate, in any given context. In music this often takes the form of practice; through persistent repetition of technical exercises with reference to specific stylistic *rules*, students are steered to develop the craft; sometimes students are encouraged to approach the exercises with an inquisitive improvisational playfulness, but there are usually boundaries to ensure the distraction of complete freedom does not result in only re-creation.

The study of key works by master craftsmen becomes a feature with the objective to extract salient *rules*. The author's' memory of the three years of harmony training, courtesy of the publications of William Lovelock (1946), at times seemed a very oppressive experience consisting of the learning predominantly of what one should *not* do which often, from the perspective of a late 20th century student of popular music, seemed very counter intuitive.

> *"12. Harmonic Progression*
> *The following points must be memorised:*
> *(a) No two parts may move in parallel perfect 5ths or octaves in consecutive chords. Consecutive octaves or 5ths in contrary motion are also forbidden, as are the progressions unison to octave and octave to unison.*

> *(b) S. and B. may not approach an octave or 5th in similar motion, with a leap in the S. This fault is called an "exposed" octave or 5th. If the S. moves by step, the progression is good."*
>
> — Taken from Lovelock, W (1946) First Year Harmony.

The objective of this instruction is to learn what is *normal*, to distil what other composers build into habitual routines. This does not really help with the understanding of creativity but does give some insight into the craft involved and the stylistic norms. This is usually accompanied with the familiarization of key masterworks. Why should we begin by studying the developed and mature works of masters how is this helpful? Why not their early less developed works where the language and technique is not fully formed; how did, for example, Mozart's *Symphony No.1* composed in 1764 when he was only eight years of age develop onto the much more sophisticated *Symphony No.41* composed in 1788; influences are visible in the form of stylistic imitation, the symphonic works of J.C Bach may have been particularly influential, and the young Mozart would most certainly have received fatherly support and guidance.

In the more popular idiom how did the band the *Beatles* evolve their song writing techniques exhibited in *Please Please Me* (1963) onto *Sgt. Pepper's Lonely Hearts Club Band* (1967) within just four years? Or throughout this process as illustrated by Pedler (2003), how did *Lennon & McCartney* develop a relatively mature understanding of western dominant harmony apparently without a single formal overt lesson in harmonic progression?

How did the artist Kandinsky develop from his pictorial representation within such early works as *Odessa Port* (1898) onto the more abstract later works such as *Composition* (1944), and how did the early figurative work of Mark Rothko such as *Hierarchical Birds* (1942) inform is later expressive explorations such as the *Four Darks in Red* (1958). What can be learned from studying technique? How much history is needed for modernism?

> *"It doesn't make much difference how the paint is put on as long as something has been said. Technique is just a means of arriving at a statement"*
>
> —Jackson Pollock. Taken from *Pollock, Veiling the Image* by Donald Wigal (2006)

If one wished to compose a symphony, write a popular song or paint a picture, where would one begin? Therein lies our first obvious constraint, the

art form. Creative individuals tend to focus upon particular art-forms; even the most adventurous Jazz free-improviser will generally not pedal their trade on an unfamiliar instrument despite eliciting a multitude of unconventional arrangements of sound; they are bound by their instrument and their technical abilities; the constraints can be understood, certainly in this context, to offer tremendous expressive freedom within the boundaries of their chosen stylistic discipline. Imitating the styles and techniques of contemporaries is the most traditional method on the path to develop original creative ideas. This is usually achieved through exposure of some form to the wisdom and works of other artists and the formalized path would involve attending art college or a music conservatoire, either that or join a cover band and tour the bars of Hamburg for four years.

Constraints are common within educational exercises but what are the virtue of these? Sometimes the learning is implicit and the experience alone induces comprehension. The exercises below, drawn from a number of art-college exercises encountered by the lead author in the mid-1980s, are designed to heighten sensory awareness of particular attributes, to focus attention upon particular characteristics and ensure that novelty, at least on the part of the student, is experienced. Each exercise is defined by the constraint (see figure 3 below), and may be repeated, after evaluation, within a set timeframe with variational adjustments to provoke a different experience. The evaluative phase could be a self-appraisal or might involve tutor or peer input to establish the successful attributes to be enhanced. A primary objective throughout the exercises was to provoke *divergent thinking* producing as many ideas as possible, and as such much of the activity was time constrained.

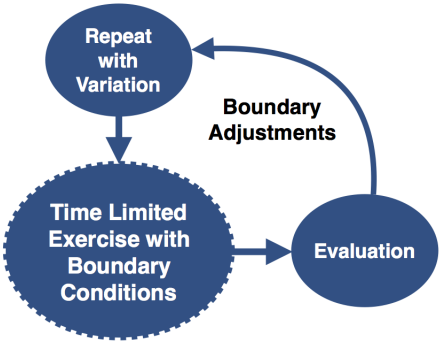


Figure 3: Boundary Conditions

Artistic Workshop Constraints

- ***Remote Observation***—The life-model is situated on the top floor of the building and the easel is located on the ground floor. The artist may make visual observations only in the presence of the life model; no sketches or photographs are allowed. The artist may visit the model any number of times during the two-hour session.
  Objective: Learn to observe more carefully, making visual measurements of proportions, working from memory.

- ***Limited Media***—The artist is instructed to produce a representation of a given still-life or life-model but is restricted to using directed media only. Drawing, painting or collage with limited media or color palette.
  Objective: Understand the given media better developing new techniques in unfamiliar ways.

- ***Themed Still-Life*** —The still-life materials are constrained to being sourced from a directed location; for example only assembling the composition from household containers found in a single cupboard or building.
  Objective: Develop an awareness of and preference for composition.

- ***Observational Restriction***—Imposing observational constraints such as extreme angles, possibly onto a canvas of limited size or unconventional dimensions/material.
  Objective: to appreciate perspective, focus awareness upon tonal qualities.

- ***Less Dominant Hand***—Drawing or painting with the weaker less dominant hand. Making the task much more difficult technically.
  Objective: to encourage more careful and deliberate movements, slowing up the work and decisions made. Possibly thought to stimulate alternate side of brain to increase creativity?

- ***Limited Time***—Exercises such as life-drawing are given time limits.
  Objective: to discourage too much thinking and more intuitive work.

- ***Changing Easel***—moving to another student's easel to continue their work after a limited time.
  Objective: to learn to work with what is provided. Develop critical perspectives trying to appreciate and develop what is there rather than begin again each time.

- ***Negative Space***—Focus upon the space around and in between the object.
  Objective: To 'look' differently and appreciate how the environment/ negative space around and within the object contributes to the composition.
- ***Scale***—Focus on a smaller part of the object or make the object smaller in the environment.
  Objective: to find alternate interest in the object and develop a sense of composition.
- ***Fragmentation***—The work is cut up and reassembled.
  Objective: *to find alternate interest in the object and develop a sense of composition.*
- ***Distortion***—Consciously distort or exaggerate aspects of the object. View the object's shadow or reflection only or imagine light falling from different directions.
  Objective: *to find alternate interest in the object and develop a sense of composition.*
- ***Eclecticism***—working in a particular style, like a particular artist, or juxtaposing other traditions.
  Objective: to explore and absorb new technical and stylistic characteristics and potentially synthesis new ones.
- ***Continuity***—*Once the pen touches the paper it cannot be removed. The work is completed with a single continuous line.*
  Objective: to create the work with very considered movements demonstrating the capacity to plan the creative space.

Most of the learning was implicit in that the reasons for the exercises were never made completely clear at the outset; very often there was considerable frustration and confusion but this seemed to be a desirable, on the part of the tutor, feature and part of the challenge. Frequently throughout the exercises the students would be called to respond to formative guidance, see figure 4 below, to steer the student to a more secure, determined through aesthetic criteria, solution.

Figure 4: Constraint Pairs, Adapted from Stokes (2006)

The discussion would involve the sharing of the work informally to evaluate the most and least successful or interesting features; from this an attempt would be made to enhance or augment some features and remove or diminish others. This is mirrored in Stokes (2006) who presented the idea of constraints being considered in pairs to preclude negative aspects but promote positive attributes. This may involve incidental or even strategic contradictions of the student creating a paradox to be solved, from two or more qualified perspectives - Learning through paradox embracing as Lewis (2000, p. 760) explains, denotes a *"contradictory yet interrelated elements—elements that seem logical in isolation but absurd and irrational when appearing simultaneously."*;

> ***Man:*** *Oh look, this isn't an argument.*
> ***Mr. Vibrating:*** *Yes it is.*
> ***Man:*** *No it isn't. It's just contradiction.*
> ***Mr. Vibrating:*** *No it isn't.*
> ***Man:*** *Argument is an intellectual process.*
> *Contradiction is just the automatic gainsaying*
> *of any statement the other person makes.*
> ***(short pause)***
> ***Mr. Vibrating:*** *No it isn't.*
> —Taken from Monty Python's Flying Circus, *The Argument Clinic* (1972)

There is invariably more than one technical/aesthetic solution; this practice was intended to encourage the student to choose and express a preference, developing a more individual attitude to the work. Artistic perspectives would be revealed later through seminar discussion, as motivations were revealed and a consensus of what worked and did not was sometimes reached;

however, differences of opinion were common. History would be studied, generally of key styles and significant artists, offering some insight into techniques and processes. Theories of composition and perspective would be explored and it was understood that select key works were good examples of 'great' art but it was not always clear why. The development of a *sense-of-aesthetic* it seemed was to some extent left to chance and personal style grew out of repetition habits and discovery; the 20th century would always be a difficult place for both art and music students because of modernistic trends that broke with tradition. In more recent years the authors have adopted and translated some of the above given exercises music in addition to the more common methods of developing musical compositional technique. These limitations are similarly designed to increase focus, relieve anxiety and to some extent creative responsibility as to where to begin in a compositional task; failure then is not so inhibiting, and the potential for serendipitous discovery elevated and significant.

- ***Timbral Limitation I***—composition for one instrument only.
  Objective: To investigate the sonic potential of a single directed force appreciating the limits and potential.
- ***Timbral Limitation II***—a limit on the number, kind or combination of instruments.
  Objective: To investigate the sonic dialogue possible between the directed instrumental forces.
- ***Collaboration I***—division of labor or group improvisation.
  Objective: To interrogate roles and relationships and explore the nature and potential of partnership in creativity.
- ***Collaboration II***—compose for a designated colleague to perform considering instrument, ability and musical preferences.
  Objective: To develop a sense of realism in compositional design and appreciate the limitations of the individual performer.
- ***Partial Solutions***—directions take the form of completing given materials such as lyrics, chord sequence or a missing section for example: a complete chorus needing a verse. Complete the given phrase/harmonize the given melody/produce a melody or improvisation over the given harmony/produce a countermelody or full contrapuntal structure around the given harmony. Modulate from key/mode A to key/mode B etc.

Objective: To develop divergent capabilities in the production of multiple solutions to given problems.

- ***Found Sounds***—Only use found-sounds collected from a designated space/time developing a composition from non-musical sounds.
  Objective: To consider the concept of *Sound Art* and develop sound manipulation techniques.
- ***Fusion***—merge together two or more designated musical attributes such as style and/or technique.
  Objective: To explore and appreciate the combinatory opportunities presented from unlikely unions of form.
- ***Polarity***—Complete freedom in one dimension but severe restriction in another, for example: unlimited rhythmic facility but limited tonality.
  Objective: To explore the potential of finding novelty in the conflict of opposing constraints.
- ***Transformation***—Explore the mechanisms variation involving distortions of scale, augmentation, diminution, rhythmic addition and subtraction.
  Objective: To develop the technique of developing progressive divergent variations.

Why do this at all? To encourage the student to look at the problem of creation from as many viewpoints as possible. The prevalent and favored learning experience of FE popular music students seems to be largely self-directed playful exploration informed by online tuition. This is partly informed by the nature of the subject and the social aspects and why students are drawn to the subject in the first instance. When complete creative freedom is offered in an assignment, students seem naturally inclined to respond in one of three ways:

1. ***Recreation***—repeat past successes, using formulaic mechanisms generally referred to as *operational conditioning.*
2. ***Resubmission***—resubmit an existing work verbatim.
3. ***Inactivity***—the lack of definition is inhibiting and results in significant creative frustration

The exercises are to make re-creation is less likely and creativity a more likely consequence. As a result the student is forced to solve a problem using

unfamiliar criteria that will inevitably result in novelty, at least from the perspective of the student, and may reveal some hitherto unknown characteristic of the subject or process. Imposing these constraints in this for results in a number of definable outcomes and illustrated in figure 5.

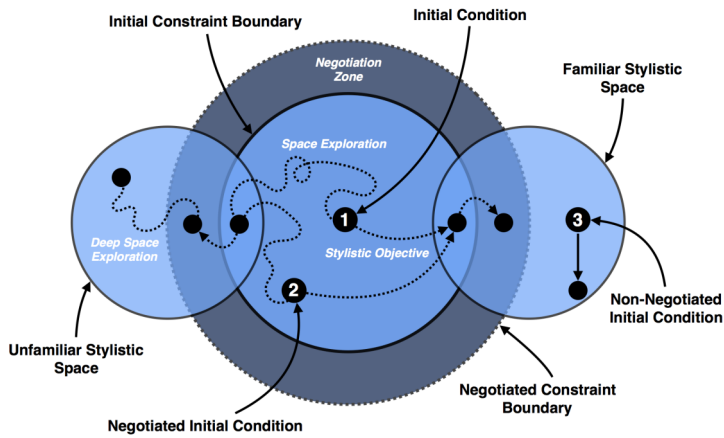


Figure 5: Constraint Outcomes

The outcomes of imposing the constraints fall into six main categories, some more creatively profitable than others:

1. **Compliance I**—the student accepts the direction and finds novelty within the boundary of the constraint. The process is profitable and to some extent creatively liberating.

2. **Compliance II**—the student attempts to *recreate* within the constraint boundaries. This may be have meaning and function to develop further technical facility but is not creatively significant.

3. **Compliance with Negotiation**—the limitations are accepted, up to a point, then the student negotiates additional conditions or inclusions which may involve multimodal considerations.

4. **Negotiation**—the constraints stimulate the imagination to the extent that new boundary conditions are proposed at the outset, represented as number two in the above figure.

5. **Inactivity**—The student appears frustrated with the constraint and is demotivated.

6. **Non-Compliance**—The constraints are completely disregarded, represented as initial condition number three in the above figure, and student engages in re-creation.

The exercises are generally very productive and engagement one through four are the most common. The prospect of negotiation on some level is expected and may arrive at different stages depending upon motivation, imagination and sometimes time allowed; this invites the possibility that new unfamiliar creative space, for the student, may be explored.

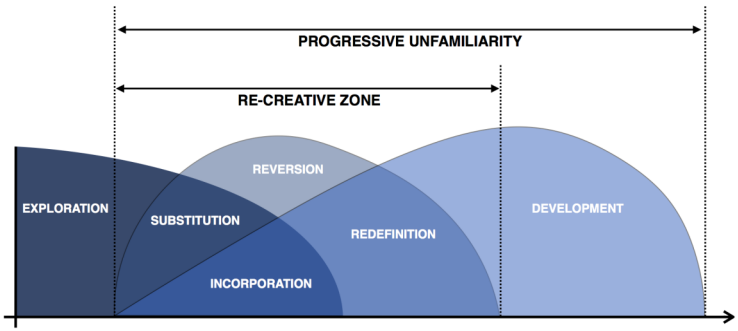


Figure 6: Unfamiliar Perspectives

There are a number of definable behaviors, illustrated in figure 6 above, that are often exhibited depending upon the starting condition, time, motivation and guidance offered. After an initial period of *exploration,* the students generally attempt to assimilate what is happening based upon their current experience and aesthetic sense. Some eventually find themselves in unfamiliar creative spaces. A common stage is *substitution* where the new ideas are used to routinely express a more familiar structure. *Redefinition* is a process where new ideas create opportunities to extend or expand existing forms but this is still largely considered a re-creative experience. Some eventually find their way into uncharted territory away from the familiar and into a more *developmental* area.

Are these exercises applicable, or even needed, professionally? Constraints of expression are used professionally for the same reasons. As the opening quote by Stravinsky indicated constraints can help to define a problem to be solved and ultimately offer a very significant sense of expressive freedom; as Rollo May (1975, Ch. 6 : On the Limits of Creativity, p. 115) expresses it: *"Creativity arises out of the tension between spontaneity and*

limitations, the latter (like the river banks) forcing the spontaneity into the various forms which are essential to the work of art or poem."

Don't Mess with Mr In-Between

The Arlen and Mercer sermon within the 1944 song "Ac-Cent-Tchu-Ate the Positive" may be stating the obvious, but fundamentally outlines a primary creative mechanism in that clearly one should develop a creative solution that meets the requirements of the context, whatever that may be. Deviations from acceptable norms may be the result of creative endeavor and this may be intuitively achieved, but how far and where this deviation might exist is hard to predetermine.

> *"There is sometimes a greater judgment shown in deviating from the rules of art, than in adhering to them; and... there is more beauty in the works of a great genius who is ignorant of all the rules of art, than in the works of a little genius, who not only knows but scrupulously observes them."*
> *—Joseph Addison (1714)*

If composing a popular song for a particular vocalist for example, then innovation in sonic design is perhaps not called for on this occasion and the song should stylistically resemble all other songs for it to be performable by the artist and acceptable by the audience; statistically, based upon recent chart analysis (See HSD http://reports.hitsongsdeconstructed.com/hsdwire/), the currently most common and predictable dimensions, see figure 7 below, are that the song will likely be delivered by a male vocalist or duo, the song will be around 90 BPM (beats per minute) and last around three-and-a-half minutes, will contain lyrics which will discuss *love* or *relationship problems* and achieve this within a largely predetermined structure.

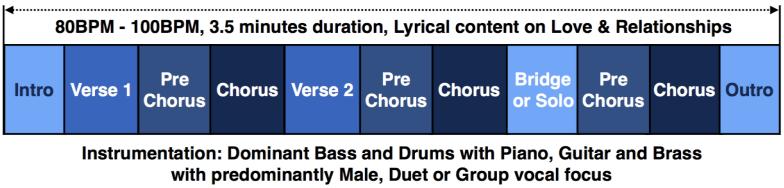


Figure 7: Commercial Song Structure, adapted from HSD

It must also pass the scrutiny of the *gatekeepers* of the domain who will determine if the work manifests sufficient novelty and does not infringe copy-

right regulations. There are of course examples of rule breaking art that achieves success or notoriety through this very characteristic to invalidate these observations. Indeed this may result in the dawn of a new domain or may remain a novelty in its own but it is worth noting that great art, in this example a great song, does not have to break the rules significantly, or at all, to achieve this designation. The *rules* in this context constitute the *normal* and can be applied to any dimensional element of the art form, for example figure 8 and 9 below define and present the *normal* attributes of dominant harmony, the prevalent *common practice* harmonic strategy in Western culture.

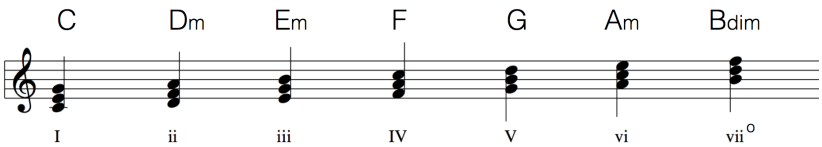


Figure 8: Roman Numerals

Here, see figure 9, the *normal* connections are expressed graphically as three behavioral guidelines: 1. Mostly, 2. Sometimes and 3. Less Often. This does not mean that other connections are not permitted just that they were not so common.

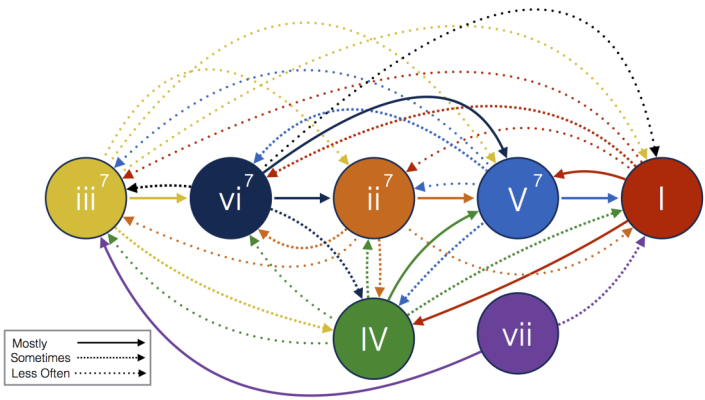


Figure 9: Normal Harmonic Tendencies, adapted from Piston (1946), Harmony

There are also prescribed ways that the guidelines have been evolved consistently over time, accommodated and absorbed to syntactically expand the system. Breaking the rules or ignoring what is normal continually would potentially result in incoherence and loss of expressive identity. In actuality it

may be more likely for the more secure forms of expression to appear at the epoch of a style than at the beginning. The constraints then in this case then are generally clearly defined and the interest for the composer lies in the latitude within, which makes the composition of music with mass-appeal potentially a great challenge. Stokes (2016) discusses this notion of a creative model that is defined by promoting (working with) or precluding (working against) ideas as a method to comprehending and possibly achieving novelty and contrast. This way of thinking encourages the augmentation of desirable features and the diminution of less desirable features and is governed by aesthetic sensibilities.

In broad terms with respect to music, preclude may dismiss the features not appropriate to the context and promote would focus attention on the attributes that are contextually desirable or interesting. The development of this sense to some extent depends upon experience, innate or otherwise, and exposure to the environment within which the creative act is encultured. Stokes (2016) also discussed the inherent constraints within the creative process defining four key characteristics, as illustrated in figure 10 below.

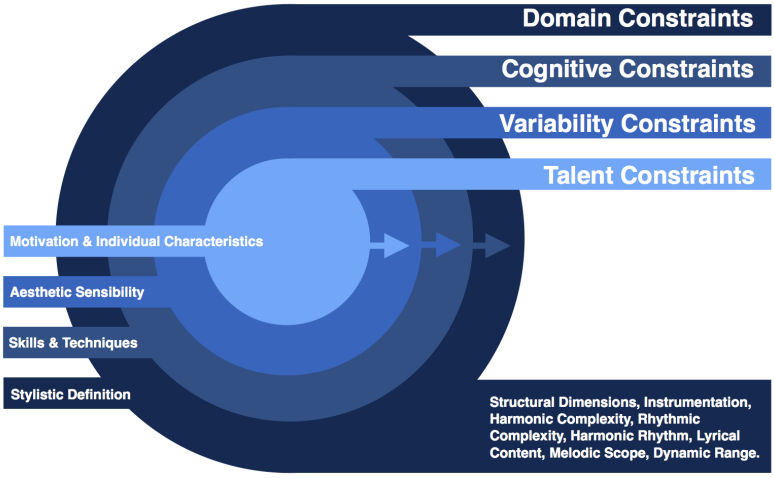


Figure 10: Creative Constraints, Adapted from Stokes (2016)

The *Domain* constraints determine the acceptable stylistic conditions; the domain can change and evolve and the artist can, within reason, move to other domains but the form of any particular domain constitutes particular characteristic expectations. *Cognitive* constraints are dependent upon the artist's

skill-set, training and chosen techniques; this will potentially temper the imagination to what is technically possible and achievable. *Variability* constraints govern the acceptable outcomes to determine which expressive combinations are aesthetically interesting and appropriate. *Talent* constraints determine the motivational and individual characteristics of the artist without which the others will not be manifested; talent for a particular discipline is often considered innate (see Stokes, 2006) and includes intuition or aesthetic sensibilities involved in the making of particular creative decisions.

With a Little Help

How certain are we that we are complicit in determining what we actually like, what we consume, what we feel? How do we decide creatively which path to pursue, which tunes to keep and which to discard? It is not uncommon for students to validate their creative ideas by asserting expressive credentials or declaring it as a product of the free imagination; but products of inspiration are invariably never outside the domain with which the artist is associated. There may be the conviction that art exists for its own sake and should not pander to fashion and the lowest common perceptual denominator but fundamental imperatives to communicate very often bind the product.

> *"To allow only the kind of art that the average man understands is the worst small-mindedness and the murder of mind and spirit. It is my conviction that the intellect can be certain that in doing what most disconcerts the crowd, in pursuing the most daring, unconventional advances and explorations, it will in some highly indirect fashion serve man - and in the long run, all men."*
> —Thomas Mann (1947), *Doctor Faustus*

There may be aspirational ideals that steer the expressive voice to explore more remote domains but to what extent may the product regarded as *authentic*. To say: *I compose from the heart* as though this imbues the artifact with reverential qualities that are critically beyond reproach is also not very informative or helpful.

As an undergraduate student the lead author developed an interest in contrapuntal writing, the composition of multiple melodic lines in counterpoint coming together harmoniously; this is exemplified within the texture and techniques of a fugue which has been adopted by numerous composers. How is a fugue composed? Perhaps listening to one or many might be start; studying them would be normal, followed by analysis to identify features, perhaps

a few years prior to this studying harmony would be prerequisite, and the logistics of the keyboard with consideration of the skill of the pianist. Below are the first few bars of Fugue No.1.

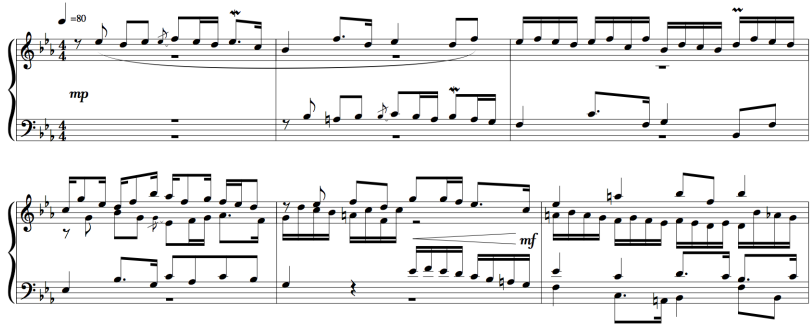


Figure 11: Brown, M. (1992): Fugue No.1 in E□, the first six bars.

What is this? Is it the product of inspiration? Is it authentic? Is it original? Is it stylistically derivative? Is it any good? The basic ideas arrived as often is the case as a form of involuntary auralized memory. It is the product of the imagination, it is likely formed from the memory of features absorbed from listening to many other forms of contrapuntal music; it certainly has a number of stylistically identifiable characteristics. It is product of music that is assembled in the mind then consciously replayed internally, deciphered and dictated with the aid of an instrument. This experience does not necessarily make the work any more authentic than any other composition and could have perhaps been derived through other more calculated means and the tutor, after first establishing the stylistic and instrumental intent, was keen to point out its contextual and technical failings. Nevertheless the process of *hearing* the music internally has been reported by other composers for example, *Albert Christoph Dies* reported a conversation with *Joseph Haydn* from 1806, in his biography, which exemplifies the experience:

> *"...usually musical ideas are pursuing me, to the point of torture, I cannot escape them, they stand like walls before me..... My imagination plays on me as if I were a clavier. "*

The musical example above is given to illustrate the process and the potential fallibility of the imagination, especially one that is not fully developed or best informed and also the illusion permitted through the use of technology. Technology allows the transcendence to some extent of the limitations

defined by human performance; cognitive constraints as such are are circumnavigated sometimes by innocence and naivety.

How do we understand art or recognize authenticity within art? Do we need to understand the historical evolution of art and theories of aesthetics in order to validate our perception of beauty? Or is this a route to a creative impasse? Learning may be implicit and sometimes this is inevitable, as we as academics struggle to understand what is *not* understood by the student. Implicit learning may actually be a feature engineered into the educational process to impart more involved experiential aspects.

> *"I enrolled upon a Mozart appreciation class; I knew very little about Mozart. The teacher taught me virtually nothing, for he spoke infrequently. He would simply play a complete Mozart symphony then declare the lesson over.*
> *Then in the final session I believe he made a mistake.*
> *That last symphony he played us was almost certainly not by Mozart!"*
> —Adapted from a staff development session on *Formative Evaluation* by the authors.

If creativity can be regarded as part discovery, then could AI (Artificial Intelligence) play a role? What is the difference between a composition created by a human and one calculated by a machine? Are there any perceptual or qualitative differences? Algorithmic artistic objectives are to realize sensual experiences through procedural computational models to imitate or reproduce the conditions of creativity. Holtzman (1995) and Boden (2010) discuss a number of computational approaches to the integration of computers into artistic practice; particularly insightful is the discussion of the generative art program AARON by Harold Cohen. Could there ever be such a thing as an *Inspiration Machine*? If so, what form should it take? It perhaps should have the capability of receiving input in the form of existing artwork or specification; it must have the capability to analyze this input with reference to a database of known work to allow the categorization, contextualization and evaluation of the extent of novelty; it should have the capability to explore relationships between given objects and look for opportunities to connect or combine, then evaluate the output to determine if the results are aesthetically acceptable. Figure 12 below outlines the modules required and their likely relationships.

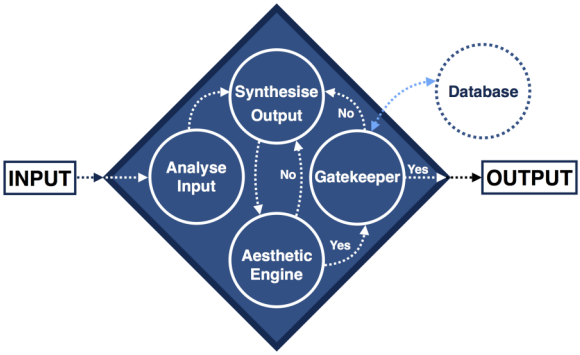


Figure 12: An Algorithmic Inspiration Machine

Why would this even be of interest? To overcome barriers, personal, technical, social or cultural, to creation; or to automate appropriate aspects of the creative process. To allow the exploration of ideas beyond personal horizons. Might this require a redefinition of creativity? Must creativity ultimately require emotional attributes for the audience to invest? In essence the work of composer David Cope (2008) has explored these ideas over the past thirty years in the form of his *Emily Howell* computer program developed from his earlier *Experiments in Musical Intelligence* (EMI); in 2006 he submitted a patent invention to provide a *"recombinant composition algorithm that creates new musical compositions based on existing musical compositions"*.

Conclusions

> *"Man built most nobly when limitations were at their greatest."*
> – Frank Lloyd Wright (quoted in Roberts, 2010)

An ideal creative environment might be one which is considered free and unstructured with respect to time, resources and space; allowing the artist to explore dimensions according to interests and playfulness focused upon the *intrinsic motivation perspective* (see Amabile, 1988, 1996) not directly influenced or inhibited. Imposed constraints may be regarded then as fundamentally inhibiting, limiting our creative potential to think and express ourselves freely (Smith & Tindall, 1997), but artists tend to self-impose expressive constraints through the very mechanism that defines their essence. Certain imposed constraints may actually be advantageous, Baer and Oldham (2006) found that there is a relationship between time pressure and individual levels of perceived creativity and Mayer (2006) stated that *"creativity thrived best when constrained"*. Not all constraints would be regarded as beneficial and

extreme external limitations, such as environmental, times, resources, social routines etc., would almost certainly be regarded as inhibiting creativity (Amabile, 1988, 1996).

If constraint is defined in less austere ways as part of the creative process, in which certain aspects are limited to take place within particular limits, creativity may then be regarded as freedom within the boundaries of the domain. A composer the piano for example, is free to choose any of the 88 notes in any order or combination; in reality there are further constraints such as the definitions of style, technical ability of the performer, number of fingers. Artistic creativity is necessarily bounded by the conditions of the artist, for example painter is defined by the act of painting which has associated predictable expectations of the form and the patterns of behavior of the given artist. The boundaries of style and technique may be extended to further define the artist or the artist may transcend the boundaries of the domain. Creativity may be regarded as innovative if the boundaries are redefined but is not a requirement or necessary an artistic objective; artistic creativity may be considered as the selection or *discovery* of favorable unique event sequences or combinations within the constraints of the art-form. The constraints of tonal music evolved over time to the point where in the minds of some composers it had failed to maintain the fundamental need to assert sonic coherence; this prompted the development of a new system of expression that posed new problems, not least of all the very thing it sought to solve, namely defining a new framework for musical coherence. The future of music, at least in practical terms it seems, may indeed depend significantly upon the the past, for the sake of listener coherence, as Pierre Schaeffer expressed (Hodgkinson, 1987):

> *" ...Unfortunately it took me forty years to conclude that nothing is possible outside DoReMi ...I think of myself as an explorer struggling to find a way through in the far north, but I wasn't finding a way through ...There is no way through. The way through is behind us."*

There may be benefits in suspending certain constraints in the design process to invite novelty that would have otherwise been inhibiting, for example in music the constraints of instrumental range or polyphony can be circumvented by the imagination and technology allowing new patterns to emerge. The involvement of computing technology into the process presents a number of intriguing opportunities and potential frustrations; it may become the fundamental medium of expression or a preparatory tool to expedite the generation of new solutions within conventional structures. One of the attrac-

tions of the use of the computer is the capacity for simulating chance operations to surrender control or neutralize personal influence over the creative process, but as Christian Wolff observed (Duckworth, 1999) freedom is invariably limited:

> *"What was so shocking intellectually to everybody was the notion of randomness; that you gave up control. And yet it was clear that control operates at many different levels or angles, and that there was just as much control in John's [Cage] work as there might be in Stockhausen's or Boulez's. It was just a question of where you applied it and how you focused it."*

Some artists explore the given tools and others may endeavor to create their own tools, either way the parameters and the extent of the usage must be defined in order for selections to be made; as Candy (2005) states, *"The constraints have to be specified in such a way as to make the computer generate an outcome that is satisfying to the artist."* Computers in art necessitate a more prescriptive use of constraints but offer the potential to take greater control and explore the potential of cross-fertilization between equally defined domains. If the parameters of the domain can be defined then the extent of the freedom can be calculated. Digital art pioneer Manfred Mohr explored the creation of works that were completely calculated and produced by computer algorithms introducing the element of constant mutating animation within such works as *Space.Colour.Motion* (Mohr, 2002), which ensures unique starting conditions so that the work is never repeated. Mohr states: *"My algorithms have developed over the years and have always drawn on my aesthetic decisions and knowledge as an artist. My programs are continually updated through an interactive procedure between my abstract ideas and the creation of my algorithms."*

If music is confined to discrete notes and durations then there are only so many ways that these events can be sequenced melodically, combined harmonically and ordered rhythmically. Digital technology also presents an opportunity to create a correspondence with between divergent domains through virtue of the mechanism of common data storage. Novelty can emerge from such collisions for example, Yasunao Tone (Tone, 2007) explored the relationship between text and sound within Molecular Music (1982-5) to convert written symbol into sonic sequences. Gina Czarnecki explored the possibility of creative live interaction in a process modeled on biological evolution,

within the work *Silvers Alter* (Czarnecki, 2002) inviting participants evolve the installation by creating hybridized images mediated through technology.

Introducing digital tools into the creative process necessitates a very calculated and limited creative environment since for the computer to make choices, however freely that is facilitated, the space requires careful definition but this could potentially produce new creative directions. If we figure into the solutions only those results that are acceptable, then novelty alone is not enough to focus the aesthetic compass. People generally love exceptions to the rule, the romantic notion that these special talents break the rules or redefine them for the rest of us to follow. People we should all aspire to be, to draw inspiration not just from the work but their very essence, but what is the purpose of Art? Leonard Bernstein (1982) attempted to find the answer in his book *Findings*:

> *"Communication and self-expression were voted the two real motivations for the artist; every creator is one because he must express himself and, what's more, must share that expression with mankind. These may be platitudes, and they may also be true, as far as they go. But whether or not true, they do not explain that devil with a pitchfork who goads an artist into doing dangerous, unpopular, unpredictable works."*

The names of John Cage and Pablo Picasso often amongst the first to be cited as evidence of free spirited creative expression but are these really exceptions unbounded by laws that constrain the rest of us. These men were defined by influences and styles; the western background of Cage was supplanted by Eastern philosophies and from this perspective his constraints are very clear. Picasso went through a number of definable styles within which his constraints are clear including the influences of primitive African art. These artists are perhaps highlighted as paragons of creative ideals that we all should strive to emulate, but there are characteristics that define these particular artists within definable periods? The eagerness to embrace the new *and* the old is certainly a feature of both of these characters and their capacity to assimilate cultural traditions from outside. They are both regarded as catalysts for change and we certainly need characters like this in our society but how many individuals like this do we really need? Change is inevitable but inviting change too frequently would be incoherent for both artist and audience. Generally artists, particularly musicians are seeking variety within given expressive frameworks, whereas this certainly constitutes frustrations for some, it is within that creative identities are evolved and developed.

"I wish I found some better sounds no one's ever heard,
I wish I had a better voice that sang some better words,
I wish I found some chords in an order that is new,
I wish I didn't have to rhyme every time I sang,"
—Twenty-One Pilots (2015) song, *Stressed Out*

Artists in the past have considered inspiration as an external process perhaps finding it therefore easier to attribute the process to mythology; the nine muses were themselves classically bound to protect their designated art-form. It is perhaps easier for some to leave well alone and attribute the creative urge to the daughters of Zeus or surrender to subconscious processes so perhaps attending to the conditions of creativity is not such a bad thing; whether that includes meditation, a formal arrangement with *Mephistopheles* at the crossroads or the result of playful serendipity constrained by an aesthetic governor.

Freedom of creative expression is an illusion, we are bound by style, inherent semantics and syntax of the communication; we are constrained by the very people to whom we wish to communicate, assuming this is indeed the intent. It is an illusion, but a necessary illusion without which the artist may feel bereaved of the desire to create.

"There is a great deal of illusion in a work of art; one could go farther and say that it is illusory in and of itself, as a work."Its ambition is to make others believe that it was not made but rather simply arose, burst forth from Jupiter's head like Pallas Athena fully adorned in enchased armor. But that is only a pretense. No work has ever come into being that way."
—Thomas Mann (1947), *Dr Faustus.*

References

Armstrong, A. & Page, N. (2015) *Creativity and constraint: leadership and management in the UK creative industries*. Creative Skillset. Available online: http://creativeskillset.org/assets/0001/5933/Creativity_and_constraint_leadership_and_management_in_UK_2015.pdf (Accessed 7 February 2016).

Ashton, K. (2015) *How to Fly a Horse*. London: William Heinemann.

Barrat, J. (2013) *Our Final Invention*. New York: St Martin's Press.

Barron, F., Montuori, A. and Barron, A. (1997) *Creators on Creating*. New York: Putnam.

Bernstein, L. (1982) *Findings.* New York: Simon & Schuster.

Boden, M. (2010) *Creativity and Art - Three Roads to Surprise.* Oxford: Oxford University Press.

Cage, J. (1961) *Silence*. Middletown, Conn.: Wesleyan University Press.

Cage, J. (1969) *A Year from Monday*. Middletown, Conn.: Wesleyan University Press.

Candy, L. (2005) *Constraints and Creativity in the Digital Arts.* Leonardo. Volume 40, Number 4, pp. 366-367. Available online: http://www.creativity-embodiedmind.com/downloads/papers_workshop2/Linda_Candy_Paper.pdf (Accessed 7 February 2016).

Carafoli, E. (2016) *The Creativity Process: Freedom and Constraints.* The Two Cultures, Rendiconti Lincei, pp. 1-13.

Chace, C. (2015) *Surviving AI*: The Promise and Peril of Artificial Intelligence. Bradford: Three Cs Publishing.

Cohen, H. WWW page: http://www.aaronshome.com/aaron/index.html (Accessed 31 March 2016).

Collins, N. and d'Escriván, J. [Editors] (2007) *The Cambridge companion to Electronic Music*. Cambridge: Cambridge University Press.

Cooper, B.B. (2014). *Proof that Constraints can actually make you More Creative*. Fast Company, Work Smart. Available online: http://www.fastcompany.com/3027379/work-smart/the-psychology-of-limitations-how-and-why-constraints-can-make-you-more-creative (Accessed 31 March 2016).http://www.fastcompany.com/3027379/work-smart/the-psychology-of-limitations-how-and-why-constraints-can-make-you-more-creative

Cope, D. (2008) *Tinman*. New York: Bloomington.

Cope, D. (2006) US Patent US7696426 B2 *Recombinant Music Composition Algorithm and Method of Using the Same*. Available online: http://www.google.com/patents/US7696426 (Accessed 31 March 2016).

Coyle, D. (2009) *The Talent Code*. New York: Bantam Books.

Csikszentmihalyi, M. (1996) *Creativity*. New York: Harper Collins Publishers.

Czarnecki, G. WWW site: http://ginaczarnecki.com/ (Accessed 31 March 2016).

Czarnecki, G. (2002) Silvers Alter, Available online: http://www.artscatalyst.org/silvers-alter (Accessed 31 March 2016).

Danto, A.C. (1983) *Art, Philosophy, and the Philosophy of Art*. Humanities, Vol. 4, No. 1 (February 1983), pp. 1-2.

Duckworth, W (1999) *Talking Music*, New York: Da Capo, p197.

Eadie, W.F. (2009) *21st Century Communication. A Reference Handbook,* Available online: danielciurel.files.wordpress.com/2011/10/21stcenturycommunication2.pdf (Accessed 31 March 2016).

Fig, J. (2009) *Inside the Painter's Studio*. New York: Princeton Architectural Press.

Glimcher, A. (2012) *Agnes Martin: Paintings, Writings.* London: Phaidon Press.

Goleman, D. (2013) *Focus*. London: Bloomsbury.

Goodman, N. (2013) Striking the Perfect Balance Between Creative Freedom and Realistic Limits. Entrepreneur. Available online: http://www.entrepreneur.com/article/227673 (Accessed 7 February 2016).

Graf, M. (2013) From Beethoven To Shostakovich - The Psychology Of The Composing

Process. Coss Press.

Haught, C. & Johnson-Laird, P.N. (2003). *Creativity and Constraints: The Production of Novel Sentences.* Cogsci Society. 25th Annual Meeting of the Cognitive Science Society. Available online: http://mentalmodels.princeton.edu/papers/2003creativity.pdf (Accessed 7 February 2016).

Haworth, F.,Gollifer, S., Faure-Walker, J., Coldwell, P., Kemp, T., & Pengelly, J. (2005) *Freedom and Constraint in the Creative Process in Digital Fine Art: An AHRB Invited Workshop*. Proceedings of the 5th conference on Creativity & cognition. Pages 310-317. Available online: http://www2.rgu.ac.uk/subj/ats/pengelly/papers/candc05.pdf (Accessed 7 February 2016).

Hodgkinson, T (1987), Re-records *Quarterly Magazine,* Vol. 2 No 1., (March 1987) pp. 5-9.

Holtzman, S. (1994) *Digital mantras*. Cambridge, Mass.: MIT Press.

James, J. (1995) *The Music of the Spheres*. London: Abacus.

Johnson-Laird, P.N. (1988). *Freedom and Constraint in Creativity*. In *The Nature of Creativity*, edited by R. Sternberg. New York: Cambridge University Press. PP. 202 -19. Available online: http://mentalmodels.princeton.edu/papers/1988freedomandconstraint.pdf (Accessed 7 February 2016).

Kao, G., Lin, S. and Sun, C. (2008) *Breaking concept boundaries to enhance creative potential: Using integrated concept maps for conceptual self-awareness*. Computers & Education, 51(4), pp.1718-1728.

Kaufman, J. C & Beghetto, R. A (2013) *Do people recognize the four Cs? Examining layperson conceptions of creativity,* Psychology of Aesthetics, Creativity, and the Arts, Vol. 7(3), pp. 229-236.

Kaufman, J.C. and Sternberg, R.J. (2010) *The Cambridge Handbook of Creativity*, Cambridge: Cambridge University Press.

Komar, V. and Melamid, A. (1995) *The Most Wanted Paintings on the Web.* Available online: http://awp.diaart.org/km/index.php (Accessed 31 March 2016).

Klein, G. (2013) *Seeing what others don't*. London: Nicholas Brealey Publishing.

Kleon, A. (2012) *Steal like an artist*. New York: Workman Pub. Co.

Lewis, W.M. and Smith, W.K. (2000) *Learning through Paradox: A Pedagogical Strategy for Exploring Contradictions and Complexity.* Journal of Management Education December 2000 vol. 24 no. 6 708-725

Lewis, W.M. and Smith, W.K. (2014) *Paradox as a Metatheoretical Perspective: Sharpening the Focus and Widening the Scope.* The Journal of Applied Behavioral Science 2014, Vol. 50(2) 127–149. Available online: http://jab.sagepub.com/content/50/2/127.full.pdf <accessed 9 Feb. 2016>

Lois, G. (2012) *On Creativity - Interview* (2016), Available online: http://oncreativity.tv/?/site/videos/george-lois/bKZu70ukkBQ (Accessed 31 March 2016).

Lovelock, W (1946-56) *First, Second and Third Year Harmony*, London: Hammond Textbooks

Lu, S. & Wu, A (2009). *Freedom and Constraints in Creativity Cognition Process*. Available online: https://wiki.cc.gatech.edu/designcomp/images/b/bc/CDC10_TabletopCreativity.pdf (Accessed 7 February 2016).

Maisel, E. (2000) *The Creativity Book - A Year's Worth of Inspiration and Guidance*. New York: Penguin-Putnam Books.

May, R. (1994) *The Courage to Create*. New York: W.W. Norton.

Minsky, M. (2006) *The Emotion Machine*. New York: Simon & Schuster.

Mohr, M. (2002) *Space.Color.Motion*. Available online: http://www.emohr.com/www_m1/motion_777.html (Accessed 31 March 2016).

Paul, E.S. and Kaufman, S.B.(editors). (2014) *The Philosophy of Creativity*. Oxford: Oxford University Press.

Pedler, D (2003) *The Songwriting Secrets of the Beatles*. London: Omnibus Press.

Perry, G (2013) *Reith Lectures: Who decides what makes art good?* Available online: http://www.ft.com/cms/s/2/c37b1b6a-3017-11e3-9eec-00144feab7de.html (Accessed 31 March 2016)

Piston, W. and DeVoto, M (1978). *Harmony*. London: V. Gollancz.

Roberts, D. (2010) *The Innovator's Sourcebook: A Guide to Creating Compelling Business Ideas.* Chicago: West Futon Media.

Rosso, B.D. (2011). *Creativity and Constraint: Exploring the Role of Constraint in the Creative Processes of New Product and Technology Development Teams*. *Organization Studies*, 35(4), pp.551-585. Available online: http://docplayer.net/9304591-Creativity-and-constraint-exploring-the-role-of-constraint-in-the-creative-processes-of-new-product-and-technology-development-teams.html (Accessed 7 February 2016).

Saleh, S.H. (2015). *Freedom from Freedom: The Beneficial Role of Constraints in Collaborative Creativity*. A thesis submitted to the Faculty of the Graduate School of the University of Colorado. Available online: http://atlas.colorado.edu/wp-content/uploads/2015/09/Sid_Saleh_PhD_dissertation.pdf (Accessed 7 February 2016).

Shekerjian, D. (1991) *Uncommon genius*. New York, N.Y., U.S.A.: Penguin Books.

Smith, S.M. and Tindall, D.R. (1997) *Memory blocks in word fragment completion caused by involuntary retrieval of orthographically similar primes.* Journal of Experimental Psychology: Learning, Memory and Cognition 23, pp 355-370.

Stokes, P. (2016) *Creativity from Constraints - In the Performing Arts.* New York: Springer Pub. Co.

Stokes, P. (2006) *Creativity from Constraints - The Psychology of Breakthrough.* New York: Springer Pub. Co.

Stravinsky, I. (1982) *Poetics of music in the form of six lessons*. Cambridge, Mass.: Harvard University Press.

Tchaikovsky, M. (2004) *The Life & Letters of Peter Ilich Tchaikovsky*. Hawaii, USA: University Press of the Pacific.

Tharp, T. (2003) *The Creative Habit*. New York: Simon and Schuster.

Tone, Y (2007) *Noise Media Language*. Available online: http:// www.errantbodies.org/pdf/Yasunao_Tone.pdf (Accessed 31 March 2016).

Villasante, T.R. (1994) *Las ciudades hablan: identidades y movimientos sociales en seis metrópolis latinoamericanas.* p. 264. Universidad de Salamanca, España.

Walker, A. (2011). *'Creativity Loves Constraints': The paradox of Google's twenty percent time*. Ephemera: theory & politics in organization. Available online: http://www.ephemerajournal.org/sites/default/files/11-4walker.pdf (Accessed 7 Feb. 2016).

Wypijewski, J, ed. (1997) *Painting by Numbers: Komar and Melamid's Scientific Guide to Art*, New York: Farrar Straus Giroux.

Young, J.W. (1976, reprinted 2003) *A Technique for Producing Ideas*. New York: McGraw-Hill.

Correspondence

Michael Brown, Senior Lecturer in Music, BSc(Hons), , MA, PGCE, AMus-LCM, FHEA, University of Derby, UK, m.brown2@derby.ac.uk

Christopher Wilson, Learning Enhancement Manager, BMus (Hons), MPhil, PG Cert HE, SFHEA, University of Derby, UK, c.j.wilson@derby.ac.uk

Authors' Brief Bios

Michael Brown is the Programme Leader for the BA (Hons) Music degree in the College of Arts, at the University of Derby in the UK. He holds diplomas in both Art and Music, a BSc (Hons) degree in Software Engineering, Mathematics and Music, and a Master's degree in Contemporary Composition, which combine to serve his interest in computer creativity. He is a Principal Researcher with over twenty-five years of teaching experience, an active art-

ist, composer and musician. As well as maintaining his professional role, he is a member of the American Creativity Association and has presented his research in multimodal creativity internationally.

Chris Wilson is the Learning Enhancement Manager at the University of Derby in the UK and an active composer and educator. He is a classically trained violinist, composer and practitioner in the technological arts, and has published, and presented internationally on the subjects of creativity, artistry, project management, and education. With a musical teaching career He now leads university projects and works with national and international organizations in the development of creative learning and teaching practice.

CHAPTER SIX

THE FUTURE PROBLEM SOLVING PROGRAM INTERNATIONAL (FPSPI): A CHALLENGE FOR CREATIVE CITIZENS

IVETE AZEVEDO, MARIA DE FÁTIMA MORAIS, FERNANDA MARTINS & BONNIE CRAMOND

Abstract

The *Future Problem Solving Program International* (FPSPI) is an educational program for the development of creative skills, especially in children and young people (Future Problem Solving Program International, FPSPI, n.d). At the same time, it promotes critical, analytical and futuristic thinking, oral and written communication, teamwork, as well as emotional and decision making skills (FPSPI, n.d.). It is thus an educational tool that can be applied in many contexts, formal and informal, in order to promote creative problem solving skills. The stated mission of the FPSPI is "to develop the ability of young people globally to design and promote positive futures through problem solving using critical & creative thinking" (FPSPI, n.d.). It is designed to involve young people in thinking about the future and its challenges and unpredictability in all domains, including arts, technology and sciences. This program, based on futuristic thinking and the Osborn-Parnes Creative Problem Solving method (Osborn, 1953; Parnes, 1967; Parnes, Noller, & Biondi, 1977), begins with problem finding and definition and ends with a proposal for an effective and original solution. Begun by Torrance in the U.S. in 1974, the program is currently applied in countries from every continent. This chapter will present this program in detail, illustrating its goals, application methodology and agents. It will also share results obtained in several studies about the program and its effectiveness, thereby, raising awareness of the potential of its application for creative problem solutions in various contexts.

Keywords: Creativity, Future Problem Solving Program, Creative Problem Solving, futuristic thinking, futures, critical thinking

Introduction

The vicissitudes and challenges of our times, and the reasonable expectation that life will continue to change at a rapid pace, demand individuals and companies that are able to deal with change, risk and unpredictability. New, complex, global challenges require problem solvers who can go beyond logic to address these challenges in adaptive and innovative ways (Maclaren, 2012; Starko, 2010). In this sense, creative problem solving has been seen as a set of skills necessary for future survival for individuals, institutions, and societies (Caniels, 2013; Csikszentmihalyi, 2007).

Torrance warned that "to appeal only to analytical methods to solve problems is no longer viable, as problems are increasingly unpredictable. Our survival as a species requires adapting to changes, it requires creativity" (Torrance, 2002, p.57). Convergent thinking, or looking for one right answer, remains the primary method used to solve current problems, but problems need to be regarded with innovative approaches and even with the ability to be predicted in a futuristic perspective (Guerra & Abreu, 2005).

Education needs to follow the social and economic demands of a more global scope. The new conditions of globalization and of the interconnected economy of the late twentieth century and early twenty-first century have made it more vital than ever to consider the future of humanity in terms of the development of creativity (MacLaren, 2012; Trilling & Fadel, 2012). For instance, the financial crisis of the early twenty-first century, particularly in Europe, reinforced the need to deepen knowledge about creativity and innovation (Lubart & Zenasni, 2010) at all social levels. Now is the "time to prepare young people for the challenges of the twenty-first century, promoting adaptation and innovations skills" (Partnership for the 21st Century Skills, 2006, p.10). Creative problem solving has, thus, become an essential key to success (Péter-Szarka, 2012).

At the same time, domains like Art, Science, and Technology increasingly materialize the need for creative, critical and entrepreneurial citizens (Sahlberg, 2011; Smith-Bingham, 2007). In fact, a recent study by Adobe (2012) illustrated that among college-educated, employed Americans surveyed, 85% agreed that creative thinking is critical for problem solving in their career, but nearly one third of them did not feel comfortable thinking creatively at work. Therefore, 88% agreed that creativity should be built into the education curriculum.

Several authors have emphasized the importance not only of the diagnosis or research in education on this subject, but also the implementation of creative skills, requiring a direct or indirect link with the school curriculum in either formal or informal settings. This appeal then encompasses research and action in the various fields of knowledge (particularly in the fields of arts,

science and technology) and throughout the educational path (Craft, 2005; Pfeiffer, 2013; Wechsler & Souza, 2011).

One such educational program, which aims to promote creative thinking skills through a futuristic approach to problems, is the Future Problem Solving Program (FPSP) designed by Torrance and collaborators (Torrance, Torrance, Williams & Horng, 1978). This program has grown beyond its start in one state in the U.S. into a multi-state, multi-nation program presently called the Future Problem Solving Program International (FPSPI). In recent years, it has been object of several studies that have found that there are improvements in creative problem solving skills, as well as in emotional and social ones, for the children and adolescents involved in the program, but also in their mentors and coaches (Cramond & Fairweather, 2013; Kauffman, 2012; Margison, 2004; Treffinger, Selby, & Crumel, 2012; Vijayaratnam, 2012).

To understand the FPSPI program, one must first understand how it is contextualized in the concept of creativity, the main outlines of the FPSI program itself (fundamentals, goals, contents, methodology), as well as some of its results, namely in Portugal. It is expected that this chapter will raise the awareness of educators, businesspeople and other professionals responsible for the development of skills about a tool that seems to promote creative problem solving for any field of knowledge.

Creativity

What is meant by creativity? This concept has led to multiple definitions (Barbot, Besançon, & Lubart, 2011; Runco & Jaeger, 2012), as is explicit in the title and text of the book The 101 Definitions of Creativity (Aleinikov, Kackmeister, & Koening, 2000). Creativity is clearly a multidisciplinary concept, complex, simultaneously rich and challenging (Kaufman, Beghetto, & Pourjalali, 2011). It is not reducible to a reassuring definition, or as Yashin-Shaw (1994) contended, there is not a sufficient definition to represent it.

However, in the multiplicity of existing definitions, there is an agreement that reflects the key elements of creativity: the simultaneity of originality and effectiveness. An idea or a creative product must necessarily have originality, novelty, or even rupture with what is known, but at the same time, it must make sense, be valuable, or have the utility which originality can bring to a given context and moment (Lubart & Guinard, 2006; Runco & Jaeger, 2012). The simple difference of originality is trivial; creativity also requires an effective response to the implicit or explicit request that caused it (Runco, 2014).

In the concept of creativity, it is important to emphasize the aggregation or the coincidence of different requirements (Megalakaki, Craft, & Cremin, 2012; Morais, 2013). These include high motivation, particularly intrinsic (Hennessey Amabile, 2010); in-depth and interdisciplinary knowledge (Boden, 2007; Sternberg, 2015); personality and emotional characteristics (Davis, 2009); cognitive processes (Starko, 2010); as well as, socio-cultural

influences facilitating or blocking what is labeled as creative (Csikszentmihalyi, 2007). Despite this conceptual complexity, creativity is already universally seen (El-Murad & West, 2004) as a target for systematization allowed by the conceptual schema of the 4 P's (Rhodes, 1961). This means that one can understand creativity as (a) a creative Person concerning the characteristics of the person who creates; (b) a Product, looking at the outlines of the creative response and the evaluation of it; (c) the result of social Pressure, sometimes called Press, from micro contexts such as family or school, to broad variables such as the socio-historical moment; and, (d) Process, thereby often appealing to the model of Creative Problem Solving (Isaksen, Dorval, & Treffinger, 2011) to operationalize stages and cognitive processes.

Myths

In defining what creativity is, it is also important to explain what it is not. There are several mistaken beliefs about creativity that have resisted the empirical evidence that contradicts them for decades, thus disturbing the study and practice of creativity (Starko, 2010, Montuori, 2011). We've already explained that originality is a necessary but not sufficient condition for creativity, thus negating the common myth that they are one and the same (Kaufmann & Beghetto, 2009).

Another frequent myth of particular importance for intervention is the privileged association of creativity to the artistic context. We see it mentioned in international research, from the classic studies on perceptions conducted by Fryer (1996), to the handbooks about creativity (Craft, Jeffrey & Leibling, 2007; Cropley, 2009). This privileged association of creative expression to the arts denies the creativity extant in other human endeavors, such as scientific research, invention, technology, humanities and social sciences, sport, or leadership. Creativity is an added value inherent in any academic or personal context (Sawyer, 2006; Sahlberg, 2011).

It is also often conveyed that creativity is essentially the result of a sudden and inexplicable inspiration. It is not accidental that one of the images associated with creativity or innovation is a light bulb in the brain. Such a moment of sudden enlightenment - the insight or successive and consequential mini insights - does not happen before a long, and often slow, path of work, knowledge, persistence, re-evaluations and stubborn maintenance in a sense of purpose, as the already classic works of Gruber (1974), Perkins, (1981) or Weisberg (1987) have shown. Both for recognized creative productions and genius in any area, as for the daily creative process, such a persistent pathway is necessary. The oft-quoted observation by Louis Pasteur that "chance only favors the mind which is prepared" (quoted in Vallery-Radot, 2008, p. 76) is an excellent encapsulation of this idea.

Controversies

General or specific

The last underlying idea refers more to a controversy than to less stringent conceptions of creativity. It concerns the generality/specificity that this concept represents. The question, asked in a practical manner, is as follows: are we creative in every field of knowledge or are we creative in one specific area? Plucker and Beghetto (2006) have classified this issue as one of the most enduring controversies in the study of creativity. It is known that authors like Martindale (1989) have referred for decades to something global about creativity. Also studies, such as those of Root-Bernstein and Root-Bernstein (2006) have shown that there are cognitive and personality similarities in individuals who are highly creative in different areas, such as science and arts.

However, authors such as Kaufman and Baer (2006) or Sternberg and Lubart (1995) showed that the domain specificities in which we try to be creative greatly determine the probability of being so. Such authors argue that importance of the specific skills and knowledge in the fields of creative expression (such as arts, technology or science) really seems to prevail rather than the similarities between them (Baer, 2011; Weinstein et al., 2014).

A third possibility is that creativity, like intelligence, has elements of both generality and specificity (Sternberg, 2005). For example, Amabile (1998) conceptualized creativity as composed of expertise, motivation, and creative thinking skills. Individuals may creatively excel in some specific areas because those are the areas in which they have expertise, yet they still have the motivation and creative thinking skills that they apply more effectively in other areas. This would explain the commonalities found in different areas of personality and thinking tools (e.g. Root-Bernstein & Root-Bernstein, 2006), but not the same level of accomplishments across the board (e.g. Kaufman & Baer, 2006). Given the amount of time that it takes to gain expertise in most fields now, it is not surprising that most people providing creative contributions do not claim equal levels of expertise in several.

Big C little c creativity and the promotion of creative skills

Can creativity be promoted? Can any person's creativity be promoted? The answer may depend on whether we are talking about eminent creativity, Big C, of the Mozart or Einstein type, or little c creativity, which is considered the everyday creativity of solving a problem in a unique way or developing a new recipe.

Authors such as Vernon (1989) or Wahlberg (1988) did not consider Big C (creativity socially recognized) as equivalent to the little c (creativity in

everyday life). Vernon (1989) even joked that he did "not want Da Vinci's creativity to be in the continuity of that of my gardener…" (p. 95). So, this is the perspective according to which there is an asymmetric distribution of creativity (Feist, 2006), where very few individuals would express a lot of creativity and many individuals would express very little.

Nevertheless, already in the 60s, 70s or 80s, authors like Torrance (1963a), Maslow (1983) or the cognitivist precursors, Newell and Simon (1972), advocated a normal distribution for creativity, a non- radical difference in the core of the creative tools, for every person. Currently, several authors reiterate this viewpoint that all individuals can be creative if they have a set of techniques within their reach that enable the development of their skills—they talk about a universal creative potential (Runco, 2006; 2014; Fairweather & Cramond, 2010).

Accordingly, several studies have shown that creativity can be taught and encouraged through training (Ma, 2006; Sanchez, Martínez & García, 2003; Scott, Leritz & Mumford, 2004; Shanahan, 2004). In this perspective, Runco (2006) stated that an individual with moderate creative potential and provided with the necessary skills to upgrade his ability, may display a higher performance than those with highest creative potential not strategically used.

Developing Creativity

The simple practice of creative skills does not mean that a person possessing a median capacity becomes a brilliant creator. Rather than a sudden and surprising result, as a result of learning creative skills, one might expect a gradual change in everyday behaviour, which may be reflected in increased attention to the world around, in a more powerful critical thinking, on a better understanding and adaptation to given situations (Piirto, 2004). Thus, the suggestions to stimulate creativity vary from the conditions of an influencing environment to systematic techniques that improve cognitive and/or emotional conditions (Craft, Jeffrey, & Leibling, 2007; Amabile, 2010). In either case, it is assumed, based on research results that creativity is likely to be promoted. Many of these studies have occurred in academic contexts and comprise a wide range of curriculum areas (Maker, Joe, &Muammar, 2008; Woythal, 2014) and of educational levels (Fautley & Savage, 2007; Cropley & Cropley, 2009).

Environment for Developing Creative Thinking

The intentional development of creativity may involve creating conditions in the individual's surrounding environment. This facilitative environment, both physical and psychological (Cramond, 2005), can be present in any context (school, family, work) where the non-prevalence of routines, the variety of strategies and materials, and the interaction between what is pro-

posed and what the individual is looking for are available. Creative responses, in all of those contexts, should also be encouraged and recognized explicitly, producing constructive feedback during and after the accomplishments. Learning should not be seen independent of what is recreational, humorous, or imaginative (Lucas, Caxon & Spencer, 2012; Romo, 2012). Under these conditions, it is understandable that motivation and commitment rise and the role of intrinsic motivation for creativity is emphasized (Lucas, Caxon & Spencer, 2012; Romo, 2012).

CPS for Developing Creative Thinking

The kind of environment that facilitates creativity can exist when any creative task is required, but it is enabled with the techniques and training programs for creative skills, which are currently quite diverse (Shanahan, 2004; Starko, 2010; Runco, 2007). One of the most effective methods (Scott, Leritz & Mumford, 2004) for promoting creative thinking is the Creative Problem Solving (CPS) method. The CPS tools were initially created by Osborn (1953) and Parnes (1967) and later completed by Noller and Biondi (Parnes, Noller & Biondi, 1977), focusing at first on divergent thinking.

In the eighties, a set of convergent cognitive tools to balance the strong presence of divergent thinking techniques were developed and incorporated (Miller, Vehar & Firestien, 2001). In later years, one creative thinking competence was associated (Puccio & Murdock, 2001) for each step of the method (which meanwhile operationalizes a theoretical model), which will be shown below. This model has being greatly developed over the years, and has provided the fundamentals for the operational training tools that is now used in CPS (Sawyer, 2006).

The great novelty and utility of this method is that it focuses on producing innovative responses, combining the application of divergent and convergent thinking (Alencar, 2000). It includes three components - Understand the Problem, Generate Ideas, Preparing for Action in a sequence of six steps: Exploring Data, Framing Problems, Constructing Opportunities, Generating Ideas, Developing Solutions and Building Acceptance (Isaksen, Dorval, & Treffinger, 2011). Thus it leads to the development of skills to conceptualize, analyze, synthesize, produce, evaluate and communicate information as well as skills for collecting that information through direct observation, experience, or reflection (Cojorn, Koocharoenpisal, Haemaprasith, & Siripankaew, 2013).

This process requires a wide range of cognitive and interpersonal skills such as skills of creative thinking, critical thinking and analytical thinking, as well as communication and interpersonal skills (Treffinger & Young, 2002; Vijayaratnam, 2012). Despite being a method more explicitly oriented for the development of creative skills, the CPS process reinforces its value in optimizing different cognitive skills (Czerwiec, 1992; Treffinger, Selby &

Crumel, 2012) as a whole, i.e. "to learn and to practice the CPS may help building the intellectual skills and developing mental processes that increase the individual's ability to face changes either of the personal or professional daily life " (Switalski, 2003, p. 6).

The Creative Problem Solving process has been proclaimed a requirement for the present and for the future (Csikzentmihaliy, 2007; Runco, Lubart, & Getz, 2012). Creativity and innovation are highlighted in the present, however, there have been training programs for Creative Problem Solving based on the described methods that have emerged for several decades in business and academic contexts (Proctor, 2005). It is in the educational context that the Future Problem Solving Program– FPSP (Torrance, Torrance, Williams & Horng, 1978) developed. The following section will address this program.

The Future Problem Solving Program—(FPSPI)

The FPSP was conceived in 1974 in Athens, GA, when Paul Torrance and his wife, Pansy, were sitting at their kitchen table. Paul had gotten a call from the local high school principal asking him to devise a creative task for the students. Reflecting on his concerns that students were not very knowledgeable about their past or concerned about their future and that that they were not learning to think creatively or use what knowledge they had imaginatively, Torrance conceptualized a task that would change these things. This task constructed upon futuristic thinking is described next.

Futuristic Thinking

Another major influence on the development of the FPSP was futuristic thinking. Futuristic thinking was mentioned for the first time in 1902 by Herbert Wells at a conference in London entitled "The discovery of the future", in which he advocated the possibility of the future to be scientifically studied (Wells, 1913). Nowadays, the need to look to and think about the future is more important than ever. Such future thinking includes the awareness that we live in uncertainty and, therefore, with the possibility of error. If we want to affect our future and reduce the level of uncertainty, we must go beyond knowledge, training the ability of strategic thinking, critical thinking, manipulation of probabilities, and other thinking skills (Masini, 2011).

Torrance (1978) had recently read Toffler's Future Shock (1970), which predicted the stress that people would face from the immense changes that would take place in the next 30 years. Toffler warned that people who were not able to adapt to the accelerated changes facing them would feel stressed and disoriented. Torrance believed that giving students the tools and encouragement to address the problems of the future would help inoculate them against this shock.

The futuristic thinking approach in FPSPI emerges from themes of everyday life, by making issues of the future relevant. Torrance advised that talking about the future should always begin by using "everyday problems. The daily newspaper is full of ideas" (Torrance, Torrance, Williams & Horng, 1978, p. 15).

The Structure of FPS

Paul and Pansy Torrance opted to use the CPS model, but to add elements of societal problems of the present and future as the context (Cramond, 2009). Thus, the program started as a single activity at one high school and is now a year-long program applied in 40 affiliates around the world.

The theoretical framework of FPSPI is the Creative Problem Solving method already characterized, with the addition of futuristic thinking. Therefore its main goal is the creative thinking development of the participants (children and young people, but also adult mentors of the program), while issues related to the future are explored (Treffinger, Selby, & Crumel, 2012; Cramond, Fairweather, 2013; Treffinger, Solomon, & Woythal, 2012). This way, it addressed Torrance's concern (1978) that we all be involved in creating our future and learning the skills to do so creatively and collaboratively.

The Creative Problem Solving process assumes that every problem has a solution, admitting that all problems are challenges (Fobes, 1993; Harris, 2002). Here, the word problem is related to any concern, desire, or aspiration, and its solution has the sense of change or adjustment of ourselves or of the situation (Proctor, 2005).

FPSPI primarily differs from CPS in the nature of the problems, which changes the process a bit. CPS can be applied to any problem, from a personal concern to a business dilemma. However, FPSPI stresses that the problems addressed are major issues that face humankind and are typically global and futuristic in nature. Thus, the participants do research to learn about the problem before they attempt to address it.

Generally, FPSPI participants practice six sequential steps, which is typically preceded and accompanied throughout by research.

1. They identify all the issues in a problematic situation. In other words, they generate challenges or problems connected with the presented context.
2. From the generated list, they select an underlying problem, which will be operationalized for solving.
3. Once they have worded the problem for attack, they produce ideas or solutions, divergently and without judgment.
4. They generate and select criteria to use in evaluating their generated solutions.
5. They evaluate the solutions.

6. Finally, having created a challenge and a solution, they develop an action plan, showing how the solution found will work to solve the underlying problem (Torrance, Torrance & Crabbe, 1983).

The FPSPI program (www.fpspi.org) runs over a year, and the participants of this educational process may be adults of any age or academic training, as well as children and young people from kindergarten to the last year of high school. Adults can take two roles: coaches or competitors. Whenever they take the role of coach, they develop the FPSPI together with children and young people in a curricular context—as an educational method—or as an extracurricular activity (Hibel, 1991). They also apply their skills on the FPSPI competition over the year.

The success in this program depends on the continuous dedication of participants, the research of the themes under analysis, the application of the program in context and the self-training by analyzing the reports of progress made by experts (Jackson, 2001). The FPSPI defines this program as a training one; however, it is associated with an international competition, which includes various stages of works presentation, evaluation and classification, with the best competitors from each state or country invited to participate in the International Conference Future Problem Solving event in the United States.

There are three alternative components involved in the international competition (Community Problem Solving, Global Issues Problem Solving, and Scenario Writing) and a non-competitive activity (Action-based Problem Solving). What distinguishes each of the components are the specificities in the number of participants, in the core of the challenges to be addressed, and in the expected products that result (Treffinger, Jackson, & Jensen, 2009).

The Community Problem Solving component involves participants in real contexts connected with areas such as education, culture, environment, health or humanitarian services. A group of and unlimited number of young people, often a whole class, identifies a problem/challenge in the community (local, regional, global) related to any topic of interest and is expected to produce and enact a solution to that problem. Examples of some community problems that have been addressed include getting legislation passed for historic preservation in a town, providing clean water for a community in Africa, and connecting disenfranchised elders in a home with latchkey kids for an afterschool reading program. For the competition, students create a presentation about their year-long project, which includes a report, a visual presentation, and a public interview (Arbor, 1999).

Every year, there is also an international proposal of topics in three strands: Business and Economics; Science and Technology; and Social and Political Issues. Topics within these strands may address issues such as human rights, healthy lifestyle, genetic testing, celebrities, and the pharmaceutical industry. The participants in this component, called the Global Issues, compete in groups of four or as individuals to propose a solution for the problem as they conceptualize it from the issue. The creative problem solving

skills are to be expressed in a specific report showing that the participants go through the process. This is the only component in which adults can also take the role of competitors.

The participants can also experience the FPSPI through the component called Scenario Writing. This requires individuals to write a story projected at least 25 years in the future about the issue presented (Shewach, 1991). The texts are related to one of the topics chosen for the year as explained in the previous component.

The FPSPI is also a good pedagogical strategy to prepare young people to learn different content (Cramond, Fairweather, 2013; Treffinger, 2011), and this is the main purpose of the non-competitive component, Action-based Problem Solving. Thus, this component is always developed in groups (unlimited number of participants) and the problems to be solved may arise from stories, academic texts, newspaper articles, or other places. Like all other components, work is submitted to a committee of evaluators and participants will receive a report with specific feedback.

This program provides in depth training for adults (coaches) who identify themselves as educators in this method. Teachers have been the most involved adults as coaches, as they have favorable conditions for its implementation. They spend a lot of time with children and young people and also because they have many opportunities to observe them in situations potentially generating creative behavior (Caldeira, 2006). Other professionals can, however, assume this role in the implementation of FPSPI in different environments (e.g. companies or other organizations).

When implementing the program, most of the exercises for learning the process are training activities whose purpose is, in addition to promoting specific skills, to develop creative thinking (Funke, 2010). These exercises are carried out individually (e.g., free association, find common properties, force-fitting) and collectively (e.g., brainstorming, kinetics, morphological analysis). Torrance and Meyers (1970), for instance, provided an interesting perspective on the process of creative problem solving that is reflected in the course of FPSPI: "... become aware of the problems, of deficiencies and gaps in knowledge, of the lack of elements, of disharmonies; merge the information available, set the difficulty or identify the missing element; look for solutions, establish hypotheses, modify and re-test them, improve them; and, finally, communicate the results ... " (p. 32).

In addition, some of the creative activities present in FPSI training address the affective component of learning (Shapiro, 2012), including the implementation of games and simulations, metaphors and analogies, imagery sessions and the decrease of emotional blockages as instruments that require coaches and young participants to explore personal and interpersonal dimensions. Moving from the individual to the group level, this method may favor the change in attitudes and behaviors that affect the maintenance of discipline and group cohesion, as well as motivation, negotiation, and decision making (Azevedo, Morais, Jesus, Ribeiro, & Brandão, 2012; Cramond, 2006). The

program also trains communication skills in the group work context and in presenting results through tasks such as written reports, drawings, videos, interviews and public presentations (Treffinger, Selby, & Crumel, 2012).

Evaluation Studies

Some studies have assessed the effects of FPSPI (Cramond, 2009; Reschke, 1991). Overall, the results have been positive in the cognitive dimensions of creative thinking (Alves, 2013; Kauffman, 2012), critical and analytical thinking, (Cramond, & Fairweather, 2013; Treffinger, Selby, & Crumel, 2012; Woythal, 2014), as well as in oral and written communicational skills (Tallent-Runnels, 1993; Volk, 2008) and in emotional and interpersonal dimensions (Cramond, 2002; Treffinger & Young, 2002; Vijayaratnam, 2012).

It was also found that the practice of FPSPI increased motivation for learning (Azevedo et al, 2012; Rimm & Olenchak, 1991) and the appetence for teamwork and research skills (Alvino, 1993; Crabbe, 1989). Some of the program participants have also said that being involved in FPSPI during adolescence was one of the most stimulating and rewarding experiences of their lives, and functioned as an aid in selecting their professional future, including challenging careers (Cramond, 2002; Hibel, 1991).

The FPSPI use some strategies such as critical discussions, imagery, metaphors and analogies, free association of ideas, forced relationships or brainstorming (Cramond, 2006), tasks that help produce more and new ideas, improvements in ideas, or abstraction. Finally, one must not forget that managing emotions and reduction of emotional and creative blockages in personal expression is also present in the course of FPSPI sessions - this intentionality can result in greater emotional richness. This aspect becomes more interesting when one knows that the training of creative skills have effects more easily observed in cognitive dimensions than in emotional ones (Runco, Lubart, & Getz, 2012).

In a study led by the STS-Scholastic Testing Service (Kauffman, 2012; Woythal, 2014), which is still in progress, the skills associated with the Torrance Tests of Creative Thinking (TTCT) were improved by the FPSPI. Fifth and sixth grade students showed better overall creativity levels on the TTCT when compared with a control group (Kauffman, 2012). In 2014, these same students, now in the 7th and 8th grade, also showed significant differences from the control group in Fluency, Originality, Abstraction of Titles, and Resistance to Premature Closure – which are more cognitive skills (Woythal, 2014). Alves (2013), applied the FPSPI program in Portugal to adolescents in vocational courses and found significant improvements in Fluency and Originality, assessed by the TTCT, as well as in motivation for learning.

Several studies have been conducted in Portugal to assess the effects of the FPSPI. In one study with adolescents, it was found that correct conceptions of creativity increased with the program (Azevedo et al., 2012). This

investigation also showed benefits in motivation for learning. Another study with pre- and post- evaluation in experimental and control groups with adolescents (Azevedo, Morais, & Martins, 2014, unpublished report), found significant gains in several creative skills (both cognitive and emotional) evaluated by the TTCT. There still was an overall improvement on a global creativity rating on this test, as well as on the indicators of creative solving problems styles of participants (innovator or adaptor).

Conclusions

Nowadays, it is particularly important to promote creative skills in any educational or professional field (Sahlberg, 2011; Smith-Bingham, 2007). In this regard, a program that has been highlighted by its international multiplicity of implementation is the Future Problem Solving Program International - FPSPI (Torrance, Torrance, Williams & Horng, 1978). It is a program that can be the intervention tool in various contexts, since the method used in it - the Creative Problem Solving process - is adaptable to different contexts. Thus, it can be a good bet to promote creativity in arts, scientific research and technology, which are specifically of interest in this book.

In its forty years of existence, the FPSPI has given evidence of efficiency and efficacy taking into account its goals (Cramond, 2002; Lubart, 2001; Trefinger, 2011; Treffinger, Solomon & Woythal, 2012). Several positive results have shown that the FPSPI fulfills its goals either during the intervention process or at its end (Treffinger, Solomon & Woythal, 2012). This program is currently bringing challenges and effective methods for creative problem solving to countries, like Portugal, that don't have a tradition of implementation of such programs, but which have a strong motivation to capitalize on creativity from it. Nevertheless, many challenges still remain for implementation of the FPSPI more widely. More international systematic studies are required about the effects and the transfer of training, as well as about the duration of the program impact. Comparisons among specific populations of participants, including the gifted and those with learning difficulties, as well as those of different ages and schooling, and in different contexts such as business, will surely expand the potential of this program.

Today, it is no longer enough to produce and implement solutions. It is necessary to take risks (McWilliam, 2008; Kim & Hull, 2012) and identify problems and opportunities that others do not identify (Craft, 2007). Only through teaching our young people to envision a future that disturbs the present and the methods to enact positive change, may we promote more proactive individuals with the confidence, skills, and persistence to ensure a higher quality of personal and social life - in any field of knowledge these individuals pursue.

References

Adobe (2012, November, 7). Creativity and education: Why it matters. Retrieved from

http://wwwimages.adobe.com/content/dam/Adobe/en/education/pdfs/adobe-creativity-education-findings.pdf

Aleinikov, A. G., Kackmeister, S. & Koening, R. (Eds.) (2000). Creating creativity: 101 definitions. Midland, MI: Alkden B. Dow Creativity Center Press.

Alencar, E. (2000). O processo da criatividade: Produção de ideias e técnicas criativas. São Paulo: Makron.

Alves, M. M. (2013). Resolução criativa de problemas de âmbito comunitário em adolescentes do ensino profissional (Tese de Mestrado). Universidade do Minho.

Alvino, J. (1993). Teaching our children to solve "fuzzy" problems. PTA Today, 18, 13-14.

Amabile, T. (1998, Sept-Oct.). How to kill creativity. Harvard Business Review. Retrieved from https://hbr.org/1998/09/how-to-kill-creativity/ar/1

Amabile, T. (2010). Creativity. Annual Review of Psychology, 61, 569–598.

Arbor, M. I. (1999). Community Problem Solving: International Conference champions. Melbourne, FL: Future Problem Solving Program.

Azevedo, I, Morais, M. F., Jesus, S. Ribeiro, I & Brandão, S. (2012, Julho). A aplicação do Future Problem Solving Program International em adolescentes: Um estudo exploratório. In M. F. Morais (Coordenador), Resolução Criativa de Problemas: Conceitos e Contextos. Simpósio conduzido no II Seminário Internacional Contributos da Psicologia em Contextos Educativos, Universidade do Minho, Portugal

Azevedo, I. (2016). Resolução Criativa de Problemas: Estudo de um programa de intervenção em adolescentes no contexto educativo. Braga: Universidade do Minho.

Baer, J. (2011). Why teachers should assume creativity is very domain specific. The International Journal of Creativity & Problem Solving, 21(2), 57 -61.

Barbot, B., Besançon, M., & Lubart, T. (2011). Assessing creativity in the classroom, The Open Education Journal, 4, (Suppl1), 58-66.

Boden, M. A. (2007). Creativity and knowlwdge. In A. Craft, B. Jeffrey, & M. Leibling (Eds.), Creativity in education (pp. 95 – 102). London: Continuum.

Caldeira, M. (2006). Desenvolvimento da criatividade em contexto escolar. Contributo para o estudo da formação contínua de professores na área da criatividade. Lisboa: Universidade de Lisboa.

Caniels, M. C. J. (2013). Organizing creativity: Creativity and innovation under constraints. Creativity and Innovation Management, 22(1), 100-102.

Cojorn, K., Koocharoenpisal, N., Haemaprasith, S., & Siripankaew, P. (2013). Effects of the Creative Problem Solving (CPS) Learning Model on Matter and Properties of Matter for Seventh Grade Students. Journal of Education, 35(1), 18-30.

Crabbe, A. (1989). The Future Problem Solving Program. Educational Leadership, 7(1), 27-29.

Craft, A. (2005). Creativity in schools: Tensions and dilemmas. London, UK: Routledge.

Craft, A. (2007). Creativity in schools. In N. Jackson, M. Oliver, M. Shaw, & J. Wisdom (Eds.), Developing creativity in higher education (pp. 19-28). New York: Routledge.

Craft, B. Jeffrey, & M. Leibling (Eds.), (2007) Creativity in education. London: Continuum.

Cramond, B. (2002). The study of creativity in the future. In A. G. Aleinikov (Ed.). The Future of creativity. Bensenville, IL: Scholastic Testing Service, pp. 83-89.

Cramond, B. (2005). Fostering creativity in gifted students. Waco, TX: Prufrock Press.

Cramond, B. (2006). Creative strategies. In F. A. Karnes & K.R. Stephens (Eds.). Practical strategies series set II. Waco, TX: Prufrock.

Cramond, B. (2009). Future Problem Solving in gifted education. In L. Shavinna (Ed.). Handbook on Giftedness (Part 2, pp. 1143- 1156). NY: Springer.

Cramond, B. L., & Fairweather, E. C. (2013). Future Problem Solving as Education for Innovation. In L. V. Shavinina (Ed.). The Routledge International Handbook of Innovation Education (pp. 215-226). Routledge: London and New York.

Cropley, A. (2009). Creativity in education and learning: A guide for teachers and educators. New York: Routledge Falmer.

Cropley, A., & Cropley, D. (2009). Fostering creativity: A diagnostic approach for Higher Education and Organizations. Cresskill, NJ: Hampton Press.

Csikszentmihalyi, J. A. (2007). Foreword: Developing creativity. In N. Jackson, M. Oliver, M. Shaw, & J. Wisdom (Eds.), Developing creativity in higher education (pp. xvii-xx). New York: Routledge.

Czerwiec, I. T. (1992). An analysis of the future Problem Solving Program and its impact on Massachusetts participants (Doctoral Dissertation). Massachusetts: University of Massachusetts, Education Department.

Davis, M. A. (2009). Understanding the relationship between mood and creativity: A meta-analysis. Organizational Behaviour and Human Decision Processes, 108(1), 25-38.

El-Murad, J. & West, D. C. (2004). The definition and measurement of creativity: What do we know? Journal of Advertising Research, 44(2), 188-201.

Fairweather, E., & Cramond, B. (2010). Infusing creative and critical thinking into the curriculum together. In R. Beghetto & J. Kaufman (Eds.), Nurturing creativity in the classroom (pp. 113-141). New York: Cambridge University.

Fautley, M., & Savage, J. (2007). Creativity in secondary schools. Exeter, UK: Learning Matters.

Feist, G. J. (2006). The evolved fluid specificity of human creative talent. In R. Sternberg, E. Grigorenko & J. L. Singer (Eds.), Creativity – from potential to realization (pp. 57 - 82). Washington DC: APA.

Fobes, R. (1993). The Creative Problem Solver's Toolbox: A complete course in the art of creating solutions to problems of any kind. Corvallis, OR: Solutions Through Innovation.

Fryer, M. (1996). Creative teaching and learning. London: Paul Chapman.

Funke, J. (2010). Complex problem solving: a case for complex cognition? Cognitive Processing, 11(2), 133-142.

Future Problem Solving International, FPSPI (n.d.). Website. http:// fpspi.org/

Gruber, H. E. (1974). Darmin on man. London: Wilwood House London.

Guerra, V., & de Abreu, R. (2005). Relativity—Einstein's lost frame. Retrieved January 31, 2007 from http://www.lostrelativity.com

Harris, R. A. (2002). Creative Problem Solving: A Step by Step Approach. Los Angeles: Pyrczak Publishing.

Hennessey, B., & Amabile, T. (2010). Creativity. Annual Review of Psychology, 61, 569–598. http://dx.doi.org/10.1146/ annurev.psych.093008.100416

Hibel, J. (1991). Future Problem Solving: Taking it beyond the classroom. GCT, 14 (2), 23-27.

Isaken, S., Dorval, K.., & Treffinger, D. (2011). Creative approaches to problem solving: a framework for change. (3º Edição). Dubuque, IA: Kendall/Hunt

Jackson, J. (2001). Future Problem Solving Program Coach's Handbook. Ann Arbor, MI: Future Problem Solving Program.

Kaufman, J. (2012). Future Problem Solving Program International: Brief Summary of Year One for Longitudinal Study. Disponível a 1 de dezembro de 2014 em http://www.fpsp.org/impact.html

Kaufman, J. C. & Beghetto, R. A. (2009). Beyond big and little: The four C model of creativity. Review of General Psychology, 13 (1), 1 – 12.

Kim, K. H., & Hull, M. F. (2012). Creative personality and intercreative environment for high school dropouts. Creativity Research Journal, 24, 169-176.

Lubart, T. & Guinard, J. H. (2006). The generality-specificity of creativity: a multivariate approach. In R. Sternberg, E. Grigorenko & J. L. Singer (Eds.), Creativity – from potential to realization (pp. 43 - 56). Washington DC: APA.

Lubart, T. I. (2001). Models of the creative process: Past, present and future. Creativity Research Journal, 13(3/4), 295-308.

Lubart, T., & Zenasni, F. (2010). A new look at creative giftedness. Gifted and Talented International, 25, 53-57.

Lucas, B., Claxton, G., & Spencer, E. (2012). Progression in creativity: Developing new forms of assessement. Comunicação apresentada na OECD Conference "Education for Innovative Societies". Disponível em http:// www.oecd.org/dataoecd/62/29/50153675.pdf.

Ma, H.-H. (2006). A synthetic analysis of the effectiveness of single components and packages in creativity training programs. Creativity Research Journal, 18, 435-446.

MacLaren, I. (2012). The contradictions of policy and practice: Creativity in higher education. London Review of Education, 10, 159-172.

Maker, J., Jo, S., & Muammar, O. M. (2008). Development of creativity: The influence of varying levels of implementation of the DISCOVER curriculum model, a non-traditional pedagogical approach. Learning and Individual Differences, 18, 402–417. http://dx.doi.org/ 10.1016/ j.lindif.2008.03.003

Margison, J. (2004). Future Problem Solving Program Coaches' Efficacy in Teaching for Successful Intelligence and Their Patterns of Successful Behavior. Roeper Review, 26(3), 175.

Martindale, C. (1989). Personality, situation and creativity. In J. A. Glover, R. R. Ronning & C. R. Reynolds (Eds.), Handbook of creativity (pp. 211-232). New York: Plenum.

Masini, E. (2011). How to Teach Futures Studies: Some Experiences. Journal of Futures Studies, 15(4), 111-120.

Maslow, A. H. (1983). La personalidad creadora. Barcelona: Kairós

McWilliam, E. (2008). Unlearning how to teach. Innovations in Education and Teaching International, 45(3), 263-269. doi: 10.1080/14703290802176147

Megalakaki, O., Craft, A., & Cremin, T. (2012). The nature of creativity: Cognitive and confluence perspectives. Electronic Journal of Research in Educational Psychology, 10(3), 1035-1056.

Miller, M., Vehar, J., & Firestien, R. (2001). Creativity unbound. Williamsville, NY: Innovation System Group.

Montuori, A. (2011). Beyond postnormal times: The future of creativity and the creativity of futures. Futures, 43 (2), 221-117.

Morais, M. F. (2013). Creativity: Challenges to a key-concept for the 21th century. In A. Antonietti, B. Colombo, & D. Memmert (Eds.), Psychology of creativity – Advances in theory, research and application (pp.3 –19). New York: Nova Publishers.

Newell, A. & Simon, H. A. (1972). Human problem solving. Englewood Cliffs, NJ: Prentice Hall.

Osborn, A.F. (1953) Applied imagination: Principles and procedures of creative thinking. New York, Scribner's.

Parnes, S. (1967). Creative behavior guidebook. New York: Scribner's.

Parnes, S. J., Noller, R. B. & Biondi, A. M. (1977). Guide to creative action. New York: Scribner´s Sons.

Partnership for 21st Century Skills. (2006). Young people urgently need new skills to succeed in the Global Economy. Retrieved January 18, 2007, from www.21stcenturyskills.org

Perkins, D. N. (1981). The mind's best work. Cambridge, MA: Harvard University Press.

Péter-Szarka, S. (2012). Creative climate as a means to promote creativity in the classroom. Electronic Journal of Research in Educational Psychology, 10, 1011-1034.

Pfeiffer, S. I. (2013). Serving the gifted: Evidence-based clinical and psycho-educational practice. New York: Routledge.

Piirto, J. (2004). Understanding creativity. Scottsdale, AZ: Great Potential.

Plucker, J. A. & Beghetto, R. A. (2006). Why creativity is domain general, why it looks domain specific, and why the distinction does not matter. In R. Sternberg, E. Grigorenko & J. L. Singer (Eds.), Creativity – from potential to realization (pp.153 - 168). Washington DC: APA.

Proctor, T. (2005). Creative Problem Solving for Managers: Developing Skills for Decision Making and Innovation (2nd Ed.). New York: Routledge

Puccio, G. J. & Murdock, M. C (2001). Creative thinking: An essential life skill. In A. Costa (Ed.), Developing minds: A source book for teaching thinking (pp. 67-71). Alexandria, VA: ASCD.

Reschke, R. (1991). The Future Problem Solving Program: How and Why It Works. Gifted Child Today, 14(2), 30-31.

Rhodes, M. (1961). An analysis of creativity, Phi Beta Kappen, 42, 305-310.

Rimm, S. & Olenchak, F.R. (1991, March/April). How FPS helps underachieving gifted students. Gifted Child Today, 19-22.

Romo, M. (2012). Educational creativity - selected research. (2012). In Fundacíon Botín (Ed.) Good Morning Creativity: Awakening human potential through education (pp. 69-86). Santander: Belinda Hayes.

Root-Berstein, R. & Root-Bernstein, M. R (2006). Artistic scientists and scientific artists: the link between polymathy and creativity. In R. Sternberg, E. Grigorenko & J. L. Singer (Eds.), Creativity – from potential to realization (pp. 127 – 152). Washington DC: APA.

Runco, M. & Jaeger, G. (2012). The standard definition of creativity. Creativity Research Journal, 24(1), 92-96.

Runco, M. (2006). Reasoning and personal creativity. In Kaufman, J. C. & Baer, J. (Eds.), Creativity and reason in cognitive development (pp. 99 - 116). New York: Cambridge University Press.

Runco, M. A. (2007). Creativity: theories and themes, research, development and practice. London: Elsevier Academic Press.

Runco, M. A. (2014). Creativity; Theories and Themes: Research, Development and Practice. San Diego, CA: Academic Press.

Runco, M. A., Lubart, T, I., & Getz, I. (2012). Creativity and economics. In M. A. Runco (Ed.), The creativity research handbook (Vol. 2, pp. 173-198). New York: Hampton Press.

Sahlberg, P. (2011). The role of education in promoting creativity: Potencial barriers and enabling factors. In R. Schenkel, & O. Quintin (Eds.). Measuring Creativity (pp. 337-344). Brussels: The European Commission. http://ec.euope.eu/education/lifelong-learning-policy/creativity-book_eu.htm

Sanchez, M. P., Martínez, O. L. & García, C. F. (2003). La creatividad en el contexto escolar: Estrategias para favorecerla. Madrid: Pirámide.

Sawyer,R. K. (2006). Explaining creativity – The science of human innovation. New York: Oxford University Press.

Scott, G., Leritz, L. E., & Mumford, M. D. (2004a). The effectiveness of creativity training: A quantitative review. Creativity Research Journal, 16, 361-388. http://dx.doi.org/10.1080/10400410409534549

Shanahan, A. (2004). A journey into creative process of learning a new skill. Buffalo, NY: State University of New York, Buffalo State College, International Center for Studies in Creativity.

Shapiro, D. L. (2012). Creative Problem Solving: Not Just About the Problem.Psychological Components of Sustainable Peace, 85.

Shewach, D. L. (1991). Scenario writing: A vision of the future. Gifted Child Today, 14, 32-36.

Smith-Bingham, R. (2007). Public policy, innovation and the need for creativity In N. Jackson, M. Oliver, M. Shaw, & J. Wisdom (Eds.), Developing creativity in higher education (pp. 10-18) New York: Routledge.

Starko, A. J. (2010). Creativity in the classroom - schools of curious delight. New York: Routledge.

Sternberg, R. J. (2005). Creativity or creativities? International Journal of Human-Computer Studies, 63, 370-382.

Sternberg, R. J. & Lubart, T. I. (1995). Defying the crowd cultivating creativity in a culture of conformity. New York: The Free Press.

Sternberg, R. J. (2015). Wisdom, intelligence and creativity synthesized. Cambridge: Cambridge University Press.

Switalski, L. (2003). Evaluating and organizing thinking tools in relationship to CPS framework. New York: State University of NewYork, Buffalo State College, International Center for Studies in Creativity.

Tallent-Runnels, M. K. (1993). The Future Problem Solving Program: An investigation of effects on problem-solving ability. Contemporary Educational Psychology, 18, 382-388.

Toffler, A. (1970). Future Shock. New York, NY: Bantam.

Torrance, E. (1978). Giftedness in solving future problems. Journal of Creative Behavior, 12, 75–86.

Torrance, E. P. (1963a) (Ed.), Education and the creative potential (pp. 34-43). Minneapolis: University of Minnesota.

Torrance, E. P. (2002). Future needs for creativity research, training and programs. In A. G. Aleinikov (Ed.), The future of creativity. Bensenville: Scholastic Testing Service, INC.

Torrance, E. P. e Myers, R. E. (1970). Creative learning and teaching. New York: Dodd, Mead.

Torrance, E. P. e Myers, R. E. (1970). Creative learning and teaching. New York: Dodd, Mead.

Torrance, E., Torrance, L., Williams, S., & Horng, R. (1978). Handbook for training future problem solving. Athens, GA: University of Georgia, Department of Educational Psychology.

Treffinger, D. J., & Young, G. (2002). Building creative excellence. Glassboro, NJ: Destination ImagiNation

Treffinger, D. J., Selby, E. C., & Crumel, J. H. (2012). Evaluation of the future problem solving program international (FPSPI). IJCPS-International Journal of Creativity and Problem Solving, 22(2), 45.

Treffinger, D. J., Solomon, M., & Woythal, D. (2012). Four Decades of Creative Vision: Insights from an Evaluation of the Future Problem Solving Program International (FPSPI). The Journal of Creative Behavior, 46(3), 209-219.

Treffinger, D., Jackson, J., & Jensen, B. (2009). FPSPI: Past, present, and future. Louisville, KY: Future Problem Solving Program.

Trefinger, D.J. (2011). Future problem solving program international: Catalyst for talent recognition and development. Melbourne, FL: Future Problem Solving Program International.

Trilling, B. & Fadel, C. (2012). Century skills: Learning for life in our times. NY: Jossey Bass.

Vallery-Radot, R. (2008). The life of Pasteur. Charleston, SC: Bibliobazaar

Vernon, P. E. (1989). The nature-nurture problem in creativity. In J. A. Glover, R. R. Ronning & C. R. Reynolds (Eds.), Handbook of creativity - Perspectives on individual differences (pp. 93-110). New York: Plenum.

Vijayaratnam, P. (2012). Developing Higher Order Thinking Skills and Team Commitment via Group Problem Solving: A Bridge to the Real World. Procedia-Social and Behavioral Sciences, 66, 53-63.

Volk, V. (2008). A Global Village Is a Small World. Roeper Review, 30, 39-44.

Walberg, H. J. (1988). Creativity and talent as learning. In R. J. Sternberg (Ed.), The nature of creativity (pp. 340-361). Cambridge, NY: Cambridge University.

Wechsler, S. M. & Souza, V. L. T. (Orgs.). (2011). Criatividade e aprendizagem. São Paulo: Edições Loyola.

Weisberg, R. W. (1987). Creatividad: El genio y otros mitos. Barcelona: Editorial Labor.

Wells, H. (1913). The Discovery of the future. NY: B. H. Huebsch

Wenstein, E. C., Clark, Z., DiBartolomeo, D. J., & Davis, K. (2014). A decline in creativity? It depends on the domains. Creativity Research Journal, 26(2), 172-184. doi:10.1080/10400419.2014.901082

Woythal, D. (2014). So… How well are we doing in meeting these goals?. FPSPI: Parent Perspectives, 16, 4. Disponível em http:// www.fpspi.org/newsletters.html

Yashin-Shaw, I. (1994). Cognitive structures of creativity: Implications for instructional design. European Journal for High Ability, 5, 24-38.

Correspondence

Prof. Ivete Azevedo, Torrance Center-Portugal, Portugal, iveteazevedo@tcportugal.org

Prof. Maria de Fátima Morais, Universidade do Minho, Portugal, famorais@ie.uminho.pt

Prof. Fernanda Martins, Faculdade de Letras, Universidade do Porto, Portugal, mmartins@letras.up.pt

Prof. Bonnie Cramond, University of Georgia, United States of America, bcramond@uga.edu

Authors' Brief Bios

With a degree in Mathematics by Porto University (1987), **Ivete Azevedo** has broadened her investigation field with a PhD (2008) in Educational Psychology by the Education and Psychology Institute of Minho University. Currently, as a post doctorate, has kept sight of her main research field: creativity and its applications. She has several published articles on the subject in both national and international magazines, as well as participations in conferences, communications and courses in national and international congresses. Ivete is the President of the Board and of the Scientific Council of the Torrance Center Portugal. She is also the Director in Portugal for the Future Problem Solving Program International and is responsible for the validation of the internationally acknowledged test of creative evaluation: Torrance Test of Creative Thinking. She is a project manager, professor, researcher and trainer in several areas.

Maria de Fátima Morais is graduated in Psicologia (University of Porto, Portugal) and has a PhD in Psicology of Education (Universty of Minho- Braga, Portugal). Is Professor in the Institut de Education (University of Minho), giving courses of graduation and post-grduation. Her research domain is creativity in the educational context, having published national and international papers and supervising master and PhD dissertations in that thematic.

Fernanda Martins is graduated and has a Master and a PhD degree in Psychology. She has been a teacher of Psychology in the aim of Teacher Education and responsible for that scientific area at the Faculdade de Letras, University of Porto. Since 2005 she teaches Research Methodology and Cognitive Psychology at the same Faculty at graduation, Master and PhD courses. She has participated in research projects and has published and presented her research results at national and international scientific encounters. She also supervises Master and PhD dissertations. Since 2007 she is a member of CETAC-MEDIA where she integrates different research teams. She is a member of Ordem dos Psicólogos Portugueses, of the American Psychological Association and of the American Psychological Society. Her main research areas of interest are Cognitive Psychology, particularly emotions and cognition interactions.

Bonnie Cramond, PhD, is a Professor of Educational Psychology at the University of Georgia. She has been the Director of the Torrance Center for Creativity and Talent Development, a board member of the National Association for Gifted Children, and editor of the Journal of Secondary Education. She is on the Advisory Board for the American Creativity Association; the Future Problem Solving Program International; the Global Center for Gifted and Talented Children; is a member of the International Creativity Society; on the review board for several journals; and, has published numerous articles, chapters, and a book. A national and international speaker, she has visited over 35 countries working toward infusing creativity into classrooms at all levels. She was honored in 2011 to be invited to give a TEDx Talk on creativity and has gratefully received other international and national honors.

CHAPTER SEVEN

THE UNIVERSALITY OF CREATIVITY

KATHY GOFF & ERIK E. GUZIK

Abstract

So long as creativity is connected in a reductionist manner to a particular subset of creative acts (art, music, poetry, writing, etc.), there is little chance that we might recognize the centrality of creative intervention within nearly every area of human intellectual pursuit and achievement. If, however, we view creativity as a complicated set of human abilities that are drawn upon to realize some goal or objective, we might better understand how creativity can be applied wherever and whenever new, original, and useful outcomes are of benefit and value. This understanding of creativity includes its practice in science, art, music, mathematics, engineering, technology, healthcare, business, etc.—extending to even athletics and politics. This chapter describes the theoretical and philosophical roots of creativity qua problem solving in the works of Wallace, Guilford, Torrance, etc. It also addresses the practical side of this conception, describing how this creativity is now shaping interventions in education, creativity assessment, and cognitive rehabilitation for people with cognitive decline or injury, including subjects with traumatic brain injury and dementia.

Keywords: Creativity, Creative Problem Solving, STEM, 21st Century skills, Technology, Education, Digital Assessment, Brain Training

Introduction

Creativity is a uniquely human ability, a defining and differentiating factor of human existence. As the philosopher David Hume noted during the Scottish Enlightenment, the ability of the human species to generate novel insight into its environment and to develop unique solutions to its problems seemingly sets it apart from every other species (Miller, 1987). Though we humans lack the thick coat of fur and sharp claws that other species use effectively to their advantage, Hume argued, we nevertheless hold an asset of unparalleled power—the ability to imagine and create new solutions to problems within our environment. We tend to agree with Hume—creativity is very likely our species' unique and comparative advantage in a natural world

marked by endless change and ceaseless challenge.

Perhaps precisely because of its centrality to human experience, creativity has been investigated from many different viewpoints and perspectives. Indeed, one might argue that creativity has been successfully applied to an understanding of its own existence, generating a range of interesting insights into its manifold character and operation. Creativity has also been examined for decades, with many of the findings and signs of the times still relevant today and for the future. This chapter begins by building a historical foundation of creativity research as a form of problem solving and moves to current investigations into cognitive interventions in education, assessment, and cognitive training based on this particular conceptualization.

Creativity Qua Open-ended Problem Solving

Creativity has led to many definitions. One of the first definitions of creativity described it as a highly developed form of intuition, rarely found in the human race (Galton, 1870). Freud (1910) viewed creativity as a substitute for achieving satisfaction and thus avoiding the hardships of reality. These early views of creativity contributed to the misconceptions of creativity—that creativity is found only in the elite and that creativity is necessarily a negative characteristic of a person.

However, in 1926, Wallas proposed that creativity is a process of forming new thoughts and consists of four stages: (1) preparation—investigation of the problem; (2) incubation—time when the individual is not consciously thinking about the problem; (3) illumination—when the idea(s) occur, the "aha" moment; (4) verification—the idea is tested and refined into final form.

In the 1920's and 1930's, interesting and exciting attempts were made to develop tests for measuring the creative thinking abilities and identifying creative talents. From this work, measures that tapped different aspects of mental functioning and different intellectual talents than traditional tests of intelligence of scholastic ability were devised. However, these efforts attracted very little attention with no sustained research and development efforts (Torrance, 1965). The 1940's were dominated by World War II.

Following World War II, J. P. Guilford was a pioneer in creativity research and one of the first to propose a distinction between divergent and convergent thinking. In 1949, as president of the American Psychological Association, he devoted his Presidential Address to creativity. According to Guilford (1950):

> I discuss the subject of creativity with considerable hesitation, for it represents an area in which psychologists generally, whether they be angels or not, have feared to tread. It has been one of my long-standing ambitions to undertake an investigation of creativity. Circumstances have just recently made possible the realization of that ambition. (p. 444).

In that 1950's presidential address, Guilford suggested that creativity is comprised of certain factors with the primary abilities of ideational fluency, flexibility of set, ideational structure and evaluating ability. With further exploration, he believed that we should know enough about the primary abilities to do something in the way of education, to support them and to increase their utilization.

Guilford used a factor analytic technique to begin isolating the various factors of thinking, to separate out creativity and other skills from the factors measured by IQ.

Hr provided a three-dimensional cubical model to explain his theory of the Structure of the Intellect. According to this theory, an individual's performance on an intelligence test can be traced back to the underlying mental abilities or factors of intelligence (Guilford, 1967).

Structure of the Intellect (SOI)

Originally Guilford proposed 120 intellectual abilities or factors that have evolved to include 180 abilities/factors. Each ability/factor stands for a particular operation in a particular content area and results in a specific product. He conceptualized the intellect as being 3 dimensions with a variety of abilities/factors.

I. Operations Dimensions—SI includes six operations or general intellectual process.

1. Cognition—The ability to understand, comprehend, discover and become aware of information.
2. Memory recording—The ability to recall information.
3. Divergent production—The ability to generate multiple solutions to a problem; creativity
4. Convergent production—The ability to deduce a single solution to a problem.
5. Evaluation—The ability to judge whether or not information is accurate, consistent or valid.

II. Content Dimensions—SI includes four broad areas of information to which the human intellect applies the six operations

1. Figural—Concrete, real world information, tangible objects
2. Symbolic—Information perceived as symbols or signs that stand for something else
3. Semantic—Concerned with verbal meaning and ideas; generally considered to be abstract in nature
4. Behavioral—Information perceived as acts of people.

III. Product Dimension—The SI model includes six products resulting from applying particular operations to specific contents, in increasing complexity.

1. Units—Single items of knowledge
2. Classes—Sets of unit sharing common attributes.

3. Relations—Units linked as opposites or in association, sequence or analogies.
4. Systems—Multiple relations interrelated to compromise structures or networks.
5. Transformations—Changes, perspectives, conversations or mutations to knowledge.
6. Implications—Predications, inferences, consequences, or anticipations of knowledge.

In the SOI model, Guilford (1975) indicated that there are twenty-four places for divergent production abilities. In order to address an open-ended question or task, some divergent thinking must be used. Divergent thinking is a kind of problem solving leading an individual to numerous and varied responses (Runco, 2014). Guilford indicated that all problem solving is creative, but left the question open as to whether all creative thinking is problem solving.

Although Guilford's SOI model has relatively few supporters today in the field of creativity, his work is sited almost exclusively as the foundation for modern day neuropsychological research into creativity. (Beaty, et al, 2014; Boccia, et al., 2015; Shamay-Tsorya, et al., 2011; Schwab, et al., 2014). Therefore it seemed important to describe the SOI Model to gain a better understanding of Guilford and his work as a precursor to today's research efforts.

Subsequent leaders in the fields of creative problem solving were Alex Osborn and Sid Parnes. According to Parnes (1987), their creative problem solving process parallels Guildford's Structure-of-the-Intellect (SOI) model very closely. For their research, Osborn and Parnes used tests from Guilford's SOI, with a strong connection to creative problem solving (Parnes, Noller and Biondi, 1977).

Alex Osborn, an advertising executive, had written his widely acclaimed text, Applied Imagination in 1953. Osborn established the Creative Education Foundation to expand the use of creativity and innovation worldwide. He is also credited with initiating the Journal of Creative Behavior in January, 1967. He has been labeled the "father of brainstorming" (Vehar, Firestien & Miller, 1997). Osborn (1953) described brainstorming as:

> …nothing more than a creative conference for the sole purpose of producing a checklist of ideas—ideas which can serve as leads to problem-solution—ideas which can subsequently be evaluated and further processed. (p 151-152)

Osborn believed that, in order for the idea producing session to be fruitful, certain rules must be understood and faithfully followed. Those rules are: 1) Criticism is ruled out, 2) Free-wheeling is welcomed, 3) Quantity is wanted, and 4) Combination and improvement are sought.

Osborn (1953) initially theorized that a creative problem solving process was ideally comprised of three procedures: 1) Fact finding, 2) Idea finding,

and 3) Solution finding. He said "Regardless of the sequence, every one of those steps calls for deliberate effort and creative imagination" (Osborn, 1953, p 86).

Osborn was a co-founder of the Creative Problem Solving Institute (CPSI) in Buffalo, NY in 1955 where Dr. Sidney J. Parnes (1975) first became acquainted with Osborn's work. Through his participation in CPSI, Parnes came to understand and appreciate the tremendous potential of the imagination.

Parnes believed in developing a balance between the freedom of imagination and self-discipline. Parnes pointed out that knowledge provides the opportunity for creativity, but it is the imaginative use of knowledge that leads to creative productivity (1967).

Although problem solving models were not new, Osborn's problem solving model added the deliberate and exaggerated use of the imagination (Parnes, 1975). Through the years, Parnes determined that imagination stretching, i.e. brainstorming, was necessary and could be used in all stages of the creative problem solving process. The flow of idea generation diverges and then converges to the next step throughout the creative problem solving process illustrated below.

Osborn-Parnes Creative Problem Solving Process

1. Fact finding
2. Problem finding
3. Idea finding
4. Solution finding (Idea evaluation)
5. Acceptance finding (Idea implementation)

Parnes was an educator. He believed a common educational objective is to help each person develop the mind to its fullest potential, teach her/him to live effectively in a changing world, to prepare institutional changes where they are needed and to adjust and accept those changes (Parnes, 1967). Creative learning builds a bridge between known facts and the unknown future (Parnes, 1967).

Teachers were increasingly aware of the need for opportunities for encouraging creative behavior (Parnes, 1962), yet still today our present educational system generally overlooks the intentional enhancement of creative behavior. Students have had hours upon hours devoted to training in solving problems by reasoning, but almost none devoted to cultivation of the imagination (Rugg, 1963). Teaching has been and still is too authoritative (Torrance, 1962).

On a parallel track was E. Paul Torrance beginning his research in 1951 at the U.S. Air Force Survival Training School. Torrance began researching the psychology of survival upon his arrival. Torrance's research unit developed the training about how to survive in extreme conditions. They (Millar, 1995) identified these skills as being important in survival:

- inventiveness
- creativity
- imagination
- originality
- flexibility
- decision-making ability
- courage

During his work with the USAF Survival Training School, Torrance began investigating creativity. The survival training was to teach airmen to survive emergencies and extreme conditions. These airmen were facing new situations for which they had no learned or practiced solutions.

In survival situations, airmen need creative solutions from imaginatively recombining old elements with the new situation. Torrance found that the elements of creative solutions can be taught, but creativity itself must be self-discovered and self-disciplined. The training emphasized self-discovery, self-discipline and the use of the imagination.

Torrance's survival definition of creativity (1987) states that some degree of creativity is required when faced with problems with no learned or practiced solutions. Support for Torrance's survival definition of creativity was provided by seven years of research in support of the U.S. Air Force survival training program (1951-1957).

Following his work in the Air Force, Torrance began formal research into the nature of creativity at the University of Minnesota in 1958. His primary method for learning about the nature of creativity was through testing and teaching creative behavior.

At the University of Minnesota, E. Paul Torrance conducted vigorous programs of research on creative abilities and creative performances of children and teachers who attempted to teach creative thinking (Guilford, 1970). He undertook a close analysis of Guilford's mental operations of convergent/divergent thinking in order to understand creative thinking and how it is different from traditional measures of intelligence.

Torrance developed a battery of tests for creativity for use with elementary and high school students in 1958. The Minnesota Tests of Creative Thinking (MTCT) were used in two longitudinal studies: 1) from 1958-1964, elementary students were administered various batteries of the MTCT and 2) in 1959, high school students, grades 7-12, took the tests. Torrance believed that these longitudinal studies would provide strong evidence of a relationship between test behavior and later creative achievement.

The 50 year follow-up to the Torrance longitudinal studies was published by Millar in 2010. Results demonstrated that there was still predictive validity for the Torrance Tests of Creative Thinking of adult creative achievement. The Torrance Tests of Creative Thinking (TTCT), formerly the Minnesota Tests for Creative Thinking, were first published in 1966.

The TTCT consists of a battery of tests of creative thinking abilities for use from kindergarten through graduate and professional education. The Torrance Tests of Creative Thinking (TTCT) are the most widely used tests of creative talent in the United States and have been translated into over 50 different languages. The TTCT have been standardized and published and France, Italy and China. Very little racial, socioeconomic or cultural bias has been found in using the TTCT (Torrance, 1988).

For research purposes, Torrance chose a process definition of creativity. He believed that if he chose the creative process as a focus, he could then ask what kind of person engages in the process successfully, what kinds of environments facilitate it and what kinds of products result from success use of the process (Torrance, 1965).

Torrance (1970) research definition of creativity is:

> …the process of becoming sensitive to or aware of problems, deficiencies, gaps in knowledge, missing elements, disharmonies and so on; brining together in new relationships available existing information; defining the difficulty of identifying the missing elements; searching for solutions, making guesses, or formulating hypotheses about the problems of deficiencies; testing and retesting them; and, finally, communicating the results. Strong human motivations are involved

The creative process may be considered as a new way of seeing, a different point of view, an original idea or a new relationship between ideas (McCaslin, 1984), A patented invention is a tangible product that results from the creative process. An everyday example of the creative process is the use of a brick or shoe to hammer in a nail when a hammer is unavailable. It requires seeing the brick or the shoe in a different way. It is the way in which the problem is solved.

Torrance (1972) summarized 142 studies designed to test approaches of teaching children to think creatively. Most of the studies used performances on tests of creative thinking and other creative school performances as criteria. According to Torrance (1972):

> …it does seem possible to teach children to think creatively. The most successful approaches seem to be those that involve both cognitive and emotional functioning, provide adequate structure and motivation, and give opportunities for involvement, practice and interaction with teachers and other children. Motivating and facilitating conditions certainly makes a difference in creative functioning but

> differences seem to be greatest and most predictable when deliberate teaching is involved (pp. 132-133).

In 1983, Torrance examined 166 experimental studies at the elementary and secondary level and 76 at the college and adult level conducted since the 1972 survey. Torrance (1987) reported that the college/adult training was more successful than the elementary/secondary training (86% compared to 70%).

The most frequently used intervention at the college/adult level was the use of complex programs involving several strategies. In many cases these were courses in creative thinking or regular subject matter courses taught by creative procedures (pg. 206).

Torrance often said that to get creative behavior, we must reward it (Guilford, 1975). For adults, creativity assessments may provide that "reward" by identifying creative abilities and their levels of development. Learning that there are identifiable aspects of creativity and that everyone is creative to some degree, can be very enlightening as well as rewarding.

With Torrance's focus on understanding and nurturing people's creativity, the TTCT were not designed merely as a measure of creativity, but also serve to foster people's creative thinking. According to Guildford (Parnes, 1967), creativity is the key to education in its fullest sense and to the solution of mankind's most serious problems.

Creative Problem Solving

Parnes and Torrance's research demonstrate that a variety of techniques for training in creative problem solving produce significant creative growth without interfering with traditional kinds of educational achievement. Creative growth seems to be the greatest and most predictable when deliberate, direct teaching of creative thinking skills are involved (Torrance, 1995).

Caswell (2006) describes it as an approach to finding workable answers to problems that exist in real life. Creative problem solving skills operate at the most general level and can influence performance in any domain (Amabile, 1989). Problem solving activities shift the focus of the class to a student centered orientation that provides a more creative and interactive environment of engagement (Yen & Lee, 2011). These skills can be influenced by training and by experience. As stated earlier, Torrance (1957) found that elements of a creative solution can be taught, but the creativity itself must be self-discovered and self-disciplined.

There is a big difference between getting ideas and doing something about them. An idea all by itself is nice, but doesn't mean much unless it's attached to people and things. The value of ideas comes when they are applied. In creative problem solving, students work in groups to creatively solve a problem or issue that generally has no known or predetermined solution (Caswell,

2006). Creative problem solving is a teaching method that incorporates active learning strategies to engage students in working with complex situations (Samson, 2015).

A key way to engage students is to integrate active learning strategies into the curriculum (Delialioglu, 2011; Hayden, Ouyand, Scinski, Ollsterwski & Bielefeldt, 2011). Active learning strategies that incorporate student collaboration, that provide timely feedback, help increase both learning and academic achievement (Delialioglu, 2011). Creative problem solving is an effective strategy to motivate and engage students in learning. It promotes deeper learning and fosters the development of effective problem solving and critical thinking skills (Samson, 2015).

Practical Applications

Understanding creativity as a type of open-ended problem solving, we believe, holds a number of advantages, not the least of which is its practical application. The rest of this chapter explores how creativity qua problem solving is now being applied in a range of fields and the promise it holds for future areas of implementation and study. We focus especially on applications in education, cognitive assessment, and cognitive health.

Creativity and Education

> Imagination is more important than knowledge. For knowledge is limited to all we now know and understand, while imagination embraces the entire world, and all there ever will be to know and understand.— Albert Einstein

Despite the history of creativity studies and education we have detailed, the proper place of creativity in education remains a contentious issue. While many agree about the need to infuse creative practice into education models, there is often vehement disagreement about the form this intervention should take and the practicality of such practice. We believe a conception of creativity as open-ended problem solving opens a number of possibilities for improving education and pedagogy while developing the requisite skills in students that underlie creative action, including current STEM, 21st Century Skills, and technology initiatives within the classroom.

Creativity and STEM

The National Science Foundation developed the acronym of STEM for science, technology, engineering and mathematics. STEM is an integrative approach to curriculum and instruction that removes boundaries between subjects (Morrison & Bartlett, 2009). STEM is a transdisciplinary vehicle for

overcoming the compartmentalized disciplinary approach to education (Holley, 2009), and one that has gained traction in attempts to improve educational outcomes.

According to Boy (2013), creativity cannot be treated separately from STEM. We certainly agree—imagination and open-ended inquiry are central, defining components of the scientific method, mathematics, and engineering. Far from rote memorization of facts defining the natural world, science itself is a creative process of generating new, sound ideas about the ever-changing environment in which we operate.

In a STEM based curriculum, students apply previously learned information to creatively address a problem that they have not previously encountered (Roberts, 2012). STEM is an inquiry-based approach that incorporates teamwork and instruction in the "soft skills" needed for business and industry (The Partnership for 21st Century Skills, 2007).

Creativity and the Partnership for 21st Century Skills

Besides basic competency in core subjects, students need to learn how to keep learning and how to make effective and innovative use of what they know throughout their lives. The Partnership for 21st Century Skills has developed a vision for 21st century student success in the new global economy. This vision included an educational process that emphasizes the learning and thinking skills of:

- Creativity and Innovation
- Critical Thinking and Problem Solving
- Communication and Collaboration
- Information and Media Literacy

Often there is a profound gap between the knowledge and skills most students learn in school and the knowledge and skills they need in typical 21st century communities and workplaces. People in the 21st Century live in a media-driven and technological environment with a variety of literacy needs. It is critical that learners possess a fundamental understanding of the ethical/ legal issues surrounding the access and use of information.

Creativity and Technology

It is important to realize that teaching technology for its own sake is not the answer, but rather applying appropriate technologies to instructional tasks in order to enrich the learning of content and skills. Today's digital tools expand the walls of the classroom and enable the integration of resources from across the globe. Digital communications can bring life to learning (The Partnership for 21St Century Skills, 2007).

Information, Communication and Technology Literacy

- Using digital technology, communication tools and/or networks appropriately to access, manage, integrate, evaluate and create information in order to function in a knowledge economy
- Using technology as a tool to research, organize, evaluate and communicate

Experiential learning has long inspired the designers of digital learning environments (Kiiili, 2005). Experiential learning theory stresses the importance of direct experience and reflective observation (Kolb, 1984). Mobile apps are expanding the learning experience both inside and outside of the classroom, making it more interactive, immersive, and engaging. When students are more engaged, they are more motivated and they perform better.

Technology as a Possible Solution

Technology now affords the opportunity to develop learning systems that offering open-ended, divergent thinking games (scenarios, competitive simulations, etc.) that may be applied across core subject areas in K20 classrooms. We envision future software frameworks that allow developers to define and apply multi-step problem solving models to core content areas across the curriculum, thereby better promoting and developing imagination and creativity along the lines originally envisioned by Parnes, Torrance, et al., detailed earlier.

As many creative thinking models (e.g., the scientific method, the writing process, entrepreneurship, design thinking) depend on such common thinking components as idea generation, idea testing, idea verification, and idea elaboration, such frameworks allow developers to create an array of scaffolded STEM activities for students: researching biological systems, analyzing historical events and outcomes, analyzing the impact of mTBI in high school athletes, understanding causality and the functioning of elements within interdependent systems, composing Haikus, thinking critically about current social issues, generating new business ideas, and more. Application of the creative problem solving process to core subject areas also allows for the targeted assessment of cognitive skills like divergent thinking, supporting improved evaluation and development of student STEM skills.

We envision that such platforms will combine team project-based learning with specialized software tools that allow developers to create open-ended, multi-step problem solving games. Games might be integrated as part of the existing classroom curriculum, providing important experiential learning opportunities to support existing core areas of study and learning goals. A high school American history teacher would be able to select a divergent thinking game on the social and economic causes of the American Revolution. A col-

lege marketing instructor would be able to select a divergent thinking game on developing a new product idea for low-cost housing. A high school English teacher would be able to select a game for creating and assigning symbols to each of the characters of Romeo and Juliet that best represents their conflicting motivations. An economics college instructor would be able to select a design thinking game that challenges students to develop a new business idea in response to an unmet consumer need.

Activities could be aligned with existing classroom curricula, implemented directly as part of classroom instruction. Students are naturally curious and respond well to unexplored options in the field of open-ended problem solving—including the opportunity to invent. Gifted and Talented programs like Future Problem Solving, Odyssey of the Mind, Imagination Destination, and Lego Robotics generate passionate devotion on the part of students, teachers, and facilitators. When given the opportunity, students engage thoroughly in activities of scientific investigation and technical design, becoming the main investigators and questioners within such activities. Investigation, creative thinking, and problem solving are central to science and technology education—they are also precisely the skills that creative problem solving programs might seek to promote within future classrooms.

Leading the Change in Education

Problem solving and effective divergent thinking can be learned and applied throughout the curriculum and throughout one's life. This can lead to improved test scores on core academic subjects, as well as critical STEM competencies required for lifelong success, including scientific thinking, divergent thinking, idea testing and verification, and idea implementation and development. The development of higher order thinking skills and movement from memorization and recall to analysis, evaluation, and synthesis is a central component of Bloom's Taxonomy (Bloom et al., 1956; Anderson and Krathwohl, 2001) and many traditional higher order thinking models.

We believe a cps-based learning platform will initiate the following proximal and distal outcomes in education:

Proximal Outcome 1: Teach students new creative problem solving techniques

1. Students learn to break down a problem solving opportunity into manageable steps, such as identifying challenges, selecting one main challenge, generating solution ideas, and selecting one idea to develop in further detail.
2. Students learn brainstorming and divergent thinking techniques, as well as means to select appropriate solution ideas based on defined criteria.

Proximal Outcome 2: Apply problem solving techniques to classroom topics

1. Students learn to view classroom activities and problems from multiple perspectives.

2. Students learn to generate multiples solutions to problem areas.
3. Students learn to elaborate ideas for implementation.
4. Students learn to prototype and test ideas.
5. Students learn to work as a team and communicate effectively to solve task.

Distal Outcome 1: Application of problem solving skills to new content areas

1. Students see challenges as open to multiple solutions.
2. Students view projects as an opportunity to showcase innovation and creative thinking abilities.
3. Students are motivated to generate different educational artifacts.
4. Students view assignments and coursework in new ways, as challenges that entail active student involvement and outcomes.
5. Students improve traditional assessment scores and outcomes, as one effect of increased motivation and problem solving strategies.

Distal Outcome 2: Increased student engagement in open-ended problem solving, including ongoing, lifelong application in science, engineering, arts, and business

1. Graduates move into fields demanding advanced problem solving abilities.
2. Graduates apply problem solving abilities in occupations.
3. Graduates contribute to overall innovation and creativity in society.

Research strongly suggests that open-ended, problem-based learning is not only more engaging than rote instruction for students, it secures a stronger impact on traditional learning outcomes as well. Students learn to explore options, see problems from new perspectives, and try solutions that at first seem like distant and remote possibilities—all behaviors of true innovators in science, business, and society.

An expansive meta-study completed by Hattie (2008; 2012) lists problem solving, creativity, project-based learning, and detailed, formative assessment as some of the most powerful interventions teachers can pursue in the classroom. Further, students involved in integrated problem-solving curriculum display increased engagement, satisfaction and enjoyment (Havice, 2009). Deslauriers, Schelew and Wieman, 2011) confirmed that students become enthusiastic when experiencing problem-based learning. Likewise, Kemple and Snipes (2000) note the positive impact of real-world skills like group problem solving, creative thinking, and decision-making on student engagement and retention.

The enriched curriculum provided by cps learning models also directly supports findings into student engagement and motivation. Dynarski et al. (2008) suggest that such curriculum enhancement "allows students to learn and apply essential academic concepts and skills for a functional purpose," arguing that experiential learning opportunities and simulations impact "student achievement, including the development of problem-solving and analytical reasoning."

Pilot Research: VPS and the Beyonders Program

As a comprehensive study into the potential effectiveness on student creativity of infusing STEM activities with collaborative, cloud-based technology, we piloted a research project called Virtual Problem Solving (VPS) involving three undergraduate classes at the University of Science and Arts of Oklahoma and twelve K12 Oklahoma schools, including approximately 300 students. The project was supported by the Hewlett Packard Catalyst Initiative, the International Society for Technology in Education (ISTE), and Carnegie Mellon's Open Learning Initiative.

The project focused on two pre-created, prototype creative problem solving activities: student invention ideas and community problem solving. The topics were team-based and asked student to apply scientific understanding and design principles to their assigned tasks. The submissions were human scored with VPS online evaluation tools and awards were provided to top-performing teams. Through pre- and post-intervention, student and teacher feedback indicated significant enhanced student interest in scientific learning as well as concepts and classroom engagement, a necessary component of long-term student engagement and retention efforts (Wehlage, 1987).

One deficiency, discovered during the VPS project, was the assessment system included within the intervention depended exclusively on human scoring. Though results were scored and submitted back to students and teachers within their online accounts, both students and teachers were very anxious to receive results and team rankings much more quickly than traditional assessment allowed. Students also expressed an interest in some form of machine scoring of results, even if overall results and rankings within the simulation were provided at a later date due to the inclusion of human scoring. The idea of gamifying the scenarios during a year-long competition with other classrooms and teams, with machine scores provided during the simulation to supplement human scoring, greatly appealed to the students and faculty.

In response to such feedback, a project to machine score certain steps of the problem solving process (primarily idea generation) was begun in 2012. This effort aimed to provide some immediate summative feedback to supplement the rich, formative feedback provided by program evaluators. The result was the development of new software algorithms, using semantic analysis and natural language processing, designed to score certain aspects of the user's work based on imagination and creative thinking abilities. We see the inclusion of this automated creativity assessment prototype as a key step in the development of future open-ended problem solving learning systems.

A continuation of research and development involved integrating VPS into the curriculum of a residential treatment facility with an on-site public school. During the 2014-15 academic year, secondary students, ages 11-18 at the Tulsa Boys Home, participated in the pilot program that consisted of 28 fifty

minute weekly sessions during school. Students were digitally introduced to a variety of creative problem solving models that were applied to the local and global challenges.

The project was named Beyonders to draw attention to E. Paul Torrance's term for identifying and developing individual creative talent so far above the norm that it moved beyond traditional scoring measures. As part of the project, students applied new and previously learned information to creatively address a problem that they had not previously encountered (Roberts, 2012).

Overall, students showed a significant increase in divergent thinking ability after using the Beyonders system and the creativity exercises ($p < .001$). A similar test over a 3 month period during the following summer months with a smaller group of students showed results approaching significance ($p = .053$). Students also expressed increased enthusiasm and engagement for STEM topics following the Beyonders intervention.

In addition to the problem solving simulations, students tested very simple, prototype creativity exercises (again, primarily idea generation exercises) and the automated scoring system. Students expressed great enthusiasm for the exercises and scoring, providing key evidence that automated scoring of some aspects of the STEM simulations would be of great benefit to students and classrooms.

These previous development projects provide critical evidence of initial usability and feasibility of a cloud-based divergent thinking learning system. The projects also illustrate that Beyonders could be implemented within college and high school classrooms and would work well within the requirements and constraints of these particular learning environments. The feedback from machine scoring of divergent thinking exercises provides additional evidence that automated scoring of student work will be valuable, adding another dimension to assessment that already includes rich, formative feedback from human evaluators.

Digital Assessment of Creativity

During our decades of research of creativity we have found that very few of us think we are creative. In fact, when many of us think about creativity, we often conjure up images of musicians, artists, and writers—the mystical "creatives" who we dream about being, but never dreamed we could actually be. These misperceptions have led to the lack of validation of everyday creativity and the importance of creativity in learning environments.

The truth is that most of us do not realize what unique creative abilities we hold and the interesting ways in which they can be applied. Worse still, lacking an adequate understanding of our own personal creativity, we very often place ourselves at a disadvantage when building careers, attending staff meetings, or even deciding what (or how) to prepare dinner. After all, how can we

effectively develop and apply our creativity if we do not understand our own unique creative strengths and potentials?

We are currently researching a new cloud-based tool called the Vast Creative Abilities Indicator (VCAI) in response to these concerns. The VCAI asks users to complete a small set of interactive, hands-on challenges that allow respondents to showcase their actual creative abilities and talents. The short version of the test takes about 20 minutes to complete a small set of tasks whose results are evaluated by trained scorers to determine an individual's current creative strengths and potentials. The tasks include a variety of different cues—verbal, visual, spatial, audible—in order to identify different aspects and kinds of creativity.

The VCAI seeks to measure: (1) FLUENCY: The generation of multiple ideas, alternatives or solutions in response to a given prompt or challenge; (2) FLEXIBILITY: The ability to abandon old ways of thinking and initiate different directions; (3) ORIGINALITY: The ability to produce ideas that generally are not produced or ideas that are totally new or unique; (4) ELABORATION: The ability to embellish ideas/plans with details.

Based on our previous research into assessing creative, using machine scoring, the VCAI offers an automated creative strengths finder based on software algorithms designed to detect creative markers within submitted work. Automated results of imaginative and creative strengths are made available to users immediately upon completion of the provided challenges. Since users respond to a variety of cues as they work on challenges, the automated results also include a description of the different forms of imagination and creativity identified within submissions.

Though we certainly would not want to remove the essential human element from creativity evaluation and enjoyment (nor, we would argue, is this possible), the automated assessment offers a number of interesting benefits and opportunities. As mentioned above, users receive feedback and results instantly. The results provide the basis for the development of future individualized, self-paced creativity training —creative brain training, if you will (this training is described in more detail below).

Perhaps most appealing of all, however, the cost of administering the short version of the automated assessment within organizations is extremely low compared to traditional methods of talent evaluation. Combined with human scoring, we believe this automated, cloud-based approach to creativity evaluation—a form of blended assessment—holds great promise in evaluating creativity quickly, yet effectively, within both education and business. Using this system, we are now beginning to map the creative abilities of K16 students in Montana, Oklahoma, and Massachusetts, hoping to find hotspots of creativity where one might least expect them, perhaps in a disadvantaged school or otherwise neglected school district.

We should also be careful to note that we see creativity assessment as a beginning rather than an end, a way to discover creative strengths and an opportunity to better develop the creative capacities that each of us holds. As

researchers and evaluators, we are very careful not to get caught within popular webs of misconception that view creativity as an innate individual gift rather than a shared human ability—an ability that we firmly believe can be further developed with better practice, learning, and understanding.

The VCAI is based on the latest cognitive research into how to best assess and develop effective creative thinking in individuals, groups, and organizations. Once identified, individual and team creative abilities can be further developed and applied more effectively within classrooms and businesses, leading to breakthrough innovations and creative solutions. In short, creativity assessment and research-based training may provide the most effective means—a tested path—for students and individuals to realize innovative solutions and resolve difficult and often ambiguous issues.

Future Research

Cognitive Exercise and Training: Brain Disease

So what next in the area of creativity research and digital assessment? Currently, over 36 million adults worldwide are afflicted with Mild Cognitive Impairment (MCI) and Alzheimer's disease (AD) (Barnett, et al., 2014). AD is now the most costly health condition in the United States with direct costs estimated at $214 billion, with an additional $220 billion in indirect costs borne by family and friends providing unpaid care to AD patients. Further, the incidence of AD is projected to triple during the next three decades, with direct costs in the United States projected to climb to $1.2 trillion by 2050 (Alzheimer's Association, 2014).

Can anything be done to delay the onset or actually prevent this devastating brain disease? Recent findings suggest that neural plasticity, the brain's ability to reorganize itself by forming new neural connections, is apparent in individuals even as we reach older ages (Strobach et al., 2012). One form of intervention that has shown great promise in the battle against MCI and AD is guided cognitive exercises and training. Recent interventions for older adults include computer-based cognitive training programs, with focus on working memory and recall, often referred to as brain games or 'brain training' programs. Examples of this type of brain training include Lumosity, Elevate, and BrainHQ programs.

Importantly, current brain training programs largely target the cognitive control network of the brain, involving the dorsolateral prefrontal, anterior cingulate, and posterior parietal cortices (Cole and Schneider, 2007). While these platforms target such cognitive functioning as numerical problem solving and flexible thinking, they do so primarily through the deployment of convergent thinking exercises; that is, activities dependent on the user's closure of thinking to one, pre-determined answer.

Of significance, there are currently no brain training interventions that specifically and methodically target cognition relating to divergent thinking, imagination, and creativity along the lines we have described in this chapter. Significantly, however, creativity and imagination have been recently linked with structure, function, and activation of the brain's default mode network (DMN), areas of the brain that include the medial prefrontal cortex, posterior cingulate cortex, and the precuneus (Sheline et al., 2010). The DMN shows brain abnormalities in patients diagnosed with MCI and AD (Weiler et al., 2014). The DMN is furthermore preferentially targeted by the neurofibrillary plaques and tangles associated with the progression of these forms of cognitive decline.

Interestingly, recent neuroimaging literature suggests that creativity and imagination activate key nodes of the brain's DMN (Takeuchi, 2012). Unlike convergent thinking, divergent thinking involves an individual's ability to open thinking toward the generation of many, varied, and original ideas in response to an environmental challenge or cue. In contrast to working memory and recall, divergent thinking targets different cognitive and neural mechanisms to encompass higher order forms of cognition, including the exercise of episodic memory, abductive reasoning, synthesis, creativity, and analogical thinking.

A well-known example of a divergent thinking exercise is the Alternative Uses (AU) task, such as: "How many different and unique ways can you use a tin can?" A popular visual example is providing the user with an incomplete or repeating figures, and asking the user to complete the figures via new drawing and sketching activities. As users respond to divergent thinking tasks, they are asked to consider many, varied, and unexpected answers, which often requires subjects to draw from past experiences and knowledge.

Assessment software can incorporate latent semantic analysis and natural language processing as part of its assessment solution, which could be designed to autoscore user submissions based on identified creative abilities. The software could provide an innovative means to measure divergent thinking ability and development, forming the basis of new training platforms. Assessment software and algorithms can now identify four distinct abilities related to creativity, as introduced above: (1) fluency, (2) flexibility, (3) originality, and (4) elaboration. Critically, all four cognitive domains have been well established to be at the core of cognitive domains affected by MCI and AD:

1) FLUENCY: Low semantic fluency has been related to the development of AD.
2) FLEXIBILITY: Cognitive inflexibility has been linked to AD, as well as other forms of dementia.
3) ORIGINALITY: Perseveration, or inability to move beyond familiar modes of responding, has been linked to AD.

4) ELABORATION: AD patients tend to lack elaboration in their written and verbal communication, associated with a breakdown of semantic associations.

As the above abilities indicate, creativity necessarily involves the user's creation of new conceptual connections and linkages in response to provided exercises. We hypothesize that these items also get at the heart of what goes awry in AD, due to sematic breakdown later in the disease. Creativity as a thinking process is embodied by numerous and distinct cognitive acts: drawing from long-term and episodic memory, combining existing ideas in new ways, seeing new connections, imagining alternative solutions, transforming elements, thinking of new uses, discovering new answers, extending current conceptions, and so on. The creative mind is often capable of generating a large number and variety of possibilities in response to a given trigger and is willing to break away from expected solutions in new and unconventional ways.

Originality, for instance, is an individual's cognitive capacity to produce ideas, representations, transformations, combinations, and products that generally are not produced, or ideas that are totally new or unique in response to a given prompt or challenge. Hence, creativity often involves moving away from the obvious and commonplace or breaking away from habit-bound thinking, which we believe may be an essential element of maintaining cognitive health and potentially preventing the onset of MCI and AD. Significantly, the brain's DMN has been strongly linked to an individual's imagination and is most active when one is completely engaged in thought, contemplating the past and considering the future, all cognitive activities that we hypothesize to be potentially critical elements in the prevention of MCI and AD.

We hypothesize that a creativity-based cognitive training system, focused on divergent thinking and imagination and targeting the brain's DMN, will provide a heretofore unexplored avenue to intervene in the cognitive decline associated with dementia and Alzheimer's. We envision a future full-blown creativity training system, developed to be game-like and engaging, offering exercises of increasing difficulty and challenge for older adults, while also offering prescriptive advancement based on identified creativity strengths and weaknesses. For instance, a subject with an identified comparative creativity weakness of Ideational Fluency will be asked to work through exercises that seek to better develop this particular ability.

Cognitive Exercise and Training: Brain Injury

A related issue affecting a growing population is traumatic brain injury (TBI). Each year, approximately 2.5 million TBIs occur either as isolated injuries or along with other injuries, often caused by a bump or blow to the head (NVSS, 2010). The majority of TBIs are caused by falls and accidents, especially among older adults. Though many TBIs are mild in nature (called mTBIs, or

more commonly, concussions), severe TBI is also a growing issue, often involving the loss of consciousness and leading to significant cognitive, emotional, and functional problems among subjects.

While the cognitive effects of TBI are often understood to include loss of attention and memory, research indicates that divergent thinking and figural and verbal fluency too is affected in a significant manner by brain injury (Ruff, 1994; Zakzanis et al., 2011). Such findings suggest that digital creativity assessment may provide a new key measure of TBI severity, and perhaps even provide additional information about the location of the injury, which is often difficult to determine using functional magnetic resonance imaging (fMRI) technology, especially if the injury involves deep white matter damage.

Such research also suggests new forms of cognitive rehabilitation for those suffering from brain injury. Pursuing these leads, we have begun preliminary study into the impact of creativity-focused brain training on mTBI. Utilizing the basic creativity measures of fluency, flexibility, originality, and elaboration, we are now beginning the research and testing of a cognitive training platform for brain injury patients. Patients will work through multiple levels of exercises that are based on figural and verbal activities that have long been part of creativity research initiated by Torrance and others. Our research into the impact of such training on TBI is ongoing with expected preliminary results to be published by the end of 2016.

Summary and Conclusions

Individuals today face a rapidly transforming world, one marked by dramatic economic, social and environmental changes. Our unique advantage, as a species, is our ability to generate novel solutions to new problems. Conceiving of creativity as a diverse set of cognitive abilities holds great promise, not only for the future of creativity research, but also for future developments in education, assessment, and cognitive health.

In education, K16 students of today—our future scientists, inventors, entrepreneurs, developers, and leaders—will be called upon to explore a host of scientific and social issues in new ways, evaluate numerous compelling ideas, and generate innovative technological solutions to a variety of unique challenges and situations. Projecting forward, classrooms of tomorrow will require innovative, new learning programs and applications to better promote and assess advanced scientific thinking, entrepreneurship, divergent thinking and problem solving—a tomorrow in which imagination and creativity are no longer considered luxuries for the few, but basic necessities for the many.

Assessment and cognitive health, we believe, will also benefit from a conceptualization of creativity as a form of open-ended problem solving. Evaluating creativity as a collection of creative abilities, including flexibility, fluency, originality, and elaboration, offers a unique means to measure its applica-

tion in education and business—and track its progress and development. Further, if imagination, creativity and divergent thinking are indeed linked to new, innovative means of counteracting brain disease and injury, as current research is just beginning to suggest, then this conceptualization of creativity holds potentially ground-implications for maintaining brain health in the future.

As such, the universality of creativity proposed within this chapter not only serves to illustrate its cross-disciplinary and uniquely human nature, but also its implications for practical concerns and future applications. In this regard, creativity holds the unique power to shape how we will develop future interventions and solutions to the pressing issues and challenges facing us all.

References

2014 Alzheimer's Disease Facts and Figures. Alzheimer's & Dementia: The Journal of the Alzheimer's Association 10(2), 47–92.

Amabile, T. M. (1989). Growing up creative. NY: Crown Publishers

Anderson, L. W., and Krathwohl, D. (Eds.). (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Longman.

Barnett, J., Lewis,L Blackwell, A., and Taylor, M. (2014). "Early Intervention in Alzheimer's Disease: A Health Economic Study of the Effects of Diagnostic Timing." BMC Neurology, 14 (1), 101.

Beaty, R. E., Benedek, M., Wilkins, R. W., Jauk, E., Fink, A., Silvia, P. J., Hodges, D. A., Koschutnig, K., and Neubauer, A. C. (2014). Creativity and the default network: A functional connectivity analysis of the creative brain at rest. Neuropsychologia, 64, 92–98.

Bloom, B., Englehart, M. Furst, E., Hill, W., and Krathwohl, D. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain. New York, Toronto: Longmans, Green.

Boccia1,M., Piccardi, L, Palermo, L., Nori, R. and Palmiero, M. (2015). Where do bright ideas occur in our brain? Meta-analytic evidence from neuroimaging studies of domain-specific creativity. Frontiers of Psychology, 6, 1 -12.

Dynarski, M., Clarke, L., Cobb, B., Finn, J., Rumberger, R., and Smink, J. (2008). Dropout prevention: A practice guide. Washington, DC: National Center for Education Evaluation and Regional Assistance, Institute of Education Sciences, U.S. Department of Education.

Boy, G. A. (2013). From STEM to STEAM: Toward a human centered education. Paper submitted to the European Conference on Cognitive Ergonomics, Toulouse, France.

Caswell, D. (2006). Creative problem-solving. London: Society for Teaching and Learning in Higher Education.
Cole, M.W., and Schneider, W., 2007. The cognitive control network: Integrated cortical regions with dissociable functions. Neuroimage 37, 343-360.

Delialioglu, O. (2011). Student engagement in blended learning environments: With lecture-based and problem-based instructional approaches. Educational Technology of Society, 15(3), 310-322.

Deslauriers, L, Schelew, E. and Wieman, C. (2011). Integrated learning in a large-enrollment physics class. Science, 332(6031), 862-864D

Freud, S. (1910). Three contributions of the theory of sex. NY: Nervous and Mental Disease Publishing Co.

Galton, F. (1870). Hereditary genius. NY: Appleton.

Guilford, J. P. (1950). 1950 Presidential address to the American Psychological Association, American Psychologist, 5, 444-454.

Guildford, J. P. (1967). The nature of human intelligence. New York: McGraw-Hill.

Guilford, J. P. (1970). Creativity retrospect and prospect, Journal of Creative Behavior, 4(3), 149-165.

Guilford, J. P. (1975). Creativity: A quarter century of progress. In I. A. Taylor and J. W. Getzels (Eds.). Perspectives in creativity (p. 37-59). Chicago: Aldine Publishing Co.

Hattie, John (2008). Visible learning: A synthesis of over 800 meta-analyses relating to achievement. New York: Routledge.

Hattie, John (2012). Visible learning for teachers. London, UK: Routledge.

Havice, W. (2009). The power and promise of a STEM education: Thriving in a Complex technological world. IN ITEEA (Ed.). The Overlooked STEM Imperative: Technology and Education (pp.10-17). ITEEA.

Hayden, K., Ouyand, Y., Scinski, L., Ollsterwski, B., and Bielefeldt, T. (2011). Increasing student interest and attitudes in STEM: Professional development and activities to engage and inspire learners. Contemporary Issues in Technology and Science Teacher Education, 11 (1), 1-22

Holley, K. M. (2009). Understanding interdisciplinary challenges and opportunities in higher education. ASHE Higher Education Report, 35(2), 1-131.
Kemple, J. J., and Snipes, J. C. (2000). Career Academies: Impacts on Students Engagement and Performance in High School. New York: Manpower Demonstration Research Corporation.

Kiili, K. (2005). Digital game based learning: Towards an experiential gaming model. Internet and Higher Education, 8, 13-24.

Kolb, D. (1984).Experiential learning: Experience as the source fo learning and development. New Jersey: Prentice Hall

McCaslin, N. (1984). Creative drama in the classroom. NY: Longman, Inc.

Millar, G. W. (1995). E. Paul Torrance: The creativity man. Norwood, NY: Ablex Publishing Corp.

Miller, E. F (Ed.) (1987). Essays, Moral, Political, And Literary. Indianapolis: Liberty Classics.

Morrison, J. and Bartlett, B. (2009). STEM as a curriculum: An experimental approach. Retrieved from http://www.lab-aids.com/docs/stem/EdWeekArticleSTEM.pdf

National Vital Statistics System (NVSS), 2010. Data source is maintained by the CDC National Center for Health Statistics.

Osborn, A. F. (1953). Applied imagination. Charles Scribner's Sons: New York.

Parnes, S. J. (1967). Creative behavior guidebook. New York: Charles Scribner's Sons.

Parnes, S. J. 1975). Aha! In I. A. Taylor and J. W. Getzels (Eds.). Perspectives in creativity. (pp. 224-248). Chicago: Aldine Publishing Co.

Parnes, S. J. (1987). The creative studies project. In S. G. Isaksen (Ed.). Frontiers of creativity research (p. 156-188). Buffalo, NY: Bearly Limited.

Parnes, S. J., Noller, R.B. and Biondi, A. M. (1977). Guide to creative action. New York: Scribners.

Raboutet, C., Sauzéon, H., Corsini, M., Rodrigues, J., Langevin, S. and N'Kaoua, B. (2010) Performance on a semantic verbal fluency task across time: Dissociation between clustering, switching, and categorical exploitation processes, Journal of Clinical and Experimental Neuropsychology, 32(3), 268 -280.

Roberts, A. (2012). A justification for STEM education. Technology and Engineering Teacher. 3, 1-5.

Ruff, R. M., Allen, C. C., Farrow, C. E., Niemann, H. and Wylie, T. (1994). Figural Fluency: Differential Impairment in Patients with Left Versus Right Frontal Lobe Lesions. Archives of Clinical Neuropsychology. 9, 41-55.

Rugg, H., (1963). Imagination. New York: Harper and Row.

Runco, M. A. (2014). Creativity theories and themes: Research development and practice. Boston: Elsevier.

Samson, P. L. (2015). Fostering student engagement: Creative problem-solving in small group facilitations. Collected Essays on Learning and Teaching, 8 , 153-164.

Schwab, D., Benedek, M., Papousek, I , Weiss, E. M. and Fink, A. (2014). The time-course of EEG alpha power changes in creative ideation. Frontiers of Human Neuroscience, 8, 1-8.

Shamay-Tsoorya, S. G., Adlera, N., Aharon-Peretzb,J. Perrya, D., and Mayselessa, N. (2011). The origins of originality: The neural bases of creative thinking and originality. Neuropsychologia, 49, 178-185.

Sheline, Yvette I., Marcus E. Raichle, Abraham Z. Snyder, John C. Morris, Denise Head, Suzhi Wang, and Mark A. Mintun. "Amyloid Plaques Disrupt Resting State Default Mode Network Connectivity in Cognitively Normal Elderly." Biological Psychiatry, 67(6), 584–87.

Strobach T., Frensch P., Müller H. J., and Schubert T. (2012). Testing the limits of optimizing dual- task performance in younger and older adults. Front. Hum. Neurosci. 6, 39.

Takeuchi, Hikaru, Yasuyuki Taki, Hiroshi Hashizume, Yuko Sassa, Tomomi Nagase, Rui Nouchi, and Ryuta Kawashima (2012). "The Association be-

tween Resting Functional Connectivity and Creativity." Cerebral Cortex, 22 (12), 2921–29.

Torrance, E.P. (1957). Psychology of survival. Unpublished manuscript, Air Force Personnel Research Center, Lackland Air Force Base Texas.

Torrance, E. P. (1962). Guiding creative talent. Englewood Cliffs, NJ: Prentice-Hall.

Torrance, E. P. (1965). Rewarding creative behavior. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Torrance, E. P. (1970). Encouraging creativity in the classroom. Dubuque, IA: Wm. C. Brown Co.

Torrance E. P (1972). Can we teach children to think creatively? Journal of Creative Behavior, 6, 136-140.

Torrance E. P. (1987). Part two: Recent trends in teaching children and adults to think creatively. In S. G. Isaksen (Ed.). Frontiers of creativity research. (pg. 204-215). Buffalo NY: Bearly Limited.

Torrance, E. P. (1995). Why fly? A philosophy of creativity. Norwood, NJ: Ablex Publishing Corp.

The Partnership for 21St Century Skills (2007) www.21stcenturyskills.org
Vehar, J., Firestien, R., & Miller, B. (1997). Creativity unbound. Williamsville, NY: Innovation Systems Group.

Wallas, G. (1926). The art of thought. NY: Morton.

Wehlage, G. G. (1987). At-risk students and the need for high school reform. In W. T. Denton (Ed.). Dropouts, pushouts and other casualties. Bloomington, IN: Phi Delta Kappa.

Weiler, M., Teixeira, C., Nogueira, M., de Campos, B., Damasceno, B., Cendes, F., and Balthazar, M. (2014). Differences and the relationship in default mode network intrinsic activity and functional connectivity in mild Alzheimer's disease and amnestic mild cognitive impairment. Brain Connect. 4 (8):567-74.

Yen, J. C. and Lee, C. Y. (2011). Exploring problem solving patterns and their impact on learning achievement in a blended learning environment. Computers & Education, 56, 138-145.

Correspondence
Dr. Kathy Goff
VAST: Next Generation Learning Systems
USA, mcgoff@cimtel.net

Dr. Erik E. Guzik
University of Montana Western, USA,
Email: erik@vastlearningsystems.com

Author Brief Bios

Kathy Goff is the Director of the Oklahoma Torrance Center for Creativity and Chief Creative Officer/Co-founder of Vast Learning Systems, a cloud-based edtech software company that focuses on creativity assessments and brain trainings. She earned a doctorate at the University of Georgia in Adult Learning and Creativity under Dr. E.Paul Torrance, the "Father of Creativity". Kathy served as Torrance's personal research assistant and collaborator for over 16 years. Goff and Torrance (2000) created the Abbreviated Torrance Test for Adults (ATTA), one of the first instruments to measure creativity in adults. She is an internationally recognized author, researcher, educator, patented inventor, consultant and entrepreneur with over 3 decades of experience researching the creativity of people of all ages and backgrounds.

Erik Guzik is Associate Professor of Economics in the Department of Business and Technology at the University of Montana Western. Guzik received his PhD in economics from the University of Massachusetts Amherst. His current research centers on the micro-foundations of creativity and software-based problem solving methodologies. Erik is the executive director of the non-profit Virtual Problem Solving Program and co-founder and CEO of Vast Learning Systems. For his latest research into cloud-based learning to promote problem-solving in the classroom, Guzik received the 2011 Creative Oklahoma Great Inspirations Award, the Oklahoma Journal Record's 2012 Creativity Award, and Hewlett Packard's 2012 Catalyst Showcase People's Choice Award.

CHAPTER EIGHT

EXAMINING THE RELATIONSHIP BETWEEN TWO INSTRUMENTS OF INDIVIDUALS' CREATIVE PROBLEM SOLVING—FOURSIGHT AND CREATIVE PROBLEM SOLVING PROFILES (CPSP): A PILOT STUDY

KUAN CHEN TSAI

Abstract

The purpose of the current study was to examine the nature and degree of the relationship between Chinese students' CPS cognitive styles/preferences as established using FourSight and CPSP, described below. Guided by the purpose of the study, two research questions were asked: (a) How does our Taiwanese sample perform on FourSight and CPSP? And (b) What, if any, are the relationships between our participants' responses to these two instruments? A total of 47 Taiwanese second-year high school students will be recruited to this pilot study. In order to answer research questions, descriptive analysis and four-group discriminate analysis will be used to the current study.

Keywords: Creative problem solving styles, creative problem solving profiles, discriminate analysis

Introduction

The original Creative Problem Solving (CPS) model proposed by Osborn (1952) included seven steps: orientation, preparation, analysis, hypothesis, incubation, synthesis, and verification. This model was later modified into three-group version, with *fact-finding* referring to problem definition, data gathering and analysis; *idea-finding* to idea production and idea development; and *solution-finding* to evaluation and implementation (Osborn, 1963).

Parnes (1967) further modified Osborn's three-group model to a five-group version known as the Osborn-Parnes CPS model, which includes fact-finding, problem-finding, idea-finding, solution-finding, and acceptance-finding. Isaksen and Treffinger (1985) added an initial step called mess-finding, and changed the name of fact-finding to data-finding. A decade later,

Isaksen, Dorval, and Treffinger (1994) proposed a component-based approach to using the CPS process flexibly, and returned to a three-group version made up of *understanding the problem* (which incorporates mess-finding, data-finding, and problem-finding); *generating ideas* (idea-finding); and *planning for action* (solution-finding and acceptance-finding).

Creative Problem Solving Style: FourSight

Puccio (2002) developed a measurement of individuals' creative process preferences that is closely related to the CPS model. FourSight, initially known as the Buffalo Creative Process Inventory, uses statements that describe the activities associated with CPS processes. For example, the statement "I enjoy stretching my imagination to produce many ideas" refers to the idea-generation step of CPS, while "I really enjoy implementing an idea" relates to the solution-implementation step. In other words, FourSight asks people to provide direct responses about their mental activities that relate to the CPS process.

FourSight has continued to evolve, and the current version is FourSight 6.1 (Puccio, 2002), which involves four preferences that identify four key elements of the creative process: *clarifier* referring to problem identification, based on a merging of data-finding and problem-finding response; *ideator* referring to idea generation, a combination of mess-finding and idea-finding items; *Developer* referring to solution development, responses related to solution-finding and the planning aspect of acceptance-finding; and *implementer*, covering the taking-action aspect of acceptance-finding). Puccio (2002) reported Cronbach alpha coefficients for this version of FourSight as follows: clarifier = .78; ideator = .81; developer = .79; and implementer = .81.

The Creative Problem Solving Profile (CPSP)

The section headings are available on the styles menu. However, the authors are not obliged to format their section headings. Just make heading level 1 bold left; heading level 2 – italic left.

Based on the Osborn-Parnes CPS model, Basadur et al. (1990) developed an inventory called the Creative Problem Solving Profile (CPSP) with two underlying information-processing dimensions: *apprehension*, which involves acquiring knowledge, and *utilization*, which involves applying it. Its originators argued that the CPSP inventory measures states, not traits. According to Basadur and Gelade (2003), the major goal of the CPSP is to "capitalize on an individual's preferred orientation" and to "tap resources in all four quadrants to help the individual, team, or organization cycle skillfully through the complete innovation process" (p. 33).

The CPSP inventory measures an individual's blend of preferences regarding four stages of the process: *generators* prefer problem-finding and fact

-finding, *conceptualizers* prefer defining the problem and idea-finding, *optimizers* prefer evaluating and selecting ideas, and *implementers* prefer seeking acceptance for ideas and taking action. A coordinate plane system is used to depict the results of individuals' preferences, with the X-axis indicating the way individuals prefer to use knowledge, and the Y-axis show they prefer to obtain it. As such, four separate quadrants are created: with quadrant one representing the generators, quadrant two the conceptualizers, quadrant three the optimizers, and quadrant four the implementers.

The CPSP consists of 12 scored items, and six dummy items that are not scored. Each scored item involves four words, descriptive of learning experientially, learning theoretically, creating options, and evaluating options. Respondents are asked to rank the four words, from one ("least characteristic of me as a problem solver") to four ("most characteristic of me as a problem solver.") An individual's CPSP is obtained by summing his/her scores for these four preferences and then graphing them.

In summary, the main goal of the FourSight and CPSP is similar: to understand and appreciate individuals' thinking styles/preferences when they are problem solving. However, both instruments are slightly different on their measuring dimension: on the one hand, FourSight involves four cognitive styles/preferences—*Clarifier*, *Ideator*, *Developer*, and *Implementer*; on the other, the CPSP contains—*Generators*, *Conceptualizers*, *Optimizers*, and *Implementers*. Another major difference is measurement approaches of two instruments: FourSight includes 10 Likert-type scales with 37 items, whereas CPSP uses rank sets of four words (i.e., a forced-choice issative scale) with 18 groups of items.

Purpose

The purpose of the current study was to examine the nature and degree of the relationship between Chinese students' CPS styles as established using FourSight, on the one hand, and on the other, their CPS profiles as determined by CPSP.

Research Questions

Guided by the purpose of the study, two research questions were asked:

1. How does our Taiwanese sample perform on FourSight and CPSP?
2. What, if any, are the relationships between the participants' CPS styles and their CPS profiles?

Methods

Participants

A total of 47 Taiwanese second-year high school students, 20 male and 27 female, were recruited from a high school in Hsinchu Taiwan, using convenience sampling. Their average age was 16.15 years old (*SD* = .36). All participants were asked to participate on a voluntary basis and were informed of the purpose of the research.

Instruments and Procedure

For the current study was used the Chinese version of FourSight 6.1 translated by Lien Ding (2013). For this study we used 5 Likert-type scales instead of original version of 10 Likert-type scales. *T*he Chinese version of the CPSP were both translated by the researcher into Traditional Chinese (Mandarin). Two high school teachers were then invited to check the translation to confirm that the content fit the Taiwanese context. Based on their feedback, revised versions of both translated instruments were presented to an independent translator for back-translation. Comparing the back-translated versions to the original English versions, the researcher made several additional changes of wording and consulted the two high school teachers a second time before finalizing the Mandarin versions. The Mandarin FourSight and CPSP versions were then administered to all participants, each of whom took approximately 30 minutes to complete both.

Results

Descriptive analysis of FourSight and the CPSP shows that for FourSight, clarifiers in our sample had the highest mean scores (3.54, *SD* = .44) and implementers the lowest (3.39, *SD* = .52). For the CPSP, the numbers in each group were more or less equal: with the largest group being generators (14 people, 29.8%) and the smallest being conceptualizers (10 people, 21.3%).

For purposes of the current study, CPS profiles were treated as the dependent variable and as a categorical variable, while CPS style, the independent variable, was a metric variable. Therefore, four-group discriminate analysis was used. To assess group differences, the researcher used Wilks' lambda and univariate ANOVA to assess the significance of differences between the means of the independent variables for each of the four groups. These tests found no variables with significant differences between the groups. As such, no variables were proper candidates for use in discriminant analysis.

The multivariate measures of overall model fit were also examined. All three discriminant functions were not significant. The first function displays a canonical correlation of .497, which implies that 24.7% of the variance in the function can be accounted for. The second function displays a canonical correlation of .321, which explains 10.3% of the variance. The last function displays a canonical correlation of .093, which explains 8% of the variance.

Because it is a four-group discriminant analysis model, three discriminant functions were calculated to discriminate among the four groups. The structural matrix of unrotated discriminant loadings for three discriminant functions was examined. Selecting variables with loadings of .40 or above as descriptive of the functions, function 1 has three such variables exceeding .40, while one variable was descriptive of function 2, and three variables were descriptive of function 3. Though we could have used these variables to describe each function, we were faced with the issue that four variables had double loadings; when we examined standardized discriminant function coefficients, the double-loadings issue was similar. The lack of distinctiveness of the loadings of each variable descriptive of a single function renders it difficult to interpret the four-group discriminant analysis results.

Discussion

The current study of the possible links between CPS styles and CPS profiles used discriminant analysis in pursuit of two research objectives: (a) determining whether statistically significant differences exist between the average scores on four CPS styles for the four corresponding CPS profile groups; and (b) establishing the number and composition of the dimensions of discrimination between groups formed from a set of independent variables.

The results indicate that there were no significant differences between four profiles (generator, conceptualizer, optimizer, and implementer) and a set of four independent variables (developer, clarifier, ideator, and implementer). These findings suggest that four CPS styles cannot present dimensions of discrimination between four CPS profiles. When we estimated the discriminant model and assessed overall fit, the results of simultaneous estimation show that the overall model was not statistically significant, which suggests that the collective discriminatory power of the discriminant functions was weak. When we considered the significance of individual discriminant functions by retaining significance levels at .3 level, as suggested by Hair, Black, Babin, and Anderson (2010), we found that developer ($p = .231$) and ideator ($p = .049$) could be retained for further discriminant analysis. However, according to results of Wilks' lambda and chi-square tests, the overall model fit was not suitable for the use of discriminant analysis.

When we further investigated the discriminant weights and discriminant loadings, the results indicated the issue of cross loading, which renders the interpretation of three functions difficult. Additionally, the overall model re-

sults were not acceptable in terms of either statistical or practical significance. Therefore, based on findings from the discriminant analysis, we concluded that individuals' CPS styles as measured by FourSight are not good predictors of their CPS profiles as measured by CPSP. This finding is fairly surprising, given that these two instruments were derived from the same theoretical framework.

FourSight and CPSP appear to have the same goal: the identification of creative-process preferences that are associated with the CPS model (Basadur et al., 1990; Puccio, 2002). However, two main differences in their approaches should be noted. First, where Puccio (2002) recognized the unique mental activities related to CPS steps, Basadur (1998) developed his four process preferences based on two information-processing dimensions. Second, Puccio and Basadur used different measurement approaches to assess the creative-process preferences: where Puccio used a Likert-type scale (non-ipsative) ranging from "not like me at all" to "very much like me", Basadur had respondents rank sets of four words (i.e., a forced-choice issative scale) that reflected the four poles of his information-processing dimensions.

Conclusion

The results of the current study suggest that individuals' CPS styles are not a good predictor of their CPS profiles. This finding seems to indicate some issues of concurrent validity of both instruments. In Puccio's (2002) report, he examined the correlations between FourSight and the CPSP and concluded that the results supported a conceptual link between the two, despite the small sample size (N =36). However, the current study employed discriminant analysis and arrived at the opposite results.

In order to correctly interpret the results of this pilot study, some limitations should be noted. First, only 47 participants were recruited for our sample, which – while larger than Puccio's (2002) by more than 30% - was quite small. Replication of the results with a larger number of participants is necessary. Following this line of reasoning, the current sample was also drawn from a single institution, which raises concerns about generalizability. Future research on this topic should include a more diverse pool of respondents. Finally, some of the high school students in the current study reported having some difficulty in understanding the CPSP, which might reflect translation or cultural issues. In order to tackle these, it is suggested that future research be cross-cultural. It might also be useful to conduct another study using exploratory and confirmatory factor analysis to validate the construct validity of the Mandarin version of the CPSP.

References

Basadur, M. (1998). The Basadur simplex creative problem-solving profile inventory: Development, reliability and validity. Retrieved from

https://macsphere.mcmaster.ca/bitstream/11375/5385/1/fulltext.pdf
Basadur, M., & Gelade, G. (2003). Using the Creative Problem Solving (CPSP) for diagnosing and solving real-world problems. *Emergence*, *5* (3), 22-47.
Basadur, M., Graen, G., & Wakabayashi, M. (1990). Identifying individual differences in creative problem solving style. *Journal of Creative Behavior*, *24*, 111-131.
Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis*. Upper Saddle River, NY: Pearson.
Isaksen, S. G., & Treffinger, D. J. (1985). *Creative problem solving: The basic course*. Buffalo, NY: Bearly Limited.
Isaksen, S. G., Dorval, K. B., & Treffinger, D. J. (1994). *Creative approaches to problem solving*. Dubuque, IA: Kendall/Hunt.
Osborn, A. F. (1952). *Wake up your mind*. New York: Charles Scribner's Sons.
Osborn, A. F. (1963). *Applied imagination: Principles and procedures of creative problem-solving*. New York: Charles Scribner's Sons.
Parnes, S. J. (1967). *Creative behavior workbook*. New York: Charles Scribner's Sons.
Puccio, G. J. (2002). *FourSight: The breakthrough thinking profile: Presenter's guide and technical manual*. Evanston, IL: Thinc Communications.

Correspondence
Assist. Prof. Dr. Kuan Chen Tsai
City University of Macau, Macau
Email: tsaikuanchen@cityu.edu.mo

Author's Brief Bio

Kuan Chen Tsai received his PhD from the program of Organizational Leadership at the University of Incarnate Word (UIW) where he also worked as teaching and research assistant. He currently is an assistant professor in the Art and Design Department at the City University of Macau (CUM). He is the member of the American Creativity Association. He is also the author of numerous journal articles and several book chapters. His research interests include creativity, adult learning, organizational behavior, and art & design.

Appendix A
FourSight Chinese version

說明: 下面是在面對挑戰或解決問題時的各種不同活動的陳述。針對每一項陳述，評量和你自己相似的程度。不用考量您在這項活動做的多有效，只單純地想這個陳述和你自己有多像。針對每一項陳述，在和你自己最相似的數字上打勾，回答的範圍從 1 "**一點都不像我**" 到 5 "**非常像我**" 。

題目	1 一點都不像我	2 不像我	3 不確定	4 像我	5 非常像我
1.在想出最佳解決方案或最佳產品之前，我喜歡先調試然後修正我的構想	1	2	3	4	5
2.我喜歡花時間去釐清問題真正的本質	1	2	3	4	5
3.我喜歡採取必要的步驟將自己其中一個構想付諸行動	1	2	3	4	5
4.我喜歡把一個大範圍的問題拆解開來，從各種不同的角度去檢視它	1	2	3	4	5
5.我發現要想出一個與眾不同的點子來解決問題很困難的	1	2	3	4	5
6.我喜歡找出和問題能具相連性的關鍵處	1	2	3	4	5
7.我發現自己沒有耐性停下來找出問題背後能切的原因	1	2	3	4	5
8.我喜歡找出一些與眾不同的方式來看待一個問題	1	2	3	4	5
9.我喜歡列出一個具潛力的解決方案的所有優缺點	1	2	3	4	5
10.在執行一個問題的解決方案前，我喜歡將此方案拆解成步驟	1	2	3	4	5
11.整個創意過程中我最喜歡的部分，不是將構想化為行動的這個部分	1	2	3	4	5
12.我喜歡找出一些評量條件，用以確認最佳的解決方案	1	2	3	4	5
13.我喜歡花些時間觀看以跳脫出對問題的最初看法	1	2	3	4	5
14.我發現自己的本性不會花太多時間專注於需要被解決的確切問題點上	1	2	3	4	5
15.我喜歡以整體全貌的視野來看待所處的情況	1	2	3	4	5
16.我喜歡釐清定義不清的新奇問題	1	2	3	4	5
17.處理問題時，我喜歡想出一個此問題最適切的陳述方式	1	2	3	4	5
18.發生問題時我總是享受解決它的過程	1	2	3	4	5
19.我喜歡一個有精準陳述的問題	1	2	3	4	5
20.我喜歡擴展我的想像力，以利於產生很多的點子	1	2	3	4	5
21.在一個具挑戰的情境裡，我喜歡將注意力聚中在其中的關鍵資訊	1	2	3	4	5
22.我喜歡花時間將一個構想發展到最善盡美	1	2	3	4	5
23.當要將自己的構想付諸實行時，我發現自己難以將這些構想實現	1	2	3	4	5
24.我喜歡將粗略的構想轉換成具體的解決方案	1	2	3	4	5
25.我喜歡思考一個構想付諸執行需要做的所有事情	1	2	3	4	5
26.我真的很享受將一個構想付諸實行的樂趣	1	2	3	4	5

27.在進行下一步之前，我喜歡對問題有一個清楚的陳述	1	2	3	4	5
28.我喜歡花時間在獨特的點子上	1	2	3	4	5
29.我喜歡將點子付諸實行	1	2	3	4	5
30.我喜歡去探索一個潛在可行解決方案的長處與短處	1	2	3	4	5
31.我喜歡蒐集資訊，以便能找出一個特定問題其根本的原因	1	2	3	4	5
32.我喜歡將粗略的概念轉換成一個可行構想的那種分析及所付諸的努力	1	2	3	4	5
33.我的本性就是不會為一個問題想出很多很多的點子	1	2	3	4	5
34.我喜歡用比喻及類比的方式來想出解決問題的新點子	1	2	3	4	5
35.我發現自己沒有什麼耐性投入心力於琢磨或精進一個構想上	1	2	3	4	5
36.我傾向找尋馬上可用的解決方案，然後就做了	1	2	3	4	5

下面列了18個群組，每1群組皆有4個描述。在每一個水平群組中寫下1到4的號碼到不同的數字欄中來表示最能反映你的問題解決時的態度。例如，最能描述你的問題解決風格請寫4，最不能反映你的問題解決風格請寫1。以此類推。
範例：在解決問題時，你是先...
(4)警覺的 (1)沉著的 (2)敏捷的 (3)熱切的

	第一欄		第二欄		第三欄		第四欄	
群組	數字	描述	數字	描述	數字	描述	數字	描述
1		警覺的		沉著的		敏捷的		熱切的
2		有耐心的		勤勉的		有說服力的		事先準備好的
3		實行		直覺的		超然的		挑選的
4		體驗的		樂觀的		客觀的		驗證的
5		矜持的		嚴謹的		喜歡作樂的		愛玩的
6		察覺		自由思想		邏輯的		做試驗
7		感覺		其他選擇		分析		評估
8		行動		發散性		抽象		收斂性
9		率直的		可能的事		概念的		實用性
10		不激動的		值得信賴的		不可靠的		富于想像力的
11		專心的		激增擴散		推想的		試驗的
12		尋根究底		規劃		建構		檢驗
13		立即的		聚集		理解		順應
14		沒有人情味的		自覺的		抱有希望的		擔心的
15		執行實徹		形象化		模型化		果斷的
16		現在導向		未來導向		理性的 R		細節導向
17		有同情心的		務實的		情緒化的		推延的
18		觀察到的		天真的		有秩序的		現實的

CHAPTER NINE

TRAINING TOWARDS INNOVATION AND CREATIVITY: A COMPARISON BETWEEN EMPLOYEES ATTITUDES

GAVIN SUSS

Abstract

Organizational innovation has been widely defined as the creation of new ideas and new behaviors that change the organization. The need for innovation has become essential to companies' success and imperative to long-term survival. Increasing numbers of companies are allocating time, budgets, and energy to develop, train, and engage employees in innovation and creativity at all levels of management and development. Innovation has become almost a prerequisite for business success. Companies such as Procter & Gamble, General Electric (GE spends USD 1 billion annually on training), Whirlpool, 3M, Google, Apple, and others have created organizations that are based on innovation and are inspiring others to follow in their path. Some of these companies had previously been labeled as traditional and conservative; however, by deciding to change and engaging in innovation, they have developed unique value, new products and services, improved operations, and are innovative and creative. This study seeks to understand employees' perspectives linked to their creativity and innovation in their companies. It further aims to evaluate whether those companies that did engage in education for innovation and creativity eventually developed a strong positive sense of their employees and managers to innovation and a more creative competence.

Keywords: Innovation, creativity and education

Introduction

In the past 25 years several researchers have sought to measure the effect of firm sponsored training on productivity using firm-level data. Holzer et al. (1993) found that training has a positive effect on the quality of output (measured by the overall scrap rates), but effects on sales and wages are not significant. Bartel (1994) reported a positive effect of training on productivity

in her cross sectional analysis of about 150 Canadian firms. Ballot, Fakhfakh and Taymaz (2001) confirm that training is a significant input in the production function. Likewise there is increasing attention placed on human capital in relation to innovation (Chen & Huang, 2009; Lau & Ngo, 2004) and studies have found that some human resources' (HR) practices are positively associated with organizational innovation (Sung & Choi, 2014). The knowledge and skills of workers acquired through training have become important in the face of the increasingly rapid changes in technology, products, and systems. Most organizations invest in training because they believe that higher performance will result (Aragón, Aragón, & Sanz-Valle, 2003). Becker's (1964) influential study on human capital has spawned a voluminous literature on firms' and workers' investment in human capital, especially in the form of general and specific training. This literature has shown that the human capital stock of the firm accumulated through training activities is one of the main factors of production. In this study, the issue is explored by focusing on organizational training and developmental investments as key HR practices. Innovation and creativity are teachable skills and enterprises can engage in training to increase them in their workforces (Hattori & Wycoff, 2004).

Research on innovation in firms is important as there may be a unique set of processes and resources involved that may help explain innovation as a critical factor in predicting SME performance (Anderson and Eshima, 2013). Scholars general consider innovation to be about the introduction or improvement of products or processes, the activity of defining or redefining market position, or the alteration of an enterprise's dominant paradigm (Tidd, Bessant, & Pavitt, 2005). If achieved, the influence on an enterprise can be cardinal. Employees need to be more open and creative to help enterprises reach these goals. Training and educating employees to be more innovative can help them to obtain these goals. Creativity is usually defined as the process of bringing something new into being; as an ability to transcend traditional ideas, rules, patterns, relationships, and so on; and the ability to develop meaningful new ideas. Michalko (2011) argued that creative thinkers form more novel combinations because they routinely conceptually blend objects, concepts, and ideas from different contexts or categories. Furthermore to succeed in innovation managers have to structure a culture and system with the relevant talent and technology that can embrace creativity and innovation, this alone is a disruptive.

Recently, we have conducted several educational programs in enterprises in Israel and Europe that were seeking to train and teach their employees in ways that would enhance innovation, creativity, and strengthen the employees' perspectives and understanding towards innovation to say ignite the spirit and need of creativity and innovation. These programs included workshops, seminars, brainstorming sessions, and others. All of the programs were supported by the enterprises' managements and were part of the enterprises' comprehensive strategies aiming to identify practical actions that would promote innovation. The employees that participated in the training sessions

were exposed to tools, techniques, and methods that had been proven to encourage creativity, "thinking outside the box," and to eventually lead to innovation and value.

According to Skarzynski and Gibson (2008), there are two kinds of enterprises. There are those, such as Google and Apple, which emerged from innovation and creativity, with strong mythologies and cultures of fostering and promoting innovation. Then, there are those, such as Whirlpool and Cemex (a global Mexican building materials' enterprise), which are relatively better at executing than at generating innovation. The enterprises that embraced innovation to become leaders in innovation have dramatically increased their revenues and created cultures of innovation. Their successes are due to training programs that were an important part of their development of innovation (Suss, 2014).

A similar approach was taken by the enterprises sampled in this study that started training and education of their employees to encourage them to use tools to promote and lead to creativity and innovation. Procter and Gamble (PG) is a good example of an enterprise that understood the need to generate a strategy for innovation. It launched such a program in 2004 that included several goals, such as, teach senior management and project team members the mind-sets and behaviors that foster disruptive growth. The training, which has changed over time, initially ranged from short modules on topics such as assessing the demand for an early-stage idea to multiday courses in entrepreneurial thinking. (Brown & Anthony, 2011)

In 2007, PG established a "disruptive innovation college." The college enabled PG's employees that were working on new-growth projects to choose from more than a dozen courses related to innovation and entrepreneurship. The foundation of teaching and encouraging innovation is in the "Who," which is the human capital that eventually will be required to transform and deliver results. Today, there is a growing recognition that an increasing amount of enterprises' market values rest on their human capital (Lawler & Worley, 2006). Therefore, empowering human capital is expected to have a dramatic return to the investor/enterprise (Suss, 2010).

Regarding innovation, the return on investment can be disruptive and dramatic. For example, General Electric, under the leadership of Jeff Immelt, advocates continuous education for all its employees and managers (Magee, 2009). The within study examined the views of employees toward innovation and creativity and the need to engage the process of training in creativity and innovation. The sample consisted of employees that were part of an innovation training program and employees that were not so engaged. Sung and Choi (2014) specifically suggested that the training and developmental investments made by an enterprise influence its innovative performance by promoting learning practices and it appears safe to say that innovation contributes to improved firm performance in both family (the manufacture company in this research is a family firm) and non-family firms (Price, Stoica & Boncella, 2013)

Teaching Innovation and Creativity: WHY?

Innovative performance is arguably essential for the success and economic growth of enterprises over the past few decades and it may even be cardinal for an enterprise's survival (Baumol, 2004; Potocnik & Anderson, 2012). During this period, a large body of research has been produced about the characteristics of individuals, teams, and organizations that are related to outcomes of innovation (Anderson, De Dreu & Nijstad, 2004). Some of studies' results converge around factors that have been reliably found to influence innovation, such as having a shared vision or having an innovative organizational culture (Naveh & Erez, 2004). The emphasis has been on exploration rather than exploitation, and on investment in research and development (Zahra & George, 2002). Innovation scholars have highlighted the role of active learning and the pursuit of new knowledge at different stages of innovation, including problem identification, idea generation, idea promotion, and implementation (Shalley, Zhou & Oldham, 2004). Managers are challenged to provide an organizational culture that encourages employees to actively participate in learning and effective knowledge sharing. According to Hattori and Wycoff (2004), managers should introduce the fundamentals of innovation to every employee in workshops or other similar venues.

The Four Factor Theory of Team Climate for Innovation (West & Farr, 1990) posits that four team climate factors facilitate innovation: (1) vision, (2) participative safety, (3) task orientation, and (4) support for innovation. The fourth factor is the focus of the within study based on the claim that such support for innovation, through instruction and training, can yield very positive results for an enterprise in the short run in the form of new ideas and better results. In addition, positive long-term results are achieved with respect to a culture that is oriented toward innovation and creativity and innovative agents who change the DNA of the enterprise.

The process of training people to increase their creativity and innovation is generally complicated, similar to the way that growing older and developing knowledge and specialized expertise has both positive and negative dimensions.

Age may be a blessing because with experience comes an ability to quickly grasp the complexity of our surroundings, an understanding of the ways that things logically connect, and we become adept at sensing and trimming nonsensical ideas. Yet, age may be a challenge because, arguably, age and experience can lead to the accumulation of constraints, structures, and filters that hinder innovation.

Investments in training and development nurture enterprises overall learning culture (Gómez, Lorente & Cabrera, 2004; Noe, Tews & Dachner, 2010), which increases employees willingness to advance their capabilities and engage in learning activities.

To truly achieve creativity and innovation, people throughout an enterprise must understand that training is not merely a corporate initiative, a one-time project, or an activity for a chosen group of people. The employees must grasp the fact that for innovation to really work, and to be sustainable, it must become systemic and widely distributed (Skarzynski & Gibson, 2008), and education is the best tool to achieve that goal. Many tools and options are available to engage meaningful ways to improve innovation, from one-day workshops or seminars to comprehensive programs comprised of multiple meetings and sessions, feedback, brainstorming, and practice with tools intended to develop creativity and result in innovation. These learning and knowledge management processes can be facilitated with corporate training and development by exposing employees to broad perspectives, skills, expertise, and additional insights, which can expand their reservoir of new and useful ideas for innovation (Sung & Choi, 2014). One of the programs we conducted was Innovation through Education (ITE), a unique comprehensive innovation training program (Suss, 2014).

The most important and fundamental aspects of the ITE program are the innovative/creative workshops and the development of teamwork that bring people together and in which they tend to do a better job than when they do the job alone (Fernandez-Araoz, 2014; Suss, 2014). The workshops instruct and teach employees at all levels how to use tools and techniques to diversify their thinking, properly conduct brainstorming sessions, how to ask questions, and how to take risks, be creative, and be innovative. The program also includes training and open communication, practical experience, instrumental teamwork, enrichment, and exposing managers to the arts and design fields (Suss, 2014). This type of training can increase specific results that are highly valuable to any enterprise, namely, out of the box thinking, a focus on many answers, questioning everything even when an answer seems obvious, bringing up many ideas, never saying that "It's impossible" and always asking "Why." Developing innovation agents is an entrepreneur discussion that can produce value to the stakeholders and managers, why? because innovative employees are distinguished by their ability to challenge dogma and accepted ideas, and by their confidence in taking risks (Rasheed, 2012)

Individuals can increase their personal creativity because creativity is a teachable skill (Hattori & Wycoff, 2004). Moreover, we highlighted the importance of teaching and training employees to be creative and innovative in teams. Employees, once trained, can engage in innovative and creative behaviors in their workplaces that result in value and change for their enterprises. Regarding the emphasis on teamwork, when seeking to generate organizationally meaningful innovations, collective processes that are based on communities of practice, and processes that link individuals to groups/ communities, play a more critical role than the knowledge that is embedded in individual employees (Shipton, Dawson , Birdi & Patterson, 2006; Sung & Choi, 2012). At General Electric, teamwork is used to reinforce shared goals, foster development, and match business goals (Magee, 2009).

Research model

This paper is influenced by the analytical framework, which uses a multi-level approach to training, has been offered by Kozlowski and Klein (2000). The multi-level model bridges the gap between theoretical models of training needs assessment, design, and evaluation, and the higher levels at which training must have an impact if it is to contribute to organizational effectiveness (Kozlowski & Salas 1997). The model is focused on training transfer and is embedded in two distinct transfer types: horizontal and vertical transfer. Horizontal transfer concentrates on traditional models of training effectiveness. Kozlowski and Klein (2000) proposed 'top down contextual effects' which they described as a group and organizational factors, that can have direct and moderating effects on learning and transfer (Thang, Quang & Buyens, 2010). The training process that we conducted with the 2 groups was based on this model.

Figure 1 is based on the fundamental premises of training processes, HR outcomes and firm performance. Training is predicated on contributing to higher level group and organizational objectives, results and performance. A number of HR outcomes and firm performance, which are important in analyzing the relationship, are enumerated in the second and third box. Attention is drawn to some of the critical variables. Figure 1 shows that training affects the overall knowledge, skills, abilities, attitudes, behaviors, and motivation of employees. HR outcomes have a direct impact on firm performance. In this research the outcomes were related to innovation, creative thinking and performance.

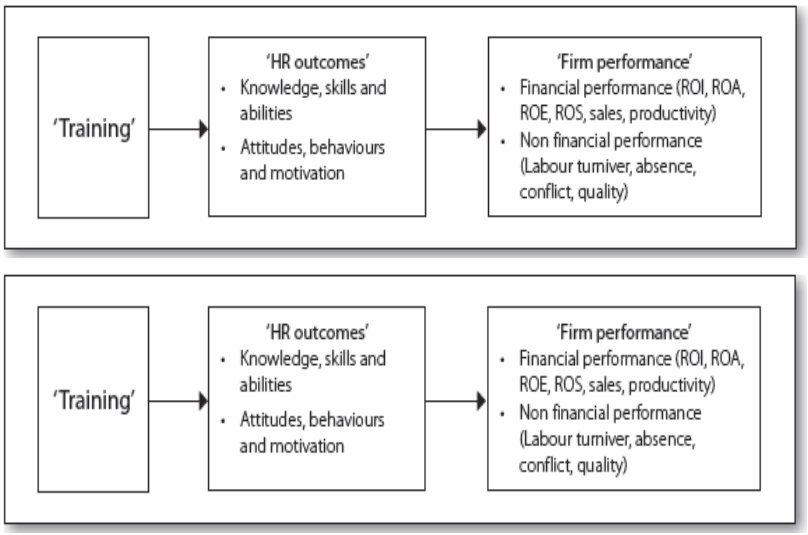


***Figure 1**:A framework for analyzing training and firm performance issues (Thang, Quang, & Buyens, 2010)*

Research Question

Applying the resource based view to training suggests that training can provide knowledge and skills for employees and this may lead to high firm performance. Employee behavior plays an important role as a mediator between strategy and firm performance therefor the main goal of this study was to test differences in efficacy of training to promote and encourage creativity and innovation between two different types of organizations. **Therefore, the study will address the question** can manufacturer organizations benefit more from creativity training as compared to a government organization? This question will be examined both by self-reported and also by behavioral measures of creativity and innovation. (Manufacturing companies like the one sampled in this paper are required to innovative and creative to promise revenue and value, so the hypothesis is that the benefit of such training will be greater in these companies as compared to the government one , where employees have tenure ship and the company is budgeted yearly by the government, Government and other support institutions should consider establishing training programs for improving managerial knowledge and competency in strategic planning (Price**,** Stoica, & Boncella, 2013)).

Method

Participants

This study was comprised of 96 employee participants, 55 (57.9%) of which were males and 40 (42.1%) of which were females. They were between 20 and 60 years old (M = 37.34, SD = 6.83). With respect to educational attainment, 12 (12.5%) had no educational degree, 9 (9.4%) were practical engineers, 37 (38.5%) had BA/BSc degrees, 35 (36.5%) had MA/MSc degrees, and 3 (3.1%) had PhD degrees. Employment rank in the sample was 50 (52.6%) were employees, 43 (45.3%) were managers, and 2 (2.1%) were executives. The range of the length of employment was from 0.5 to 25 years in the organization (M = 8.05, SD = 4.90). Two types of enterprises were represented: 55 (57.3%) worked at a manufacturing enterprise and 41 (42.7%) worked for the government.

Measures

Creativity was measured using a self-report measure and a behavioral measure. The self-report (attitude/opinion) measure was a 25-item Likert-type questionnaire scaling from 1 to 5. Fifteen items comprised the ***organizational creative climate*** dimension and 10items comprised the ***personal use of creativity*** dimension. The reliabilities of the ***organizational creative climate***

and of the ***personal use of creativity*** dimensions were high, such that Cronbach's alpha = 0.93 (M = 2.80, SD = 0.78) and Cronbach's alpha = 0.93 (M = 2.96, SD = 1.04), respectively, and Cronbach's alpha = 0.93 for the overall scale (M = 2.88, SD = 0.78).

In addition, ***Creativity*** was measured as the participants' behavior with responses to two questions that asked the participants to write as many ideas and uses as they could think of for how to use a clip (first question) and how to use a garbage can (second question). The participants were given 10 minutes to answer the questions. The sum of the numbers of ideas was used to measure creativity, such that the more ideas, the more creative was the participant. The number of ideas for a clip ranged from zero to 25 (M = 5.34, SD = 4.70) and the number of ideas for a garbage can ranged from zero to 28 (M = 4.67, SD = 4.66).

Innovation was measured with a 7-item Likert-type questionnaire scaling from 1 to 5. The reliability of the measure was very adequate (Cronbach's alpha = 0.81, M = 4.05, SD = 0.88).

Procedure

A quasi-experimental design was used to test the effectiveness of creativity training. The control group consisted of 53 (55.2%) of the participants (they received no creativity training) and the experimental group consisted of 43 (44.8%) participants (who participated in creative training).

Data Analysis

Most of the statistical tests were conducted between outcomes measures of training group in compare to control group, mainly testing the hypothesis that training sessions induce creativity. In order to do so, an Analysis-of-Variance procedures was conducted. Testing both the group effect (creativity vs. control), and also the effect of the company type (manufacturer vs. government). Company type effect was tested in order to understand whether organization climate of each organization affects creativity improvement due to training. In addition Pearson correlation were produced for each group in order to test differences in associations between groups.

Moreover, only for the training group, behavioral creativity measures were gathered in the first session and in the last session, creating a pre-post design (with no parallel measurements of control group). Due to small sample size of training group, only descriptive statistics were obtained to support the hypothesis.

Results

The present study introduces theoretical propositions that explain the mechanism through which training and development investments affect em-

ployees' views and attitudes towards creativity and innovation and whether participation in such programs that teach and train creativity actually change participants' perspectives to the extent that they are significantly different from employees who did not participate.

Correlations of the main variables in the control and experimental groups

Table 1 shows the correlations of the main variables in the study in the control group. Tenure is positively related to age and job rank, but negatively related to creative climate, personal creativity, and creativity (total). Specifically, the older the employee, the longer the tenure, the more senior the employee, and the higher the rank. However, older participants had lower creativity (climate, personal, and total). The creative climate is positively related to personal creativity, creativity (total), and clip ideas, such that as the creative climate in the enterprise increases, the employees are more creative and more clip ideas were produced. Personal creativity is positively related to creativity (total), clip ideas, and garbage can ideas, such that as employees' personal creativity increased, the more ideas (clip and garbage) were produced. Moreover, creativity (total) is positively related to clip ideas and garbage can ideas. Innovation is positively related to garbage can ideas, such that the more innovative the employees were, the more ideas (garbage can) were produced. Clip ideas and garbage ideas are positively related to each other.

Variable	1	2	3	4	5	6	7	8	9	10
Gender[a] (1)										
Tenure (2)	-.013									
Education (3)	.202	-.052								
Age (4)	.080	.638**	-.154							
Job rank (5)	.091	.330*	.124	.505**						
Creative climate (6)	.039	-.446**	-.069	-.229	-.135					
Pers. creativity (7)	.046	-.527**	-.118	-.219	-.183	.661**				
Creativity (total) (8)	.047	-.539**	-.106	-.245	-.178	.887**	.933**			
Innovation (9)	.437	.170	.702	-.150	-.157	.052	.711	.742		
Clip ideas (10)	.177	-.219	.240	-.208	-.208	.292*	.519**	.460**	.799	
Garbage ideas (11)	.272	-.170	.243	-.205	-.258	.147	.426**	.333*	.979*	.795**

* = $p < 0.05$, ** = $p < 0.01$
[a] 1 = male, 2 = female
Table 1: CONTROL GROUP: Correlation matrix of the demographic and research variables

Table 2 shows that among the experiment group's participants, gender is negatively related to education; therefore, the men in the group were better educated than the women. Tenure is positively related to age, but negatively related to education, so the more senior the employee, the older but less educated is the employee. Age is positively related to rank, but negatively related to creative climate. Therefore, the older the employee, the higher the rank, but the lower is the creative climate. In addition, creative climate is positively related to personal creativity, creativity (total), and innovation, suggesting that the more creative is the climate, the more creativity there is on the personal level, overall, and the more innovation is present. Personal creativity is

positively related to creativity (total) and innovation as well; therefore, as creativity in the employees increased, innovation increased. The numbers of clip and garbage ideas positively related to each other.

Variable	1	2	3	4	5	6	7	8	9	10
Gender[a] (1)										
Tenure (2)	-.046									
Education (3)	-.338**	-.356*								
Age (4)	.013	.433**	-.214							
Job rank (5)	-.165	-.041	.256	.320*						
Creative climate (6)	-.045	-.049	.135	-.368*	.142					
Pers. creativity (7)	-.037	.005	.232	-.019	.086	.444**				
Creativity (total) (8)	-.048	-.034	.198	-.285	.140	.925**	.751**			
Innovation (9)	-.051	-.197	.293	.117	.101	.451**	.595**	.575**		
Clip ideas (10)	-.133	.047	-.062	.011	.000	-.240	.006	-.174	-.084	
Garbage ideas (11)	-.136	.025	.037	-.125	.098	-.126	-.159	-.161	-.096	.701**

* = $p < 0.05$, ** = $p < 0.01$
[a] 1= male, 2 = female

Table 2: EXPERIMENTAL GROUP: Correlation matrix of the demographic and research variables

The effectiveness of creativity training in the self-report measures

To test the effectiveness of creativity training, two-way analysis of variance tests (ANOVA) were employed that compared the control group to the experimental group and the manufacturing to the government types of enterprises. Tables 3 through 5 show the means, standard deviations, and sample sizes.

Table 3 shows a marginal significant main effect of the difference between the groups in organizational creative climate. The experimental group (M = 2.89, SD = 0.89) had a higher average organizational creative climate than the control group (M = 2.73, SD = 0.68). In addition, there is a significant main effect of the difference between the types of enterprises in organizational creative climate, such that manufacturing (M = 3.27, SD = 0.67) enterprises had higher average creative climates than government enterprises (M = 2.17, SD = 0.37).

Moreover, there is a significant interactive effect of groups by enterprise type in organizational creative climate, suggesting that the difference between the groups depends on the type of enterprise. To test the differences with greater precision, post-hoc analyses were performed that found the following:

- In the control group, manufacturing enterprises (M = 3.08, SD = 0.66) scored higher, on average, in organizational creative climate than government enterprises (M = 2.19, SD = 0.21, p = .001).

- In the experimental group, the manufacturing enterprises (M = 3.53, SD = 0.60) scored higher, on average, in organizational creative climate than government enterprises (M = 2.15, SD = 0.49, p = .001).

- Among the manufacturing enterprises, the experimental group (M = 3.53, SD = 0.60) scored higher, on average, in organizational creative climate than the control group (M = 3.08, SD = 0.66, p = .014).

- Among the government enterprises, there was no significant difference (p = .994) between the experimental group (M = 2.15, SD = 0.49) and the control group (M = 2.19, SD = 0.21) in terms of organizational creative climate.

Groups	Enterprise type	Mean	Standard Deviation	Number of cases (*n*)
Control group	manufacturer	3.08	0.66	32
	government	2.19	0.21	21
	Total	**2.73**	**0.68**	**53**
Creativity training	manufacturer	3.54	0.60	23
	government	2.15	0.49	20
	Total	**2.89**	**0.89**	**43**
Total	manufacturer	3.27	0.67	55
	government	2.17	0.37	41
	Total	**2.80**	**0.78**	**96**
Main effects of *groups*: F (1,92) = 3.39, p = .069, $\square^2$ = .035				
Main effects of *enterprise type*: F (1,92) = 103.12, p = .000, $\square^2$ = .529				
Interaction effect: F (1,92) = 4.97, p = .028, $\square^2$ = .051				

Table 3: Means, standard deviations, and effects summaries of the control and creative training groups and two types of enterprises for organizational creative climate

Table 4 shows that there is a significant main effect of the difference between groups in average personal creativity use, such that the experimental group (M = 3.79, SD = 0.51) scored higher, on average, in personal creativity use than the control group (M = 2.29, SD = 0.88). There is a significant main effect of the difference between the types of enterprises in personal creativity

use. Manufacturing enterprises (M = 3.19, SD = 0.95) had higher personal creativity use, on average, than government enterprises (M = 2.66, SD = 1.11).

Moreover, there is a significant interactive effect of groups by enterprise type in personal creativity use, suggesting that the difference in personal creativity use between groups depends on the enterprise type. To test the differences with greater precision, post-hoc analyses were performed that found the following:

- In the control group, the manufacturing enterprises (M = 2.70, SD = 0.88) scored higher, on average, in personal creativity use than the government enterprises (M = 1.67, SD = 0.35, $p < .001$).

- In the experimental group, there was no significant difference ($p = .759$) between manufacturing (M = 3.88, SD = 0.49) and government (M = 3.69, SD = 0.53) enterprises in terms of average personal creativity use.

- Among the manufacturing enterprises, the experimental group (M = 3.88, SD = 0.49) scored higher, on average, in personal creativity use than the control group (M = 2.70, SD = 0.88, $p < .001$).

- Among the government enterprises, the experimental group (M = 3.69, SD = 0.53) scored higher, on average, in personal creativity use than the control group (M = 1.67, SD = 0.35, $p < .001$).

Groups	Enterprise type	Mean	Standard Deviation	Number of cases (*n*)
Control group	manufacturer	2.70	0.88	32
	government	1.67	0.35	21
	Total	**2.29**	**0.88**	**53**
Creativity training	manufacturer	3.88	0.49	23
	government	3.69	0.53	20
	Total	**3.79**	**0.51**	**43**
Total	manufacturer	3.19	0.95	55
	government	2.66	1.11	41
	Total	**2.96**	**1.05**	**96**
Main effects of *groups*: F (1,92) = 146.75, p = .000, $\square^2$ = .615				
Main effects of *enterprise type*: F (1,92) = 21.15, p = .000, $\square^2$ = .187				
Interaction effect: F (1,92) = 9.92, p = .002, $\square^2$ = .097				

Table 4: Means, standard deviations, and effects summaries of control and creative training groups and two types of enterprises for personal creativity use

Table 5 shows a significant main effect of the difference between the groups in average total creativity. The experimental group (M = 3.34, SD = 0.60) scored higher, on average, in total creativity than the control group (M = 2.51, SD = 0.71). In addition, there is a significant main effect of the difference between the types of enterprises in total creativity, such that manufacturing enterprises (M = 3.23, SD = 0.72) had higher average total creativity than government enterprises (M = 2.41, SD = 0.59). There was no significant interactive effect of group by enterprise type regarding total creativity.

Groups	Enterprise type	Mean	Standard Deviation	Number of cases (*n*)
Control group	manufacturer	2.89	0.67	32
	government	1.93	0.22	21
	Total	**2.51**	**0.71**	**53**
Creativity training	manufacturer	3.71	0.50	23
	government	2.92	0.41	20
	Total	**3.34**	**0.60**	**43**
Total	manufacturer	3.23	0.72	55
	government	2.41	0.59	41
	Total	**2.88**	**0.78**	**96**
Main effects of *groups*: F (1,92) = 74.49, p = .000, $\square^2$ = .447				
Main effects of *enterprise type*: F (1,92) = 69.61, p = .000, $\square^2$ = .431				
Interaction effect: F (1,92) = 0.63, p = .429, $\square^2$ = .007				

Table 5: Means, standard deviations, and effects summaries for the control and creativity training groups and two types of enterprises for total creativity

The effectiveness of creativity training in the behavioral measures

To test the effectiveness of creativity training, two-way ANOVAs were employed to compare the control group to the experimental group and to compare the manufacturing enterprises to the government enterprises with respect to the number of ideas the participants were able to think of regarding

a clip and regarding a garbage can. Tables 6 and 7 show the means, standard deviations, and the numbers of cases in those tests.

Table 6 shows that there is a significant main effect of the difference between the groups in the average number of clip ideas. The experimental group (M = 8.91, SD = 4.29) had many more clip ideas, on average, than the control group (M = 2.46, SD = 2.52). The effect size of this difference was particularly high ($\square^2$ = .518). However, there is a no significant main effect of the difference between manufacturing (M = 5.08, SD = 3.71) and government (M = 5.78, SD = 2.52) enterprises in the average number of clip ideas.

Moreover, there was a significant interactive effect of groups by enterprise type with respect to clip ideas, suggesting that the difference between the groups depends on the type of enterprise. To test the differences with greater precision, post-hoc analyses were performed that found the following:

- In the control group, there is no significant difference (p = .157) between the manufacturing (M = 3.22, SD = 2.86) and government (M = 1.25, SD = 1.07) enterprises in terms of clip ideas.

- In the experimental group, there is no significant difference (p = .052) between the manufacturing (M = 7.70, SD = 3.17) and government enterprises (M = 10.30, SD = 5.02) in terms of clip ideas.

- Among the manufacturing enterprises, the experimental group (M = 7.70, SD = 3.17) had higher average clip ideas than the control group (M = 3.22, SD = 2.86, p = .001).

- Among the government enterprises, the experimental group (M = 10.30, SD = 5.02) had higher average clip ideas than the control group (M = 1.25, SD = 1.07, p = .001).

Groups	Enterprise type	Mean	Standard Deviation	Number of cases (*n*)
Control group	manufacturer	3.22	2.86	32
	government	1.25	1.07	20
	Total	**2.46**	**2.52**	**52**
Creativity training	manufacturer	7.70	3.17	23
	government	10.30	5.02	20
	Total	**8.91**	**4.29**	**43**
Total	manufacturer	5.09	3.71	55
	government	5.78	5.82	40
	Total	**5.38**	**4.70**	**95**
Main effects of *groups*: $F(1,91) = 97.81$, $p = .000$, $\square^2 = .518$				
Main effects of *enterprise type*: $F(1,91)=0.22$, $p=.643$, $\square^2 = .002$				
Interaction effect: $F(1,91)=11.18$, $p=.001$, $\square^2 = .109$				

Table 6: Means, standard deviations, and effects summaries for the control and creativity training groups and two types of enterprises for clip ideas

Table 7 indicates a significant main effect of the difference between the groups on garbage can ideas, where the experimental group (M = 8.19, SD = 4.78) had many more garbage can ideas, on average, than the control group (M = 2.31, SD = 2.29). The effect size was particularly high ($\square^2 = .416$). There is a no significant main effect of the difference by enterprise type on garbage can ideas; manufacturing enterprises (M = 5.09, SD = 4.02) and government enterprises (M = 4.80, SD = 5.47) were similar in terms of average

numbers of garbage can ideas. There also is not a significant interactive effect of groups by enterprise type with respect to garbage can ideas.

Groups	Enterprise type	Mean	Standard Deviation
Control group	manufacturer	2.97	2.67
	government	1.25	0.72
	Total	**2.31**	**2.29**
Creativity training	manufacturer	8.04	3.74
	government	8.35	5.86
	Total	**8.19**	**4.78**
Total	manufacturer	5.09	4.02
	government	4.80	5.47
	Total	**4.97**	**4.66**
Main effects of *groups*: F (1,91) = 64.86, p = .000, $\square^2$ = .416			
Main effects of *enterprise type*: F (1,91) = 0.87, p = .353, $\square^2$ = .009			
Interaction effect: F (1,91) = 1.80, p = .184, $\square^2$ = .019			

Table 7: Means, standard deviations, and effects summaries for the control and creativity training groups and two types of enterprises for garbage can ideas

Change over time in the behavioral measures

Five meetings were held in which creativity training) brainstorming) took place. The numbers of ideas produced by the group members in each meeting were documented. Figures 2and 3chart the numbers of ideas that were generated at each meeting. As shown in Figure ,2in every meeting, the number of ideas generated after creativity training was much higher than the number of ideas generated before the training. Training apparently increased the number of ideas from about 32 to 43 (M = 38.6, SD = 4.03). As shown in Figure ,3in every meeting, the number of ideas after creativity training was

much higher than the number of ideas before the training. Training apparently increased the number of ideas from about 41 to 61 (M = ,53.4SD = 7.70).

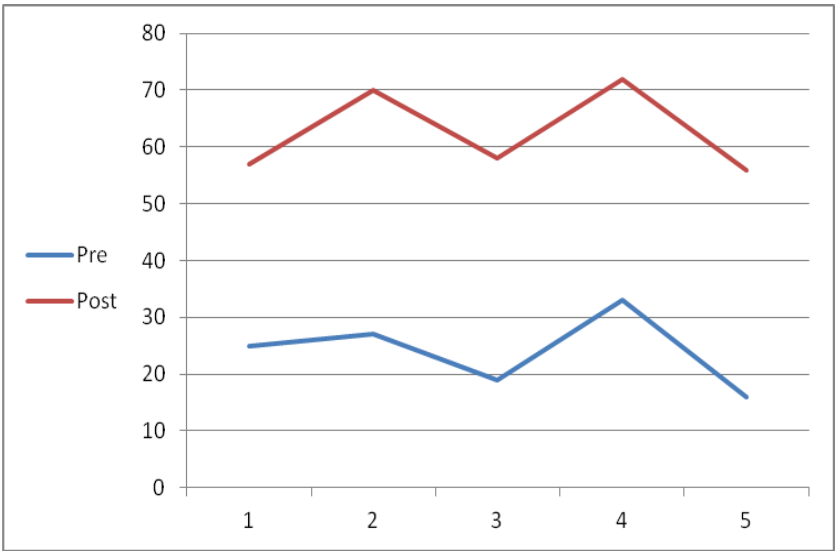


Figure 2: Comparison of the numbers of ideas before and after creativity sessions for manufacturing enterprises

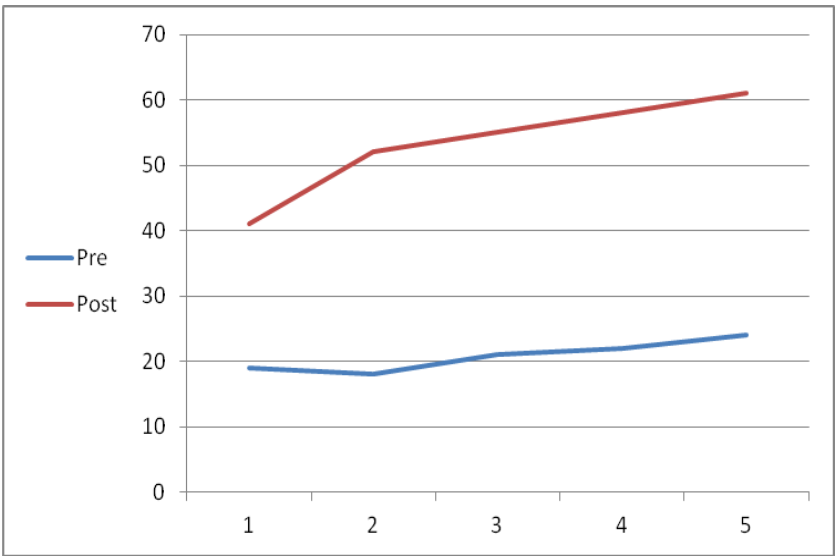


Figure 3: Comparison of the numbers of ideas before and after creativity sessions (brain storming) for the government enterprises

Discussion

Training has a variety of positive effects on the financial and nonfinancial firm performance. These effects might be much broader than the results of many previous studies suggest (Thang, Quang & Buyens, 2010). This study presents the influence of training as a valuable asset for all types of organizations.

At the institutional level, managers and enterprises have an imperative role to play in facilitating discussion and promoting their employees' excellence at removing the barriers to and helping to create the conditions for creativity and innovation. Managers are challenged to provide an organizational culture that encourages employees to actively participate in learning and effective knowledge sharing. The findings from this study have contributed to our understanding of the value that training and education can bring to employees to enhance their creative and innovative behaviors, perspectives, and performances.

The main goals of this study were to examine the influence that a training program has on employees' creativity and innovation competence and to explore its measurement in a multi-source framework that includes performance and behavioral measures and to answer the question, can manufacturer organizations benefit more from creativity training as compared to a government organization?

Scholars have argued that training practices enhance innovation by promoting a learning climate (Gómez, Lorente & Cabrera, 2004; Shipton, Fay, West, Patterson & Birdi, 2005), Shipton, Dawson , Birdi & Patterson (2006) reported, in a longitudinal study of 22 United Kingdom manufacturing enterprises, that training, induction, teamwork, appraisal, and an exploratory learning focus predict innovation. To make the best use of employees' creative potential, enterprises must ensure that employees receive targeted training and are enabled to operate in the appropriate environments. This study explained the training–creativity/innovation link that has only recently begun to receive research consideration.

The most important practical implication that emerges from these results concerns ways to increase the likelihood of innovation success. A good understanding of management supported by a serious training and developmental program is necessary. Based on our reasoning and empirical findings, the ability to develop a positive approach in employees to improve their creativity and innovation on the one hand, and contribute to the process of increasing value on the other hand, can be achieved with training. This conclusion was supported by the results of our analysis in that the experimental group had significantly higher average scores in the quantitative questionnaire and in the behavioral measures than the control group, regardless of the type of enterprise.

Innovation often results from the ability to utilize existing knowledge and information to generate different combinations and reconfigurations (Cantner, Kristin & Schmidt, 2008). The training and developmental investment of an enterprise creates a climate for constant learning that facilitates the exchange of knowledge and ideas among employees, thereby promoting the generation of new knowledge and innovation (Lau & Ngo, 2004). To test the contribution of creativity training to employees' innovation, a quasi-experiment was conducted, in which half of participants were trained, and half of them were a control group. This study yielded several significant results. The primary effect resulted from training because participants in the experimental group had a higher organizational creative climate, higher personal creativity use, and more innovative ideas, on average, than the control group. Moreover, the results found that creativity increased across the five training sessions. In addition, a main effect was found regarding the type of enterprise, such that the manufacturing enterprises had higher average organizational creative climates and personal creativity use than the government enterprises.

The present study reiterates the importance of investment in human capital for continuous organizational innovation and success. These investments can ensure a positive approach and a strong will to engage in the process of innovation, which is a challenging task. The results suggest that if an organization expands its expenditures on creative training (particularly internal training), then its capacity to improve employees' perspectives on innovation are increased and the abilities of those who participated in creativity training will enhance their innovation significantly. Furthermore, the study results confirmed that there is a positive effect of training on the two different types of enterprises. This result implies that the organizational cultures of the two types of enterprises had direct influences on the employees' views and their personal abilities to be creative. The manufacturing enterprise that develops products was hypothesized to be more positive with respect to creativity in the views and practices of its employees, which was supported.

The influence of the training (i.e. the tools and techniques taught) is a valuable asset in the long term for all types of organizations. These organizations can leverage their businesses based on knowledge and the training processes that were implemented. Individuals that are psychologically attached to organizations usually have feelings of loyalty, perceptions of work position, and trust in the organization's value. In many ways, the development of employees and their transformation into better and more creative organizational members through education and training can influence their performances and their feelings of loyalty to the organization.

The vision presented here is based on the assumption that managers have the power to create environments that enable employees to establish practices based on mutually-agreed upon principles and to act independently within the scope of those principles (Hockings, 2005). In this study, creativity and innovation were those principles and, as presented, they can be realized if training is conducted. This study contributes to our understanding of the significant

repercussions that training has on intellectual capital and it suggests that, when organizations devote time and budget to creativity training, they can magnify innovative execution and creative thinking that can manifest as value for the organization. Sun & Choi (2014) reported that if an organization reduces its training expenditure (particularly for internal training) as a reaction to a crisis, its capability for innovation can be degraded in the coming years despite the increasing importance of persistent innovation to overcome the crisis and create turnarounds (Laursen & Mahnke, 2001). Likewise, innovative people are not motivated by financial rewards, they respond better to self and peer appraisal (Rasheed, 2012). They are motivated by the quality of their work and the allocation of challenging projects, and this coincides with the Simon Sinek who gave an inspiring talk at TED during 2009 "Great companies don't hire skilled people and then motivate them, they hire motivated people and inspire them…", this research confirms that organizations can inspire their employees through training, drive them to better results and scale up their perspectives on innovation and creativity. Further conceptual efforts may be directed to explore the long term effect of innovation training in organizations, as such investments can ensure the long-term survival and growth of an organization.

Future research might estimate the impact of training on firm performance in other specific sectors in order to provide another potentially interesting result on the relationship and contribute to the current literature within the field**.**

This research can be important for managers and practitioners dealing with training and firm performance in the workplace. Training is a valuable path to follow when an organization would like to improve its performance and be innovative, and in the light of the results presented together with the framework for analyzing training and firm performance issues, managers could find some interesting clues and directions to the advantages of creative and innovative training. Managers can decide when and how to provide training programs for their employees in order to obtain their best performance.

References

Anderson, N., De Dreu, C. K., & Nijstad, B. A. (2004). The routinization of innovation research: A constructively critical review of the state-of-the science. Journal of Organizational Behavior, 25, 147-173.

Anderson, BS, & Eshima, Y (2013). The influence of firm age and intangible resources on the relationship between entrepreneurial orientation and firm growth among Japanese SMEs. Journal of Business Venturing, 28 (3), 413-429.

Anderson, N., Potocnik, K., & Zhou, J. (2014). Innovation and creativity in organizations: A state-of-the science review and prospective commentary. Journal of Management, 40(5), 1297-1333.

Aragón-Sánchez, A., Barba-Aragón, I., & Sanz-Valle, R. (2003). Effects of training on business results. International Journal of Human Resource Management, 14, 956–980.

Ballot G., Fakhfakh F. and Taymaz, E. (2001). "Firms' human capital, R&D and performance: A study on French and Swedish firms", Labour Eco nomics, 8: 443- 462.

Bartel, A.P. (1994), "Productivity gains from the implementation of employee training programs", Industrial Relations, 33: 411-425.

Baumol, W. J. (2004). Four sources of innovation and stimulation of growth in the Dutch economy. In G. G. Klomp, L. S. Raes, &T. Roelandt (Eds.,) Fostering productivity: Patterns, determinants and policy implications (pp. 183-196) in Vol. 263 Contributions to Economics. Amsterdam, the Netherlands: Elsevier.

Becker, G. S. (1964). Human capital: A theoretical and empirical analysis, with special reference to education, New York: Columbia University Press and the NBER

Brown, B., & Anthony, S. D. (2011). How PG tripled its innovation success rate: Inside the company's new-growth factory. Harvard Business Review.

Cantner, U., Kristin, J., & Schmidt, T. (2008). The effects of knowledge management on innovative success – an empirical analysis of German firms. Jena Economic Research Papers.1-34

Chen, C. J., & Huang, J. W. (2009). Strategic human resource practices and innovation performance: The mediating role of knowledge management capacity. Journal of Business Research, 62, 104-114.

Damanpour. F. & Gopalakrishnan, S. (2001). The dynamics of the product and process innovations in organizations, Journal of Management Studies, 38(1), 45-65.

Fernandez-Araoz, C. (2014). It's not about the How or the What but the Who. Boston, MA: Harvard Business Review Press.

Gómez, P. J., Lorente, J. J. C., & Cabrera, R. V. (2004). Training practices and organizational learning capability. Journal of European Industrial Training, 28, 234-256.

Hattori, R. A. & Wycoff, J. (2004). Innovation Training. ASTD Press (Digital).

Hockings, C. (2005). Removing the barriers? A study of the conditions affecting teaching innovation. Teaching in Higher Education, 10(3), 313-326.

Holzer, H.J., Block, R.N., Cheatham, M. and Knott, J.H. (1993). "Are training subsidies for firms effective? The Michigan experience", Industrial and Labor Relations Review, 46: 625-636.

Kozlowski, S. W. J., & Klein, K. J. (2000). A multilevel approach to theory and research in organizations: Contextual, temporal, and emergent processes. In K. J. Klein & S. W. J. Kozlowski (Eds.), Multi-level theory,

research, and methods in organizations: Foundations, extensions, and new directions (3-90). San Francisco, CA: Jossey-Bass Publishers.

Lawler, E., & Worley, C. (2006). Built to change: How to achieve sustained organizational effectiveness. San Francisco, CA: Jossey-Boss.

Lau, C. M., & Ngo, H. Y. (2004). The HR system organizational culture and product innovation. International Business Review, 13, 685-703.

Laursen, K., & Mahnke, V. (2001). Knowledge strategies, firm types and complementarity in human-
resource practices. Journal of Management and Governance, 5, 1–27.

Magee, D (2009). Jeff Immelt and the New GE Way: Innovation, Transfor mation and Winning in the 21st
Century: Innovation, Transformation and Winning in the 21st Century. NY. McGraw-Hill.

Michalko, M. (2011). Creative Thinking. California, New World Library.

Naveh, E., & Erez, M. (2004). Innovation and attention to detail in the quality improvement paradigm. Management Science, 50, 1576-1586.

Noe, R. A., Tews, M. J., & Dachner, A. M. (2010). Learner engagement: A new perspective for enhancing our understanding of learner motivation and workplace learning. Academy of Management Annals, 4, 279-315.

Potocnik, K., & Anderson, N. (2012). Assessing innovation: A 360-degree appraisal study. International Journal of Selection and Assessment, 20(4), 497-509.

Price, D.P, Stoica, M & Boncella, R.J (2013) The relationship between innovation, knowledge, and
performance in family and non-family firms: an analysis of SMEs Journal of Innovation and
Entrepreneurship, 2, (14)

Rasheed, H (2012) Innovation Strategy. Seven keys to creative leadership and a sustainable business
model. Universe Inc, Bloomington.

Shipton, H., West, M., Dawson, J., Birdi, K., & Patterson, M. (2006). HRM as a predictor of innovation. Human Resource Management Journal, 16, 3-27.

Shipton, H., Fay, D., West, M., Patterson, M., & Birdi, K. (2005). Managing people to promote innovation. Creativity and Innovation Management, 14, 118-128.

Skarzynski, P. & Gibson, R. (2008). Innovation to the core: A blueprint for transforming the way your company innovates. Boston, MA: Harvard Business Press.

Sun Y. S., & Choi, J. N. (2014). Do organizations spend wisely on employees? Effects of training and development investments on learning and innovation in organizations. Journal of Organizational Behavior, 35(3), 393-412.

Sung, S. Y., & Choi, J. N. (2012). Effects of team knowledge management on the creativity and financial performance of organizational teams. Organizational Behavior and Human Decision Processes, 118, 4-13.
Suss, G, (2010). d-Vision: Seeking excellence through a hands on engineering multidiscipline global internship program. American Journal of Business Education, 3(4), 99-104.
Suss, G. (2014). The "Innovation through Education" (ITE) Program: Teaching and encouraging innovation for middle management. International Journal of Knowledge, Innovation, and Entrepreneurship, 2(2), 1-25.
Shalley, C., Zhou, J., & Oldham, G. (2004). The effects of personal and contextual characteristics on creativity: Where should we go from here? Journal of Management, 30, 933-958.
Thang, N. N., Quang, T. & Buyens, D. (2010). The Relationship between Training and Firm Performance: A Literature Review, Research and Practice in Human Resource Management, 18(1), 28-45.
Tidd, J., Bessant, J., & Pavitt, K. (2005). Managing innovation: Integrating technological, market, and organizational change. New York, NY: John Wiley & Sons.
West, M. A., & Farr, J. L. (1990). Innovation at work. In M. A. West & J. L. Farr (Eds.), Innovation and creativity at work: Psychological and organizational strategies (pp. 3-13). Chichester: Wiley.
Zahra, S. A., & George, G. (2002). Absorptive capacity: A review, reconceptualization, and extension. Academy of Management Review, 27, 185-203.

Correspondence

Dr Garvin Suss
Innovation Center
Keter Group
Israel
Email: Gavin.suss@keter.co.il

Author's Brief Bio

Dr. Gavin Suss is the Manager of the e-Vision program at the Keter Group; he earned his PhD in Education and Management from the Tel Aviv University and is a graduate of the executive manager's course at Harvard Business School. In the past he served as the Academic Director of the Shenkar College of Engineering and Design and CEO of the Tomashin College. Suss lecturers and teaches at leading firms and Universities around the globe. His expertise is innovation and creativity. He has published several academic articles and recently published his first book "Wake Up: you only live once".

Appendix

This questionnaire includes several groups of issues related to the company innovation potential. By filling-out the questionnaire thoroughly, we will obtain an overview of the strong and weak points in the company and what deserves your attention. This questionnaire is anonymous and seeks to understand the point a views of employees of all level towards Innovation in the company. Thanks for your cooperation

Part 1: General Data

1. **Gender:** Male/Female
2. **Years in company:** _____
3. **Degree:** no degree/practical engineer/BA/MA/PhD
4. **Age:** _____
5. **Level of employment:** Employee/manager/executive
6. Since working in the company I participated in a workshop on innovation/managers course in the company YES/NO
7. **Is your company:** Manufacturer/ Governmental

Part 2: Quantitative Part

There are several statements in the following table, please mark to which level of agreement you agree with each of the following statements. (1 = strongly disagree, 2 = disagree, 3 = nor disagree nor agree, 4 =agree, 5 = strongly agree; X = do not know)

Statement	1	2	3	4	5	X
The leaders in the company encourage creativity and innovation						
The company has a formal approach for generating ideas and using creativity/innovation to address business issues						
I use Brainstorming more often						
The company break downs barriers between different functional areas so that ideas can be exchanged						
The company encourages team work						
The general atmosphere is pro-innovation						
I feel more creative today as compared before training (d-Vision/e-Vision)						
The company's mission statement specifically mentions creativity and/or innovation						
The company performances in innovation are high						
The company has programs to encourage innovation						
The innovation training programs improved my ability to be innovative						
I work often in teams						
The company is successful in developing new products and getting them to market						
My ability to be more innovative has developed						
There are quantified goals for innovation and its impact on future performance						
Innovation is part of my day-to-day missions						
Innovation is celebrated and rewarded?						
Senior management encourage innovation by demonstrating that "It's okay to fail"						
My critical thinking has improved						
Entrepreneurs and creative employees are supported?						
The company is open to learning from your competitors and other industries?						
Innovation is part of my DNA						
The company is successful in exploiting the diversity of people's talents?						
I have developed critical thinking skills						
I have developed an expertise in team work						

If you participated in innovation training:
With which of the following statements can you agree **that you have developed from your innovation training:**

Statement	**1**	**2**	**3**	**4**	**5**	**X**
Out of the box thinking						
Focus on many answers						
Questioning everything even if things are very obvious						
Bringing up many ideas.						
Never say "It's impossible".						
Always ask why? Take nothing for granted						
I have developed critical thinking skills						

Part 3: Performance Part (10 minutes)
Please write down as much ideas you think can be used with a:

1) **Clip**

2) **Garbage Can**

CHAPTER TEN

SHIFTING BETWEEN MODES OF THOUGHT: A DOMAIN-GENERAL CREATIVE THINKING SKILL?

ANDREW PRINGLE, PAUL T. SOWDEN,
CARYS DEELEY & SARIKA SHARMA

Abstract

In this chapter we argue that shifting between different modes of thought, termed 'mode shifting' for short, is a fundamental cognitive skill underlying human creative thinking across different domains. We introduce empirical evidence revealing a relationship between mode shifting and creativity. Findings also show a relationship between mode shifting, as assessed by the mode shifting index (MSI), and creativity across five different domains, as assessed by the Kaufman domains of creativity scale (K-DOCs), suggesting that mode shifting is important for creativity across different domains. However, findings demonstrate that the relationship between mode shifting and creativity hinges on the component of mode shifting (metacognitive awareness of shifting or shifting competence), with certain components more important in some domains than others. In sum, mode shifting has domain-specific in addition to domain-general elements. We conclude the chapter by discussing the implications of our findings for creativity training and educational practice.

Keywords: mode shifting, creative cognition, domain specificity, metacognition, creativity training

1. Defining creativity

Creativity is a multifaceted construct (Ward & Kolomyts, 2010; Kaufman, 2009). We use Plucker, Beghetto & Dow's (2004) definition which captures this quality defining creativity as *"the interaction among aptitude, process and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context*". Aptitude reflects ability and affective influences and can be shaped by experience and learning. Processes reflect activities, such as creative problem solv-

ing, which when engaged in may lead to creative outcomes. The environment refers to the present context an individual or group is operating in (Plucker, Beghetto & Dow, 2004). This definition of creativity applies across all domains. For example to be deemed creative, both a design for a new smartphone and an artwork must be novel and useful, where we can further define useful as being specified, valuable, meaningful, relevant or worthwhile (Plucker & Beghetto, 2004). Evidently a novel artwork may be useful because experiencing it induces a meaningful experience in the beholder while a novel smartphone design may be useful because it increases the value of the experience, for example containing a more sophisticated camera than competitor models. The key point is that novelty and usefulness are components of any outcome, an idea or product, across any domain and these are both necessary components imbuing it with the quality of being creative (Cropley & Kaufman, 2012).

2. Definition of the different modes of thought and mode shifting

The conceptualisation of two fundamental modes, types or stages of thinking is a key component of many models of creativity (see Sowden, Pringle & Gabora, 2015 for a review of these models). Here, we draw specifically on a subset of these models (Gabora, 2010; Gabora & Ranjan, 2013; Howard-Jones, 2002; Kaufman, 2011; Vartanian, 2009) that closely agree on the characteristics of the two modes of thinking. In these models the two modes are differentiated based on their attentional characteristics. Similar to Gabora (2010), we use the label 'associative' to describe a mode of thought characterised by defocused attention and 'analytic' to describe a mode of thought characterised by focused attention. Models of creativity also emphasise the importance of *shifting* between the two different modes of thinking during the creative process (see Sowden, Pringle & Gabora, 2015 for a review). Parallels have been drawn between associative and divergent thinking and analytic and convergent thinking (Gabora, 2010; Martindale, 1999). However it has been argued that divergent thinking, also termed ideation, involves an element of analysis in the form of evaluations of previously generated ideas (Runco, 2010). Further, the process of insight described by Mednick (1962) as an associative process involves convergence on a single idea or solution, which also requires analysis and evaluation. Hence simple mappings between associative thinking and divergent thinking and between analytic thinking and convergent thinking are not possible (see Sowden, Pringle & Gabora, 2015 for an elaboration of these arguments but see also Tanner & Reisman, 2014 for alternative conceptualisations). Associative and analytic modes of thinking are involved in both divergent and convergent thought. Shifting may occur in either direction between associative and analytic modes, for example shifting from analytic to associative thinking may enable one to overcome

being 'stuck in a rut' while shifts from associative to analytic thinking enable the evaluation of previously generated novel insights (Gabora & Ranjan, 2013). Thus, associative and analytic thinking are interwoven and both must be harnessed to effectively generate and evaluate in order to produce creative ideas or products.

In terms of Plucker, Beghetto & Dow's (2004) definition of creativity, mode shifting can be defined as a process humans engage in that may lead to a creative outcome. Gabora & Ranjan (2013) view mode shifting as a process that all humans are capable of performing but others (Howard-Jones, 2002) have also proposed that there exist individual differences in the ability to shift between different modes of thought. These proposals are mutually compatible and we view mode shifting as both a process and an aptitude on which people differ. A final important point about mode shifting is that it may be influenced by the environment/context in which a person is operating. Gabora & Ranjan (2013) term shifting 'contextual focus' and describe it as the capacity to modulate the focus of attention to match the demands of the current situation. Shifting is conceptualised as occurring in response to changes in the nature of a task one is working on or the situation one is in. To illustrate, the nature of a problem requiring a creative solution may at first be ill defined but becomes progressively better defined as the problem solver works on it (Vartanian, 2009). During the stage when the problem is ill defined one may rely more on the associative mode to think laterally about how to approach the problem. Later in the task, once an approach has been decided on, one may rely more on the analytic mode to determine how to implement it (Gabora & Ranjan, 2013). Additionally, this may be a non-linear process with problem solvers going "back to the drawing board" and re-engaging the associative mode to search for a new way of approaching the problem if they discover, using the analytic mode that their initial strategy was ineffective and is leading towards a dead end. Ill-defined 'creative' problems may therefore engage mode shifting to a greater extent than 'non creative' well-defined problems which have one correct solution with a logical deductive procedure (Schraw, Dunkle & Bendixen, 1995), underpinned by an analytic mode of thought, guaranteed to reach that solution.

In sum, mode shifting appears to be a fundamental component of creative thinking and, like creativity, is multifaceted being an interaction between one's aptitude in carrying out shifts between different modes of thought, the process of shifting and the environment within which one is operating.

3. Is mode shifting a domain-general or domain specific creative thinking skill?

Novelty and usefulness lie at the core of definitions of creativity, definitions that apply across domains from the arts to the sciences (Plucker & Beghetto. 2004). We have presented the case in the previous section of this

chapter in support of mode shifting as a fundamental thinking skill that enables humans to produce novel ideas that are also useful. On the face of it, mode shifting would appear be to a domain-general thinking skill, important for creativity across domains. The notion that mode-shifting could be a domain-general creative thinking skill leads us to one of the core debates in creativity research and to the heart of what it means to 'be creative' (Baer & Kaufman, 2005). This debate concerns the extent to which there are common elements, for example the same cognitive processes, underlying creativity in different domains, termed the domain-general position, or whether creativity in one domain such as design is completely different to creativity in another such as poetry (Baer & Kaufman, 2005). The latter position is termed the domain-specific view. In other words, is creativity the same thing across multiple domains or are we just applying the same term "creativity" to the products of processes, abilities and environments that in reality differ widely across domains? Is there a creative equivalent of the *g-factor* in intelligence (Barbot & Tinio, 2015) or does creative ability in one domain represent a highly specialized suite of knowledge and skills that can't easily be transferred in order to be creative in another? This is not simply a debate of theoretical importance it also has practical implications for the design of creativity training programs and educational practice (Baer, 1996; 1997; 1998).

3.1 A bridge between domain specific and domain general views of creativity: the Amusement Park Theoretical (APT) Model of Creativity

A helpful response to this debate was proposed by Baer & Kaufman (2005) in the form of their Amusement Park Theoretical model of creativity (APT). The APT draws upon the metaphor of an amusement park to bring together both domain-general and domain-specific views of creativity in a hybrid model. The reasoning behind the amusement park metaphor is to highlight how domain-general and domain specific factors are linked together. For example, initial requirements required for creativity across all domains are likened to the basic requirements needed to visit any amusement park, for example having a ticket for the park. The general thematic areas in the APT model are likened to deciding what amusement park to visit, for example a water park or a zoo (Baer & Kaufman, 2005). The APT model presents a hierarchical view of creativity, going from domain-general at the highest level to sequentially more domain specific as you move down the hierarchy. At the top of the hierarchy is a set of initial requirements required in order to be creative across all domains. Initial requirements are a basic level of intelligence, motivation and the right environment to express one's creativity (Baer & Kaufman, 2005). The next level down the hierarchy is the general thematic area in which one can be creative, for example within the arts and science. Within each of these general thematic areas are more specific

domains such as dance, music (for the arts) and for example biology, geology and computer science (for the sciences) (Baer & Kaufman, 2005; Kaufman, 2009). Within each domain there are micro-domains that consist of the specific tasks one does in a domain, for example studying fruit flies may be a task that helps one develop creative insights in one of biology's micro-domains but may be of little use in others (Baer & Kaufman, 2005). The level of micro-domains is at the bottom of the hierarchy and represents highly specialized domain-specific expertise.

The question then is at what level does mode shifting sit in the APT hierarchy? On the face of it mode shifting would appear to be important across all domains, and if so would sit at the level of *initial requirements.* However the role of mode shifting and creativity across different thematic areas or domains has yet to be explored. Previous work has suggested a relationship between mode shifting and creativity but has only relied on domain-general measures of creative potential (Vartanian, 2009; Vartanian, Martindale & Kwiatowksi, 2007; Dorfman, Martindale, Gassimova & Vartanian, 2008). As such, this did not allow for the relationship between mode shifting and creativity across different thematic areas or domains to be examined.

4. The present work

The empirical work presented in this chapter focuses on examining if mode shifting is associated with creativity across different thematic areas/ domains. We used the Kaufman Domains of Creativity Scale (K-DOCs) (Kaufman, 2012) as a measure of creativity across domains and the mode shifting index (MSI) (Pringle & Sowden, under review) as a measure of mode shifting. A sample of participants (N = 56) aged between 16 and 56 years of age (M =29, SD =11) completed both the K-DOCs and the MSI and a series of other task based measures (see below) on-site at the University of Surrey in the UK. Regression analyses were run to examine the relationship between mode shifting and creativity across different domains.

4.1 Mode shifting index (MSI)

The MSI is a self-report measure based on a conceptual framework of mode shifting which proposes mode shifting has two components (Pringle & Sowden, under review). The first component is shifting competence. This reflects the effectiveness of the operation of a shifting mechanism that shifts the balance of thinking by regulating the intensity of use of both the associative and analytic modes such that one may be more active than the other, or both may be equally active (or inactive). The second component is metacognitive awareness. This includes one's awareness of the individual modes of thinking, and of the shifting process itself (Sowden, Pringle & Gabora, 2015), for example, monitoring when one is shifting or not and one's rate of shifting

during a task, and thus *awareness* of how effective one is at shifting. The MSI has previously demonstrated validity by showing that participants studying or working in architecture, an occupation that might be expected to require shifting in order to devise creative solutions (Cross, 2011; Dorst & Cross, 2011), reported greater metacognitive awareness of shifting compared to two control groups, from medicine and other professions (Pringle & Sowden, under review). It is also worth noting that in the aforementioned study all groups (architecture, medicine & other professionals) reported levels of metacognitive awareness of shifting and shifting competence that differed from the minimum possible values. These findings suggest that mode shifting is at least to some extent evidenced across different domains. Finally, the MSI has also been shown to be capable of capturing differences in mode shifting expected as a function of the environment/context in which a person is operating (Gabora & Ranjan, 2013). Specifically, architects reported greater mode shifting in their professional role compared to within their everyday life (Pringle & Sowden, under review).

4.2 Kaufman Domains of Creativity Scale (K-DOCs)

The K-DOCs is a self-report measure of self-perceived creativity across five broad domains; self-everyday, scholarly, performance, mechanical/ scientific and artistic (Kaufman, 2012). These broad domains appear to lie somewhere between the general thematic areas and specific domains of the APT model. The important point for our purposes is the K-DOCs allows us to examine if the relationship between mode shifting and creativity is similar or differs across a diverse set of domains.

The K-DOCs asks participants to report how creative they rate themselves at performing a variety of different acts such as 'helping other people cope with a difficult situation' and 'figuring out how to fix a buggy computer'. There are 50 acts in total that fall into the five broad domains of creativity measured. The measure asks participants to indicate how creative they think that they are in comparison to people of approximately the same age and life experience as them. For given acts that participants have not performed, they are asked to estimate their creative potential based on their performance on similar tasks. Participants are asked to indicate responses to each act on a five point scale, with *1* indicating they are much less creative and *5* indicating they are much more creative in comparison to their peers of approximately the same age and life experience. Creativity is scored by summing the scores of all acts that refer to the same domain giving five separate domain scores for creativity.

4.3 Assessing the validity of the self-report measures of creativity and mode shifting in the present sample

To complement the K-DOCs and MSI, we included a brief measure of divergent thinking in the form of the Product Improvement test from the Torrance tests of creative thinking (Torrance, 1974), a consensual assessment of the functional creativity of designs (Cropley & Kaufman, 2012) produced on the disposable coffee cup design task (Jansson & Smith, 1991; Chrysikou & Weisberg, 2005) and a measure of set-breaking (Gasper, 2003). The presence of relationships between K-DOCs domains and task based measures from the coffee cup design task, product improvement test and mental set task would indicate that, within our sample, K-DOCs domain scores are capturing one's actual creative performance and real mode shifting behaviour and not merely one's self-perception of creativity (Kaufman, 2012) or mode shifting. The reasons for expecting positive relationships between certain K-DOCs domains and task-based measures of creativity and mode shifting are explained for each task-based measure in turn.

4.3.1. Product improvement test

The product improvement test enabled us to assess if the scores for creativity on the K-DOCs dimensions correlated with divergent thinking, as divergent thinking is a measure of creative potential. Further, there is good evidence that divergent thinking ability is related to actual creative performance. For instance, the Torrance tests of creativity thinking (TTCT) (Torrance, 1974), of which the product improvement test is one component, demonstrated that divergent thinking was a strong predictor of later creative achievement (Plucker, 1999). Hence indices of divergent thinking performance from the product improvement test will enable an assessment of the validity of the K-DOCs domain measures.

Furthermore, the generation of ideas and judgements and evaluations of them are fundamental to divergent thinking tasks (Runco, 2010). Specifically, the product improvement test requires individuals to generate novel ways of changing an existing stuffed toy elephant so that children will have more fun playing with it. The instructions and scoring criteria specify that responses must be focused on things that could conceivably make the toy more fun for children to play with and do not instead fulfil different purposes, such as making the toy do your homework (Torrance, 1974). Since this task requires the generation of ideas which also must have utility in fulfilling the purpose of making the toy more fun to play with, it would appear to require the use of both associative and analytic modes of thought. Hence product improvement test scores would also be expected to capture individual differences in mode shifting. Evidence for a relationship between product improvement test

scores and MSI measures would support the validity of the MSI as a valid measure of mode shifting.

There are three measures of divergent thinking on the product improvement test: fluency, originality and flexibility. The total fluency score is calculated by adding up all appropriate responses. The total score for originality consists of the total number of responses that are distinct from a set of frequently generated responses listed in the test manual. Also listed in the manual are different categories that responses fall into. For example suggestions for adding bells and adding a squeaker would both fall into the same category of 'adding things that means the toy will make a noise'. The suggestion to give it a removable trunk would fall into a different category. The score for flexibility consists of the total number of different categories that participant's responses fall into.

4.3.2. Coffee cup design task

The reason for including the coffee cup design task was to assess if scores on the K-DOCs dimensions correlated with the functional creativity of designs produced on the task. Functional creativity is a measure of the creativity of a product, in this case a design, which takes account of both the design's novelty and usefulness (Cropley & Kaufman, 2012). It therefore was a measure of actual creative performance against which we could assess the validity of K-DOCs domain scores. Further, its emphasis on measuring both novelty and usefulness means that it may also tap mode shifting.

For this task participants were presented with a brief asking them to solve a problem concerning flaws with a disposable coffee cup and, in the process, come up with their own designs for disposable coffee cups. Participants were presented with a brief together with a set of constraints that designs must adhere to and also a set of criteria previously used by Silvia et al. (2008) to emphasize ways that they could make the designs more creative.

Functional creativity was assessed using a consensual assessment of the creativity of disposable coffee cup designs (Cropley & Kaufman, 2012). Using the revised creative solution diagnosis scale, designs were rated by three independent raters and a single score for functional creativity for each rater obtained from this scale (Cropley & Kaufman, 2012). Cronbach's alpha showed a moderate level of consistency of ratings of functional creativity across raters ($\alpha = .68$), above the required threshold (Amabile, Conti, Coon, Lazenby & Herron, 1996). Participants often produced more than one design for a disposable coffee cup. For each participant we obtained a single score for functional creativity by taking the mean of his or her two most creative designs (See Silvia et al. 2008 for a similar approach).

4.3.3. Mental set task

The mental set task is used to measure set-breaking (Gasper, 2003) and was included in order to further validate if the MSI captures real shifting behaviour. Specifically, strong evidence for the validity of the shifting competence component of the MSI is currently lacking (Pringle & Sowden, under review). The set-breaking task would appear to tap how effectively one's shifting mechanism operates. It has been argued that the mental set task taps a key facet of creativity, namely one's ability to flexibly generate a novel and appropriate alternate strategy when an established 'mental set' strategy has been shown to fail (Gasper, 2003). The mental set task comprises a series of 12 problems. For the first six problems there is only one strategy that can be used to solve the problem. Prior to working on the series of problems participants are presented with an exemplar showing them how to solve the problems using a specific strategy. This exemplar and the first six problems are designed to prime participants into using this strategy with the aim of ensuring they get stuck in a set way of approaching the problems; termed the mental set strategy. Two subsequent problems, numbered seven and eight, can be solved by either the mental set strategy or an alternative strategy, which participants have to discover for themselves. The key aspect of the task for our purposes appears on problem number nine, which cannot be solved by the mental set strategy and instead can only be solved by an alternative strategy. The change from following a rule-based analytic strategy, the mental set strategy, to the need to broaden one's attentional focus to discover a novel problem solving strategy suggests a shift from analytic to associative thinking is required. Thus, this task appears to tap the competence with which one can shift the balance of thinking away from an established analytic strategy to an associative mindset conducive to discovering a new approach. The need to identify when the rule-based strategy has failed may also require metacognitive awareness of shifting (Pringle & Sowden, under review).

4.4. Measures of intelligence, inhibition and working memory

Finally, we also included measures of intelligence, inhibition and working memory. These were included to examine how key cognitive abilities are associated with different components of mode shifting and creativity across different domains. The APT model of creativity categorises intelligence as an initial requirement (Baer & Kaufman, 2005) hence we would expect it to be important and required for creativity across domains. However, previous work has demonstrated that beyond a certain level of intelligence there is no relationship between intelligence and creativity (Runco, 2010). Since our sample consists of university students we may therefore find no association between intelligence and creativity in the present sample. Further, research has suggested a positive relationship between inhibition and creativity

(Carson, Peterson & Higgins, 2003) and between working memory and divergent thinking (Takuechi et al. 2011). The APT however leaves unspecified as to where working memory and inhibition might fit within the hierarchy of the model. Intelligence, inhibition and working memory were measured using the matrix-reasoning subtest from the Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999), the Stroop task (Stroop, 1935) and the Automated Reading span (ARSPAN) task (Unsworth, Heitz, Schrock & Engle, 2005) respectively.

4.5. Hypotheses

In this section we state the series of hypotheses we tested through regression analyses. Prior to listing each hypothesis we explain the reasoning behind the prediction, referring to prior theory and research.

4.5.1. Examining the relationship between mode shifting and creativity across different domains

The Amusement Park theoretical model of creativity suggests that some abilities may be more important to success in some creative domains while other abilities may be more important to success in others (Baer & Kaufman, 2005). While mode shifting would appear to be important across domains for the reasons we argued earlier, certain components of mode shifting may indeed be more important in some domains than others. A tentative rationale for hypotheses was therefore proposed based on differences in the types of abilities that would appear to be important in performing creative acts in different domains.

We predicted that within the mechanical/scientific domain, where established methods of operating would appear deeply entrenched, a strong shift between modes may be required to break away from an entrenched analytic mode of thinking to enter an associate mode conducive to discovering new approaches. For example, items on the mechanical/scientific scale include "writing a computer program" and "helping to carry out or design a scientific experiment" that would appear to require an extended sequence of logical step-by-step activities involving analytic thinking. Specifically, "writing a computer program" presumably draws on a step-by-step sequence of logical coding rules, whilst "helping to carry out or design a scientific experiment", on following a set sequence of rules to establish that the experiment has the required rigour. To produce creative solutions for these activities may therefore require a strong shift from an entrenched analytic sequence of thinking to an associative mode conducive to leaving the 'well-worn path' to discover a new approach. This line of reasoning suggests that the extent to which one is able to shift, that is shifting competence, will predict scores on the K-DOCs mechanical/scientific scale. The hypothesis is summarised as follows:

H1: Shifting competence will positively predict creativity scores on the K -DOCs mechanical/scientific scale.

It is less clear how metacognitive awareness of shifting might be related to mechanical/scientific creativity. It could however be important to be aware of when the analytic mode of thinking is not working. For example when a rule based strategy for computer programming is not working, engaging the associative mode to generate a workaround may help one to reach a solution. Greater metacognitive awareness of shifting should help one to identify the need to shift in situations like this and hence lead to more creative solutions in the mechanical/scientific domain. The hypothesis is summarised as follows:

H2: Metacognitive awareness of shifting will positively predict creativity scores on the K-DOCs mechanical/scientific scale.

Within the domain of artistic creativity, metacognition may be important to monitor the degree to which one's current mode of thinking is functioning correctly so as an optimal point is reached between idea generation and evaluation (Basadur, 1995). For example, in the context of artistic practice it would seem important for one to actively monitor the global progress of an artwork (e.g. a drawing) one is working on and to be aware of which areas of the artwork are going better than others (Fayena-Tawil, Kozbelt & Sitaras, 2011). Applying one's metacognition in this way could enable one to adjust the balance between associative and analytic thinking to be more analytic if there are problems in the global progress of the artwork or problems in certain areas of it are identified. There is also some evidence supporting the importance of metacognition in the artistic domain. Fayena-Tawil, Kozbelt & Sitaras (2011) conducted a study examining the thinking processes of artists and non-artists as they created original drawings, finding that artists evidenced more metacognition concerning monitoring the emerging progress of drawings than non-artists. Greater metacognitive awareness of shifting may have helped the artists in this study maintain an optimal balance between the two different modes of thinking with this being important to producing a creative end product. The hypothesis is summarised as follows:

H3: Metacognitive awareness of shifting will positively predict creativity scores on the K-DOCs artistic scale.

The capacity to shift may still aid the process of actually conducting shifts between different modes of thinking during the creative process in the artistic domain. As such it was tentatively predicted that:

H4: Shifting competence will positively predict creativity scores on the K -DOCs artistic scale.

It was not clear how mode shifting would be associated with creativity in K-DOCs domains other than mechanical/scientific and artistic. The reason for this is that there is no prior research investigating the relationship between mode shifting and domain specific measures of creativity in performance, self/everyday or scholarly domains. Hence no specific predictions were made for performance, self/everyday or scholarly creativity.

The extent to which relationships between mode shifting on the MSI and creativity on the K-DOCs domains differ across professional and everyday contexts depends on whether people do the same activities, as captured by the K-DOCs items, at study or work as they do in their non-study/work time. For example, people studying or working in certain fields that have work specific activities requiring mode shifting, for example designing scientific experiments (Cross, 2011; Dorst & Cross, 2011), may display greater mode shifting in their professional context, that is at study or at work, than they do in their everyday context, that is during their non-study/work time. Previous research has already shown that those studying or working in architecture display greater metacognitive awareness of shifting in their professional context, where mode shifting would appear to be particularly important (Lawson, 1997), compared to their everyday context (Pringle & Sowden, under review). However, the direction of the difference in mode shifting between professional and everyday contexts is difficult to predict because we do not have data concerning the extent to which participants engaged in activities (e.g. designing a scientific experiment) in any of the K-DOCs domains in their everyday *compared to their* professional context. As such we propose the following two non-directional hypotheses:

H5: The relationship between metacognitive awareness of shifting and K-DOCs creativity in each domain will vary as a function of the context in which mode shifting is measured.

H6: The relationship between shifting competence and K-DOCs creativity in each domain will vary as a function of the context in which mode shifting is measured.

4.5.2. Examining the validity of the K-DOCs domains as measures of creativity in the current sample

There is some existing evidence that supports the validity of the five broad K-DOCs domains. Specifically, scores on the five K-DOCs domains have evidenced a profile of correlations with personality factors consistent with prior research examining the relationship between personality and crea-

tivity with domain specific measures of creativity. To summarise, work by Kaufman (2012) showed that, mirroring work by King, Walker, & Broyles (1996), McCrae, (1987) and Silvia, Kaufman, & Pretz (2009), openness positively correlated with all K-DOCs domains other than mechanical/scientific creativity. Consistent with prior research by Kaufman, Cole, & Baer (2009) and Silvia, Kaufman, & Pretz (2009), K-DOCs performance creativity was positively correlated with extraversion (Kaufman, 2012). Finally, similar to Feist (1993) and Silvia, Kaufman, Reiter-Palmon, & Wigert (2011), K-DOCs mechanical/scientific creativity was negatively correlated with agreeableness and like Silvia, Kaufman, & Pretz (2009) was also positively correlated with emotional stability.

This body of evidence suggests the K-DOCs domains are valid measures. However, there is a lack of prior research examining the relationship between K-DOCs domain scores and actual creative performance. While there was a lack of prior research on which to base our predictions we examined the alignment between measures of task based creativity and the K-DOCs items comprising K-DOCs domains in order to make tentative predictions. As argued earlier, the product improvement test requires one to generate novel ideas, that is ways of changing an existing stuffed toy elephant, and ensuring that these ideas also have utility, so that children will have more fun playing with it. The coffee cup design task requires one to generate novel designs for a disposable coffee cup that have utility by way of meeting a set of constraints that designs are required to adhere to.

The creative behaviours captured by certain domains of the K-DOCs would appear similar to the activities one must perform to achieve creative performance on the product improvement test and coffee cup design task. We tentatively predicted relationships between K-DOCs mechanical/ scientific, artistic and scholarly domains with the two task based measures of creative performance for the following reasons.

The K-DOCs mechanical/scientific scale includes items that, like the coffee cup design task, tap design ability such as "helping to carry out or design a scientific experiment" and "building something mechanical (like a robot)". Like the product improvement test the mechanical/scientific scale appears to tap one's ability to both produce something novel that is also useful, specifically a "scientific experiment" or a "computer program". As such we predicted that:

H7: K-DOCs mechanical/scientific domain scores will positively predict functional creativity on the coffee cup design task

H8: K-DOCs mechanical/scientific domain scores will positively predict divergent thinking as indexed by product improvement measures

The K-DOCs artistic scale includes items that tap one's creativity in producing an artwork, for example "drawing a picture of something I've never

actually seen (like an alien)" and "sketching a person or object". The coffee cup design task requires people to draw novel designs for disposable coffee cups on paper so both would appear to tap a similar creative drawing ability to that measured by the K-DOCs artistic scale. The product improvement test requires one to simply list changes one would make to a toy elephant in writing as opposed to drawing those changes. However, research has shown that university students with majors in the fine and performing arts score higher on divergent thinking than non-arts majors (Silvia et al., 2008). Hence we would expect a relationship between the K-DOCs artistic scale and divergent thinking ability. The following predictions were made:

H9: K-DOCs artistic domain scores will positively predict functional creativity on the coffee cup design task.

H10: K-DOCs artistic domain scores will positively predict divergent thinking as indexed by product improvement measures

Kaufman (2012) proposes that the scholarly dimension of the K-DOCs involves "creative analysis" (p. 300). The concept of "creative analysis" is embodied by K-DOCs items that form the scholarly scale such as "figuring out how to integrate critiques and suggestions while revising a work". This item taps one's ability to both analyse and generate ideas and appears similar to the product improvement test instruction to *change an existing stuffed toy elephant so it is more fun for children to play with* and the coffee cup design task instruction to *solve a problem concerning flaws with a disposable coffee cup and, in the process, come up with your own creative designs for disposable coffee cups.* As such we predicted that:

H11: K-DOCs scholarly domain scores will positively predict functional creativity on the coffee cup design task

H12: K-DOCs scholarly domain scores will positively predict divergent thinking as indexed by product improvement measures

4.5.3. Examining the validity of the MSI as a measure of mode shifting in the current sample

We explained earlier the rationale, from a conceptual standpoint, of expecting set breaking to be positively associated with MSI shifting competence and metacognitive awareness of shifting. There is however no previous work that has examined the relationship between mode shifting and set breaking. There is evidence of correlations between skill transfer errors, which resemble the failure to break mental set on Lunchins (1942) mental set problems, and a latent measure of attentional disengagement formed from measures of

attentional switching and inhibition (Woltz, Gardner & Gyll, 2000). These findings lend some evidence to suggest that the mental set task involves attentional flexibility, which, as argued earlier, appears related to mode shifting. There were two measures of set breaking, set breaking *before* and set breaking *after* the set-breaking problem was presented. Gasper (2003) only proposed the latter to be a measure of creative thinking. However, conceptually speaking, both measures would appear to tap mode shifting and there is no reason to expect that the relationships between components of mode shifting will differ across everyday and professional contexts. As such, we made the following predictions:

H13: Metacognitive awareness of shifting will positively predict set breaking both before and after the set-breaking problem is presented

H14: Shifting competence will positively predict set breaking both before and after the set-breaking problem is presented

Finally, since both functional creativity on the coffee cup design task and divergent thinking on the product improvement test would appear to involve mode shifting, we also made the following predictions. Again, there is no reason to expect that the relationships between components of mode shifting will differ across everyday and professional contexts:

H15: Metacognitive awareness of shifting will positively predict the functional creativity of designs on the coffee cup design task

H16: Shifting competence will positively predict the functional creativity of designs on the coffee cup design task

H17: Metacognitive awareness of shifting will positively predict divergent thinking on the product improvement test

H18: Shifting competence will positively predict divergent thinking on the product improvement test

5. Results

Linear regressions were performed to investigate if there were linear relationships between different measures. Linear regressions were only performed between measures that preliminary bivariate correlations revealed were correlated. Marginally significant regressions were those with p value's of $<.10$ but $>.05$ where the power of tests was $< .8$.

5.1. Examining the relationship between mode shifting and creativity across different domains

We ran a set of linear regressions to explore whether the four MSI measures predicted each of the five K-DOCs domains. Linear regressions are reported in table 1.

						Model	
Predictor	Outcome	B	SE	β	*p-value*	R^2	Adjusted R^2
(constant)	K-DOCs mechanical/	-94.71	35.67				
SP Competence	scientific creativity	6.76	2.01	.42**	.001	.18	.16
(constant)	K-DOCs scholarly	-4.36	25.40				
SP Competence	creativity	2.44	1.43	.23	.09	.05	.04
(constant)	K-DOCs performance	6.97	7.58				
SP awareness	creativity	.72	.29	.33*	.02	.11	.09
(constant)	K-DOCs performance	9.14	6.13				
SE awareness	creativity	.64	.23	.36*	.01	.13	.11
(constant)	K-DOCs artistic	11.91	6.00				
SP awareness	creativity	.55	.23	.32*	.02	.10	.09
(constant)	K-DOCs artistic	14.61	4.90				
SE awareness	creativity	.45	.19	.32*	.02	.10	.09
(constant)	K-DOCs self/	39.16	4.40				
SE competence	everyday creativity	.48	.25	.26	.06	.07	.05

***p<.01, p<.05*

N= 54

Table 1: Results of the linear regressions with MSI measures as predictor variables and K-DOCs domains as outcomes

The linear regression with shifting competence in a professional context as the predictor variable and K-DOCs mechanical/scientific creativity as the outcome variable revealed that K-DOCs mechanical/scientific creativity was significantly predicted by SP competence (F (1, 52) = 11.35, p = .001). The unstandardized B and standardized Beta are significantly different from zero (t = 3.37, p= .001). R^2 indicates that 18% of the variance in K-DOCs Mechanical/Scientific creativity was explained by SP competence. A second linear regression with shifting competence in a professional context as the predictor variable and K-DOCs scholarly creativity as the outcome variable

revealed that SP competence was a marginally significant predictor of K-DOCs scholarly creativity (F (1, 52) = 2.91, p = .09). The unstandardized B and standardized Beta are marginally significantly different from zero (t = 1.71, p= .09). R^2 indicates that 5% of the variance in K-DOCs scholarly creativity was explained by SP competence.

A linear regression with metacognitive awareness of shifting in a professional context as the predictor variable and K-DOCs performance creativity as the outcome variable revealed that K-DOCs Performance creativity was significantly predicted by SP awareness (F (1, 52) = 6.24, p = .02). The unstandardized B and standardized Beta are significantly different from zero (t = 2.50, p= .02). R^2 indicates that 11% of the variance in K-DOCs Performance creativity was explained by SP awareness. As was the case in the professional context, K-DOCs performance creativity was also significantly predicted by metacognitive awareness of shifting in the everyday context (F (1, 52) = 7.55, p = .01). The unstandardized B and standardized Beta are significantly different from zero (t = 2.75, p= .01). R^2 indicates that 13% of the variance in K-DOCs Performance creativity was explained by SE awareness.

A linear regression with metacognitive awareness of shifting in a professional context as the predictor variable and K-DOCs artistic creativity as the outcome variable revealed that K-DOCs artistic creativity was significantly predicted by SP awareness (F (1, 52) = 5.89, p = .02). The unstandardized B and standardized Beta are significantly different from zero (t = 2.43, p= .02). R^2 indicates that 10% of the variance in K-DOCs performance creativity was explained by SP awareness. As was the case in the professional context, K-DOCs artistic creativity was also significantly predicted by metacognitive awareness of shifting in the everyday context (F (1, 52) = 5.89, p = .02). The unstandardized B and standardized Beta are significantly different from zero (t = 2.43, p= .02). R^2 indicates that 10% of the variance in K-DOCs performance creativity was explained by SE awareness.

A linear regression with shifting competence in an everyday context as the predictor variable and K-DOCs self/everyday creativity as the outcome variable revealed that SE competence was a marginally significant predictor of K-DOCs self/everyday creativity (F (1, 52) = 3.73, p = .06). The unstandardized B and standardized Beta are marginally significantly different from zero (t = 1.93, p= .06). R^2 indicates that 7% of the variance in K-DOCs performance creativity was explained by SE competence.

Considered as a whole, these findings demonstrate that there is a relationship between mode shifting and creativity and that this relationship holds *across different domains.* Scores on K-DOCs mechanical/scientific creativity were predicted by shifting competence in a professional context. Scores on K-DOCs performance creativity were predicted by metacognitive awareness of shifting reported in both professional and everyday contexts. Similarly, scores on K-DOCs artistic creativity were also predicted by metacognitive awareness of shifting reported in both professional and everyday contexts. Scores on K-DOCs self/everyday creativity were predicted by shifting com-

petence in an everyday context and scores on K-DOCs scholarly creativity were predicted by shifting competence in a professional context, albeit these two findings were only marginally significant. All relationships were positive, with greater metacognitive awareness of shifting or greater shifting competence associated with higher creativity.

It is important to note that different components of mode shifting were associated with creativity in different domains. Namely, shifting competence in a professional context predicted K-DOCs mechanical/scientific creativity and, to a lesser extent, scholarly creativity. Shifting competence in an everyday context predicted K-DOCs self/everyday creativity. Metacognitive awareness of shifting in both professional and everyday contexts predicted creativity in both K-DOCs performance and artistic domains. These findings are discussed further in the discussion section.

5.2. Examining the validity of the K-DOCs domains as measures of creativity in the current sample

It was important to establish the validity of K-DOCs scores as measures of actual creativity in our sample by examining the relationship between participant's K-DOCs domain scores and task based measures of creativity. Linear regressions were run to examine the relationship between K-DOCs domain scores and task based measures of creativity from the product improvement task (Torrance, 1974) and the disposable coffee cup design task (Jansson & Smith, 1991; Chrysikou & Weisberg, 2005) scored using a consensual assessment of the functional creativity of coffee cup designs (Cropley & Kaufman, 2012). K-DOCs domain scores were entered as the predictor variables and task based measures of creativity as the outcomes in linear regressions. Linear regressions are reported in table 2 below.

						Model	
Predictor	Outcome	B	SE	β	*p-value*	R^2	Adjusted R^2
(constant)		2.11	.39				
K-DOCs mechanical/ scientific creativity	Product improvement originality	.03	.01	.28*	.04	.08	.06
(constant)		1.37	.51				
K-DOCs artistic creativity	Product improvement originality	.06	.02	.39**	.004	.15	.14
(constant)		5.47	4.55				
K-DOCs artistic creativity	Product improvement fluency	.34	.17	.27*	.05	.07	.05
(constant)		2.05	.52				
K-DOCs scholarly creativity	Coffee cup design functional creativity	.02	.01	.25	.07	.06	.04

***p<.01, p<.05*
N= 54

Table 2: Results of linear regressions with K-DOCs domain scores as predictor variables and task based measures of creativity as outcomes

A linear regression with K-DOCs mechanical/scientific creativity as the predictor variable and product improvement originality as the outcome variable revealed that product improvement originality was significantly predicted by K-DOCs mechanical/scientific creativity (F (1, 52) = 4.48, p = .04). The unstandardized B and standardized Beta are significantly different from zero (t = 2.12, p= .04). R^2 indicates that 8% of the variance in product improvement originality was explained by K-DOCs mechanical/scientific creativity.

A linear regression with K-DOCs artistic creativity as the predictor variable and product improvement originality as the outcome variable revealed that product improvement originality was significantly predicted by K-DOCs artistic creativity (F (1, 52) = 9.29, p = .004). The unstandardized B and standardized Beta are significantly different from zero (t = 3.05, p= .004). R^2 indicates that 15% of the variance in product improvement originality was explained by K-DOCs artistic creativity. Similarly, a linear regression with K -DOCs artistic creativity as the predictor variable and product improvement fluency as the outcome variable revealed that product improvement fluency was significantly predicted by K-DOCs artistic creativity (F (1, 52) = 3.97, p = .05). The unstandardized B and standardized Beta are significantly different from zero (t = 1.99, p= .05). R^2 indicates that 7% of the variance in product improvement fluency was explained by K-DOCs artistic creativity. Finally, a linear regression with K-DOCs scholarly creativity as the predictor variable and functional creativity on the coffee cup design task as the outcome variable revealed that K-DOCs scholarly creativity was a marginally significant predictor of functional creativity (F (1, 52) = 3.38, p = .07). The unstandardized B and standardized Beta are significantly different from zero (t = 1.84, p= .07). R^2 indicates that 6% of the variance in functional creativity was explained by K-DOCs scholarly creativity.

Regressions revealed positive associations for three out of five K-DOCs domains with scores on measures of creativity. Creativity reported within the K-DOCs mechanical/scientific domain was a significant predictor of product improvement originality. Creativity reported within the K-DOCs artistic domain was a significant predictor of both product improvement originality and fluency scores. K-DOCs scholarly creativity was a marginally significant predictor of the functional creativity of designs produced on the coffee cup design task. There were no significant relationships between task-based measures of creativity and K-DOCs self/everyday or K-DOCs performance creativity. In sum, these findings demonstrate some evidence for the validity of the K-DOCs artistic, mechanical/scientific and, to a lesser extent, scholarly domains as measures of actual creative performance.

5.3. Examining the validity of the MSI as a measure of mode shifting in the current sample

Previous research has provided evidence that the MSI is a valid measure of one's metacognitive awareness of mode shifting (Pringle & Sowden, under review). As stated previously, evidence for the validity of the shifting competence component of mode shifting requires further assessment. In order to address this, we examined whether self-reported shifting competence was associated with a task-based measure of shifting; the mental set task (Gasper, 2003). Regressions were run to examine the relationship between one's tendency to break set on the mental set task and self-reported shifting on the MSI. Only a subset (N = 33) of the full sample was included in these analyses. The reason for this was that only 33 participants had established the mental set in the first place. In order to ensure that participants' had switched strategy and, as we argued earlier, had shifted to a new mode of thought it was crucial that we ensured they were following the rule based mental set strategy in the first place.

A series of Logistic regressions were performed to determine if mode shifting reported on the four MSI components predicted task based mode shifting as indexed by the two measures of set breaking on the mental set task; breaking set *before* and *after* the set breaking problem was presented. Logistic regressions were performed instead of linear regressions as scatterplots suggested that scores on both of the measures of breaking set were not continuous and there was some evidence of homoscedacity. Regressions are presented in table 3.

		Model				95 % CI for Odds ratio	
Predictor	Outcome	β	Wald test	*p-value*	Odds ratio	*Lower*	*Upper*
(constant)	breaking set *after* the set	-39.99	5.11				
SP competence	breaking problem	2.26	5.12*	.02	9.54	1.35	67.35
(constant)	breaking set *after* the set	-2.28	1.13				
SE awareness	breaking problem	.09	1.23	.27	1.10	0.93	1.29
(constant)	breaking set *before* the set	5.57	2.61				
SP awareness	breaking problem	-.25	3.24	.07	.78	0.6	1.02
(constant)	breaking set *before* the set	3.47	3.1				
SE awareness	breaking problem	-.16	2.37	.08	.85	0.7	1.02

N= 33

*$p < .05$

Table 3: Results of logistic regressions with MSI scores as predictor variables and whether set was or was not broken (before or after the set breaking problem) as the dichotomous outcome variable. The p-values reported are those for the Wald test.

A first set of logistic regressions were performed with participants divided to form a dichotomous measure of those who had broken set *after* the set

breaking item and those who had not broken set *after* the set breaking item had been delivered. This outcome variable was entered into two separate logistic regressions, one with SP competence as predictor and the other with SE awareness as a predictor.

A test of the full model with SP competence against a constant only model was statistically significant, $\chi 2$ (1, N =33) = 8.13, p = .004; nagalkerke R^2 = .29, indicating SP competence did successfully distinguish between those evidencing no instances of set breaking *after* the set breaking item and those evidencing at least one instance of set breaking *after* the set breaking item. Prediction success was mixed with 82.4% of the group who demonstrated at least one instance of set breaking being correctly predicted but only 50% of the group demonstrating no instances of set breaking correctly predicted, for an overall success rate of 68%. Table 3 shows the regression coefficient, Wald statistic, odds ratio and its 95% confidence interval. According to the Wald criterion, shifting competence in a professional context predicted set breaking group (z= 5.12, p=.02). A large odds ratio of 9.54 indicated that a one unit increase in the predictor, SP competence, resulted in just over a 9-fold increase in the odds of being a member of the group who demonstrated at least one instance of set breaking *after* the set breaking problem.

A test of the full model with SE awareness against a constant only model failed to reach statistical significance, $\chi 2$ (1, N =33) = 1.30, p = .25; nagalkerke R^2 = .05, indicating SE awareness did not successfully distinguish between those evidencing no instances of set breaking *after* the set breaking item and those evidencing at least one instance of set breaking *after* the set breaking item. Prediction success was poor with 58.8% of the group who demonstrated at least one instance of set breaking being correctly predicted and only 50% of the group demonstrating no instances of set breaking correctly predicted, for an overall success rate of 54.5%. The regression coefficient, Wald statistic, odds ratio and its 95% confidence interval are shown in table 3. According to the Wald criterion, metacognitive awareness of shifting in an everyday context failed to predict set breaking group (z= 1.23, p=.27).

A second set of logistic regressions were performed with participants now divided to form a dichotomous measure of those who had broken set *before* the set breaking item and those who had not broken set *before* the set breaking item had been delivered. This outcome variable was entered into two separate logistic regressions, one with SP awareness as predictor and the other with SE awareness as a predictor.

A test of the full model with SP awareness against a constant only model was statistically significant, $\chi 2$ (1, N =33) = 4.01, p = .05; nagalkerke R^2 = .16, indicating SP awareness did successfully distinguish between those evidencing no set instances of set breaking *before* the set breaking item and those evidencing at least one instance of set breaking *before* the set breaking item. Prediction success was poor with 90.1% of the group who demonstrated no instances of set breaking being correctly predicted but only 9.1% of the group demonstrating at least one instance of set breaking correctly predicted,

for an overall success rate of 63.6%. The regression coefficient, Wald statistic, odds ratio and its 95% confidence interval are shown in table 3. According to the Wald criterion, metacognitive awareness of shifting in a professional context was a marginally significant predictor of set breaking group (z= 3.25, p=.07). A small odds ratio of .78 indicated that a one unit increase in the predictor, SP awareness, resulted in a 22 % increase in the odds of being a member of the group who demonstrated no instances of set breaking *before* the set-breaking problem.

A test of the full model with SE awareness against a constant only model was marginally significant, $\chi 2$ (1, N =33) = 3.57, p = .06; nagalkerke R^2 = .14, suggesting that SE awareness did successfully distinguish between those evidencing no set instances of set breaking and those evidencing at least one instance of set breaking *before* the set breaking problem. Prediction success was poor with 90.9% of the group who demonstrated no instances of set breaking being correctly predicted but only 18.2% of the group demonstrating at least one instance of set breaking correctly predicted, for an overall success rate of 66.7%. The regression coefficient, Wald statistic, odds ratio and its 95% confidence interval are shown in table 3. According to the Wald criterion, metacognitive awareness of shifting in an everyday context was a marginally significant predictor of set breaking group (z= 3.10, p=.08). A small odds ratio of .85 indicated that a one unit increase in the predictor, SE awareness, resulted in a 15% increase in the odds of being a member of the group who demonstrated no instances of set breaking *before* the set-breaking problem.

The analyses with logistic regressions demonstrated that there is only a positive relationship between shifting competence in a professional context and the odds of set breaking *after* the set-breaking problem was presented; that is on problem numbers 10, 11 and 12 when only an alternative to the mental set strategy can be used to solve the problem. Conversely, the logistic regressions with SP awareness and SE awareness suggested a negative relationship between metacognitive awareness of shifting and set breaking *before* the set-breaking problem was presented; that is on problems seven and eight when either the mental set or an alternative strategy can be used to solve the problem. The findings with metacognitive awareness of shifting were however only marginally significant. As such, findings only provide strong support for the hypothesis that shifting competence in a professional context is positively associated with the tendency to break set *after* the set-breaking item.

A final set of linear regressions were performed to examine if MSI components of shifting predicted divergent thinking on the product improvement test. The results of these regressions are displayed in table 4. We did not run linear regressions to examine the relationship between MSI component scores and functional creativity on the coffee cup design task because bivariate correlations failed to reveal any significant relationship between functional creativity and MSI components.

						Model	
Predictor	Outcome	B	SE	β	*p-value*	R^2	Adjusted R^2
(constant)	Product improvement	.69	.88				
SP awareness	originality	.09	.03	.33*	.02	.11	.09
(constant)	Product improvement	.69	.22				
SP awareness	fluency	.02	.01	.25	.07	.06	.04

***p<.01, p<.05*

N= 54

Table 4: Results of linear regressions with MSI scores as predictor variables and product improvement measures as outcome variables

The linear regression with metacognitive awareness of shifting in a professional context as the predictor variable and product improvement originality as the outcome variable revealed that product improvement originality was significantly predicted by SP awareness (F (1, 52) = 6.34, p = .02). The regression coefficient and its standard error, standardized beta and the values of R^2 and adjusted R^2 are shown in table 4. The unstandardized B and standardized Beta are significantly different from zero (t = 2.52, p= .02). R^2 indicates that 11% of the variance in Product improvement originality was explained by SP awareness.

The linear regression with metacognitive awareness of shifting in a professional context as the predictor variable and fluency as the outcome variable revealed that SP awareness was a marginally significant predictor of product improvement fluency (F (1, 52) = 3.41, p = .07). Table 4 shows the regression coefficient and its standard error, standardized beta and the values of R^2 and adjusted R^2. The unstandardized B and standardized Beta are marginally significantly different from zero (t = 3.10, p= .07). R^2 indicates that 6% of the variance in Product improvement fluency was explained by SP awareness. SP competence failed to significantly predict Product improvement originality (F (1, 52) = 2.82, p = .10).

In summary, there was support for the prediction that metacognitive awareness of shifting would positively predict product improvement originality and, to a lesser extent, fluency scores. This was a context specific effect, found only for metacognitive awareness of shifting in a professional not within an everyday context. We failed to find support for the prediction that there would be a positive relationship between shifting competence and divergent thinking on the product improvement test or for the hypothesized positive relationship between MSI components and functional creativity.

5.4. Latent abilities/tendencies that overlap between creativity and mode shifting across different domains

The analyses conducted on the data up to this point have only examined relationships between pairs of measures in order to test hypothesized relationships between mode shifting and creativity or between the K-DOCs, MSI and task based measures of creativity and mode shifting respectively. A different but complementary approach is to conduct exploratory analyses of how performance on different measures of mode shifting (from the MSI and mental set task) and creativity (from the K-DOCs, product improvement test and the coffee cup design task) together with scores on the additional measures of IQ, working memory and inhibition cluster together. An advantage of exploring which variables cluster together is that this approach is free of a priori assumptions concerning the nature of the relationships expected. It thus complements the previous analysis using regressions where we tested a priori hypotheses and specifically, helps us understand the latent abilities/tendencies that overlap between creativity and mode shifting across different domains.

Two different forms of analyses were performed in order to examine how scores on different measures cluster together. In light of the present study's relatively small sample size a regularized exploratory factor analysis (REFA) was run to examine which measures load on to the same factors. This has been recommended as an alternative to principal components analysis with small sample sizes similar to those in the present study (Jung & Lee, 2011). A hierarchical cluster analysis was also performed to examine which measures cluster together. If a similar structure is revealed across these two different methods then that would strengthen the argument that measures that cluster together are tapping similar latent abilities/tendencies.

The REFA was run in MATLAB using code developed by Jung & Lee (2011). Running REFA based on this code resulted in six factors being extracted based on the Kaiser criterion. The regularization scheme used for the REFA was based on the anti-image assumption since it was not clear that unique variances were constant across items (S.Jung, personal communication, November 28, 2013; Jung & Lee, 2011; Konecna, Weiss, Lhota & Wallner, 2012). These factors were subjected to an oblique (geomin) rotation. In accordance with the recommendations of Jung & Lee (2011) loadings equal to and above .35 were defined as salient loadings. These are displayed in table 5. For measures loading on multiple factors we based our interpretation only on the factor on which the measure loaded highest.

		Regularized exploratory factor analysis					
Measure	Component of Measure	1	2	3	4	5	6
MSI	1. SP awareness	-.80					
	2. SE awareness	-.85	.37				
	3. SP competence			.57			
	4. SE competence	-.56					
K-DOCS dimension	5. Self/Everyday				.69		
	6. Scholarly				.70		
	7. Performance	-.54					-.36
	8. Mechanical/Scientific			.57			
	9. Artistic	-.51					-.50
Product Improvement	10. Fluency		-.94				
	11. Originality		-.90				
	12. Flexibility		-.49				
Coffee cup design	13. Functional creativity of designs				-.38		
Mental set task	14. Proportion of times broke set *before* set breaking item					-.73	
	15. Proportion of times broke set *after* set breaking item			.57		-.56	
Working memory	14. RSPAN total correct			.56			
Non-verbal IQ	15. WASI matrix reasoning T score				.38		-.46
Inhibition	16. Stroop						-.62

Table 5: Regularized exploratory factor analysis run on the full sample (N=54) with the 16 measures as items. Only loadings >.35 are displayed.

Metacognitive awareness in both everyday and professional contexts, shifting competence in an everyday context, K-DOCs performance and artistic creativity loaded onto factor one, suggesting that these measures tap similar latent abilities. Metacognitive awareness in both everyday and professional contexts were the highest loading components on this factor so it was labelled 'metacognitive awareness of shifting involved in performance and artistic creativity'. Unsurprisingly, the three product improvement test measures loaded onto factor two so this factor was simply labelled 'product improvement creativity'. Factor three showed that the same latent abilities underlie shifting competence in the professional context, mechanical/scientific creativity, proportion of times breaking set *after* the set breaking item and working memory as measured by the RSPAN total correct measure. All items loaded to a similarly high degree on this factor so it was termed 'shifting competence in a professional context, working memory and set breaking *after* the set breaking item related to mechanical/scientific creativity'. No MSI measures of mode shifting loaded onto factor four but it did show that similar latent abilities underlie self/everyday, scholarly and the functional creativity of designs. The highest loading items on this factor were scholarly and self/everyday creativity and hence it was labelled 'the overlap between scholarly and self/everyday creativity related to functional creativity'. Unsurprisingly factor five demonstrated that similar latent abilities underlie set breaking *before* and *after* the set breaking item. This factor was thus labelled 'set breaking'. Finally, no MSI measures of mode shifting loaded onto factor six but it showed that similar latent abilities underlie inhibition and intelligence. The

highest loading item on factor six was inhibition so this factor was labelled 'inhibition and intelligence'.

A hierarchical cluster analysis was performed with measures as cases and the participants as variables. Scores on each measure were z-scored to overcome scaling differences between variables and the method of complete linkage, also known as furthest neighbour, was employed. The use of complete linkage avoided degenerating solutions being produced (C. Fife-Schaw, personal communication, June 2013). It also can be used when clusters are of different sizes as was clearly the case here (Everitt, Landau, Leese & Stahl, 2011). The dendrogram based on complete linkage is shown in figure 1 below.

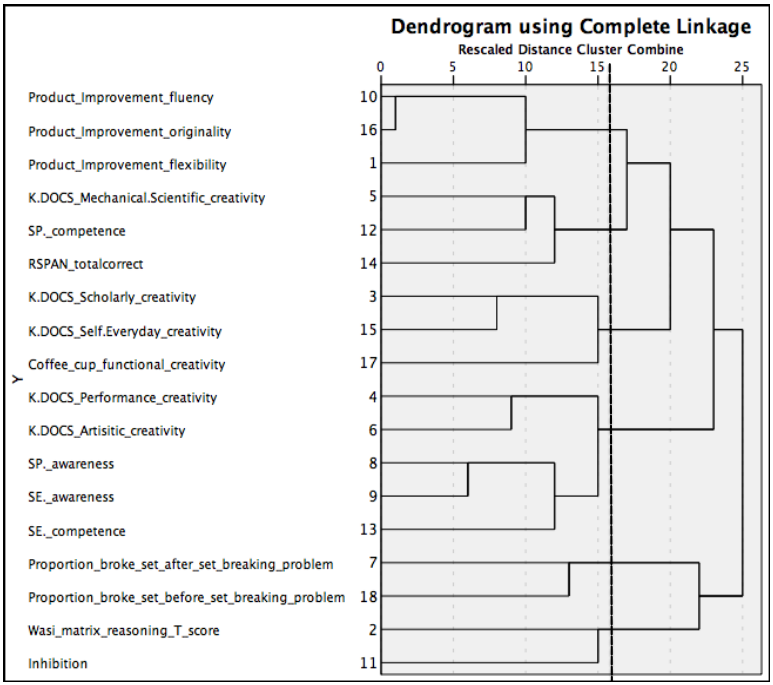


Figure 1: Cluster analysis of the 16 measures. The proposed "cut" of the dendrogram is indicated by the dashed line.

As can be seen from table 5 and figure 1, both the REFA and cluster analyses revealed six factors/clusters of measures. A similar factor/cluster structure was revealed using the two different methods. Specifically, the REFA revealed that metacognitive awareness of shifting in both a professional and everyday context, shifting competence in an everyday context and K-DOCs artistic and performance creativity all loaded onto one factor; factor one in table 5. A cluster with the exact same measures was also revealed by the cluster analysis. The REFA also revealed a factor, factor number three in

table 5, with salient loadings for shifting competence in a professional context, K-DOCs mechanical creativity, working memory, as indexed by the RSPAN total correct measure, and the proportion of times participants broke set *after* the set breaking item on the mental set task. The cluster analysis revealed a cluster with the same set of measures minus the measure of the proportion of times participants broke set *after* the set breaking item on the mental set task.

We were primarily interested in the two factors/clusters mentioned above because they contained our primary measures of interest, MSI mode shifting and K-DOCs creativity domain scores, and because they were also similar across REFA and cluster analyses. However we also briefly mention the other factors/clusters that were found. The REFA and cluster analyses both revealed a factor/cluster with K-DOCs self/everyday creativity, scholarly creativity and the functional creativity of designs from the coffee cup design task. The REFA but not the cluster analysis revealed that intelligence, as measured by WASI matrix reasoning T scores, was also a part of this grouping. Both the REFA and cluster analyses revealed a factor/cluster with the three different product improvement scores. The REFA revealed that metacognitive awareness of shifting in an everyday context was also part of this grouping. The final cluster revealed by both analyses included intelligence and inhibition. The REFA also revealed that K-DOCs artistic and performance creativity was also part of this grouping.

Returning to the two factors/clusters that we were primarily interested in, it was interesting to note that creativity in the K-DOCs domains of art and performance and three components of the MSI (metacognitive awareness of shifting in both a professional and everyday context, shifting competence in an everyday context) loaded onto one factor/cluster while creativity in the K-DOCs mechanical/scientific domain and MSI shifting competence in a *professional* context, together with working memory, loaded onto another. These findings complement those obtained from the analyses of correlations and regressions. Specifically they suggest that the latent abilities/tendencies involved in metacognitive awareness of shifting in both professional and everyday contexts and shifting competence in the everyday context overlap with those required to be creative in artistic and performance domains. In contrast, the latent abilities/tendencies involved in shifting competence in the professional context and also working memory overlap with those required to be creative in the mechanical/scientific domain.

6. Discussion

6.1. Summary of the key findings

We found evidence to support the hypothesis that there is a positive relationship between mode shifting and creativity. These findings are in accordance with those found in prior research on creativity and mode shifting that

employed domain-general measures of creativity (Vartanian, 2009; Vartanian, Martindale & Kwiatowksi, 2007; Dorfman, Martindale, Gassimova & Vartanian, 2008). Further, the current findings are the first we know of that demonstrate a positive relationship between mode shifting and creativity *across different domains.* Specifically, relationships between mode shifting and creativity were evidenced in the domains of mechanical/scientific, performance and artistic creativity as measured by the Kaufman domains of creativity scale (K-DOCs). There was also some evidence of a relationship between mode shifting and creativity in the scholarly and self/everyday domains, albeit the evidence for these relationships was weaker.

Importantly, findings revealed that the relationship between mode shifting and creativity within each domain hinged on the component of mode shifting being measured by the Mode Shifting Index (MSI). Different components of mode shifting were associated with creativity in different domains. Metacognitive awareness of shifting was positively associated with K-DOCs creativity in performance and artistic domains. In contrast, shifting competence was positively associated with K-DOCs creativity in mechanical/scientific, scholarly and self/everyday domains. In some cases these relationships were also dependent on the context in which mode shifting was reported. Specifically, only shifting competence in one's *professional context* was associated with creativity in mechanical/scientific and scholarly domains and only shifting competence in one's *everyday context* was associated with self/everyday creativity. In contrast, metacognitive awareness of shifting in both one's *professional and everyday* context was associated with K-DOCs artistic and performance creativity. The REFA and cluster analyses revealed that similar latent abilities underlie working memory, shifting competence in one's *professional context* and K-DOCs mechanical/scientific creativity.

6.2. Are the K-DOCs and MSI valid measures of creativity and mode shifting respectively?

Three out of the five K-DOCs domains that we expected to be valid measures of actual creative performance did indeed demonstrate evidence of validity. Specifically, creativity in the mechanical/scientific domain was positively associated with the originality of solutions generated on the product improvement divergent thinking task, creativity in the artistic domain was positively associated with both product improvement originality and fluency and scholarly creativity was positively associated with the functional creativity of designs produced on the coffee cup design task, albeit this last association was less strong. In sum, artistic, mechanical/scientific and, to a lesser extent, scholarly domains of the K-DOCs demonstrate validity as measures of actual creative performance on the measures used in the present study.

The Mode Shifting Index (MSI) also demonstrated validity as a measure of mode shifting. Specifically, shifting competence was positively associated

with the odds of breaking set *after* the set-breaking problem was presented. However, the positive association between shifting competence and set breaking only held true for shifting competence reported in the professional and not the everyday context. Further, there was no relationship between shifting competence and set breaking *before* the set-breaking problem was presented. In direct contrast to our predictions, the metacognitive awareness component of the MSI actually demonstrated a negative relationship with set breaking *before* the set-breaking problem, albeit this effect was relatively weak. Metacognitive awareness of shifting did demonstrate a positive relationship with divergent thinking on the product improvement task. This finding supports our prediction that divergent thinking involves mode shifting, and is another source of evidence for the validity of the MSI as a measure of mode shifting. This was a context specific effect, found only for metacognitive awareness of shifting in a professional and not within an everyday context. We failed to find any support for the hypothesised relationship between shifting competence and divergent thinking on the product improvement test. We also failed to find any support for our prediction that MSI scores would index the mode shifting we expected to be required on the coffee cup design task, with functional creativity on this task unrelated to any MSI mode shifting components.

In sum, MSI shifting competence in a professional context did demonstrate validity as a measure of real life mode shifting and there was indirect evidence, by way of the positive relationship with product improvement divergent thinking, that metacognitive awareness of shifting in a professional context was also a valid measure of mode shifting. These findings build on previous work demonstrating the MSI to be a valid measure (Pringle & Sowden, under review) and in particular strengthen the case for the validity of the shifting competence component.

6.3. Is mode shifting a domain-general or domain specific creative thinking skill?

As we argued in section 3, from a theoretical standpoint mode shifting would appear be to a domain-general thinking skill, important for creativity across domains. Our findings showing that there is at least some relationship between at least one component of mode shifting and creativity in all five K-DOCs domains appears to provide support for the position that mode shifting is a domain general creative thinking skill. However, when you examine the relationship between creativity and mode shifting at the more fine-grained level of the individual MSI components, a more complex picture emerges. The relationships between MSI components of mode shifting and creativity in different K-DOCs domains are summarised in figure 2.

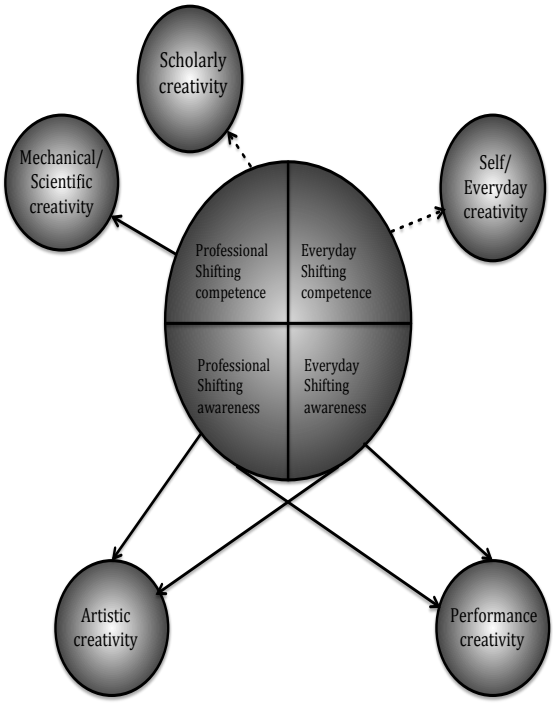


Figure 2: A conceptual diagram of the relationship between the four components of mode shifting measured by the MSI and the five domains of creativity measured by the K-DOCs. The solid arrows represent significant linear regressions between the measures. The dashed arrows represent marginally significant linear regressions between the measures.

Metacognitive awareness of shifting, simply termed 'shifting awareness' in figure 2, is the only component associated with creativity in artistic and performance domains and shifting competence is the only component associated with creativity in mechanical/scientific and scholarly domains. These findings suggest a divide between the arts and the sciences, with metacognitive awareness more important for creativity in the former and shifting competence more important for creativity in the latter. Of course the individual K -DOCs items for scholarly creativity would appear to encompass activities in not just the sciences but also in other academic areas such as the humanities and other industries such as journalism.

The distinction between the arts and the sciences is however interesting as it may help us to understand why different components of shifting were associated with creativity in different domains. Specifically, in the sciences there would appear to be a need to shift from an established way of doing things, supported by the analytic mode of thinking, to a more associative mode to discover a novel solution to a problem. For example, Items on the

mechanical/scientific domain of the K-DOCs such as 'writing a computer program' may involve following a series of established steps to write the programming code but at points, one has to break away from these entrenched ways of working to develop novel strategies such as a workaround to overcome problems that one has never encountered before. Shifting competence may capture how good one is at breaking away from an established method to adopt a novel strategy to solve an impasse. This is exactly what the measure of set-breaking *after* the set breaking problem on the mental set task measures. On this task the set-breaking problem induces the impasse and the participant is required to generate a novel workaround. It makes sense then that the ability to generate novel solutions after this impasse, as measured by set breaking *after* the set-breaking item, was related to both shifting competence and mechanical/scientific creativity. The ability to break away from an entrenched established way of working might require a strong shift. This strong shift may tap the effectiveness with which one's shifting mechanism, as indexed by shifting competence, can alter the balance of thinking to be more associative.

In contrast, in the arts people may be less entrenched at any time in one mode of thinking or another and, as such, one's competence in shifting out of one entrenched mode of thought and into another may be less important. Previous findings showing that artists demonstrated more metacognition in monitoring the emerging progress of their drawings than non-artists (Fayena-Tawil, Kozbelt & Sitaras, 2011) are consistent with ours that show a positive relationship between metacognitive awareness of shifting and artistic creativity. Metacognitive awareness of shifting may be more important than shifting competence in the arts and used to monitor and make subtle adjustments in order to keep an optimal balance between the use of the two modes of thought.

Whether or not mode shifting is conceived as a domain-general or domain-specific creative thinking skill depends on how broadly mode shifting itself is conceived. Considered as one single entity, mode shifting appears important for creativity across all domains. However when viewed as a series of distinct inter-related components, the relationship between mode shifting and creativity appears more domain specific, with a differentiation between the skills required in the arts versus the sciences.

6.4. Theoretical implications of taking a domain-general or domain-specific view of mode shifting

The present findings shed light on where mode shifting fits in the hierarchy of the amusement park theoretical (APT) model of creativity. Mode shifting appears to fit best in the APT model at the level of the general thematic areas of the arts and science, with metacognitive awareness of shifting in the arts area and shifting competence in the science area. There are a num-

ber of reasons why this distinction is important. Firstly, future empirical studies that aim to examine the relationship between mode shifting and creativity should focus on choosing measures most likely to capture mode shifting in the study's creative domain of interest. Measures that tap one's competence shifting would seem better suited to capturing mode shifting that impacts on creativity in science while measures that tap one's metacognitive awareness of mode shifting would seem better suited to capturing mode shifting that impacts on creativity in the arts. If one takes a domain-general view of mode shifting then one may end up unknowingly selecting the wrong measures, for example measures of shifting competence, which on the basis of the present findings would fail to show a relationship with creativity in the artistic domain. Furthermore, research using neuroscientific methods to study mode shifting may gain clearer results by measuring mode shifting at the more fine-grained level of its individual components. A similar point has previously been made by Dietrich (2004) with respect to the neuroscientific study of divergent thinking.

Finally, it is also important to highlight that the context in which the MSI component of shifting competence was measured in, professional or everyday, impacted on whether a relationship between mode shifting and creativity was found. The APT model of creativity doesn't currently account for the importance of context. The related construct of environment is listed as an initial requirement, that is one must be operating in an environment conducive to creativity to be able to express it (Baer & Kaufman, 2005). However, our findings demonstrate that context should be included further down the hierarchical model, interacting with the shifting competence component of mode shifting.

Clearly, research such as that reported in the present work which disentangles the different processes involved in mode shifting and creativity, together with the impact of context, may help us better understand why mode shifting benefits creativity in different domains (Baer & Kaufman, 2005).

6.5. Practical implications of taking a domain-general or domain -specific view of mode shifting

The most obvious areas that present findings appear to have implications for is in creativity training and educational practice. It has previously been argued that "creativity training programs tend to assume (either implicitly or explicitly) that creativity is a general skill or set of skills that can be applied in any domain to help solve any problem more creatively" (p. 159, Baer & Kaufman, 2005). However this approach is ineffective with evidence that creativity training on one task often fails to transfer to other tasks, even within the same domain (Baer, 1996). It has previously been argued that teaching strategies could be designed giving students practice at shifting between the different modes of thought so they can learn how to freely shift (Howard-

Jones, 2002). Taking a domain-specific view of mode shifting and closely matching the component of mode shifting with the activities required within a given domain should help one to develop an effective program that targets the specific component of mode shifting useful for creative thinking in the given domain. For example, practice at strengthening one's shifting mechanism to allow it to perform a strong shift to a more associative mode from an entrenched analytic mode of thinking may be important for unlocking one's creativity in the mechanical/scientific domain. In contrast, practice in applying one's metacognitive awareness of shifting to better identify when it is best to adjust the balance between associative and analytic modes of thinking may be important for aiding one's creativity in the artistic domain. In sum, taking a domain-specific view of mode shifting would appear beneficial for training people in creative thinking skills. Furthermore taking a domain-specific approach doesn't preclude one from choosing a creative thinking skill that can benefit one's creativity across different domains. Metacognitive awareness of shifting was associated with creativity in both artistic and performance domains, suggesting training one in this skill would benefit creativity in both.

6.6. Limitations and future research

It is important to note that the present findings only demonstrate *a predictive relationship* between mode shifting and creativity across different domains. Future research should go further and look for indicators of mode shifting during the creative process to examine how mode shifting impacts on the products produced at the end of that process within different domains. For example, researchers could employ think-aloud protocols or ERP's to identify such indicators and examine mode shifting as the creative process unfolds (Sowden, Pringle & Gabora, 2015). While the majority of the effects found were in line with those predicted, it was surprising to find a lack of an association between MSI mode shifting components and functional creativity on the coffee cup design task. This was particularly surprising given previous findings have shown elevated mode shifting in a group studying/working in the design discipline of architecture (Pringle & Sowden, under review). It could simply be that the measure of functional creativity didn't tap design creativity in this case; it may instead better capture "creative analysis" or self/everyday creativity as demonstrated by its association with scholarly creativity and also self-everyday creativity in the factor analysis. Future research is needed to examine if measures of mode shifting are associated with genuine design creativity. The findings showing similar latent abilities underlie working memory, shifting competence in one's *professional context* and K-DOCs mechanical/scientific creativity suggests a role for working memory in mode shifting. It is at present unclear what this role is and further research is required in order to examine the role of working memory in the link between

shifting competence in one's *professional context* and K-DOCs mechanical/ scientific creativity.

6.7. Conclusions

The purpose of this chapter was to examine if shifting between modes of thought, termed 'mode shifting' for short, is a domain general thinking skill important for creativity across multiple domains. The findings of the present work do indeed demonstrate a relationship between mode shifting, as assessed by the mode shifting inventory (MSI) (Pringle & Sowden, under review) and creativity *across different domains*, as assessed by the Kaufman domains of creativity scale (K-DOCs). However, when the relationship between creativity and mode shifting was examined at the more fine-grained level of the individual MSI components, a more complex picture emerged. Different components of mode shifting were associated with creativity in different domains, with shifting competence associated with mechanical/ scientific creativity and metacognitive awareness of shifting associated with artistic and performance creativity. We argue that mode shifting fits into the amusement park theoretical model of creativity at the level of the general thematic areas, with a distinction between the component of mode shifting more important in science, that is shifting competence, and the component of mode shifting more important in the arts, metacognitive awareness of shifting. This distinction is important both for informing future research examining the relationship between mode shifting and creativity and for the design of creativity training programs, that should focus on fostering the operation of the specific component of mode shifting important for creativity in a given domain.

Acknowledgments

We would like to express our gratitude to Matthew Peacock and Adam Pedley for their help with rating the functional creativity of disposable coffee cup designs.

References

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal, 39* (5), 1154-1184.

Baer, J., & Kaufman, J. C. (2005). Bridging generality and specificity: The amusement park theoretical (APT) model of creativity. *Roeper Review, 27 (3),* 158-163.

Baer, J. (1996). The effects of task-specific divergent-thinking training. *Journal of Creative Behavior*, *30*, 183-187.

Baer. J. (1997). Creative teachers, creative students. Boston: Allyn and Bacon.

Baer, J. (1998). The case for domain specificity in creativity. *Creativity Research Journal*,*11*, 173-177.

Barbot, B. & Tinio, P.L. (2014). Where is the "g" in creativity? A specialization–differentiation hypothesis. *Frontiers in Human Neuroscience*, *8*, 1041.

Basadur, M. (1995). Optimal ideation-evaluation ratios. *Creativity Research Journal, 8 (1),* 63-75.

Carson, S. H., Peterson, J. B., & Higgins, D. M. (2003). Decreased latent inhibition is associated with increased creative achievement in high-functioning individuals. *Journal of Personality and Social Psychology, 85 (3),* 499-506.

Chrysikou, E. G., & Weisberg, R. W. (2005). Following the wrong footsteps: Fixation effects of pictorial examples in a design problem-solving task. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 31 (5),* 1134-1148.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences.* NY, USA: Routledge.

Cropley, D. H., & Kaufman, J. C. (2012). Measuring functional creativity: non-expert raters and the creative solution diagnosis scale. *The Journal of Creative Behavior, 46 (2),* 119-137.

Cross, N. (2011). *Design thinking: Understanding how designers think and work.* NY, USA: Berg.

Dietrich, A. (2004). The cognitive neuroscience of creativity. *Psychonomic Bulletin & Review, 11 (6),* 1011-1026.

Dorfman, L., Martindale, C., Gassimova, V., & Vartanian, O. (2008). Creativity and speed of information processing: A double dissociation involving elementary versus inhibitory cognitive tasks. *Personality and Individual Differences, 44 (6),* 1382-1390.

Dorst, K., & Cross, N. (2001). Creativity in the design process: co-evolution of problem–solution. *Design Studies, 22 (5),* 425–437.

Everitt, B. (1977). *The analysis of contingency tables*. London, UK: Chapman and Hall.

Fayena-Tawil, F., Kozbelt, A., & Sitaras, L. (2011). Think global, act local: A protocol analysis comparison of artists' and non-artists' cognitions, metacognitions, and evaluations while drawing. *Psychology of Aesthetics, Creativity, and the Arts, 5 (2),* 135-145.

Feist, G. J. (1993). A structural model of scientific eminence. *Psychological Science*, *4*, 366–371.

Gabora, L. (2005). Creative thought as a non-Darwinian evolutionary process. *Journal of Creative Behavior, 39*, 262–283.

Gabora, L. (2010). Revenge of the "neurds": Characterizing creative thought in terms of the structure and dynamics of memory. *Creativity Research Journal, 22 (1)*, 1-13.

Gabora, L. & Ranjan, A. (2013). How insight emerges in a distributed, content addressable memory. In A. Bristol, O. Vartanian & J. C. Kaufman (Eds.), *The neuroscience of creativity* (pp. 19-44). NY: Oxford University Press.

Gasper, K. (2003). When necessity is the mother of invention: Mood and problem solving. *Journal of Experimental Social Psychology, 39 (3)*, 248-262.

Howard-Jones, P. A. (2002). A dual-state model of creative cognition for supporting strategies that foster creativity in the classroom. *International Journal of Technology and Design Education, 12 (3),* 215-226.

Jansson, D. G., & Smith, S. M. (1991). Design fixation. *Design Studies, 12* (1), 3-11.

Jung, S., & Lee, S. (2011). Exploratory factor analysis for small samples. *Behavior Research Methods, 43 (3),* 701-709.

Kaufman, J.C. (2009). *Creativity 101.* NY: Springer.

Kaufman, J. C. (2012). Counting the muses: Development of the Kaufman domains of creativity scale (K-DOCS). *Psychology of Aesthetics, Creativity, and the Arts, 6 (4),* 298-308.

Kaufman, S. B. (2011). Intelligence and the cognitive unconscious. In R. J. Sternberg & S. B. Kaufman (Ed's), *The Cambridge Handbook of Intelligence* (pp. 442-467). Cambridge, UK: Cambridge University Press.

Kaufman, J. C., Cole, J. C., & Baer, J. (2009). The construct of creativity: a structural model for self-reported creativity ratings. *Journal of Creative Behavior, 43,* 119–134.

King, L. A., Walker, L. M., & Broyles, S. J. (1996). Creativity and the five-factor model. *Journal of Research in Personality, 30,* 189–203.

Konečná, M., Weiss, A., Lhota, S., & Wallner, B. (2012). Personality in barbary macaques (macaca sylvanus): Temporal stability and social rank. *Journal of Research in Personality, 46 (5),* 581-590.

Lawson, B. (1997). *How designers think: The design process demystified.* Oxford, UK: Architectural Press.

Lunchins, A. S. (1942). Mechanization in problem solving: The effect of einstellung. *Psychological Monographs, 54* (6), i-95.

Martindale, C. (1999). Biological bases of creativity. In R. J. Sternberg (Ed.), *Handbook of creativity* (pp. 137–152). New York, NY: Cambridge University Press.

McCrae, R. R. (1987). Creativity, divergent thinking, and openness to experience. *Journal of Personality and Social Psychology, 52*, 1258–1265.

Mednick, S. (1962). The associative basis of the creative process. *Psychological Review*, *69 (3),* 220-232.

Plucker, J. A. (1999). Is the proof in the pudding? Reanalyses of Torrance's (1958 to Present) longitudinal data. *Creativity Research Journal, 12,* 103-114.

Plucker, J. A., Beghetto, R. A., & Dow, G. T. (2004). Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research. *Educational Psychologist, 39 (2),* 83-96.

Pringle, A., Sowden, P.T. (under review). The Mode Shifting Index (MSI): A new measure of the creative thinking skill of shifting between associative and analytic thinking. *Thinking Skills & Creativity*.

Runco, M. A. (2010). Divergent thinking, creativity, and ideation. In J. C. Kaufman & R.J. Sternberg (Eds.), *The Cambridge Handbook of Creativity* (pp. 414-446). Cambridge, UK: Cambridge University Press.

Schraw, G., Dunkle, M.E. & Bendixen, L.D. (1995). Cognitive processes in well-defined and ill-defined problem solving. *Applied cognitive psychology, 9,* 523-538.

Silvia, P. J., Winterstein, B. P., Willse, J. T., Barona, C. M., Cram, J. T., Hess, K. I., Martinez, J.L., Richard, C. A. (2008). Assessing creativity with divergent thinking tasks: Exploring the reliability and validity of new subjective scoring methods. *Psychology of Aesthetics, Creativity, and the Arts, 2 (2),* 68-85.

Silvia, P. J., Kaufman, J. C., & Pretz, J. E. (2009). Is creativity domain specific? Latent class models of creative accomplishments and creative self-descriptions. *Psychology of Aesthetics, Creativity, and the Arts*, *3*,139–148.

Silvia, P. J., Kaufman, J. C., Reiter-Palmon, R., & Wigert, B. (2011). Cantankerous creativity: Honesty-humility, agreeableness, and the HEXACO structure of creative achievement. *Personality and Individual Differences, 51,* 687–689.

Sowden, P. T., Pringle, A., & Gabora, L. (2015). The shifting sands of creative thinking: Connections to dual process theory. *Thinking & Reasoning, 21,* 40-60.

Stroop, J. R. (1935). Studies of interference in serial verbal reactions. *Journal of Experimental Psychology*, *18*, 643-662.

Takeuchi, H., Taki, Y., Hashizume, H., Sassa, Y., Nagase, T., Nouchi, R., & Kawashima, R. (2011). Failing to deactivate: The association between brain activity during a working memory task and creativity. *Neuroimage, 55 (2),* 681-687.

Tanner, D. & Reisman, F. (2014). *Creativity as a bridge between education and industry fostering new innovations*. NY, USA: CreateSpace.

Torrance, E. P. (1974). *The Torrance Tests of Creative Thinking. Norms technical manual research edition-verbal tests, forms A and B; figural tests, forms A and B.* Princeton, NJ: Personnel Press.

Unsworth, N., Heitz, R. P., Schrock, J. C., & Engle, R. W. (2005). An automated version of the operation span task. *Behavior Research Methods*, *37 (3),* 498-505.

Vartanian, O. (2009). Variable attention facilitates creative problem solving. *Psychology of Aesthetics, Creativity, and the Arts, 3 (1),* 57-59.

Vartanian, O., Martindale, C., & Kwiatkowski, J. (2007). Creative potential, attention, and speed of information processing. *Personality and Individual Differences, 43 (6),* 1470-1480.

Ward, T. B., & Kolomyts, Y. (2010). Cognition and creativity. In J. C. Kaufman & R. J. Sternberg (Eds.), *The Cambridge handbook of creativity* (pp. 93–112). NY: Cambridge University Press.

Wechsler, D. (1999). *Wechsler abbreviated scale of intelligence manual*. San Antonio, TX: The Psychological Corporation.

Woltz, D. J., Gardner, M. K., & Gyll, S. P. (2000). The role of attention processes in near transfer of cognitive skills. *Learning and Individual Differences, 12 (3),* 209-251.

Correspondence

Dr. Andrew Pringle
University College Dublin
Ireland
Email: andrew.pringle@ucd.ie

Dr. Paul T. Sowden
University of Surrey
United Kingdom
Email: p.sowden@surrey.ac.uk

Carys Deeley
University of Surrey
United Kingdom

Sarika Sharma
University of Reading
United Kingdom

Authors' Brief Bios

Andrew Pringle is a post-doctoral researcher in cognitive psychology at the Insight Centre for Data Analytics, University College Dublin. His research examines the psychological processes underpinning creative thought, with his PhD thesis in this area. He is also interested and researches the potential of games as a tool to examine cognition and behaviour.

Paul Sowden is Head of the Department of Psychological Sciences at the University of Surrey and Director of the ILLUME Creativity Research Network. His research explores the cognitive and affective mechanisms underlying creative thinking and methods of intervening to enhance the creative process.

Carys Deeley is a final year undergraduate student studying for a degree in Psychology at the University of Surrey.

Sarika Sharma is a final year undergraduate student studying for a degree in Psychology at the University of Reading.

CHAPTER ELEVEN

ALIGNMENT OF CREATIVITY TOOLS AND TECHNIQUES WITH THEORY AND RESEARCH

JONAN DONALDSON

Abstract

The purpose of this study was to map popular creativity tools and techniques according to diverse areas of creativity research and theory. To this end, an integrative literature review was conducted which resulted in a conceptual model which encompasses the diversity of research theory and research. This study demonstrated that mapping creativity tools and techniques to theory and research is possible. It also found that creativity tools and techniques dominantly address particular areas, and that there is potential for development of creativity tools and techniques in other areas.

Keywords: Creativity tools, creativity techniques, creativity research, alignment, literature review, conceptual model

Introduction

Creativity has been a topic of increasing interest in the public imagination over the last half century, with the intensity of interest growing rapidly since the era of Silicon Valley startup companies bringing terms such as "fail often, fail fast" and "rapid prototyping" to our collective consciousness. A natural consequence of this increased interest in creativity is the growth of a creativity industry with consultants, speakers, and authors providing a seemingly limitless plethora of tools and techniques touted as surefire methods of improving creativity.

Meanwhile, creativity research and theory in the academic literature has blossomed into what often feels like a dizzying array of highly-specific lines of research. Creativity research can be found in nearly every academic discipline, including education, psychology, sociology, business, anthropology, design, the arts, and neurology.

Although some academics such as Runco (2006, 2014) have written about research-based tools and techniques for enhancing creativity, many popular books about creativity tools and techniques have been written which

contain very little in the way of reference to creativity theory and research literature. It is therefore often unclear as to which creativity tools and techniques can be said to be grounded in the literature, which are grounded in the experience of creativity practitioners such as creativity consultants, and which are merely the product of creative imagination.

Purpose Statement

This study seeks to map creativity tools and techniques in a popular book, *Thinkertoys: A Handbook of Creative-Thinking Techniques, 2nd Edition* (Michalko, 2006), to the relevant research and theory in the academic literature. Because the landscape of creativity theory and research is extremely diverse, the mapping of creativity tools and techniques can only be accomplished in a coherent manner by first tackling the development of a conceptual framework.

Research Questions

This study seeks to address two questions: 1) Is it possible to create a conceptual framework which encompasses the diverse lines of creativity research? and 2) Is it possible to use such a framework to map creativity tools and techniques according to relevant lines of research and theory literature?

Methodology

This study used an integrative literature methodology to develop a conceptual framework encompassing the widest possible range in terms of the various lines of creativity theory and research literature. Although seminal works were included, the majority of the literature included in this study was limited to those published within the last fifteen years.

The literature was analyzed to identify the most common themes, concepts, and terminology. These were then analyzed in conjunction with reference back to the literature for relationships between the identified themes, concepts, and terminology. The relationship analysis was then used to construct a conceptual framework to describe the landscape of creativity research and theory.

The conceptual framework was applied to an analysis of the creativity tools and techniques in one book (Michalko, 2006) to determine the relationships between each tool or technique and the relevant area of creativity research or theory literature.

Findings: Conceptual Framework

The review of the themes, concepts, and terminology in the literature revealed thirty dominant lines of inquiry (listed in alphabetical order): abductive reasoning, analogical thinking, autonomy, collaboration, conceptual com-

bination, convergent thinking, creative self-efficacy, divergent thinking, elaboration, framing (procedure), framing (cognitive process), generative atmosphere, idea generation, identification of problem or need, incubation, insight, lowered inhibition, metacognitive processes, metaphor creation, mindfulness and reflectiveness, openness to experiences, pattern recognition, perseverance, perspective taking, playfulness, preparation, refining, synthetic thinking, tolerance of ambiguity, and unconscious cognition. These thirty lines of inquiry were then analyzed for relationships to each other, which led to further analysis to identify natural categories or family-groupings. This analysis revealed four broad categories into which each of the lines of inquiry could be interpreted:

- States of Mind Conducive to Creative Production
- Contextual and Environmental Attributes Conducive to Creative Production
- Elements, Stages, or Steps in Creative Processes
- Cognitive Processes Involved in Creative Production

These four broad categories will be referred to hereafter as conceptual frameworks and shortened in this paper to Creative State of Mind, Creative Context and Environment, Creative Process Model, and Creative Cognitive Processes.

Each of the thirty lines of inquiry were then situated within their respective categories, and visualized roughly according to their relationships to each -other and according to the general frequency at which they appear in the literature.

Creative State of Mind Conceptual Framework

The Creative State of Mind conceptual framework describes states of mind which are conducive to creative production. These states of mind—similar in nature to Angela Duckworth's grit mindset theory and Carol Dweck's growth mindset theory—are generally considered to be subject to growth and development through interventions and intentional practices (Duckworth, Peterson, Matthews, & Kelly, 2007; Rattan, Savani, Chugh, & Dweck, 2015). The Creative State of Mind conceptual framework includes:

- **creative self-efficacy**: the belief in one's own ability to be creatively productive (Abuhamdeh & Csikszentmihalyi, 2012; Glăveanu & Tanggaard, 2014; Tierney & Farmer, 2002, 2011);
- **mindfulness and reflective state**: conscious attention in the moment and awareness of one's own thoughts and actions in the moment (Schon & Wiggins, 1992; Cross, 2006; Runco, 2010, 2006; Frick and Brodin, 2014; Welsh & Dehler, 2013);
- **autonomy**: the belief in one's own authority and ability to act upon one's own decisions (Abuhamdeh, Csikszentmihalyi & Jalal, 2015; Csikszentmihalyi, 1990; Hennessey, 2010; Runco & Pagnani, 2011; Shernoff, Csikszentmihalyi, Shneider, & Shernoff, 2003);

- **metacognitive practices**: practices in which one observes, analyzes, and regulates one's own thoughts (Runco, 2006, 2014; Kozbelt, Beghetto & Runco, 2010; Parker, 2014);
- **perseverance** (also known as grit): a state of determination and dedication in which one continues a project or process despite obstacles (Rojas, 2015; Runco, 2010; Lemons, 2011; Pinheiro & Cruz, 2014);
- **openness to experiences**: a state of interest and decreased inhibition when encountering new experiences and ideas (Csikszentmihalyi, 2000; Runco, 2010; Gocłowska & Crisp, 2014; Hennessey & Amabile, 2010; Kozbelt, Beghetto, & Runco, 2010); and
- **tolerance of ambiguity**: a state of acceptance of, and willingness to work with, ambiguity and contradictions (Runco, 2010, 2014; Zenasni, Besançon, & Lubart, 2008; Kaplan, Sinai, & Flum, 2014).

These aspects of the Creative State of Mind are visualized in Figure 1.

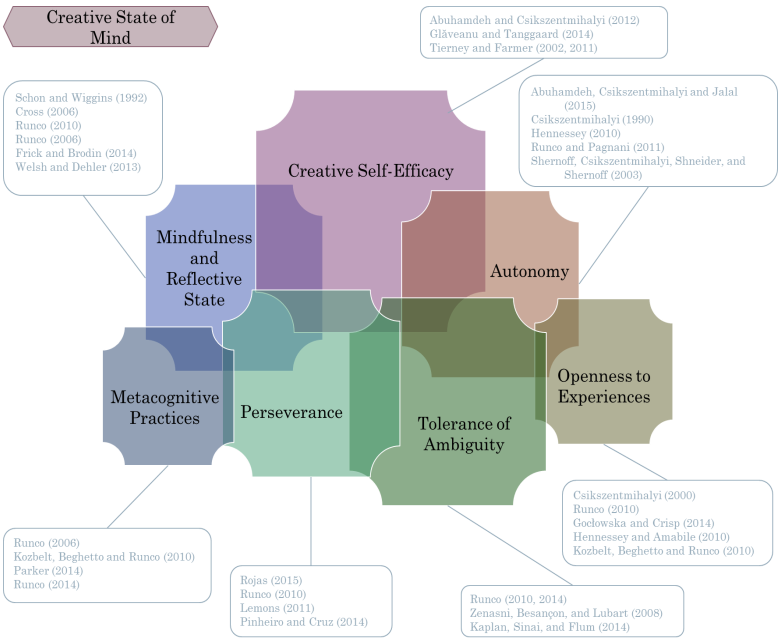


Figure: The Creative State of Mind conceptual framework, consisting of creative self-efficacy, mindfulness and reflective state, autonomy, metacognitive practices, perseverance, tolerance of ambiguity, and openness to experiences.

Creative Context and Environment Conceptual Framework

The Creative Context and Environment conceptual framework describes environmental and contextual factors conducive to creative production. Environmental factors such as sunlight or a variety of tools were excluded from

this analysis, which focused instead only on human factors. The Creative Context and Environment conceptual framework includes:

- **lowered inhibition**: an environment in which self-censorship is reduced (Lemons, 2011; Davies, Jindal-Snape, Collier, Digby, Hay, & Howe, 2013; Hoff, 2014);
- **generative**: an environment in which frequent generation of ideas is encouraged (Runco, 2012; Bruton, 2011; Knoll & Horton, 2011);
- **collaborative**: an environment in which meaning is collectively created and ideas are generated and refined through discussion, feedback, and mutual support between all participants (Davies, Jindal-Snape, Collier, Digby, Hay, & Howe, 2013; Glăveanu, 2015; Joo, McLean, & Yang, 2013; Pisanu & Menapace, 2014; Sawyer, 2012; Zhang, Zhang, Yu & Zhao, 2014); and
- **playfulness**: an environment in which play, humor, light-heartedness, tinkering, and non-goal-oriented activities are encouraged (Banaji, 2011; Ferholt, Nilsson, Jansson, & Alnervik, 2015; Chávez-Eakle, Eakle, & Cruz-Fuentes, 2012; Davies, Jindal-Snape, Collier, Digby, Hay, & Howe, 2013; Hennessey, 2010; Rathunde & Csikszentmihalyi, 2005; Runco, 2014).

These aspects of Creative Context and Environment are visualized in Figure 2.

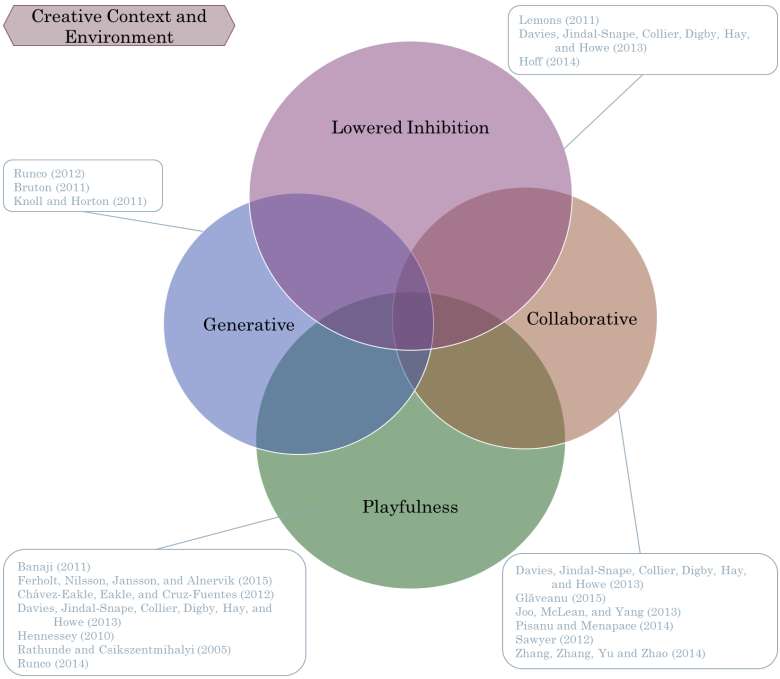


Figure: The Creative Context and Environment conceptual framework, which consists of lowered inhibition, generative, collaborative, and playfulness.

Creative Process Model Conceptual Framework

The Creative Process Model conceptual framework describes elements of the creative process which could be seen as stages, steps, or processes. Various stage models of the creative process have been proposed over the last century, the most prominent of which is the model Graham Wallas proposed in 1926 consisting of four stages: preparation, incubation, illumination, and verification (Klyce, 1927; Runco, 2004). Sawyer (2012) synthesized nine such process models popular in the creativity stage theory literature to identify an eight-stage model consisting of problem finding, acquiring knowledge, gathering related information, incubation, idea generation, idea combination, idea selection, and idea externalization.

The creative process elements of stage theories of creativity are generally seen as a primary target of creativity tools and techniques. They share many areas of alignment with domains such as design thinking and other innovation process frameworks (Sawyer, 2012). The Creative Process Model conceptual framework developed here includes eight of the prominent process elements of various stage theories. These elements are:

- **identification of problem or need**: processes involved in finding a problem or need to serve as the focal point of subsequent creative processes (Runco, 2006; Sousa, Monteiro, & Pellissier, 2011; Kozbelt, Beghetto, & Runco, 2010);
- **framing process**: the process of creating a new perspective on the problem, often through use of empathy exercises (Dorst, 2015, 2011; Schon & Wiggins, 1992; Cross, 2006; Rittel & Webber, 1973; Kozbelt, Beghetto, & Runco, 2010; Stierand & Dörfler, 2011; Ward & Kolomyts, 2010);
- **preparation**: the process of gathering relevant information, securing needed resources, and recruiting participants (Sousa, Monteiro, & Pellissier, 2011; Kozbelt, Beghetto, & Runco, 2010);
- **idea generation**: processes through which novel ideas are created (Runco, 2006, 2014; Cross, 1997; Knoll & Horton, 2011; Kimbell, 2011);
- **incubation**: the process of setting a creative project aside with the specific purpose of allowing one's mind and context to inform deeper understanding of the creative project (Runco, 2006; Sousa, Monteiro, & Pellissier, 2011; Kozbelt, Beghetto, & Runco, 2010);
- **unconscious cognition**: the process of setting aside time and space for the subconscious mind to work on the creative project (Runco, 2006; Kozbelt, Beghetto, & Runco, 2010);
- **insight**: the process of becoming aware of the ideas generated by the subconscious (Runco, 2006; Dietrich and Kanso, 2010; Sousa, Monteiro, & Pellissier, 2011); and
- **refining**: iterative processes, such as prototyping, through which ideas are developed toward greater feasibility, effectiveness, and impact

(Runco, 2014; Stierand & Dörfler, 2011; Sousa, Monteiro, & Pellissier, 2011)

The aspects of the Creative Process Model are visualized in figure 3.

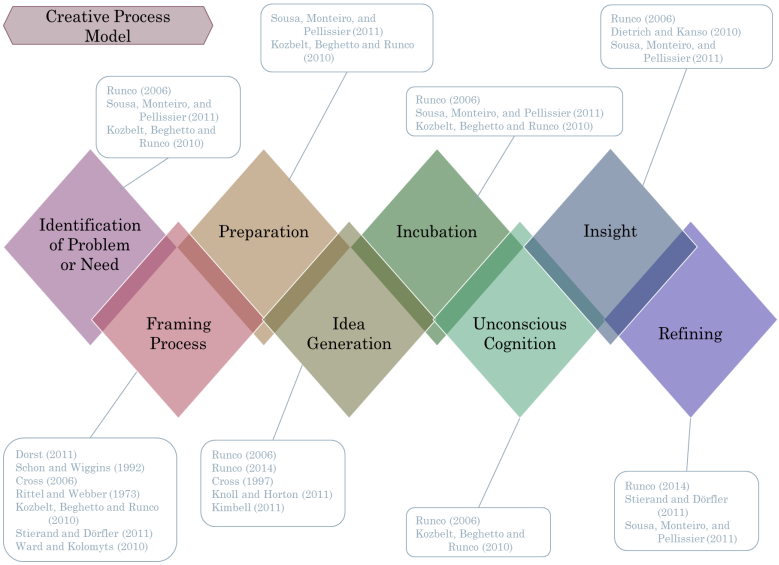


Figure: The Creative Process Model conceptual framework which consists of identification of problem or need, framing, preparation, idea generation, incubation, unconscious cognition, insight, and refining.

Creative Cognitive Processes Conceptual Framework

The Creative Cognitive Processes conceptual framework describes aspects of cognition involved in creative production. It uses the concepts of divergent thinking and convergent thinking to describe relationships between various kinds of cognitive processes, where some processes are seen primarily in the domain of divergent thinking, others as primarily in the domain of convergent thinking, and others as straddling both divergent and convergent thinking. The Creative Cognitive Processes conceptual framework includes

- **divergent thinking**: the generation of a large number of new and unique ideas, often in a chain of new ideas triggering subsequent new ideas (Torrance, 1962; Runco, 2006; Dietrich & Kanso, 2010); and
- **convergent thinking**: analysis, categorization, evaluation, and synthesis of ideas, often through bringing a large number of other ideas/ knowledge to bear (Torrance, 1962; Runco, 2006; Ward & Kolomyts, 2010). Under convergent and divergent thinking are included:
  - ***metaphor creation***: the creation of semantic links between (often) unrelated concepts, usually in the form of a story or visualization (Runco, 2006; Sanchez-Ruiz, Santos, & Jiménez, 2013);
  - ***perspective taking***: viewing a problem or need from multiple points of view, often through empathetically placing one's self

imaginatively in the situation of someone else (Schon & Wiggins, 1992; Cross, 2006);

- ***analogical thinking***: creating comparisons between concepts, often in a form answering the question "How is this like that?" (Runco, 2006; Cross, 1997; Knoll & Horton, 2011; Ward & Kolomyts, 2010);
- ***frame creation***: creation of a novel perspective to use as a lens through which to view both the problem/need and potential solutions (Rittel & Webber, 1973; Dorst, 2011);
- ***conceptual combination***: putting two distinct concepts together in such a way as to create a new conceptual entity distinct from the either of the original concepts (Runco, 2006; Cross, 1997; Knoll & Horton, 2011; Ward & Kolomyts, 2010);
- ***abductive reasoning***: a type of reasoning distinct from (but including) inductive or deductive reasoning in which one creates and tests "best guess" hypotheses in the moment (Dorst, 2015, 2011; Pauwels, De Meyer, & van Campenhout, 2013);
- ***synthetic thinking***: a type of thinking process in which multiple ideas are woven together in intricate and novel patterns (Runco, 2014; Knoll & Horton, 2011);
- ***pattern recognition***: the mental process of observing a large number of seemingly unrelated or random objects/events/ concepts and creating meaning from the relationships amongst them (Cross, 1997); and
- ***elaboration***: mentally working out the details, implications, and potential issues related to an idea (Runco, 2014).

These aspects of the Creative Cognitive Processes are visualized in figure 4.

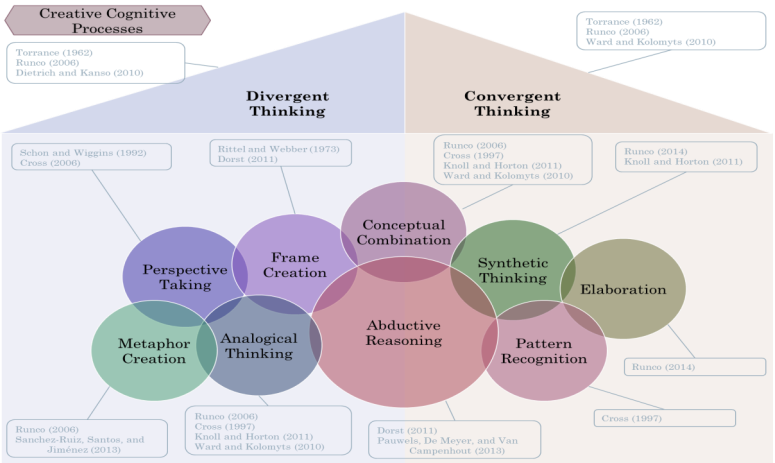


Figure : The Creative Cognitive Processes conceptual framework, which includes divergent and convergent thinking, metaphor creation, perspective taking, analogical thinking, framing, conceptual combination, abductive reasoning, synthetic thinking and elaboration

The Creativity Landscape Conceptual Framework

Together the Creative State of Mind conceptual framework, Creative Process Model conceptual framework, Creative Context and Environment conceptual framework, and Creative Cognitive Processes conceptual framework are combined in the Creativity Landscape conceptual framework as visualized in figure 5.

This overall framework sees optimal creative performance as a function of equal balance among the four, as well as equal attention being given to each of the elements within each of the four conceptual frameworks. Measurement instruments of creative potential such as the *Torrance Tests of Creative Thinking* (TTCT) (Torrance, 197) and the *Reisman Diagnostic Creativity Assessment* (RDCA) (Tanner & Reisman, 2014) measure aspects of creativity which can be conceptualized as being encompassed within all four areas of the Creativity Landscape conceptual framework.

This perspective gives rise to several hypotheses, the testing of which are beyond the scope of this study, such as: 1) If one of the frameworks is neglected, creative performance in the others will suffer, 2) If one aspect of a particular conceptual framework is emphasized, the other aspects within that framework will be weaker, and 3) If one aspect in any of the conceptual frameworks is absent, full creative potential will not be achieved.

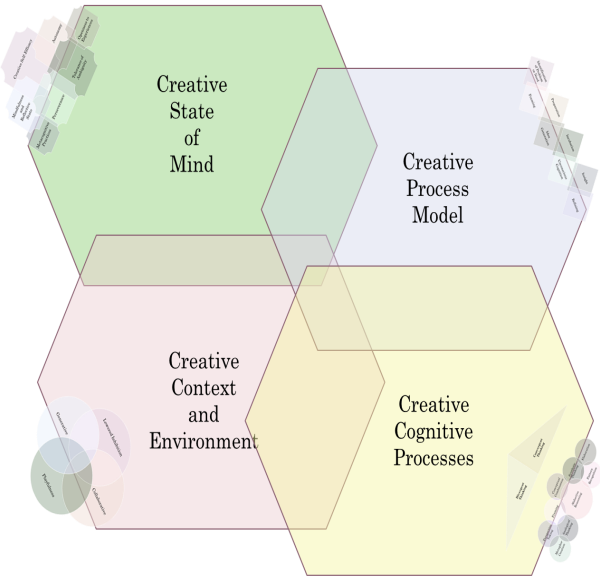


Figure: The Creativity Landscape conceptual framework, which includes the Creative State of Mind, Creative Context and Environment, Creative Process Model, and Creative Cognitive Processes conceptual frameworks.

Findings: Mapping Tools and Techniques

The tools and techniques in the book *Thinkertoys: A Handbook of Creative-Thinking Techniques, 2nd edition* (Michalko, 2006) were selected for analysis and mapping to the creativity research and theory literature because this book is a top best-selling book in creativity tools and techniques (Amazon, 2016), and because this book is typical of the genre in that it includes relatively few references to creativity research and theory literature. Each of the tools and techniques in this book were analyzed for connections to the literature by analyzing the potential of each tool to directly facilitate development and/or implementation of specific elements in each of the four conceptual frameworks in the Creativity Landscape conceptual framework.

Creativity Tools and Techniques Mapped to Creative State of Mind

In the Creative State of Mind conceptual framework, we can map tools and techniques onto all the state of mind aspects except autonomy. Only one technique each could be mapped for mindfulness, metacognitive practices, perseverance, and openness to experiences. Two techniques each were mapped for tolerance of ambiguity and creative self-efficacy. These findings are visualized in Figure 6.

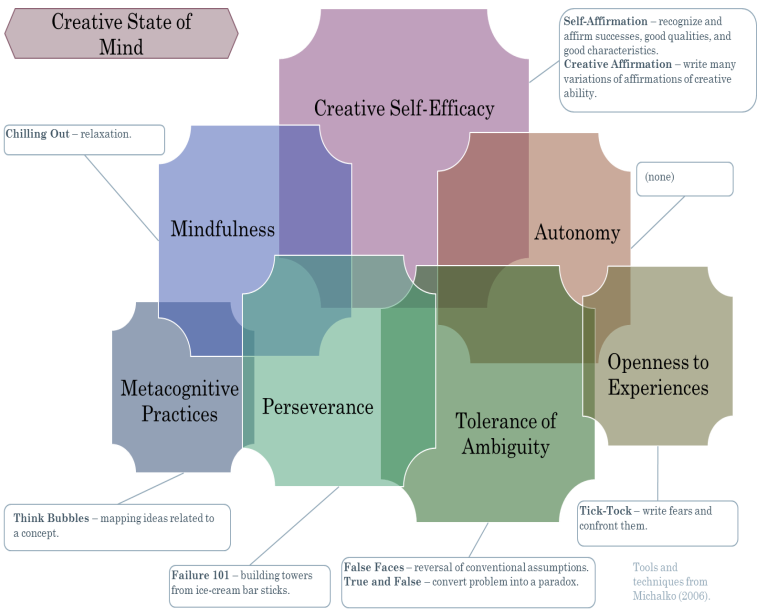


Figure: Creativity Tools and Techniques Mapped to Creative State of Mind conceptual framework.

Creativity Tools and Techniques Mapped to Creative Context and Environment

In the Creative Context and Environment conceptual framework, it was possible to map techniques onto each of the elements. Only the tools and techniques which are intended to be used to create or improve the specific environmental/contextual elements were included. Only one technique each could be mapped for the generative, playfulness, and collaborative elements, and two techniques were mapped for the lowered inhibition element. Findings are visualized in Figure 7.

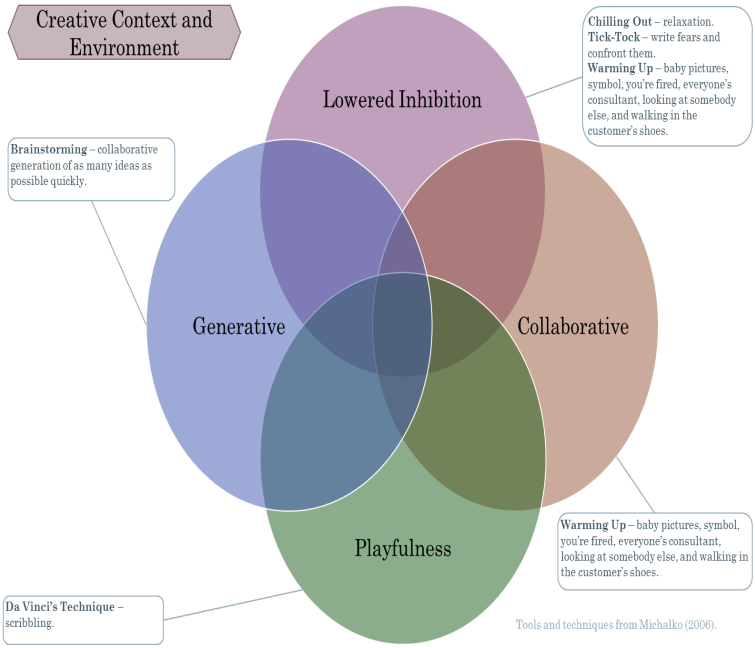


Figure: Creativity Tools and Techniques Mapped Creative Context and Environment conceptual framework.

Creativity Tools and Techniques Mapped to Creative Process Model

In the Creative Process Model conceptual framework no tools or techniques were found which specifically address the elements of identification of problem or need and preparation. Only one technique each could be mapped to the incubation and insight elements. Three techniques were mapped for the refining element, and five for the unconscious cognition element. A large proportion of tools and techniques map directly to the process elements of framing and idea generation. These findings are visualized in Figure 8.

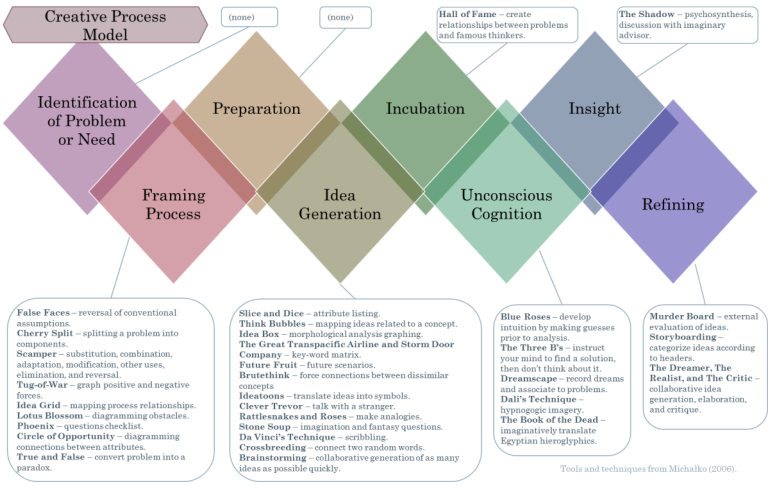


Figure: Creativity Tools and Techniques Mapped to Creative Process Model conceptual framework.

Creativity Tools and Techniques Mapped to Creative Cognitive Processes

One technique was mapped directly to divergent thinking, but the majority of tools and techniques in the book *Thinkertoys* (Michalko, 2006) were mapped onto elements of cognitive processes related to divergent thinking. Two techniques were mapped directly to convergent thinking, and one or two techniques each were mapped onto each of the elements of cognitive processes. These findings are visualized in Figure 9.

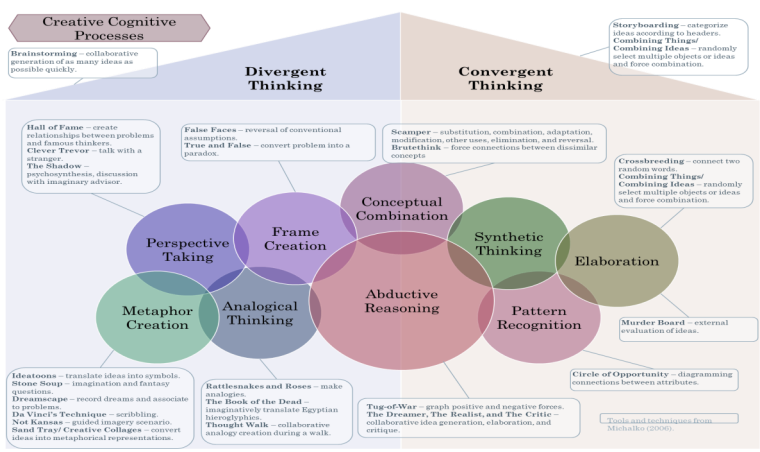


Figure: Creativity Tools and Techniques Mapped to Creative Cognitive Processes conceptual framework.

Creativity Tools and Techniques in the Creative Landscape

Most of the tools and techniques are related to aspects in the Creative Cognitive Processes conceptual framework or aspects in the Creative Process Model conceptual framework. Fewer tools and techniques are related to context/environment or state of mind. There are not many tools and techniques for developing or improving aspects related to the Creative State of Mind conceptual framework.

In terms of the Creative State of Mind conceptual framework, there are more tools and techniques for developing creative self-efficacy, metacognitive practices, and tolerance of ambiguity than there are for the other elements. Perhaps more tools and techniques are needed for developing creative mindfulness, perseverance, openness to experience, and autonomy. See visualization in Figure 10.

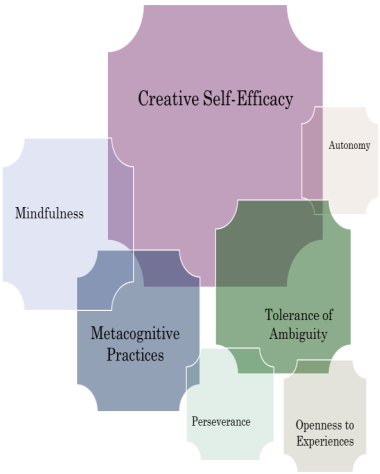


Figure 10: Number of tools for aspects in the Creative State of Mind conceptual framework.

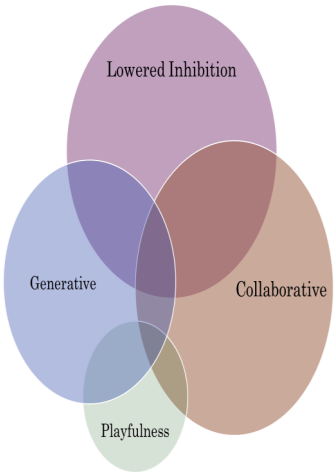


Figure 11: Number of tools for aspects in the Creative Context and Environment conceptual framework.

There are also not many tools and techniques for developing and improving an environment and context which promotes greater creativity. There are some techniques for creating an environment of lowered inhibitions and a collaborative environment. Perhaps more tools and techniques are needed to create greater levels of playfulness in the environment and to create an environment of heightened generativity. See visualization in Figure 11.

There is a great wealth of tools and techniques for creative framing (perspective-taking/perspective-making) and for idea generation. There are also some tools and techniques for improving creative unconscious cognition, as well as tools for refining ideas. Perhaps more tools are needed for improving the creative incubation and insight processes.

Although many tools and techniques take for granted the process of creative identification of problems or needs, as well as the process of creative preparation, it might be possible to create separate tools and techniques specifically designed to improve these processes. See visualization in Figure 12.

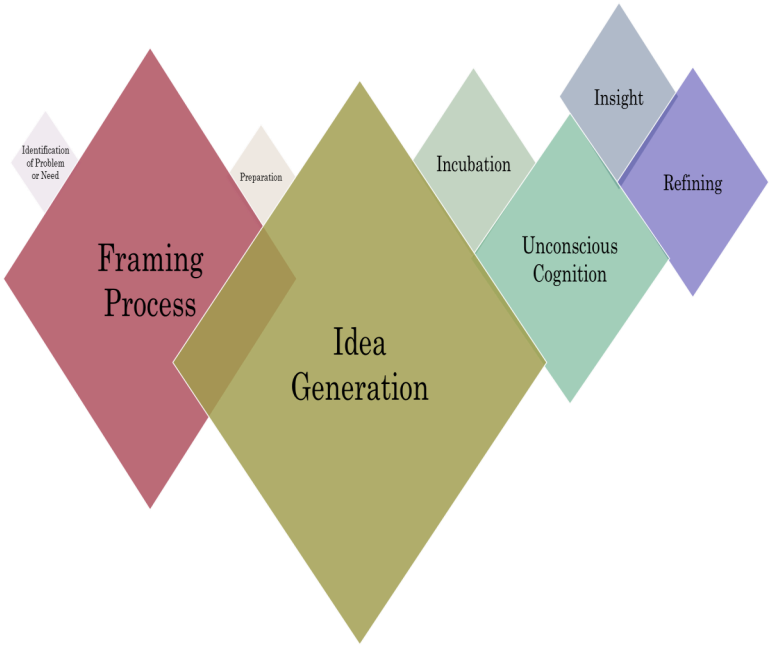


Figure 1: Number of tools for aspects in the Creative Process Model conceptual framework.

There is also a great wealth of tools and techniques for divergent thinking cognitive processes such as metaphor creation, analogical thinking, perspective taking, and framing.

In the creativity research and theory literature, divergent thinking processes and convergent thinking processes are seen as equally important aspects of creativity. However, the tools and techniques we see in the popular press – such as those found in the book *Thinkertoys* (Michalko, 2006) – are heavily imbalanced with greater weight given to divergent thinking. Perhaps more tools and techniques are needed for convergent thinking cognitive processes such as elaboration, synthetic thinking, and pattern recognition.

Also, it could be argued that more tools and techniques are needed which combine divergent and convergent thinking, particularly for the cognitive process of abductive reasoning. See visualization in Figure 13.

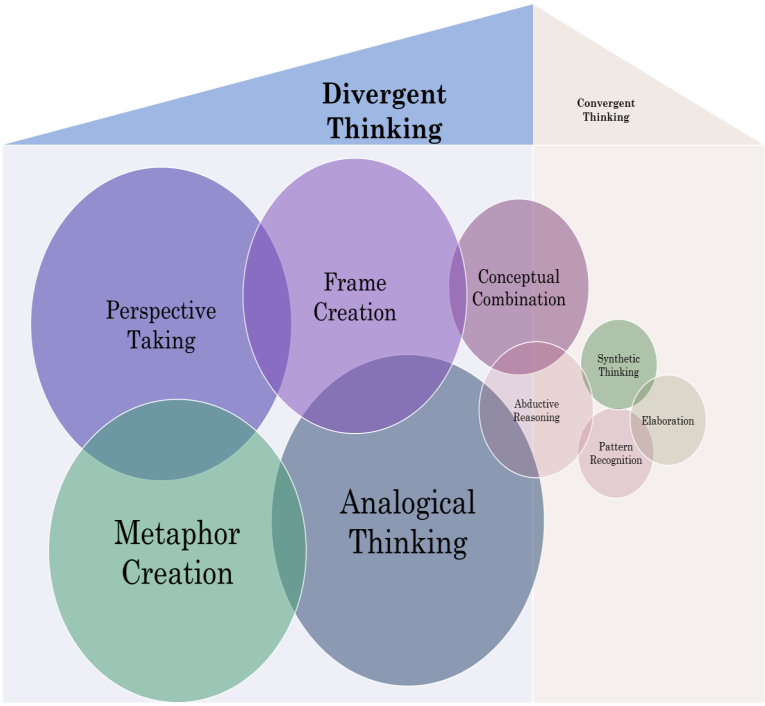


Figure 1: Number of tools for aspects in the Creative Cognitive Process conceptual framework

Discussion

This study has several important findings. First of all, mapping creativity tools and techniques to theory and research is possible. It was possible to make connections between each creativity tool/technique and a corresponding theoretical/conceptual framework.

Second, this study found that creativity tools and techniques dominantly address particular areas. The majority of tools and techniques are for idea generation and framing. There are more tools and techniques for the divergent thinking type of cognitive processes than convergent types.

Finally, this study found areas for potential development of creativity tools and techniques. There is a lack of tools and techniques for convergent thinking types of cognitive processes. Specifically, more tools are needed for abductive reasoning, pattern recognition, and elaboration. There is a total lack of tools and techniques for some elements of the creative process, specifically identification of problems or needs, and preparation. There is a lack of tools and techniques for developing the creative state of mind. No tools exist for developing autonomy, and relatively few tools exist for developing openness to experiences, perseverance, and mindfulness. There is a lack of tools and

techniques for developing a creative atmosphere and context. Particularly, few tools exist for developing a playful environment. Also, although many tools address idea generation, few tools address the development of a generative environment.

This study adds to the literature in several ways. The development of a conceptual model which encompasses the extreme diversity of areas of research and theory in the creativity literature may provide a new lens by which educators, creativity professionals, and others with interest in creativity can better understand the landscape of creativity. It also provides evidence that creativity tools and techniques can be mapped to the creativity research and theory literature.

There are certain limitations in this study. The literature reviewed for the integrative literature review was limited primarily to literature from the last fifteen years, and therefore is lacking grounding in the foundational literature of the 1960's and 1970's. Furthermore, the number of works in the literature reviewed for this study, although adequate for the purposes of this study, barely scratches the surface of the thousands of academic articles and books published each year. Future reviews of other relevant creativity literature could be valuable in refining and strengthening the Creativity Landscape conceptual framework.

References

Abuhamdeh, S., & Csikszentmihalyi, M. (2012). The importance of challenge for the enjoyment of intrinsically motivated, goal-directed activities. *Personality and Social Psychology Bulletin, 38*(3), 317-330. doi:10.1177/0146167211427147

Abuhamdeh, S., Csikszentmihalyi, M., & Jalal, B. (2015). Enjoying the possibility of defeat: Outcome uncertainty, suspense, and intrinsic motivation. *Motivation and Emotion, 39*(1), 1-10. doi:10.1007/s11031-014-9425-2

Amazon. (2016). *Amazon best sellers in creativity*. Retrieved March 17th, 2016 from http://www.amazon.com/gp/bestsellers/books/4737/

Banaji, S. (2011). Mapping the rhetorics of creativity. In K. Jones, L. Bresler, J. Sefton-Green, & P. Thomson (Eds.), *The Routledge International Handbook of Creative Learning* (pp. 36-44). Abingdon, Oxon: Routledge.

Bruton, D. (2011). Learning creativity and design for innovation. *International Journal of Technology and Design Education, 21*(3), 321-333. doi:10.1007/s10798-010-9122-8

Chávez-Eakle, R. A., Eakle, A. J., & Cruz-Fuentes, C. (2012). The Multiple Relations Between Creativity and Personality. *Creativity Research Journal, 24*(1), 76-82. doi:10.1080/10400419.2012.649233

Cross, N. (1997). Creativity in design: Analyzing and modeling the creative leap. *Leonardo, 30*(4), 311-317. doi:10.2307/1576478

Cross, N. (2006). *Designerly ways of knowing*. Dordrecht, London: Springer.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience*. New York, NY: Harper & Row.

Csikszentmihalyi, M. (2000). Creativity. In A. E. Kazdin (Ed.), *Encyclopedia of psychology, Vol. 2.* (pp. 337-342). New York: Oxford University Press.

Davies, D., Jindal-Snape, D., Collier, C., Digby, R., Hay, P., & Howe, A. (2013). Creative learning environments in education—A systematic literature review. *Thinking Skills and Creativity, 8*, 80-91. doi:http://dx.doi.org/10.1016/j.tsc.2012.07.004

Dietrich, A., & Kanso, R. (2010). A review of EEG, ERP, and neuroimaging studies of creativity and insight. *Psychological Bulletin, 136*(5), 822-848. doi:10.1037/a0019749

Dorst, K. (2011). The core of 'design thinking' and its application. *Design Studies, 32* (6), 521-532. doi:http://dx.doi.org/10.1016/j.destud.2011.07.006

Dorst, K. (2015). *Frame innovation: Create new thinking by design*. Cambridge, Mass: MIT Press.

Duckworth, A. L., Peterson, C., Matthews, M. D., & Kelly, D. R. (2007). Grit: Perseverance and passion for long-term goals. *Journal of Personality and Social Psychology, 92*(6), 1087-1101. doi:10.1037/0022-3514.92.6.1087

Ferholt, B., Nilsson, M., Jansson, A., & Alnervik, K. (2015). Creativity in education: Play and exploratory learning *Contemporary Approaches to Activity Theory: Interdisciplinary Perspectives on Human Behavior* (pp. 264-284). Hershey, PA, USA: IGI Global.

Frick, L. B., & Brodin, E. M. (2014). Developing expert scholars: The role of reflection in creative learning. In E. C. C. Shiu (Ed.), *Creativity Research an Inter-Disciplinary and Multi-Disciplinary Research Handbook* (pp. 312-333). Hoboken: Taylor and Francis.

Glăveanu, V. P. (2015). On units of analysis and creativity theory: Towards a "molecular" perspective. *Journal for the Theory of Social Behaviour, 45*(3), 311-330. doi:10.1111/jtsb.12069

Glăveanu, V. P., & Tanggaard, L. (2014). Creativity, identity, and representation: Towards a socio-cultural theory of creative identity. *New Ideas in Psychology, 34*, 12-21. doi:10.1016/j.newideapsych.2014.02.002

Gocłowska, M. A., & Crisp, R. J. (2014). How dual-identity processes foster creativity. *Review of General Psychology, 18*(3), 216-236. doi:10.1037/gpr0000008

Hennessey, B. A. (2010). The creativity-motivation connection. In J. C. Kaufman, R. J. Sternberg, & J. C. Kaufman (Eds.), *The Cambridge handbook of creativity* (pp. 342). New York: Cambridge University Press.

Hennessey, B. A. (2010). The creativity-motivation connection. In J. C. Kaufman, R. J. Sternberg, & J. C. Kaufman (Eds.), *The Cambridge handbook of creativity* (pp. 342). New York: Cambridge University Press.

Hennessey, B. A., & Amabile, T. M. (2010). Creativity. *Annual review of psychology, 61*(1), 569-598. doi:doi:10.1146/annurev.psych.093008.100416

Hoff, E. (2014). The creative place: The impact of different environmental factors on creativity. In E. C. C. Shiu (Ed.), *Creativity Research an Inter-Disciplinary and Multi-Disciplinary Research Handbook* (pp. 103-126). Hoboken: Taylor and Francis.

Joo, B.-K., McLean, G. N., & Yang, B. (2013). Creativity and human resource development: An integrative literature review and a conceptual framework for future research. *Human Resource Development Review, 12*(4), 390-421. doi:10.1177/1534484313481462

Kaplan, A., Sinai, M., & Flum, H. (2014). Design-based interventions for promoting students' identity exploration within the school curriculum. In S. Karabenick & T. C. Urdan (Eds.), *Motivational Interventions* (pp. 243-291). Bingley, UK: Emerald Group Publishing Limited.

Kimbell, L. (2011). Rethinking design thinking: Part I. *Design and Culture, 3*(3), 285-306. doi:10.2752/175470811X13071166525216

Klyce, S. (1927). [The art of thought, Graham Wallas]. *The Sewanee Review, 35*(3), 379-382.

Knoll, S. W., & Horton, G. (2011). The structure of idea generation techniques: Three rules for generating goal-oriented ideas *Technology for Creativity and Innovation: Tools, Techniques and Applications* (pp. 183-201). Hershey, PA, USA: IGI Global.

Kozbelt, A., Beghetto, R. A., & Runco, M. A. (2010). Theories of Creativity. In J. C. Kaufman, R. J. Sternberg, & J. C. Kaufman (Eds.), *The Cambridge handbook of creativity* (pp. 20-47). New York: Cambridge University Press.

Lemons, G. (2011). Diverse perspectives of creativity testing: Controversial issues when used for inclusion into gifted programs. *Journal for the Education of the Gifted, 34*(5), 742-772.

Michalko, T. (2006). *Thinkertoys: A Handbook of Creative-Thinking Techniques, 2nd ed*. Berkely, CA: Ten Speed Press

Parker, J. (2014). Disciplinarity vs. creativity? Of design thinking and 'the metacognitive mind'. *Arts and Humanities in Higher Education, 13*(4), 329-332. doi:10.1177/1474022214550572

Pauwels, P., De Meyer, R., & Van Campenhout, J. (2013). Design thinking support: Information systems versus reasoning. *Design Issues, 29*(2), 42-59.

Pisanu, F., & Menapace, P. (2014). Creativity & innovation: Four key issues from a literature review. *Creative Education, 5*(3 special issue), 145-154.

Rattan, A., Savani, K., Chugh, D., & Dweck, C. S. (2015). Leveraging mindsets to promote academic achievement: Policy recommendations. *Perspectives on Psychological Science, 10*(6), 721-726. doi:10.1177/1745691615599383

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a general theory of planning. *Policy Sciences, 4*(2), 155-169.

Rojas, J. P. (2015). *The relationships among creativity, grit, academic motivation, and academic success in college students*. (3739401 Ph.D.), University of Kentucky, Ann Arbor. ProQuest Dissertations & Theses Global database.

Runco, M. A. (2004). Creativity. *Annual review of psychology, 55*, 657+.

Runco, M. A. (2006). *Creativity: Theories and themes, research, development and practice*. Burlington, MA, USA: Academic Press.

Runco, M. A. (2010). Divergent thinking, creativity, and ideation. In J. C. Kaufman, R. J. Sternberg, & J. C. Kaufman (Eds.), *The Cambridge handbook of creativity* (pp. 413-446). New York: Cambridge University Press.

Runco, M. A. (2014). *Creativity theories and themes: Research, development, and practice* (2nd ed. ed.). Burlington: Elsevier Science.

Runco, M. A., & Pagnani, A. R. (2011). Psychological research on creativity. In K. Jones, L. Bresler, J. Sefton-Green, & P. Thomson (Eds.), *The Routledge International Handbook of Creative Learning* (pp. 36-44). Abingdon, Oxon: Routledge.

Sanchez-Ruiz, M.-J., Santos, M. R., & Jiménez, J. J. (2013). The role of metaphorical thinking in the creativity of scientific discourse. *Creativity Research Journal, 25* (4), 361-368. doi:10.1080/10400419.2013.843316

Sawyer, R. K. (2012). *Explaining creativity: The science of human innovation*. New York: Oxford University Press.

Schon, D. A., & Wiggins, G. (1992). Kinds of seeing and their functions in designing. *Design Studies, 13*(2), 135-156. doi:http://dx.doi.org/10.1016/0142-694X(92)90268-F

Sousa, F., Monteiro, I., & Pellissier, R. (2011). Methods to improve creativity and innovation: The effectiveness of creative problem solving *Technology for Creativity and Innovation: Tools, Techniques and Applications* (pp. 136-155). Hershey, PA, USA: IGI Global.

Stierand, M., & Dörfler, V. (2011). Methods against methods *Technology for Creativity and Innovation: Tools, Techniques and Applications* (pp. 121-134). Hershey, PA, USA: IGI Global.

Tanner, D., & Reisman, F. (2014). *Creativity as a bridge between education and industry: Fostering new innovations*: CreateSpace.

Tierney, P., & Farmer, S. M. (2002). Creative self-efficacy: Its potential antecedents and relationship to creative performance. *The Academy of Management Journal, 45*(6), 1137-1148. doi:10.2307/3069429

Tierney, P., & Farmer, S. M. (2011). Creative self-efficacy development and creative performance over time. *Journal of Applied Psychology, 96*(2), 277-293. doi:10.1037/a0020952

Torrance, E. P. (1962). *Guiding creative talent*. Englewood Cliffs, N.J: Prentice-Hall.

Torrance, E. P. (1974). *Torrance tests of creative thinking: Norms-technical manual: Verbal tests forms A & B, figural tests, forms A & B*. Bensenville, IL: Scholastic Testing Service.

Ward, T. B., & Kolomyts, Y. (2010). Cognition and creativity. In J. C. Kaufman, R. J. Sternberg, & J. C. Kaufman (Eds.), *The Cambridge handbook of creativity* (pp. 93-112). New York: Cambridge University Press.

Welsh, M. A., & Dehler, G. E. (2013). Combining critical reflection and design thinking to develop integrative learners. *Journal of Management Education, 37*(6), 771-802. doi:10.1177/1052562912470107

Zenasni, F., Besançon, M., & Lubart, T. (2008). Creativity and tolerance of ambiguity: An empirical study. *Journal of Creative Behavior, 42*(1), 61-73.

Zhang, W., Zhang, Q., Yu, B., & Zhao, L. (2014). Knowledge map of creativity research based on keywords network and co-word analysis, 1992–2011. *Quality & Quantity, 49*(3), 1023-1038. doi:10.1007/s11135-014-0032-9

Correspondence

Jonan Donaldson
Drexel University, USA
Email: jpd322@drexel.edu

Author's Brief Bio

Jonan Donaldson has been an educator for two decades, including a decade in Japan and a decade at Western Oregon University and Oregon State University. He is currently a Ph.D. student in the Educational Leadership Development and Learning Technologies program at Drexel University. His research focus is at the intersection of the learning sciences, creativity, learner agency, and technologies for learning.

CHAPTER TWELVE

CREATIVE INHIBITION: HOW AND WHY

PETER LENNOX, CHRIS WILSON & MICHAEL BROWN

Abstract

The aim in this chapter is to develop discourse on how we think (consciously or subconsciously) about creativity, how we treat it, why we do so and whether we are behaving toward creativity to the best of our ability. The proposal is that rational inquiry can build on what has been achieved by intuitive thinking.

It is almost axiomatic that the people who most often say the word "creative" are not the most creative; the corollary is that the most creative people find the least occasion to use the word. Talking about the job is not *doing* the job. For very creative people, creativity isn't a subject, it's imbued in the very fabric of their universe; it doesn't need external validation, it is its own reason. For the rest of us, it is as though we are color blind—we understand intellectually what people are talking about, but we don't, deep down, *feel* it. If we did, we wouldn't have to talk about it. Yet, there is an advantage in this; necessity is the mother of invention. That which we do not easily understand through intuition, drives us to seek rational understanding.

Keywords: Creativity, routine, inhibition, discipline, productivity, flow

Introduction

It is notoriously problematic to rationalize creativity; creativity is ubiquitous yet elusive. It is difficult to study in the laboratory, and the science of creativity is correspondingly underdeveloped; we know little of the origin, causal mechanisms, and influencing factors.

We do observe that it is not homogenous, being *more* or *less* present in different individuals, organizations and societies. But we can't, with certainty, declare that it is increasing; we have no way of measuring that. It could simply be that is increasingly *talked* about as an increasingly legitimate target for scientific inquiry. But the literature on creativity is asymmetric; those who are interested in the topic are overwhelmingly affirmative concerning the

benefits and desirability of encouraging creativity. There are few dissenting voices; those who find the topic uninteresting don't research and write about it. If there are actually substantive reasons for impeding creativity, we should examine them. Uncritical endorsement adds little to any rational debate.

The inquiry here is contextualized in fifteen hypotheses:

Hypothesis 1: Creativity could be logically defined
Hypothesis 2: Creativity is logically intractable
Hypothesis 3 Creativity could be measured
Hypothesis 4: Creativity is intrinsically qualitative and immune to measurement
Hypothesis 5: Creativity is indeterministic through-and-through and is therefore ineffable.
Hypothesis 6: Creativity is partially or wholly deterministic and therefore potentially predictable
Hypothesis 7: Creativity can bring about circumstances not accessible by any other means
Hypothesis 8: Creativity is amenable to manipulation
Hypothesis 9: The products of creativity constitute a net gain for the population at large
Hypothesis 10: Creativity benefits the individual
Hypothesis 11: Creativity may come at a cost to society
Hypothesis 12: Creativity might entail a net cost to the individual
Hypothesis 13: Creativity has a moral dimension
Hypothesis 14: There are significant interactions between environment and creativity
Hypothesis 15: Organizations and societies need, but do not *cause* or *own* creativity

These hypotheses are, in theory, testable. The purpose of this chapter is to elucidate the degree to which evidence is currently available, with the aim of anticipating useful lines of enquiry.

Defining characteristics of creativity

Hypothesis 1: Creativity could be logically defined

Hypothesis 2: Creativity is logically intractable

Creativity is a nebulous concept; subscribed to by many more people than can actually define it. This is hardly surprising, since creativity begets many fruit that are equally resistant to clear definitions. Art, music, poetry and ideas are slippery subjects that we all use in conversation; we 'know' what we mean, yet definitions are laborious, often failing to capture the 'essence', leading to endless disputations.

Consequently, most of us settle on rough-and-ready concepts that serve well enough (disputations notwithstanding) for everyday purposes. This yields utilitarian definitions whereby the defining characteristics concern the *uses* to which we might put creativity. So, in business, creativity is that which yields innovation; if innovation happens, it must (in part) be due to creativity and creativity must lead to innovation (otherwise, it's not creativity). So that's a 'circular definition', then. In education, creativity might be associated with healthy cognitive development, self-expression and self-esteem, but what it *is*, is equally nebulous.

Many associated concepts feature ideas, imagination, problem solving, originality/novelty and benefit. Definitions-by-association of 'creativity' are helpful to an extent, but don't take us far into understanding the cognitive mechanisms involved. Utilitarian approaches tend to focus on the desired associated characteristic, so that if problem solving is the goal, then the degree of creativity is measured according to task-oriented success. Creativity in the music industry is often strongly correlated with commercial success, which can lead to the paradox that, as is often the case, the most innovative music is of the least commercial value whilst music that stays within a genre, pushing the creative envelope only slightly, is lauded by the creative industry.

> "In practice, if you were asked which phenomenon is the defining criterion and which is a symptom, you would in most cases be unable to answer this question except by making an arbitrary decision ad hoc."
>
> —Dreyfus (1992, p. 124)

The consequences of the variations in definition (of creativity) are various: focusing on one particular definition may mean that something is being missed, or confounding factors are inadvertently included. Utility-flavored definitions have the advantage of task-oriented specialization. Definition-by-associate characteristics can mean that, in the absence of one or more such characteristics, some instantiations of creativity could be disqualified.

This all doesn't mean that creativity is wholly logically intractable, nor that the field is 'vague', merely that it is more finely nuanced than we can currently rationalize. It may simply mean that a single definition cannot meet all criteria. An analogous situation pertains with the definition of music [REF]. These are situations where human thought currently has the advantage over computer symbolic representation.

Broad approaches, encompassing as many characteristics as possible, might be:

> "The ability or quality displayed when solving hitherto unsolved problems, when developing novel solutions to problems others have solved differently, or when developing original and novel (at least to the originator) products"
>
> — Parkhurst (1999, p. 18)

Or:

> "…a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses about the deficiencies: testing and retesting these hypotheses and possibly modifying and retesting them; and finally communicating the results."
> — Torrance (1966, p. 6)

For a review of definitions of creativity, including historic perspectives, see (Runco and Jaeger, 2012).

Measuring creativity

Hypothesis 3 Creativity could be measured

Hypothesis 4: Creativity is intrinsically qualitative and immune to measurement

Given the problems with defining what is to be measured, creativity measurements are likely to be task or domain specific.

Of course, there are many tests that more narrowly focus on an associate characteristic, such as 'divergent thinking' or 'fluency of ideas'. 'Thinking outside the box' (being able to consider a problem without unconscious acceptance of unspoken rules) is a favorite term. However, it usually really means 'only just outside the box' and if an overenthusiastic workshop participant graffitied the boardroom or debagged the managing director, this would not generally be regarded as usefully divergent thinking. Jarlsberg (a kind of Scandinavian cheese associated with overt conformism but covert anarchic or individualistic tendencies) has been used (by young inhabitants of the Norwegian village of Å, Sundal, 2012) as a slang metaphor that typifies the 'bottled up' type of rebelliousness associated with 'out of the box- but not straying too far' thinking.

Hence, tests of creativity are generally goal-oriented tests of the evidence of creativity, rather than operating directly on creativity itself. This is also unsurprising, since our record for establishing test representativeness (the degree to which a given test or experimental design correlates with the target 'real life' situation) is poor (Brunswik 1942, 1953, 1956).

The more robust methods involve using diverse test methods:
Both Torrance (Treffinger, 1985) and Cropley (2000) suggested that, considering the multidimensional nature of the creativity concept, assessments should be based on several tests, rather than relying on a single score (Hee Kim, 2006).

Though how these are to be aggregated so as to address the representativeness issue is unclear. The Torrance test was designed to identify strength-and-weakness profiles of creative potential in children, and so has particular relevance to education in the context of maximizing individuals' opportunities.

Tests of scientific creativity, such as C-SAT (Ayas and Sak, 2014) focus on domain-specific testing that naturally takes in measures of fluency in associated domains, such as mathematics, evidence-evaluation, hypothesis generation and so on.

Overall, measurement of creativity is a developing field. Most evaluation operates at the individual level, but there are moves to develop reliable quantitative measures at the organizational level. These might usefully elucidate characteristics of the environment in which the individual operates.

Big creativity, little creativity

Whilst we might loosely assume that creativity is the province of creative professionals and industries, such a narrow view is unwarranted. In everyday life, individuals' sense of humor, devising of novel solutions and ingenious pastimes all indicate appetite and capacity for creativity. This 'amateur creativity' probably dwarfs the professional variety in terms of innovation. Considering how people constructively misuse whatever technology they are given is instructive. DJs developed whole genres of music around misusing the record deck. Watching teenage boys explore every possible 'wrong' way to utilize wheels (if presented with a two-wheeled vehicle, they will try to use only one, a four-wheeled skateboard- they will try to use none, sliding down handrails) one is struck by how many innovations begin, not through a logical design process, but by 'grass roots' (and often unwise) experimentation, representing an iterative sequence of *small-creative* acts (Kaufman et al, 2015) often building cumulatively.

Scientists engage in painstaking, methodical and rational activities, but also report intuitions, inspirations and 'eureka moments'. In fact, science is how one tests hypotheses but not how one generates them (Popper 1963 p. 53). The having of an idea is not rational; the testing of it is.

The bringing together of apparently logically unrelated ingredients to synthesize something unexpected brings great delight and we seem evolutionarily disposed toward it.

Philosophy and creativity

Hypothesis 5: Creativity is indeterministic through-and-through and is therefore ineffable.

Hypothesis 6: Creativity is partially or wholly deterministic and therefore runs on (potentially) predictable mechanisms

The difficulty with philosophical position of 'strong indeterminism' (Popper 1990) is that it is indistinguishable from randomness. This would mean that we cannot talk cogently about creativity – essentially, it would be akin to 'magic chaos', a divine madness that only fortuitously ever provided any benefits, but would probabilistically tend to cause harm and

disruption. Although this doesn't accord with our experience, it is not incompatible with the view that creativity, by itself, might indeed be chaotic. Fortunately we have cognitive constraint mechanisms that can ameliorate fanciful excess (see Flaherty 2005). This latter point does not expunge the possibility of chaotic elements in creativity, but does show that they can be controlled and therefore utilized.

In the strong determinism position, creativity is actually entirely rational– that is, it is logical, systematic and in theory (given sufficient computational resources) could be predicted and replicated. In this view, creativity is currently ill defined because of insufficient data, not because it is intrinsically partially non-rational. This position would imply, for instance, that with enough 'brute force' computational power, a logical symbol-manipulation system could provide precisely what a human brain achieves. It cannot, however, be logically proven before the fact.

In the philosophical positions of 'weak determinism' (or 'weak indeterminism') some causal factors that can theoretically be predicted, along with some ingredients that are probabilistic and not amenable to precise prediction. In other words, there are definable causal relationships, but the predictability of outcomes is partially confounded by some chance elements.

Overall, the only theoretical stance that can be discounted is that of strong indeterminism, the 'magic-and-ineffable' explanation. This is rejected on the basis that, if creativity were entirely chaotic, it would be immune to cognitive constraint. The strong determinate proposition, although not disproven is not a good candidate since it implies cunningly concealed strong cognitive computation along entirely logical lines, which seems to leave out the evidence that the human brain outperforms what we know of computationality in the face of massively impoverished data.

Cognition and creativity

Hypothesis 7: Creativity can bring about circumstances not accessible by any other means.

Hypothesis 8: Creativity is epiphenomenal – it is caused by the structure of the brain, but does no causing

Creativity and 'everyday perception' (everyday, but nonetheless miraculous) are strongly related, utilizing similar processing mechanisms. Perception requires, beyond sensory processing, a workable reckoning of items not currently represented in sensation.

> "…the general law of perception… that whilst part of what we perceive comes through our senses from the object before us, part (and it may be the larger part) always comes … out of our own head."
>
> — James (1890, Vol II, p. 103)

The challenge to organic perception is the classic one of 'signal-to-noise ratio'. The torrent of real-time incoming sense data has to be processed so

that salient features are extracted for cognition and (currently) non-salient features discarded. This management of cognitive resources is known as 'selective attention', and runs according to 'cognitive schemata'. The organism with the better cognitive schemata stands the better chance of survival. Hence, perception utilizes memory, imagination and the capacity to generate hypotheses about causal relationships: ideas.

The counterfactual nature of perception and ideas

We tend to think of perception as 'knowing what is', but this view obscures the real benefit of perception, and the real nature of competition in perception. It would be better to think of perception as essentially future oriented. The contents of perception predict by having ideas about the future – and not simply what will be, but what seriously shouldn't be. In other words, we cognitively model ranges of possible consequences (of action or inaction) in order to behave to best advantage. Hence, perception contains much that is necessarily fictional, that is, counterfactual (Gopnik 1996). The richness of our counterfactual ideas accounts for how we have managed to gain ascendancy over other species, many of which are faster, more powerful and have better sensory acuity. Better quality prediction is like time-travel – it can outpace the fastest reactions.

The story of human evolution is the story of the development of creativity. The evolution of larger brain size, facilitated by neoteny –prolonged immaturity allowing for a prolonged learning period (Mehmet Somel et al 2009) led to behavioral capacities offering competitive advantage. Chiefly, these consisted of abilities to affect the surrounding environment; individuals could anticipate, manipulate, avert unfavorable, and select favorable, circumstances (at least, better than the competitors could). What was being evolved was imagination, a flawed but powerful capacity for modelling the range of possible futures.

Organic intelligence and creativity go hand-in-hand, because rational processes alone cannot 'bootstrap'. The human brain uses 13-20 watts (estimates vary), which is about 20% of the body's total power consumption and a significant 'evolutionary investment'. Speculative estimates on what it would take to model human brain function using current technologies range from 10 megawatts (Benjamin et al 2014) to half a gigawatt (Markram, H. 2012) – half a million to twenty five million times as much. Clearly, heat would be a problem. In organic evolutionary terms, so too would the necessity of finding appropriate food stores before competitive advantage could be secured.

Hubert Dreyfus (1972, 1979, 1982, 1992) critiqued methods in artificial intelligence (AI) elucidating how and why computing qualitatively differs from 'thinking'. Fundamentally, the structural differences play out in differences in semantics. The computer is constrained to rational operations,

whereas the brain absolutely requires non-rational operations for proper function.

Hence, 'insight', 'intuition' 'hunch', 'creativity' can be considered evidence of 'processing shortcuts' that allow us to cognitively utilize incomplete data. This ‘quick-and-dirty’ processing allows us to jump to rough and ready conclusions even when the whole picture is not clear, in timely (for survival needs) fashion. Being able to outguess competitors is advantageous. Similar processes may underpin unexpected metaphorical conflations, leading to illogical-but-charming poetry, music and pictures.

Intuitions are often plain wrong (see Kahneman, 2003, 2011) and can stubbornly resist logical attempts to correct them. The study of cognitive biases attests to the ubiquity and pervasiveness of such biases. Nevertheless, creative cognitive characteristics such as insight, intuition, hunch, inspiration are useful, as long as they are not the only ways we think. More importantly, as Kahneman has found, we often think we are being rational, when in fact we are simply using post hoc pseudo-rational explanations to justify a conclusion we reached entirely intuitively. Most interpersonal conflicts stem from this state of affairs.

But humans are reaching the understanding of the need for using the appropriate kind of cognition for the task - intuitive when logical shortcuts are required, logic to rationalize and correct; we now have even created computers to do that 'rational legwork'.

To sum up:

- Perception involves imagination (counterfactuals) – identical to creativity
- Evolution of capacity for metaphor: language. That dog’ (fairly concrete) ‘dog’ (general, abstract)‘, some dogs could come (more abstract)
- Capacity for elaboration of metaphor: ‘stick’, ‘stick that can be useful’ (tool using) ‘stick-that-could-be-weapon-if-I-sharpened-it’: tool invention
- Cognitive associationism (metaphorical conflation: what happens if I stick this association with that one?)
- Creativity= idea –elaborate-evaluate-model consequences (counterfactuals again), judge. Reiterate.

A nuanced view of cognition and creativity features radically different types of processing, with checks and balances. Fundamentally the brain achieves what it does, with parsimonious power consumption, because it combines ‘mad’ associationist metaphorical representation with more literal symbolic representation in an elegant dance of opposing forces. Unbridled creativity would be harmful and useless. Stringent rationality would on the evidence to date, be inadequate (not to mention, boring).

The evidence against the epiphenomenal hypothesis and for the essential utility of creativity is extensive, but circumstantial.

Manipulating creativity (for fun and profit)

Human history could be viewed from the perspective of the continual tendency to manipulate creativity, and this rests on an implicit hypothesis:
Hypothesis 9: Creativity is amenable to manipulation (and this could be in the positive or negative dimension)

Even given that we don't wholly know what we are doing, there have been many attempts to understand creativity, most predicated on the premise that as creativity is good, more would be better. Indeed, if we can manipulate it, we may understand it better which takes us beyond simply having more of it, to using it more wisely.

Historical perspective

Plato (1961) thought that inspiration was a kind of 'divine madness' and divinely inspired oracles were an accepted part of the reality of life, as was magic. We have a long history of endeavoring to attract the muse, using drugs and rituals to initiate trance states and possession by spirits and/or gods (not all of whom were necessarily benevolent). Rituals and practices involving altered mental states pervade; the documented history of the birth of civilizations features ceremonial spaces, artefacts and, of course, music. The role of ancient artefacts, symbolic decorations, rituals, ceremonial spaces and activities in the development of modern man is a core subject of archaeological research.

In archeacoustics, there is a conjecture that the acoustic properties of many ancient ceremonial sites were not entirely accidental, but were tuned or chosen to resonate at the lower frequencies produced by male voices in drones or chants (Watson, 2006; Devereux, 2001) to produce otherworldly effects. Reznikoff (2006) thinks that the early cave paintings are, not coincidentally, sited at the positions where the reverberant acoustic effects of the caves are strongest and most psychologically effective.

In a sense, the birth of the 'creative industries' (used to manipulate human perception) is closely associated with development of civilization. In recorded history we have spent disproportionate time and energy on awe-inspiring buildings, music and paintings. The most complex advanced technologies were devoted to erecting impressive temples, decorated with lavish symbols. These artificial environments, in addition to utilitarian principles, were designed for manipulation of individuals' inner cognitive states through manipulation of environment.

Methods of manipulating inner cognitive states of individuals and groups, whether aimed at creativity or not, became more systematic in the last three

centuries. From the proto-hypnosis techniques of Mesmer in the 18th century and the application of Sigmund Freud's psychoanalytical theories by his nephew Edward Bernays to the issues of mass marketing [Bernays, 1923, 1929], techniques have become steadily more sophisticated. Many of the applications of these techniques are akin to propaganda and brainwashing, only indirectly related to the issue of creativity. But the principle that subconscious or preconscious cognitive processing (Dixon, 1971, 1981) can be altered by manipulation is relevant to the issue of whether such techniques can indeed be used in conjunction with creative practice.

There's an important lesson here: the creativity enhancement industry has a long track record of purportedly selling creativity, whilst actually being involved in techniques of control. This is anomalous because, whilst one facet of creativity is its intrinsic un-tameability, the dark side of these techniques seem dedicated to the exact opposite. Hence, we also have a long history of folklore bogeymen that utilize 'powers' of suggestion, from witchdoctors and the 'evil eye', through Voodoo, Dracula, cults, brainwashing and subliminal advertising. Interesting is the ubiquity of the archetype of the individual robbed of volition, in zombies, Dracula's victims and mindless consumers. Although there is more fiction than fact in these archetypal stories, their omnipresence indicates the distrust with which we view psychological manipulation techniques. It's as though the very loss of rational control that (we feel) we need to engender creativity is something we fear; this may account for the strong current of opinion that creativity is, or should be, a highly individual enterprise.

Creativity extinction events

Arguably, no amount of advanced civilization has ultimately withstood catastrophic depredations. Creativity is delicate in respect of environmental circumstances. Whilst material superfluity may actually blunt necessity, hand-to-mouth existence starves it.

Creativity extinction events are numerous through documented history: Ancient Egypt, Ancient Greece, the Song dynasty; civilizations that had seeded, incubated and grown creativity have frequently been extinguished. These civilizations commonly featured advanced engineering, decorous cities, sophisticated art, accumulated knowledge and excellent quality of life for many of their citizens.

The overarching question is this: can creativity, as a fundamental ingredient of human makeup, ever lead or contribute to a societal stability that promises fulfilment for all its citizens and is fundamentally resistant to the range of possible threats? Can we advance our way out of danger?

The evidence is that creativity is amenable to manipulation; it can be inculcated or extinguished. However, the science and ethics of creativity manipulation offer great scope for development.

For creativity:

There are terms most often used when considering how to increase creativity, such as: inspire, encourage, stimulate, nurture, cultivate. These are all catalytic terms rather than causal terms. We intuit that we can't quite cause creativity but only provide environmental ingredients that can allow it to flourish, as though creativity is some kind of spore that must find hospitable conditions in which to become established.

The fact is that many people may want to be more creative, but never quite find the time and energy. It's that tension between urgency and importance; the important matters get continually put to the back of the queue, crowded out by the urgent ones. The modern workplace involves little inspirational stimulus, much administrative bureaucracy, is tiring and time-consuming. There are few opportunities for creativity, idea-generation or playing. No one pays people to sit around idly thinking. Since our educations system is predicated on preparing people for employment, the classroom is similar, and a production line system with standardized benchmarks for class size and attainment could not, by any stretch of the imagination, be considered 'individualized'. Straw polls (by the authors) reveal that 85-90% of our students express a strong desire to develop creatively, and to find employment that involves considerable creativity. In reality, for most of us, a very small percentage of time in gainful employment will offer opportunity for creative mental activity. Is diminished creativity the price of maturity?

Readers of creativity literature will be familiar with the range of putative benefits, so we will not explore in depth here. Broadly, they are in accordance with two hypotheses:

Hypothesis 10: The products of creativity constitute a net gain for the population at large:

- Ingenious solutions (bringing benefits to public wellbeing)
- Competitive advantages (the 'arms race' theory of evolution)
- Enrich experience (beyond the basics, humans have needs for decorative and entertaining aspects of civilization)

Hypothesis: Creativity benefits the individual:

- Self fulfilment (individuals have need express creative urges)
- Playful aspects of creativity might aid cognitive development (Levitin and Tirovolas 2009)
- Makes life worth living (without it, day-to-day existence would be flat and boring)

Given that there are many voices that endorse the general concept that creativity brings benefits, such claims should be critically appraised.

Counter-creativity

If creativity is a putative good thing, why do we simply not have more of it? Is carelessness or intent the constraining factor? There is evidence of biases against creativity, and these are not wholly irrational. Some research indicates the possibility of an inverse relationship between perceived leadership potential and perceived creative potential in the individual; it appears that we would rather have stable, unimaginative leaders (Mueller, Goncalo and Kamdar, 2011, Mueller, Melwani and Goncalo 2012). Martinsen (2011), in distilling research into a set of characteristics most closely associated with creative individuals, highlighted that some traits, such as low sociability and low emotional stability can make individuals unsuitable for certain tasks and positions in organizations.

Creative inhibition: accident or design?

It could be that we traditionally undervalue creativity, we don't fully understand what creativity actually is, how it works, why it works and in what ways we accidentally (or otherwise) impede it. Moreau and Engeset (2015) describe experiments that show how well-defined problems (using Lego building blocks) with explicit instructions and standardized testing can actually hamper creativity. Hence too-narrowly defining creativity might be counterproductive.

It could also be that creativity doesn't easily yield to rational analysis, the tool that stands us in such good stead in so many endeavors; analyzing non-logical processes using logic seems paradoxical.

But it could just be that we have an irrational subconscious distrust of things we can't understand, a fear of 'magic'. Do we intuit that a little creativity goes a long way, that individuals and societies can only tolerate so much? Perhaps many people do not want to be creative, nor do they particularly want to live in an exuberant, creative society, finding it disturbing, upsetting, unsettling, and even destructive.

Creativity: the dark side

What are the potential downsides of creativity? Is subconscious resistance simply superstition, or are there real reasons why distrust might have logical underpinnings?

Vices and virtues

- Anarchic (destructive of convention) = innovative, new
- Teleologically aimless (ill disciplined) = discovery without preconceived agendum
- Unpredictable = surprising

- Irrational = inspired
- Childish = childlike
- Inimical to rationality = delightful, whimsical
- Non-deterministic = points to something beyond determinism

Focusing on the vices, for a moment, perhaps creativity is:

- Overrated: is unreliable, fails to deliver (but deliver what?)
- Untrustworthy, a 'loose cannon' that delivers unintended consequences
- Subversive and anarchic, breaking rules, incompatible with ordered society and proper accounting
- Competitive cheating; we don't want others to get ahead
- Not cost effective, always making prototypes
- Increasingly irrelevant, superseded by problem-solving rational tools
- Incompatible with rationality (is it?)
- Unnecessary/frivolous/superfluous; it's just decorative 'play' at best, a distraction at worst
- Uninteresting - ones creativity is someone else's yawn
- Hazardous to health and wealth

Hypothesis 11: creativity may come at a cost to society:

- Breaking the rules, subverting order, propagating dishonesty, 'outside the box' = cognitively flexible = ethically flexible. There is some evidence of positive correlations between creativity and dishonesty (Gino and Ariely 2012, Gino and Wiltermuth 2014). However, it's notable that the authors equate subversion of rules (of a covertly administered test of honesty) with dishonesty. A more parsimonious explanation might simply be that high-creative thinkers are less likely to accept rules imposed by authoritative figures and consider actions to subvert such impositions as intrinsically more honest than unquestioning obedience. In this paradigm, subversion does not necessarily equate to dishonesty.
- Used to manipulate populace (Huxley 1932, 1958); see next section on the moral dimension.
- Continual innovation is expensive and must pay for itself. The net result is increased consumption per capita and the inhabitant of a modern city may consume forty times as much energy as a hunter gather; advanced civilizations are energy-hungry (Lerher 2012)
- Creative destruction is messy, as in the metaphor that one can't make omelets without breaking eggs. Continual innovation means that nothing is ever finished; we all end up living in a building site, the future is rosy but right now, it's a mess.
- Creativity is selfish; it fundamentally isn't for someone else. This is the charge levelled at individualism by those whose instincts gravitate toward totalitarianism. The implication is that selfishness is nec-

essarily at others' expense, whilst conformity is necessarily in the best interests of all.
- Creativity distracts; it engenders a pale imitation of true beauty as Plato intimated (Gaut 2010).

Hypothesis 12: creativity might entail a net cost to the individual
- The torment of creativity (creativity might be self-fulfilling, but is not generally regarded as comfortable).
- Could be psychologically unhealthy; though there is anecdotal evidence of some causal links between mental illness and creativity, there have been few investigations of whether obsessive engagement in creative practice is inevitably benign
- May exacerbate relationship difficulties. At the simplest level, creative practice and personal relationships can be in competition for scant resources of time and attention. At deeper levels, creative individuals, with all their complex character traits, can be hell to live with (Russo 2015)
- Frustration at lack of success, recognition or reward
- Financial insecurity
- Disordered personal life incompatible with 9-5 working life

It appears that irrational intuition may indeed arrive at useful conclusions, and that 'creativity' is not automatically to be trusted. This is not to say that it should automatically be distrusted; rather, that if something cannot be resolved at an intuitive level, it should be elevated to conscious appraisal.

The evidence supports both hypotheses; creativity can bring benefits and costs.

The Moral dimension: ethics and creativity

Hypothesis 13: Creativity has a moral dimension

Previous writers (such as George Orwell) feared that ruthless governmental totalitarianism would quash individual thought, freedom and creativity. Today, this view seems quaintly archaic. Instead, individuals are bombarded by stimuli that manipulate their thoughts, intuitions and behavior; virtually all our television, radio and internet is free at the point of consumption, paid for by manipulation industries employing creative professionals. This scenario seems closer to Alduous Huxley's Brave New World (1932). Huxley concluded something similar in Brave New World Revisited (1958), where the author devotes sections to propaganda, selling, brainwashing and subconscious persuasion. Postman (1985) in "Are we amusing ourselves to death?" makes related arguments; totalitarianism comes not from an central authoritarian government but from insidious societal pressure to 'dumb down' and

conform. Predictably, Plato warned us of such a tendency two and a half thousand years ago (Jowett 1871).

Unsurprisingly, artists who 'sell out' are regarded as Judas by former devotees. By tacit definition their skillful output no longer qualifies as individual creativity; they become the voice of the machine and so have no claim to the 'creativity' domain. This adds an important dimension to the definition of 'creativity', one that is implicit in many people's understanding of the term; creative integrity lies in ownership, and therefore responsibility.

In a model taken from psychological and cognitive science 'valence' and 'arousal' are used to express the dimensionality of emotion (see Duffy, 1941, Tajadura-Jimenez et al 2011). So 'arousal' is how much (measured in departure from some normative situation) and valence is in what direction. It is possible to discuss creativity analogously, with a 'good-bad' axis of utility. Viewed from an ethical perspective, it is possible to have something that is very creative, and very bad. The archetypal 'evil genius' of so many stories typifies this. Many people might actually prefer 'bland' to 'potentially wicked'. Gino and Wiltermuth (2014) discuss this in Evil Genius? How Dishonesty Can Lead to Greater Creativity.

Another ethical dimension pertains in respect of the downstream consequences of our actions. For instance, suppose one had an exciting idea, could see how it could be realized and some of the marvelous implications. Then, suppose one went further, realizing the possibility of a dark side to our creation and could see that the risks of misuse of ones invention might entail great harm. Would one forego the acclaim on the grounds that an invention cannot be un-invented? We eventually come to hear when an inventor regrets their invention, but never when one deliberately turns away from success because of such fears. It may be more common than we estimate, but evidence can never come to light since secrecy is paramount.

There is, therefore, an asymmetry with respect to acclaim for creativity (nobody is lauded for not inventing a brilliant-but-dangerous artefact or idea) that can exacerbate the risky nature of creativity. The moral landscape of creativity and its products is uneven; sometimes creativity should be reined in, but isn't.

Overall, the ethical dimensions of creativity are significantly underdeveloped.

Possible causal factors in counter-creativity

Creativity is not a win-win situation; exuberant creativity maybe a marvelous aspect of human life; but it's not the only thing in life. Sometimes the craziness has to stop. Safety, comfort, law and stability come out of rational thinking. Below is a list of potential motivations for countering creativity, in oneself, others and society:

- Deliberate consequence of conscious action

This amounts to a policy of censorship of oneself or of others because of a significant probability that the consequences will be inimical to our interests. Self-censorship, (because one may embarrass oneself, lose credibility, give others competitive ammunition) falls into this category. Censorship of others, because they threaten our beliefs, income and territory, or because we believe they are behaving foolishly.

- Deliberate consequence of unconscious motives

Envy, competitiveness – it could just be that if don't find the opportunity to be creative, we don't want reminding of the fact that others have opportunities (for creative pursuits) that we don't, and we don't want others to enjoy creativity. We might be uninterested in their creativity simply because it's not our creativity. We might even feel, deep down, that they are being irresponsibly selfish in trying to pursue creativity. We may rationalize that we are behaving in their best interests ("they need to face up to the real world… it's not all about play")

- Unintended consequence of conscious action

One may realize the possibility, but feel the benefits outweigh the risks. Or one may be focused on some other, important factor, not realizing the possibility that our, or others' creativity will be depleted

- Accidental consequence of unconscious action

One may just prefer peace and quiet, having no idea that our demeanor oppresses the creativity of others. Or one may settle into comfortable lifestyle habits that smother or neglect our own creativity.

- Disinterest

It could just be that one simply doesn't care about creativity; perhaps a donut is cheaper and more satisfying than a challenging work of art.

- Exporting costs

Modern organizations tend to devolve costs and responsibility to others, removing accountability and overheads from their purview. Increased costs, bureaucracy and inconvenience are borne by users of the services, and do not appear on organizations' budget systems or performance evaluations. Apparent efficiency savings result, though overall net costs (taking into account all participants) are inflated. Users of online banking, government websites or hospital parking schemes will recognize the sheer psychic cost.

External influences: War, invasion, natural disaster, and economic catastrophe.

The most finely balanced, aesthetically advanced and sophisticated civilization can be 'swamped' by overwhelming external influences.

How?

Creativity can be starved through neglect, masked by other activities, hindered by distraction. Poor understanding of the mental process can also hamper it. Goal-directed project management methods are pernicious since

they evince the wrong kind of thinking. Instruct people to 'have a good idea' and they are likely to be creatively paralyzed; the rational, judgmental executive function of the brain is inimical to free associating 'metaphorical mash up' thinking. Trying to have a good idea is probably the worst idea of all time; wherever ideas come from, it's not the land of forceful, Gordian-knot-cutting Power Management [tm] kind of thinking.

The authors conduct an on-going straw poll, entirely at random (the questions are asked during some appropriate social interaction). Respondents are not sought out; online survey methods are not used since this would result in a self-selecting group (only those who had particularly strong views would respond, resulting in some degree of homogeneity across the sample). The rationale is this: "you only get the answers to the questions you ask" (Berg and Rumsey 2001) – to conduct a quantitative enquiry, it is necessary to elicit the broad characteristics of the terrain to be examined.

The simple survey consists of two questions:

1) Would you, if you could, like to be more creative in your life (work or home)?
2) What stops you?

Caveats: because the survey is not conducted in rigorously controlled circumstances, uncontrolled experimental variables are not excluded. Hence, credible numerical data are not feasibly elicited. This is an exploratory qualitative method that should precede a quantitative study.

Some findings…

- Too busy, not enough time and energy

"I'd like to be creative, but to be honest, who has the time? I have a million and one things to do. By the time I've done half [of them], I'm exhausted. At the end of the day, I just want to veg out… I could do this stuff, if I wasn't so busy, but…"

- Deadlines

"I have so many deadlines, all of them of someone else's making. On top of them, a deadline to be creative would be laughable. I just knock something together, when I have to. It's usually OK – not brilliant, but I can pull it off. I'd like to do better, but in the time available, I do OK…"

A few respondents said deadlines to create actually helped: "… actually, deadlines stir me into action; I suppose I'm quite lazy until it really matters…"

- Competing task demands (signal-to-noise)

"…When I'm at home, the kids want things, my wife tells me I haven't done something, my mother rings… at work the phone rings, my boss stops me doing what he told me to do by asking continually if I've done it. It's a nightmare. In between, I have to tax the car, book holidays, call at the supermarket. I could never have done all this when I was younger… but then, I used to wonder about the universe and stuff. Maybe that was just idle daydreaming, I don't know…"

- Distraction

"I check my email, see if I've got that parcel, check my phone, someone's sent me a message – then the phone rings, someone wants me to do something – there's always something. I can't think, can't find the time to remember what it is I was actually thinking about."

- Disinterest:

"When I was younger, we had a band…I used to write songs, got really caught up in it…childish, really… now, I'm not bothered…I just want to go to work, get paid for what I do, come home, relax, go out for a few beers"

- Overshadowing (by another, more demonstrative creative personality)

"Some people just have it… looking at [X]'s stuff, it's so complete…I just can't come near that; why bother?" and " …Y is always banging on about being creative, driving creativity… it's like a competition to see who can gain the most creativity credits. I don't want to compete to be creative, that's not what it's about"

- Ownership

"Unless it's mine, I can't understand it, it's someone else's ideas, I've got nothing to give, creatively. If I get told an idea, I head off in the other direction"

- Trying too hard; ideas won't come

"…nothing worse than that blank paper. I'd rather have anything but that." and ' …when I know that this is the moment, now I have to prove myself… all those ideas that used to swill around up there just dry up, nothing comes… it's like a dream with nobody in it and nothing happens; more like a nightmare, really"

- Worrying

"…Don't you understand? Everyone wants a piece of me -I have so many things I haven't done, that need doing. I feel guilty about it. My life is so complicated,, and I'm worried I'm not getting on with the right thing" "… worry is death to creativity, it's the opposite way of thinking, a continual yammering in my brain – I can't hear myself think…"

- Prevarication

"I tidy my desk, need a cigarette, have to see someone about a bit of administration – anything but the thing I'm supposed to be doing…" "I can suddenly remember all sorts of things I meant to get on with, inconsequential details… but can't focus on what I'm really supposed to be doing now"

- "Stuckness" (Pirsig 1974),

"I find a thing – could be anything- it just gets in the way, like a brick wall...It's really, really frustrating… I just can't move on until I've got past that. It fills my mind. It puts me off, knowing I'll have to go through that"… "I lose all interest in actually doing the creative thinking, I just want to have already done it"

- Atrophy:

"When I was younger, and didn't have to worry about so many things, having ideas was just natural, I didn't have to try… now, I never have that

kind of easy come, easy go ideas… I suppose I'm out of practice, or getting old or something" and "taking drugs, having a good time, thinking the only thing in life is creativity – that's fine when you're young, have nothing to lose and everything to gain; when you're older and wiser, creativity is just less important…"

- Pressure of expectations

"…I hate other people's expectations… I do it for me, not for them" and "…once I was in the frame, … as a person who could be relied on to always have a good idea, I just, sort of, froze… I had to live up to a reputation I didn't make."

- Too many ideas

"Sometimes I just can't get the ideas down on paper – they get crowded out by more ideas, then I just forget. It's really frustrating, kind of manic…"

- Watcher at the gates of the mind:

Many respondents articulated that feeling under pressure to have a good idea actually inhibited the genesis of any ideas. "..I start out with a wild idea… then I remember how people always tell me that wild ideas are fine, but I never do much with them, and the only thing that counts is good ideas, made real, everything else is hot air… so I try to focus on only good ideas, but I seem mentally stiff, like an old man"

> "In the case of the creative mind, it seems to me, the intellect has withdrawn its watchers from the gates, and the ideas rush in pell-mell, and only then does it review and inspect the multitude. You worthy critics, or whatever you may call yourselves, are ashamed or afraid of the momentary and passing madness which is found in all real creators, the longer or shorter duration of which distinguishes the thinking artist from the dreamer. Hence your complaints of unfruitfulness, for you reject too soon and discriminate too severely."
> —Schiller (1788),

Summary of this section

Overall, it seems that people really don't know how to look after their idea generating faculties and, through carelessness, many people become 'creatively unfit'. As the metaphor implies, 'use it or lose it' is the stark choice and most of us don't realize we have chosen by default until after the fact. The circumstances of modern life may simply make it too easy to forget to exercise our creativity.

Environment and creativity

Hypothesis 14: There are significant interactions between environment and creativity

We have a long history of engineering environments to communicate their purpose. Iconic buildings such as ceremonial places, temples and the like, are supposed to inspire psychological effects such as awe and reverence. The seat of government is rarely to be found in a room over the grocer's shop.

Whether we are successful in constructing environments that inspire creativity is unclear. Architects do have notions of buildings-that-inspire, but there is little supporting scientific evidence; experiment design would be problematic. In any event, there's more to an environment than just the buildings. The actual position of the individual within the pecking order might be much more relevant. Not all individuals in an organization are seen as of equal value, and the inspirational elements of an environment might not be evenly distributed. The boss may have an office with magnificent views over the city; workers at the bottom of the organization might have a windowless cubicle in a large noisy office. This can make the majority of individuals feel (probably rightly) they are not really seen as individuals but unimportant small cogs in a vast machine, whose opinions are not listened to.

Large organizations such as companies, government and societies tend to suffer from this 'individual-blindness', so organizational-level policies on creativity are doomed to partial success, at best. There may be increasing divergence between the individual and societal environment (workplace, government etc.,) in respect of creativity. Creativity resides in individuals and is operated on in their interactions with the environment (the material circumstances and organizational structure). At best, organizations can access creativity 'second hand' – they can provide fertile ground and harvest the results. At worst, organizations can quash (inadvertently or otherwise) it.

Mature organisations are less creative: big companies don't play

Hypothesis 15: Organizations and societies need, but do not cause or own creativity.

The relationship between maturity and creativity is epitomized in the corporate context. It might be simplistic to state that creativity is exclusively the domain of the immature, but there is something in the idea that mature companies, predicated on efficient delivery of products and services, have playfulness designed out of them.

Max Wessel, in an article for the Harvard Business review entitled "Why big companies can't innovate" (Wessel 2012), describes how some mature corporations do manage to strategically innovate, through the strategy of 'offspring'. Basically they create immature research companies, and shelter them from the normal day-to-day operations.

Other strategies include imitation: observe an innovation then copy it, steering through the legal niceties of Intellectual Property (IP) regulations, theft ('piracy'): similar to imitation but avoiding legal redress, and adop-

tion—go shopping for immature, creative companies and buy them, along with the associated IP.

As Wessel indicates, it's not all plain sailing. Companies can fail to understand the appropriate business model needed to bring the innovative products to market, they can suffocate their new progeny, turning them into uncreative doppelgängers; they can even undermine creativity by giving too many resources.

The competitiveness that drives corporate efficiency is the very reason that companies need to innovate, yet it is also the reason they can't – without help. Wessel point out that companies that maximize efficiency, which is measured specifically in profit, become totalitarian; there is just one goal, and everyone in the company has to subscribe to it wholeheartedly. In effect, companies optimize their degree of 'fit' to their ecological niche. The evolutionary metaphor is vivid; highly specialized species adapt poorly to gross changes in their environment.

Consequences of suppression

It could be that the positive consequences of constraining creativity, viewed logically, might entail demonstrable benefits. Addressing the 'vices' of creativity could result in a fairer, safer, more orderly society. The individualistic, impulsive, egocentric, anarchic, egocentric, unreliable and expensive influences could be excised. The competitive advantages that the kind of mentality that gave rise to creativity are no longer at a premium; after all, we've reached the top, we've beaten all the other species hands down, what is left? We could have eternal peace and order without surprises, without petty fears, ambitions or hopes. This ordered society, freed of the exhausting infighting could peacefully conduct the pursuit of 'higher truth' without hindrance by the internal friction that previously dogged all societies.

"This sounds remarkably like Plato's Republic"

—Jowett (1871).

But would it pan out like that? Would progress continue or plateau? And given that evolution is a blind process consisting of inevitable mutation and natural selection (competition), would such a society be entirely defenseless in the face of newly arising competition? Karl Popper's criticism of Plato's totalitarianism is on humanitarian grounds (Popper 2013) but the more general question here is whether such a circumstance can actually survive, or whether, like the archetypal Ponzi scheme (see: Zuckoff 2005), they are predicated on some fundamental intrinsically non-viable premises that determine that they must, eventually, crash and burn.

It's logically impossible to prove the demerits of suppression before the fact. Diminution of the kind of insane, inspired problem-solving capacity we have so far enjoyed, might be irrelevant in all but the most un-anticipatable existential threats. But 'black swan' theory reminds us that unlikely events

happen, eventually (Taleb 2007). The kind of cognitive processes involved in creativity are not merely anachronistic hangovers from a more primitive stage in our evolution, but are vital when faced with unanticipated (and logically unforeseeable) events.

A world without creativity might be regimented – but what's the point? Why have millions of identical units when one epitomizes them all? It might be ordered, but to what end? Same applies. In effect, what would be the point at all of having organic life in the universe if it were indistinguishable from all the other matter in the universe?

Of course, the above arguments amount to macro arguments that should not automatically be applicable to micro-level existence. There may indeed be no reason for life to exist (apart from the obvious observation that the universe has, somehow, in us, evolved the capacity for self-consciousness) but that's not the point. We each have a life to live, as best as we can.

In any event, we are not at a stage where we could declare creativity redundant. To the individual, creativity—large or small—is bound up with what it means to actually be an individual. The minutiae that comprise 'my life' are what it means, to a human, to exist. My creativity might be employed or enjoyed by others, but it's mine. A useful concept can be metaphorically transposed from cognitive neuropsychology: 'peripersonal space', which refers to the within-reach area around the individual in which perception is acute (Tajadura-Jiménez et al 2012). Perhaps creativity in individuals requires psychological peripersonal space.

Environmental interactions play a significant role in encouraging or constraining creativity, but the science of managing these interactions requires significant investment.

Conclusions

In this chapter, we have articulated examination of creativity in the context of a number of hypotheses. These concern the risks and benefits (of encouraging or constraining creativity), interactive factors and the potential for rational inquiry into the subject. We find that much of the thinking about creativity is itself of the intuitive kind; there is more anecdotal evidence than scientific evidence.

It has often been ruefully said: "…managing creatives is like herding cats". But of course, if you want a herd, don't get cats, and if you want cats, don't try to herd them.

In the preceding sections, what is clear is that creativity and rationality are different kinds of processes that can be antipathetic with respect to each other. Organizations, societies and individuals could not be predicated only on creativity; they would be unstable. Nor (rather counter-intuitively) should they be entirely rational; they become senile, moribund even. Locked together in eternal conflict, neither must win or the victor would perish soon thereaf-

ter. They must continue, and must stay healthy. Fortunately, we have a successful exemplar: the human brain efficiently manages to combine them through 'cognitive style switching'. Hence, cognitive neuroscience can offer insights into how we might structure societies.

Whilst organizational and societal environmental circumstances can affect creativity, creativity nevertheless resides in individuals. That is, evidence suggests that environmental circumstances can cultivate or inhibit creativity, but no political or organizational policy has ever been proven to cause creativity.

Can we have an ordered society, yet one that resolutely comprises individuals? Can we have a rational approach to the inculcation and utilization of creativity that accounts for the risks and benefits in systematic ways? Dogmatic denial of risk is no way forward, neither is dogmatic suppression of the evidence for risk. Creativity is sometimes overrated, and sometimes underrated.

Creativity is Prometheus' fire. Can we make better use of it without being burned? The difficult trick is to maximize upsides and minimize downsides. Can we tame the tiger without losing something essential to what it is to be a tiger?

On reflection, we often inhibit, suppress or even destroy creativity, sometimes intentionally (whether consciously so or not) and sometimes accidentally (carelessness or collateral damage during some other effort). Sometimes we suppress advisedly (the creativity in question is not in our best interests) and sometimes inadvisably (short termism will come back to bite us). The situation obviously is muddled and should not be allowed to continue. Only a rational approach can disentangle the hearsay, anecdote, near-superstition and sheer amateurishness with which we have approached the creativity problem in the past. The future robust health of our individuals, institutions and societies depends on our optimization of the relationships between rationality and creativity.

What is suggested here is that the route to better utilization of creativity is better understanding by the individual, organization and society of what it is, and does, and what the risks and benefits might be. This is a two-way street; individuals don't really understand organizations any better than organizations understand individuals. Tricks of technique might provide immediate results but cannot produce long-term gains. Dogma will not suffice.

We have a grasp on qualitative but not quantitative characteristics of inhibitory factors. We have no precision in understanding interactions between such factors.

Creativity can be investigated in philosophy, psychology and cognitive neuroscience. We need an ontology of creativity, an understanding of the mechanisms of creativity, and a fuller reckoning of the ethics of creativity. What is required is a detailed, systematic and scientific approach to creativity; anything less would be 'smoke and mirrors'.

References and Bibliography

Ayas, M.B., Sak, U. (2014) Objective measure of scientific creativity: Psychometric validity of the Creative Scientific Ability Test in *Thinking Skills and Creativity* Volume 13, Pages 195–205 Science Direct available http://www.sciencedirect.com/science/article/pii/S1871187114000327

Benjamin. BV, Gao. P, McQuinn. E, Choudhary. S, Chandrasekaran. A, Bussat. JM, Alvarez. R, Arthur. JV, Merolla. P, and Boahen. K, (2014) "Neurogrid: A Mixed-Analog-Digital Multichip System for Large-Scale Neural Simulations" *Proceedings of the IEEE* | Vol. 102, No. 5, pp. 699--716

Berg, J., Rumsey, R. (2001) Verification and Correlation of Attributes Used For Describing the Spatial Quality of Reproduced Sound. *Proceedings of the 19th International AES Conference*, Germany. pp. 233 – 251.

Bernays, E.L. (1923). *Crystallizing public opinion*. New York: Boni and Liveright.

Bernays, E.L. (1928). *Propaganda*. New York: H. Liveright.

Brunswik, E. (1943). Organismic achievement and environmental probability *Psychological Review*, 50, 255-272.

Brunswik, E. (1952). The conceptual framework of psychology In *International encyclopedia of unified science* (Vol. 1, no. 10, pp. 4-102) Chicago: University of Chicago Press.

Brunswik, E. (1956). *Perception and the representative design of psychological experiments.* (2nd ed.). Berkeley: University of California Press.

Cropley, D.H, Kaufman, J.C, Cropley, A.J (2011) Measuring Creativity for Innovation Management *Journal of Technology Management & Innovation* 2011, Volume 6, Issue 3

Devereux, P., 2001. *Stone Age Soundtracks, The Acoustic Archaeology of Ancient Sites* Vega

Dixon, N.F. (1971) *Subliminal Perception: The Nature of a Controversy*. London. McGraw-Hill.

Dixon, N.F. (1981) *Preconscious Processing*. Chichester. John Wiley & Sons.

Dreyfus, H., (1972), *What Computers Can't Do*, New York: MIT Press, ISBN 0-06-090613-8

Dreyfus, H., (1992), *What Computers Still Can't Do,* New York: MIT Press, ISBN 0-262-54067-3

Dreyfus, Hubert; Dreyfus, Stuart (1986), *Mind over Machine: The Power of Human Intuition and Expertise in the Era of the Computer*, Oxford, U.K.: Blackwell.

Duffy, E. (1941). An explanation of "emotional'' phenomena without the use of the concept of "emotion" *Journal of General Psychology*, 25, 283-293.

F. Gino, F., Wiltermuth, S.S., (2014) Evil Genius? How Dishonesty Can Lead to Greater Creativity *Psychological Scien*ce

Flaherty, A.W, (2005). Frontotemporal and dopaminergic control of idea generation and creative drive *J Comp Neurol* 493 (1): 147–53.

Gaut, B., (2010) The Philosophy of Creativity *Philosophy Compass* 1034 -1046

Gino, F., Ariely, D (2012) The dark side of creativity: Original thinkers can be more dishonest *Journal of Personality and Social Psych*ology, Vol 102(3), Mar 2012, 445-459.

Gopnik, A. (1996) The Scientist as Child *Philosophy of Science, Volume 63, Issue4* 485-514

Huxley, Aldous (1932). *Brave New World*. New York: Harper & Brothers

Huxley, Aldous (1958) *Brave New World Revisited* New York: Harper and Row

James, Wm., (1890) The Principles of Psychology New York, NY., Holt

Jowett, Benjamin (1871). Plato: The Republic. http://www.gutenberg.org/files/1497/1497-h/1497-h.htm

Kahneman, D. (2003). Maps of bounded rationality: A perspective on intuitive judgment and choice. In T. Frangsmyr (Ed.), *Les Prix Nobel 2002* [Nobel Prizes 2002]. Stockholm, Sweden: Almquist & Wiksell International.

Kahneman, D. (2011) *Thinking, Fast and Slow* Farrar, Straus and Giroux.

Kahneman, D., Slovic, P., & Tversky, A. (1982) *Judgment Under Uncertainty: Heuristics and Biases* New York: Cambridge University Press.

Kaufman, J. C, Beghetto, R & Watson, C (2015) *Creative metacognition and self-ratings of creative performance: A 4-C perspective*, Journal of Learning and Individual Differences, Elsevier.

Kim, K.H. (2006) Can We Trust Creativity Tests? A Review of the Torrance Tests of Creative Thinking (TTCT) in *Creativity Research Journal* Vol. 18, No. 1, 3–14 http://kkim.wmwikis.net/file/view/Can+We+Trust+Creativity+Test.pdf

Lehrer, J. (2012) The cost of creativity *Wired Magazine* March 2012 available at http://www.wired.com/2012/03/the-cost-of-creativity/

Levitin, D. J., Tirovolas A. K. (2009) Current Advances in the Cognitive Neuroscience of Music *Annals of the New York Academy of Sciences* 2009 Mar;1156:211-31

Markram, H. (2012) The human brain project *Sci. Amer*., vol. 306, no. 6, pp. 50–55

Martinsen, Ø.L., (2011) The Creative Personality: A Synthesis and Development of the Creative Person Profile. *Creativity Research Journal*; 23 (3): 185

Mayseless, Naama; Eran, Ayelet; Shamay-Tsoory, Simone G (2015). Generating original ideas: The neural underpinning of originality *NeuroImage* 116: 232–9. http://www.ncbi.nlm.nih.gov/pubmed/26003860

Moreau, C.P., Engeset, M.G., (2015) The Downstream Consequences of Problem-Solving Mindsets: How Playing with Lego Influences Creativity *Journal of Marketing Research*, 2015

Mueller, J. S., Goncalo, J., Kamdar, D. (2011). Recognizing creative leadership: Can creative idea expression negatively relate to perceptions of leadership potential? *Journal of Experimental Social Psychology*, 47, 494-49

Mueller, J. S., Melwani, S., Goncalo, J. (2012). The bias against creativity: Why people desire yet reject creative ideas *Psychological Science*, 21(1), 13-17

Parkhurst, H. B. (1999). Confusion, lack of consensus, and the definition of creativity as a construct *Journal of Creative Behavior*, 33(1), 1-21.

Pirsig, R.M., (1974) *Zen and the Art of Motorcycle Maintenance: An Inquiry into Values* New York, NY: Morrow

Plato (360 BC) *The Republic (Book VII)* trans. Benjamin Jowett. available online, retrieved Sept 2014 from http://classics.mit.edu/Plato/republic.html

Plato. *Ion. Plato: The Collected Dialogues*. Eds. Edith Hamilton and Huntington Cairns. Princeton, NJ: Princeton UP, 1961. 215–28

Popper, K (1963). *Conjectures and Refutations*.London: Routledge and Keagan Paul.

Popper, K. (1990) *A World of Propensities*, Bristol. Thoemmes.

Popper, K; Ryan, A; Gombrich, E. H. (2013). *The Open Society and Its Enemies.* Princeton and Oxford: Princeton University Press.

Postman, N., (1985) *Amusing Ourselves to Death: Public Discourse in the Age of Show Business* New York: Barnes and Noble

Reznikoff, I., 2006. The evidence of the use of sound resonance from Palaeolithic to Medieval times, in *Archaeoacoustics,* eds. C. Scarre & G. Lawson. Cambridge: McDonald Institute for Archaeological Research, 77-84

Runco, M.A., Jaeger, G.J., (2012) The Standard Definition of Creativity in *Creativity Research Journal*, 24(1), 92–96 https://www.academia.edu/1478423/The_standard_definition_of_creativity

Russo, K.K., (2015) *Costs of Creativity: As Told by the Daughter of an Alcoholic* CreateSpace Publishing

Sak, U., Ayas, M. B. (2013). Creative Scientific Ability Test (C-SAT): A New Measure of Scientific Creativity. *Psychological Test and Assessment Modeling*, 55, 316-329

Schiller, F (1788) *letter to Koerner*, quoted in (Freud, S., 2002) Civilisation and its Discontents London. Penguin pp85-86

Somela, M., Franz, H., Yan, Z, Lorenc, A., Guo, S., Giger, T., Kelso, J., Nickel, B., Dannemann, M., Bahn, S., Webster, M.J., Weickert, C.S., Lachmann,M., Pääbo,S., Khaitovich, P. Transcriptional neoteny in the human brain. *Proceedings of the National Academy of Science* Vol. 106 issue 14 pp 5743 -5748 http://www.pnas.org/content/106/14/5743.long

Sundal, F, (2012), inhabitant of Å i Lofoten. *pers. contact*

Tajadura-Jiménez A, Pantelidou G, Rebacz P, Västfjäll D, Tsakiris M (2012) I-Space: The Effects of Emotional Valence and Source of Music on Interpersonal Distance. *PLoS ONE* 7(11)

Taleb, Nassim Nicholas (2007), *The Black Swan: The Impact of the Highly Improbable,* Random House

Torrance, E. P. (1966). *The Torrance Tests of Creative Thinking-Norms-Technical Manual Research Edition-Verbal Tests, Forms A and B-Figural Tests, Forms A and B.* Princeton, NJ: Personnel Press.

Watson, A., (Un)intentional Sound? Acoustics and Neolithic Monuments. in Chris Scarre and Graeme Lawson (Eds), *Archaeoacoustics* (Cambridge, 2006), pp. 11-22

Wessel, M. (2012) Why big companies can't innovate *Harvard Business Review* September 2012 https://hbr.org/2012/09/why-big-companies-cant-innovate

Zuckoff, Mitchell (2005). *Ponzi's Scheme: The True Story of a Financial Legend.* New York: Random House

Correspondence

Dr Peter Lennox, Senior Lecturer, SFHEA, University of Derby, UK, p.lennox@derby.ac.uk.

Christopher Wilson, Learning Enhancement Manager, BMus (Hons), MPhil, PG Cert HE, SFHEA, University of Derby, UK, c.j.wilson@derby.ac.uk.

Michael Brown BSc(Hons), Senior Lecturer in Music, MA, PGCE, AMus-LCM, FHEA, University of Derby, UK, m.brown2@derby.ac.uk.

Authors' Brief Bios

Peter Lennox, PhD, is a Senior Lecturer at the University of Derby, teaching and researching in auditory perception and spatial psychoacoustics. He has a background in the oil industry, heavy engineering, corrosion engineering, and theatre and film production. He has lectured at University of York, Bretton Hall, Sheffield Hallam University, and the University of Derby. He held the post of Director of the Signal Processing Applications Research Group (SPARG) at the University of Derby from 2003 to 2010. His has special interests in the philosophy of the scientific study of perception.

Chris Wilson is the Learning Enhancement Manager at the University of Derby in the UK and an active composer and educator. He is a classically trained violinist, composer and practitioner in the technological arts, and has published, and presented internationally on the subjects of creativity, artistry, project management, and education. With a musical teaching career He now leads university projects and works with national and international organisations in the development of creative learning and teaching practice.

Michael Brown is the Programme Leader for the BA (Hons) Music degree in the College of Arts, at the University of Derby in the UK. He holds diplomas in both Art and Music, a BSc (Hons) degree in Software Engineering, Mathematics and Music, and a Masters degree in Contemporary Composition, which combine to serve his interest in computer creativity. He is a Principal Researcher with over twenty-five years of teaching experience, an active artist, composer and musician. As well as maintaining his professional role, he is a member of the American Creativity Association and has presented his research in multimodal creativity internationally.

CHAPTER THIRTEEN

STAYING CREATIVE: CREATIVE TECHNIQUE, HABIT AND EXPERIENCE

CHRIS WILSON & MICHAEL BROWN

Abstract

This chapter focuses analysis on a practice-based research project exploring personal creativity in musical composition. Seeking simply to explore the process and experience of creative routines in a more focused way—most specifically through imposed constraints of discipline, productive time and working materials—the project developed in unexpected ways and the focused act of observation itself led to the development of unanticipated insights.

Initial assumptions being that: 1) The right balance of challenge/constraint and creative context can stimulate creative fluency and flow, and; 2) The wrong balance of challenge/constraint and creative context can inhibit creativity, the subtle variations of experience and the delicate structures involved in framing 'creative balance' in the composition process developed insights into the relationship between creative boundaries, activities, and creative identity.

Creative fluency and creative quality can, and routinely does, emerge from difficult and constrained creative conditions. This text presents a personal insight into the creative experience of working through a defined programme of compositional activity, deliberately designed to test and to challenge, and how the same parameters of creative activity can frame everything from the most positive and affirming of musical activity, to the most desperate and distressing. It is through both pain and pleasure that creative value can emerge.

Keywords: Creativity, routine, inhibition, discipline, productivity, flow

Introduction

> "The arts are not a way to make a living. They are a very human way of making life more bearable. Practicing an art, no matter how well or badly, is a way to make your soul grow, for heaven's

> sake. Sing in the shower. Dance to the radio. Tell stories. Write a poem to a friend, even a lousy poem. Do it as well as you possibly can. You will get an enormous reward. You will have created something."
> — Kurt Vonnegut, *A Man Without a Country*.

This text situates a first-person narrative exploring a research project based on the composition of music. The focus of enquiry being creative experience through creative constraints, the practice-based research explores a defined period of creative musical activity and a structured programme of musical composition, publication, and creative reflection.

Originally conceived in quite focused terms, the initial project aims were simply to explore the process of artistic creativity through constraint and limitation—of time and other factors—to evaluate the extent to which the imposition of boundaries affect creative output productivity and quality. Relevant specifically to educational practice in the teaching and assessment of musical composition, the aim was to develop a better understanding of creative musical experience, a subject more often mythologized than considered logically (there is no actual magic involved, as much as creative musical thinking can be mysterious and often exceed the available speed of documentation), the practice-based and collaborative approach to the research nevertheless led both to greater personalisation and conceptual diversification in the thinking involved. The initial focus became a blur, but a blur requiring interpretation and description nonetheless.

Ultimately, this chapter is simply a reflective account of a period of creative activity undertaken within a series of self-imposed constraints. The aim throughout being to explore the process and experience of creativity under constraint, and to consider the nature of boundaries in creative activity through routine more generally, this text simply presents an insight into what it is to both flourish and struggle in creative practice and the relationship between boundaries and creative experience; an attempt simply to consider Bourdieu's 'Habitus', the schemata of creative activity, and to explore the 'rules of the game' in the composition of music (Odena, 2012: p. 10) when challenged and inhibited. Rather than for the purposes of testing specific aspects of creative process or outcome through musical composition, this is merely a story of what was learned from such an experience.

Creative boundaries and constraints

> "None are more hopelessly enslaved than those who falsely believe they are free."
> — Johann Wolfgang von Goethe, Elective Affinities.

In any discussion of creative limitations and constraints, it is important to clarify that creativity itself requires boundaries; limitation being an integral

aspect of every act, product, and experience of creativity. Without a framework or established domain through which creative ideas can be communicated and decoded, ideas cannot be perceived, never mind evaluated in terms of creative significance. Such a framework requires elements of commonality or unoriginality and, ultimately, creative limitation, for there to be any visibility, or audibility of creative ideas. As discussed in a previous publication (Wilson & Brown, 2015), both complete freedom and complete inhibition arguably represent equivalent points of zero creative potential. Creativity is ultimately defined by the relationship between new and existing ideas but without transcendence of some form or another, creativity is simply not possible.

Nevertheless, there is a clear distinction to be made between positive boundaries related to creative frameworks and cultural contexts, and negative boundaries related to creative inhibition, perhaps the most pernicious and most common being limitation of creative time and opportunity. As is often the case with creative practitioners, an exclusive focus on personal creative practice is invariably challenged by the creeping demands of wider personal and professional life. Leading frequently to a gradual dilution of creative endeavour and reduction in time spent in focused creative practice, an unintended but nevertheless inevitable un-focusing of creative attention can follow. As musicians, composers and academics, the act of actively composing music, a process that for many accounts for tens of hours per week of activity during peak intensity, often becomes an occasional endeavour, a fringe activity, and a marginalised pursuit, as other activities take over. Evident in all those who recall in memory a distant creative practice of one form or another, occasionally, and often routinely, the boundaries of time and other factors can become insurmountable and lead to creative atrophy.

All creativity ultimately develops, flourishes, and decays. The inevitable cycle of life dictates that all creative potential (both productive and receptive) emerges naive, develops through opportunities for creative experience and expression, often missed, and ultimately declines and finally disappears. All sound ultimately dissipates and is absorbed by surrounding surfaces, transduced into mere momentary vibration and miniscule temperature elevation. All creative artefacts eventually subject to the ravages of erosion over time, all temporal acts ultimately lost in those very same sands. Nevertheless, it is through creativity that the prospect of immortality is presented in its most tantalizing form. It is only through acts of creativity that any form of ongoing impact beyond the boundaries of existence can be realized; it is only by passing on originality—either through the more immediate production of offspring, or the germinal impact of ideas—that any form of existence, beyond existence, is possible.

A sense of creative accountability as a composer of music simply implies the need to ensure that the best of ideas are captured and communicated. The ideas may be plentiful and readily accessible, but the dedication to capturing and sharing these ideas is easily eroded when the activity is not a primary professional activity. Seeking in part to address this problem in this project,

through active re-engagement with creative practice, boundaries were imposed both to test, and to protect creative activity.

Creative Being: Drifting beyond boundaries

Whilst the initial intention was simply to document the experience of creative activity and routine with defined limitations, other factors relevant to the understanding of creativity as a cognitive process and perceptual experience became apparent during the project. Consequently, this text presents a mixture of focused, first person narrative and empirical research data, in the form of tangible musical results, and consideration more generally of the wider implications of creative inhibition and the marginalization of artistic practice. From the initial question - *What happens if you impose limitations on creative activity?* - The wider questions of - *Why are there limitations on creative activity; Are creative inhibitors real,* and; *what are the implications of creative inhibition?* - are explored through consideration of creative self perception, self-actualization, creative transference, and musical production.

As is common in creative practice in the arts, and indeed fundamental to the definition of creativity itself, this research did not lead quite where it was anticipated to lead. Research became 'messy' but lead to positions of understanding nevertheless worthy of onward communication.

Charting the creative project

Whilst there are artists and creatives more generally who feel compelled to create, driven almost against their will to engage in creative practice, like most, I became and remain a composer because I have always loved the process and, having therefore devoted considerable time and attention to composing, become quite good at it. I started composing music with a particular focus from about the age of 12, and this became an activity that I was fortunate to devote my complete attention to at Music College. Indeed, for many years, composing music is almost all I did, often for days at end without any break when deeply engrossed in particular projects. Over time, compositional activity, peaking at approximately 40-60 hours per week for sustained periods during my undergraduate and postgraduate studies, gradually declined as wider professional responsibilities began to occupy increasing amounts of my attention. Initially becoming punctuated by other activities during the early stages of my teaching career, eventually productivity began to decline more rapidly and creative activities become more concentrated in bursts rather than ongoing and sustained practice. Twenty years ago, I would routinely generate over an hour of new musical ideas a month, currently sixty minutes of finished compositions represents a productive year.

Nevertheless, whilst the focus of this chapter is very much framed by a sense of having drifted away from regular compositional activity in the literal sense, the process of composition being very much a cerebral one, in actual fact the narrative is more one more of exploration of deliberate contact with

the documentation and onward communication of musical ideas. For me, composition has always been more a process of thinking than doing. Doing is merely the effort required to communicate musical ideas to others. I have always maintained the process of musical composition in my own thinking and in the very way I interpret the sounds I encounter in my environment. This project is not so much about creative being, as it is about being creative in the presence of others and for the benefit of others.

Like many composers, I compose music in a variety of ways and through a range of different mechanisms, from paper-based manuscript and written notes, to computer-based software and portable recording and editing devices. Mainly I carry and juggle fragments of ideas and find means of assembling these when the opportunity or the need arises. Focusing here on the use of laptop-based music recording and production software in sculptural approaches to composition and sound editing, software-based approaches also presented the most effective means of meeting the objectives of composing and publishing of results in tight timeframes. The ability to work using headphones whilst small children slept was also advantageous and unavoidable as an additional constraint.

A routine was established. My creative practice had become more structured around sporadic bursts of creative activity and it had been many years since a regular pattern of compositional activity was commonplace. Therefore, on Friday evenings at 9pm, a period of creative production would commence, progress, and culminate with the capturing of a recorded outcome for online publication. Whatever stage a musical idea had reached by a 11pm deadline, the result, or at least an outline of the ideas involved, would be published online. Whether the process was productive or disastrous, outcomes would be made audible and available. Most importantly, whatever the perceived pressure to devote the time to other activities, the process would be completed in a disciplined way.

This process was repeated over 12 consecutive weeks collectively representing cumulatively 24 hours of creative activity. Beyond basic rules regarding time, no specific musical objectives were established. The process of creative decision making, both within individual sessions of activity and between sessions of activity, was to be explored through the creative process.

Creative processes and outcomes

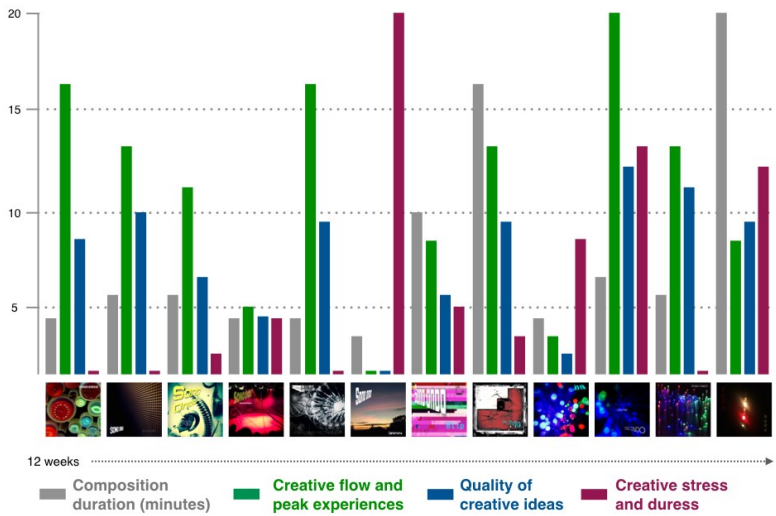


Figure 1: 12 weeks of creative practice

As outlined in Figure 1 above (and Figure 2 below), twelve consecutive weeks of creative activity produced twelve compositional ideas, of varying durations, related experiences of creative processes, and resulting quality of ideas. As with every creative project, in my experience, the beginning was marked by optimism, even excitement, as possibilities were considered. Accepting and even revelling in the naivety of the start of a creative project, particular satisfaction was evident simply for the fact that a certain sense of permission was evident for a return to creative routine. For the first time in many years musical composition would become a defined feature of my working practice. I felt like a composer and was somewhat taken aback at the significance of that experience. However, whatever was anticipated in terms of creative experience and productivity was to lead in unexpected directions and involve new creative experiences, including the most productive and fluent, and by far the most difficult and unpleasant ever encountered.

> "Demos from fragments of time spent moving dials and clicking track pads. The aim is rediscover my process by forcing ideas."
> —Author description of project compositions: https://soundcloud.com/cj101-1/sets/own-things

Figure 2: 12 compositional ideas

Initially conceived as a linear study process, with obvious value in sequential discussion, subsequent reflection and analysis of the project has led to a different approach to the structuring of discussion and analysis. Whilst a certain iterative development of fluency and technique was evident, more significant in determining the productivity, quality, and experience of creative processes were other factors, and other experiences more notable. Creative quality was generally judged to be low in overall terms in terms of explicit analysis of the musical ideas produced. Nevertheless, given the constraints involved, primarily that of time, and the creative perspective of the possibilities of the overall 'raw material' produced during the course of project (outlined at the end of this section), the value of creative investment was judged to be high in overall terms. Insights were developed and musical ideas developed capable of acting as germinal starting points for future creative activity and further, unconstrained, development.

Rather than simply describe the creative arch of the project and discuss individual creative events in sequence (See Figure 2 above), the following reflective account of creative practice instead focuses analysis on different aspects of creative experience and outcomes. Whilst compositional duration is highlighted in Figure 1, in the context of compositional activity using computers, duration is a relatively arbitrary measure of creative output; it being perfectly possible to generate greater duration of musical time than time spent

developing, given suitable use of repeat editing and faster-than-real-time mixing and audio rendering. Considered more important in this analysis are:

- **Creative beginnings** (the initiation and outset of a creative process);
- **Creative flow and peak experience** (ease and reward of practice), and;
- **Creative inhibition, distress and ambivalence** (creative difficulty and creativity under duress).

Creative beginnings

The beginning of this creative project, as with every creative project beyond a certain boundary of definition, clarity, parameter, or inevitability, in my experience, was joyous; the excitement of possibility presenting an almost panoramic sense of space and opportunity. Perhaps amplified by an underlying interest in returning to more focused composition activity, the perspective nevertheless mirrored both my own experience of creative practice and that reflected in the many biographies of composers, writers and artists outlining experience of the initiation of creative activity. It is at the outset that the possibilities are most great and most numerous, prospects so intriguing and uncertain, and creativity at its most unconstrained and open.

Infinite Circles

https://soundcloud.com/cj101-1/infinite-cycles-1

Infinite Circles was composed and produced towards the end of a short break from work and after a busy period of writing and international travel. The start of the creative project, and the prospect of the creative experience was wonderful, exhilarating even. Every possibility was available, every direction open, I was refreshed, unpressured, and I chose to play. The composi-

tional event occurred spontaneously and led directly to the development of this research project, and establishment of the basic parameters of the project introduced earlier in this text.

The process was a more recreational experience than a creative challenge. It being routine that I invest several hours work each evening on professional work (reading, writing, developing, communicating), the transference of focus and exclusivity of attention to pure musical creativity a return to familiar and well loved territory was relished, and approached with unconditional expectation of enjoyment, and a perception of zero overall risk. Nothing could go wrong. Even if it went wrong, it would only be correctable through future endeavour.

The creative process began inauspiciously. I simply reverted to what I considered at the time to be the most enjoyable possible creative approach. I opened a music production software application on my laptop, with my headphones on, and I started to explore ideas. At this stage working independently of the project parameters that were to be established subsequently, creative flow was immediate and enjoyable, any thought of constraint very far from mind. Working specifically for enjoyment rather than with perhaps what could be described as serious artistic intent, and seeking to make progress quickly so as to enrich the play, simple ideas were assembled quickly and with nothing but joyful experimentation and playfulness.

A simple software synthesizer patch (sound) was initially selected from a range of possible sound sources. Subsequently manipulated, reprogrammed, played with, and situated in specific sound environment through additional of signal processing techniques or 'effects', a short motif was captured, cycled in playback monitoring of the recorded musical ideas, and complementary musical elements added through an iterative process of musical thinking, listening, programming, and manipulation of software controls over all aspects of the developing sound environment. The capabilities of software-based music production lend themselves to constant playback of musical ideas and provide almost limitless control over sound characteristics and combinations. Consequently, at any given point, focus of interest or attention can be developed in fine detail with multiple parameters available for manipulation. Composing within a recording-based process provides opportunity to connect directly the musical idea with the musical end result, and procrastination over any given point of creative thinking or musical idea easily absorbed with tinkering with other aspects of the project.

The compositional process relaxed into patterns of activity established over decades of compositional work with computers and recording technology. Whilst the sophistication of the software and wider technologies may have changed over time, comfortable patterns of operation led to the gradual settling of musical ideas in terms of tempo, tonality, rhythm, and tonal characteristics of the sounds and sound environments. Percussive ideas were developed alongside bass elements and textural, harmonic, and melodic ideas

added in parallel with back-and-forth attention to editing of controls over other aspects of sound and sound placement of established elements.

Stylistically, *Infinite Circles* developed into a form of electronica evoking aspects of musical style and form of previous creative work. Drawing almost entirely from a sound palette of vintage synthesizers, loop-based compositional approaches also reflect sample-based computer music styles and forms indicative of previous commercial work. The track reflects a playful reminiscence more than a meaningful creative attempt to push forward.

The moniker *Sono Ondo* was adopted on a whim, at the point of publication. Meaning 'Sound Wave' in Esperanto, the language translation was a side thought as I was working in parallel at that time with several overseas projects and research involving regular use of web-based language translation tools. Consequently, I stumbled across the idea of Esperanto and then played with word combinations until a pleasing result emerged. Sono Ondo was simply the result of exploring the translation results of numerous words and phrases seemingly relevant to the musical ideas, materials involved, and general poetic value. 'Sound' being the first thought for a word to translate, the translation result, 'Sono', was immediately selected and other accompanying words explored. 'Ondo' (Wave) was eventually identified as the second word. It balanced and developed a form of pleasing symmetry that felt comfortable.

The title was determined approximately half way through the creative process. Having adopted a compositional approach involving cycled and repeated patterns, and having focused concentration on the editing and performance of musical ideas in cycled patterns during the compositional process, the title was perceived as necessary, and is therefore a result of spontaneous selection. The cover image was adapted from a photograph taken at a haberdashery of a display of thread bobbins. The selection of title and the selection of image being integrated creative selection and ideation processes, both undoubtedly connected to the experience of cycles and loop points in the musical editing process.

In the case of *Infinite Circles*, the creative beginning of this project, the creative activity is acknowledged to have been 'unconstrained' and undertaken following a period of rest which may account principally for the perceived success both of developmental process and outcomes; the evaluative framework established after the results to a great extent. The composition was only published because it was deemed suitable to do so and the outcomes ultimately the result of a period of open play. Subsequent weeks were subject to different constraints leading to different experiences. Nearly all creative events led to creative insight, and transferable benefits. Subsequent weeks established the supplementary challenge of:

- Always beginning from 'scratch' (never returning to finish something from a previous week).
- Publishing with accompanying cover image.

Creative flow and peak experience

With respect to creative flow (Csikszentmihalyi, 2014) and peak experience (Csikszentmihalyi, 1995), reflecting on the completed series of compositional ideas, the relative complexity of individual compositions can be evaluated and, given the equal timeframes involved in compositional development, a basic calculation made as to the relative fluency of creative work (or basic productivity of ideation). However, as identified in previous discussion of the basic data about the compositional outcomes, duration itself is by no means a reliable indicator of compositional fluency in a computer-based music production process. Equally and more generally, duration is not a clear measure of creative intensity or the quantity of ideas in music composition more generally. John Cage's organ version of his piece *As Slow as Possible* (ASLSP) originally composed in 1985 for example, has a concert performance duration of over 600 years, and the spiral cut groove at the end of side 2 of the original LP pressing of The Beatles' *Sgt Pepper's Lonely Hearts Club Band* renders the final moments an infinite loop, reliant only on power to supply the record player to last in perpetuity (or at least until the stylus wears down). A composer need only add the word 'infinity' to a repeat mark to lock musicians into a potentially lifelong commitment. Duration is easy, and a potentially unreliable objective indicator of creative effort. Using computer-based software, repetition of sound elements or the elongation of musical ideas, is a relatively simple process.

Equally, complexity, in and of itself, dependent on the processes involved with development, can also be a difficult factor to map to creative flow. Whilst the quantity of musical ideas may at first glance present an objective approach to the analysis of productivity, compositional simplicity can masque extraordinary effort and render hidden abandoned alternatives and prior iterations, whilst complexity can emerge from simple creative steps and can only be determined according to the musical schema concerned. John Williams' final selection for the five note musical phrase synonymous with the Spielberg film *Close Encounters of the Third Kind* (1977) for example, was selected from dozens of alternatives before eventually being selected and defining the film. The experimental and avant-garde in music may often be attributed with the characteristics of complexity, where only random or unconstrained creative processes were involved. Ultimately, any judgement of creative fluency and flow must take into account the experience of and thinking behind creative processes to frame more accurate analysis of creative activities and products.

Whilst of course not fully content with the published results from a creative editorial perspective of any of the twelve creative 'events' developed in this project, some nevertheless reflect more intuitive and more productive creative experiences. On some occasions, unexpectedly, and in different creative contexts, musical ideas came together quickly and satisfyingly. In some cases approaching peak experience, where all attention collapsed into a pro-

ductive and seemingly effortless sequence of thinking and doing, on many occasions, creative flow was more evident and experienced at the time.

When the next step, the next idea, comes quickly in composing, as with creative practice in other domains, there is no clear way of describing precisely why fluency emerges, what may account for this, or indeed precisely how this experienced beyond vague descriptions of calmness, contentment, and general satisfaction. Nevertheless, the resulting composition presents a unique opportunity for reflection and consideration of creative processes, themselves both mapped and interwoven with the resulting sounds. It may be intriguing to note, for those perhaps unfamiliar with creative arts practice, that the experience of creativity and the processes involved in creative practice are commonly recallable in vivid detail. Compositions produced over three decades ago remain recollections of considerable precision and clarity. Such is the focus and the attention associated with musical composition, the process involving every aspect of self, the act as well as the documentation of musical composition produces a recording, both often in high definition.

Descent

https://soundcloud.com/cj101-1/desc3nt

Descent was perhaps the composition developed most calmly and serenely of all twelve. Unlike the gentle excitement of the previous, inaugural week, where creative activity was started spontaneously and directed primarily for the purposes of musical recreation, this was the first occasion under which the constraints of time, imposition of title and identity, and wider publication would apply.

No preconceived musical ideas were taken into the creative activity but the musical ideas developed from an almost immediate fixation and focus on *slow*. Recalling the recent and more generally recalled experience of landing in a plane, a brief pause in creative musical activity led to the development of the resulting cover image and title; itself taken of the side of an airplane seat on a recent European flight. The creative process subsequently reflected the

personal experience of landing in a plane in terms of the mixed emotional experience of relief and anxiety. Almost certain in the knowledge that you will safely be grounded in a short period time as the clouds drift past the windows, there remains the equal certainty that the point at which the plane returns to the ground is by far the most dangerous aspect of air travel with potential to deliver terminal perceptual experience.

The initial focus on slow speed progressed through the composition. Perhaps because of the recollected stillness experienced in the cabin of the aircraft, and a personal tendency to close my eyes and to be listening to music at the point of landing, as well as determining *Descent* as being conceptually linked with the experience of landing in a plane, a focus on development of music I would like to listen to in that context also emerged as a consideration. Brian Eno's *Ambient 1: Music for Airports* (1978) providing perhaps the most notable aviation-related musical soundscape designed to enrich airport environments, this creative process developed the simple notion of assembling sounds that would nullify practical anxiety and enrich positive experience in flight. Perhaps quite literally connected to the experienced desire for 'slow' arrivals by plane, rather than sudden and terminal impact, a basic conceptual idea found a personal resonance, a context for deeper emotional reflection and consideration.

The composition and development of *Descent*, punctuated, less than thirty minutes into the two-hour creative time-frame by the development of the cover image and title, is unremarkable except to note that the establishment of the conceptual framework represented immediate creative reassurance. Simple, calm, and slow sound environments are what I always prefer to listen to when landing in a plane, therefore development of textures rather than notes represented an immediate sense of reduction in the technical demands of the creative process. Developing a series of synthesiser motifs and incorporating edited fragments of previously recorded piano improvisation, the creative process is characterised simply by the application, in part, of the recalled perception of forced calm involved in the experience of air travel, and informed by the immediacy of production requirements. Ideas had to be documented quickly to exaggerate the stillness of the sounds.

Two hours is not a long time. To be creative is by definition a spontaneous process but to coordinate the simultaneous development, capture and publication of new musical ideas in a confined timeframe is a complex task. The juxtaposition of urgency and conceptual 'slowness' framed a particularly productive and flow-like creative experience. There was in perfect symbiosis, a reassuring sense of parallel urgency and infinity. I even considered cheating and extending the boundaries beyond the two-hour timeframe when faced with the enthusiasm induced by germinal ideas, infinite latent possibilities emerging for subtlety and the development of quality, yet as the clock ticked down I could not resist the project boundaries, established on days earlier. The tension between creative constraint and creative ideas was tested immediately. The composition was published as planned. But begrudgingly. Highly

incomplete work that flowed extremely well had emerged and been communicated yet I was not ready to let go.

Fold

https://soundcloud.com/cj101-1/fold-rough-mix

Creative activity in the third week, whilst framed by the project parameters and developed through now more defined constraints of time (the preceding week with *Descent* almost the precedent for discipline with creative time), was nevertheless essentially subject to the benefits of the same conditions supporting the development of *Infinite Circles* and *Descent*; namely that of a preceding period of rest. This was true to such an extent that the enthusiasm to repeat the experiential success of the initial compositional events was such that the wider research project was conceived and the parameters devised; the imposition of which only made the prospect of the third week's creative event more enticing. Having established precedent for creative fluency and immediate publication of 'complete' musical ideas—cohesive and balanced musical compositions—the attempt to reproduce peak experience, and to mandate equivalent levels of productivity through an almost performance management approach, made the third week of the project perhaps the most exciting of all. Actual and perceived risk remained extremely low. Potential for creative fulfilment was extremely high.

Stylistically taking queues from *Infinite Circles*, and indeed very much seeking to extend compositionally from that point, the creative approach was much more strategic and focused on the 2-hour timeframe. I had of course cheated and not only edited the cover image and predetermined the title, but also developed a number of basic musical ideas in the time leading up to the compositional event. Intrigued by the constraints rather than inhibited by them, the creative process became more a technical exercise than a period of play, treated more as an assignment brief or professional commission.

Working initially to establish the basic sound elements and to 'set up' the virtual recording and production software environment, individual instrument patches and sound sources were selected quickly and basic parameters such as tempo and signal processing (sound compression, reverb) established. The compositional process was unremarkable suffice to say that the peak experience in this case was very much defined by an emphasis on effortlessness and intuitiveness. I had some basic musical ideas. I thought ahead about realising these. It all worked perfectly.

Centre

https://soundcloud.com/cj101-1/centre-mix?in=cj101-1/sets/own-things

Perhaps the most significant aspect of the composition, recording and production of *Centre* is the speed with which it was conceived and subsequently published. The track represents the most productive period of composition in the entire project from the perspective of production time and quality of results. Having tried and failed to develop a particular musical idea for over an hour of the defined two-hour creative timeframe on the date concerned, losses were cut and the creative activity was momentarily abandoned. Almost immediately, a sense of commitment to the publication of creative results led to the rapid assembly of a series of sound elements incorporating sounds of the Yorkshire coastline and the church bells of my hometown amongst a series of textural synthesiser parts.

The published results are the outcome of approximately forty minutes work. The underlying sonic ideas have merit, but have scope for much further development. Nevertheless, the ideas came quickly and the solutions emerged rapidly. Recognising that creative practice can drift towards procrastination and indulgence, often with profoundly valuable results, the imposition of strict time restrictions certainly focuses the mind and can induce effective productive responses.

Unknown Mechanism

https://soundcloud.com/cj101-1/better-known-mechanism

Unknown Mechanism whilst far from a complete musical idea, is nevertheless that which developed most intuitively and most productively of all weekly bursts of creative activity. It is one of several individual ideas for which there are plans to return for further development and completion. Fulfilment emerged despite a lack of expectation or positive anticipation, or preparatory thought. On this occasion, the project provided license to turn to musical activity despite pressure of time that would otherwise have inevitably led to catch-up or get-ahead activity on other projects. I was allowed to compose and consequently relaxed into the inevitably of this far from reluctantly and actively appreciated the project parameters as supporting my personal well being.

With respect to creative productivity, having identified the limits by which duration and musical complexity can be used to determine creative flow, *Unknown Mechanism* was perhaps second only to the first creative experience with *Infinite Circles* in terms of creative enthusiasm in the developmental process. As the fifth week of activity however, *Unknown Mechanism* emerged in the context of an extremely busy period activity in other areas. Consequently, this track represents one of the more unique creative experiences in this project. Without deconstructing the creative process in detail, suffice to say that not only did ideas emerge positively (from a creative perspective), the results present an example of rare creative experience, when the results exceed expectations, surprise, and stimulate a rising curve of creative application. When initial creative expectations are neutral rather than low, if the initial ideas lead to a positive feedback loop of recognition and enjoyment (appreciation of results), the creative process can gain traction and lead to increasing engagement and application.

Unknown Mechanism emerged better than anticipated because the creative process went better than expected. The creative process drew me in, almost seduced me into progressively switching off other cognitive processes

and mental attention to other things. Whilst the very beginning of the creative process was marked by a level of ambivalence, the peak of creative experience was amongst the most focused and invested. Quite simply, this is one of the creative artefacts with which I remain most satisfied, partly because of the experience of that ramping up of interest, but also because the perceived qualities, and potential for further development, of the resulting ideas, is judged to be high.

FRy2e

https://soundcloud.com/cj101-1/fry2e-1?in=cj101-1/sets/own-things

FRy2e mirrored the creative experience of *Unknown Mechanism* quite closely. Albeit significantly less complex compositionally, the flow in this creative process was more associated with recording and production fluency. The sound qualities of assembled elements were engaging during the creative process to the extent that the limitations of time became reconciled by the perspective that this was very much the sketching of a plan rather than the completion of an idea. As with Unknown Mechanism, ideas emerged quickly and in a way that engaged creative interest.

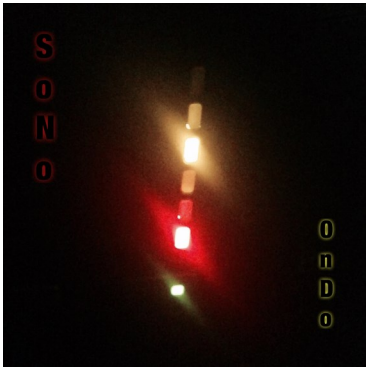
Whilst there is a degree of separation between Unknown Mechanism (Week 5) and *FRy2e* (Week 11), the recollection of the former creative experience of the first undoubtedly informed the approach taken to the latter. In the case of *FRy2e* though, it was the production qualities that were quickly identified as the primary strength. Consequently, a focus on the development of musical ideas was transferred from notes to sound characteristics.

Bl1p

https://soundcloud.com/cj101-1/bl1p

Bl1p was another example of creative processes exceeding expectation from an un-predetermined starting point. As with a number of other creative experiences, creative process was enjoyable precisely because the documentation of ideas stimulated ideas and engagement. As with a number of others, this musical sketch is one that will be returned to for further development and completion.

B1onk1



B1onk1 was the outcome of the last of the series of twelve creative exercises. It is not how the creative project was envisaged to conclude. Thinking ahead, ideas including the recombination and exploration of sound elements and musical ideas developed in the wider project, tangential move to incorporate alternative creative approaches (it occurred to me to record only an improvised musical counterpoint to a live playback of the previous eleven com-

positions, amongst many other ideas), and a sense that previous patterns should repeated consistently, all featured in thinking. Consequently, creative thinking was at its most cluttered of any point during the project. A balanced counterpoint to the openness and freedom represented by opening weeks, the sense of wrapping up and closing down became stifling. Leaving to one side discussion of aborted attempts to explore some of the clutter, confusion led to the need for another shortcut creative approach. It went wrong and quick solutions were sought. Fragments of an improvised piano performance were edited quickly and framed for publication. Very quickly, and not unsuccessfully.

Creative difficulty, distress, and ambivalence

Whilst constraint was at the heart of the project process framework, established reasonably after a successful two-hour period of creative activity in the opening weeks, the perceived risk of the process from an experiential perspective was initially confined to the potential for the dulling of enthusiasm or energy dependent on the wider personal and professional pressures at play at any given time. Failure and uncertainty being a routine aspect of the majority of creative activities—the experience of perfect flow in creative practice more myth than reality—the level to which periods of low creative productivity or difficulty could become problematic was judged to be low. This was an inaccurate judgement.

Recognising that all creative activity is framed by some form of constraint, however invisible this may feel during peak creative flow, without schema or parameter, creative activity is ultimately rendered mute and made invisible. Whilst creative uncertainty and dissatisfaction is a routine experience of all creative activity, there rarely being creative experiences that flow unimpeded by any one of multiple inhibitory factors, there are occasions where the boundaries collapse in on themselves and become insurmountable. Normally, this would simply lead to abandonment of activity and a return only when ready and prepared to. However, the pressure of a sense of commitment to deadline, no matter what, led to remarkable creative insight. I found that a sense of discipline came very close, if not actually stepped neatly over, what had always been an invisible and unconscious process of creative self-protection.

Whilst I have always sought to embrace creative risk and experimentation, even creative difficulty, I have always managed to manoeuvre myself away from situations of creative harm. I have experienced creative difficulty the developed through practice, but I had never faced inevitable creative struggle square in the face before. I not only knew ahead of time that the process would be unpleasant, the thought of potential for infliction of permanent creative damage was even considered. There was trepidation as well as profound reluctance.

Ephemera

https://soundcloud.com/cj101-1/ephemera

Having anticipated and experienced enjoyment from every aspect of preceding creative events, what came as a surprise in the creative process and the research project, was the response to, and experience of, forced creativity. On one evening, the scheduled project activity was undertaken and experienced as the single most unpleasant compositional activity I have ever experienced. On a number of occasions the prospect of having to compose, produce and publish musical ideas under time-constrained conditions was less than welcomed, but on one particular occasion, this ambivalence was so acute as to lead to an almost creative crisis.

It had been so long since I 'had to' produce new musical material, having reached the point of creative activity desiring distraction or unconsciousness more than distracting effort as a means of treating a highly pressured and fatigued mind, my first thought that evening was to defer the creative activity (recalibration of project activity could be undertaken subsequently, and the deferral of potential significance in the overall study), yet I could not shake the focus on the underlying keyword in this work; constraint. I realised that I could not recall, never mind imagine, a frame of mind less disposed to the generation of new musical ideas. My ability, at the point of commitment to the process, to appreciate creative value, never mind to generate musical thinking, was ground to dust. I had worked through an extraordinarily difficult week, was suffering in terms of health, and was in the midst of considerable professional pressures both for my time and for my attention. Focusing my attention to the process of composing music at the point at which this was very much required, felt very much like interrupting a heart surgeon at an extremely delicate moment in order to tell her a joke.

Ephemera was an unpleasant creative experience. In fact it was probably the most unpleasant creative experience I have ever had. I've experienced disappointing and unproductive periods of compositional activity many times

before, and faced creative blocks when ideas seemed to evaporate for periods of time, but I have never composed music so unwillingly or ever faced the situation where I felt compelled to do so before. As such this was amongst the most unique creative experiences of this project and perhaps the most unanticipated. To have spent two hours of my life doing the very last thing in the world I wished to do despite having complete control over the decision reveals either a dedication to an art, a commitment to a research project, or abject disregard for personal well being.

The preceding working week leading up to the creative event could not have been more perfectly designed to inhibit creative thinking and energy at the designated time of creative work. From disrupted travel, physical illness, to wider professional challenges focusing both thinking and attention on other issues, and compromising energy, time, and general capacity on every possible level, accompanied by the onset of winter, near peak limitation of daytime sunlight hours, the wider context of creative activity could not have been more challenging. I simply didn't want to do it. More than that, I recognized ahead of engagement that the process would not only be unpleasant, it would inevitably make a difficult situation worse. It was only that point that point that I realized I had never composer music under those conditions before. With the additional commitment to the research project, I decided to engage with the process. I had the weekend to recover if creative damage was done.

The process was creatively painful and revealing of entirely new creative experiences. Different from simply being forced to compose music, the self directed nature of the negative experience was akin to a painful yet self inflicted itch that could not quite be reached to scratch, or a tantalizing threat of a sneeze that does not realize that was self induced. All the while wanting to escape, to run away, do something else, I nevertheless stuck to the project parameters and attempted to get through the process as quickly as possible.

The creative process involved every shortcut of which I am familiar. Selecting generic sound sets and synthesizer settings, I simply wanted to capture the simplest possible patterns and structures and to turn away. To accomplish this, the stylistic parameters were simplified, generic percussive patterns selected, and formulaic harmonic progressions developed. Nevertheless, the process remained arduous and unpleasant throughout. With seemingly no receptor of appreciation sparking on any level whatsoever, the whole creative process felt akin to practising taxidermy as a vegan. I felt allergic to musical creativity.

I consider the results awful and these as representative of a deeply unpleasant creative experience. They are nevertheless presented as a unique insight into what the experience of unpleasant creativity like this sounds like. I tried to do the best as I could despite the experience. I selected an optimistic and hedonistic musical form, I selected and modelled patterns and conventions, but floundered in a resentful way throughout.

Blah blah blah

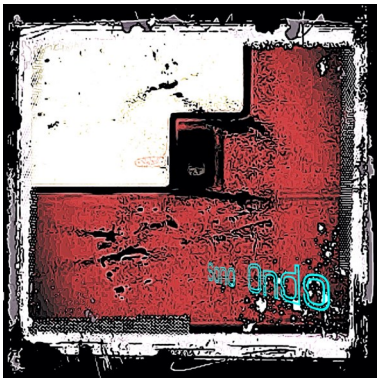
https://soundcloud.com/cj101-1/blah-blah-blah

Whilst *Ephemera* was a notably unpleasant and unusual creative experience, a certain degree of difficulty or distress or duress was routine in the majority of creative events. Indeed, as has already been highlighted, no creative process develops without uncertainty and no creative success achieved without some transcendence of boundary.

BLahblahblah is an example of a track where the image was developed ahead of the musical creation process and creative anticipation was quite high. I had an almost complete musical idea worked out that resonated pleasingly, for me, with the predetermined title and cover image. The distress in this case corresponds directly with difficulty in realising established musical ideas. I could hear how it should sound and feel, and I simply could not realise this through the compositional process.

Chalking this up very early in the creative process as 'just one of those days', everything from technical problems to distractions in the working environment seemed to occupy the foreground of attention almost immediately upon attempted creative focus. The selected sound environment is not quite right, the rhythmic feel does not quite 'sit', the production balance is poor, and whilst wrestling with these dilemmas, other developmental ideas were either lost or not forthcoming as attention was increasingly drawn towards 'correction' rather than extension. Within the first few minutes of the creative process, corrections began to be made. This got worse.

Cr33p



https://soundcloud.com/cj101-1/cr33p

Cr33p, whilst judged to be a relatively successful outcome, was nevertheless challenging in development. Confined particularly to certain compositional and production elements, difficulties were encountered realising ideas precisely and effectively. These became distracting and counterproductive distractions almost immediately. The focus became problems and 'not-quite-right' more than opportunities and 'what next'. It is the composition that drifted furthest from the imagined ideal. I simply could not make it sound as I wanted, or translate ideas effectively with the materials available.

B33p

https://soundcloud.com/cj101-1/beep

B33p is simply a prime example of laziness in creative practice. It was not an unpleasant creative experience as much as an ambivalent one. I simply went through the motions and it sounds like it. I got lazy and in this case, laziness led to creative sloppiness.

Creative reflection and evaluation

> "It is not the critic who counts; not the man who points out how the strong man stumbles, or where the doer of deeds could have done them better. The credit belongs to the man who is actually in the area, whose face is marred by dust and sweat and blood; who strives valiantly; who errs, who comes short again and again, because there is no effort without error and shortcoming; but who does actually strive to do the deeds; who knows great enthusiasms, the great devotions; who spends himself in a worthy cause; who at the best knows in the end the triumph of high achievement, and who at the worst, if he fails, at least fails whilst daring greatly, so that his place shall never be with those colds and timid souls who neither know victory nor defeat."
> — Theodore Roosevelt, *The Man in the Arena*.

Analysis of creativity under constraint has an immediate a natural home in music. By almost every definition, the success or failure of musical ideas rests with establishing an appropriate balance between convention and innovation, between predetermination and inauguration. Music, as Merker identifies, is ultimately able to generate "infinite pattern diversity by finite means" (in Deliège & Wiggins, 2006, p. 31), and represents a dichotomous cultural space where creative ideas are constantly renegotiated on the wave front of known and unknown, familiar and unfamiliar.

Music is a significant example of the simultaneously constrained and unconstrained activity, with a constant push and pull, back-and-forth, between a stretch to new territory and a snap back to familiar ground, both within individual practice, and correspondingly with wider cultural systems. Indeed, citing Belker (2002), Merker (in Deliège & Wiggins, 2006), identifies that if novelty itself was a predominant factor in determining the quality of musical ideas, it would be difficult to account for the value gained from returning to familiar and previously known musical ideas (p. 25). Yet it remains the pioneers and the innovators who become most prized and most celebrated.

The creative peaks and troughs of the twelve creative sessions involved in this project were more pronounced than had been originally anticipated. And, as with all creativity, it is the unanticipated and surprising that often provides the most focused and fertile ground for interest and analysis. The most fluent and productive creative activity exceeded expectations, and led to significant periods of creative fluency and flow, whilst preconceptions and understandings of the baseline of creative experience and output quality was given cause for significant re-evaluation; the most negative creative experience being unlike anything ever experienced. Originally intending to focus more analytically on the musical products of creative activity, it was the experience of creative process that became the more significant factor in this

project. The act of musical composition providing a forensic opportunity to evaluate wider constraint factors inhibiting creativity and creative experience.

As observed by Carson (et al, 2003), focusing on the relationship between latent inhibition-- the ability to "screen from conscious awareness" unwanted stimuli--and creative achievement, whilst it is tempting to consider how an exaggerated focus of attention might inhibit creative thinking, reducing the opportunity for new conceptual connections to be established, evidence from studies nevertheless indicate that low levels of latent inhibition generally correlate with high levels of creative achievement. Highlighting a distinction between different conceptions of inhibition through 'effective inhibition', 'disinhibition', and 'adaptive engagement with inhibition' (Benedek et al, 2012), all forms of inhibitive experience were experienced fully during the course of this project.

Creativity and play

Human beings being notable for continuation of play into adulthood more than any other species (Nowell, 2016), this capacity is perhaps most straightforwardly explained by the copresence of cognitive and practical opportunities for play. We not only have the intellectual capacity for play, we encounter more regular and sustained periods of opportunity for imagination to wander free from other distraction. This freedom leads to creativity. As soon as cognitive space is made available, possibilities emerge. Most are momentary, fragmentary, and ultimately lost, but many find ways of being captured, or become transferred over time into definable domains. Play and playfulness is the first expression and basic definition of creativity. It is the capacity to wonder in practical and transferable ways, and the ability to capture and apply insight, that defines our species and accounts for all of human progress.

The initiation of this project being driven by a simple desire to play creatively and to document this process, the aims broadly focused on exploring the creative process of musical composition and the experience and impact of imposed constraints. Developing into a more focused exploration of the relationship between compositional process and outcome limited by time and consistency of creative space and resources, the wider circumstances influencing creative activity, whatever the attempts made to shield these from overtly influencing the creative activity, inevitably crept in providing both the most destructive and most valuable influence. Seeking to play from the outset, it is the capacity for, and receptiveness to, play, that can be most inhibited by subtle factors beyond tools, space and time.

The connection between creativity and play is widely documented and almost intuitively understood; it is how we become who we are. From Lieberman (1977), who stresses the close connection between creativity and play, Bateson and Martin (2013) cite examples from Nobel Prize winning scientific researchers (Fleming, Delbruck, Feynman), artists and musicians (Escher,

Picasso, Mozart), who have identified quite explicit association with play their work. Even, in the case of Richard Feynman, a clearly documented lament at the lost memory of science as a purely whimsical and interest led pursuit as he reflected on the loss of enjoyment from his work (1985, in Bateson and Martin, 2013, p. 58), echoing factors involved in the inception of this project.

Highlighting how many of the facets of play--a willingness to improvise, to break the rules, an openness to novelty--are integral to the very definition of creativity, Bateson and Martin (2013) identify 'play' according to the following criteria:

- "the behaviour is spontaneous and rewarding to the individual
- it is intrinsically motivated and its performance is a goal in itself
- the behaviour occurs in a protected context when the player is neither ill nor stressed
- the behaviour is incomplete or exaggerated relative to non-playful behaviour in adults
- it is performed repeatedly" (p. 2)

Given that only the first of the twelve creative events in the project documented here conform to the majority of these criterion, and a number align with none other than that referring to repetition, the presence of play was at best fragmentary and at least compromised for the majority of this study. This may well account for the entire collapse of creative motivation and fluency on occasions. The repetition and routine itself providing both a space for sanctuary and cause itself of inhibition and almost traumatic experience when creative activity was mandated at acutely unreceptive points.

Creativity, whether defined using Guilford's framework of convergence and divergence (1952) or Torrance's (1972) extended focus on fluency, flexibility, and originality (Bateson and Martin, 2013), nevertheless represents the application of imagination in the development of definable or determinable outcomes, and was, ultimately, realised on each occasion of compositional activity in these terms. Nevertheless, the compositions characterised by highest levels of creative flow and peak experience corresponded directly and routinely to those experienced most playfully, and the less playful the activity, the lower the perceived quality of musical results in general terms as well as creative experience.

Working creativity

> "Choose a job you love, and you will never have to work a day in your life."
> —Confucius

Citing Stokes, Paul and Kaufman (2014) identify "cognitive playfulness and cognitive workfulness" (p. 171) as prerequisites for successful and pur-

poseful creative endeavour. All creative activity being constrained at least by some framework of convention in order to be realised and recognised—compromise being necessary to conform with some level of predetermined expectations—the pressure of constraint and boundary contributed to the development of creative insight in this project, reflecting the freedom/constraint paradox recognised more widely (Rosso, 2014). Whilst it can be tempting to associate creativity particularly in the arts with unstructured and free activity, the imposition of boundaries and more concrete objectives can aid creativity. Indeed, as observed by Biskjaer & Halskov (2013), 'decisive constraints' can themselves lead directly to innovation.

The 'workfulness', the discipline and conformity, the limits and boundaries, provide both for the perfect conditions for creative insight, and a challenging environment for a sense of play. Nevertheless, the desire to transcend the constraints of boring or even negative constraints (to break free) can be a powerful, and the creativity of subversive behaviour can be reward in and of itself. Focusing on the intrinsic rewards and experience of different forms of activity, Csikszentmihalyi (2014) highlights the direct connection between creativity and play in the development of creative 'flow' (p. 135). Play being the exercise and application of imagination, and imagination being simply the ability to "mentally transcend time, place, and/or circumstance" (Taylor, 2013: 3), the experience of flow itself is characterised by the transcendence of time, the perceived ease and fluency by which creative ideas and creative processes align, leading often to a wider experience of serenity and calm. Creative flow is an empowering and rewarding experience and can often emerge when overcoming problems as well as when dealing with perfect creative conditions.

Creativity in music is multifaceted and undoubtedly workful in being domain centred and stylistically appreciable. As observed by Burnard in Odena (2012), multiple creativities are present in music each subject to greater uncertainties of definition in the context of technologically and socially situated musical creativity. There being tensions between established cultural systems delineating forms of musical creativity, and the proliferation of new forms of collective musical creative activity, the simple involvement of networked computing in creative activity creates ambiguity and uncertainty. Computers make everything and nothing possible simultaneously. On the one hand, the range of choice to too broad, distracting attention towards filtering of options and possibilities, on the other, the opportunity to focus attention on fine details and to access parameters with which to play can provide fertile ground for creativity and inventiveness.

Creative pain and elevation

The single most unusual experience of this project was that of the most acute creative duress. Having sought initially to ring-fence time to defend and protect creative space, the mandatory aspect of compositional activity on oc-

casions became acutely stressful. Providing a stark indicator of the impact of wider personal circumstances on creative motivation, the experience of creative distress, whilst not an unfamiliar experience by any means, was nevertheless concentrated by the project parameters and consequently experienced in almost visceral terms.

On one occasion in particular, the process was so precariously balanced on the boundary of abandonment to have created almost creative crisis. I have never composed music so unwillingly or found the tools at hand so inhibitory or unintuitive to operate. I learnt nothing, gained nothing, and produced low quality ideas. Only on reflection is it possible to gain any form of value in terms of a better understanding of creative self and the need to evaluate approaches to creative practice in the context of wider responsibilities and distractions. Distinct from the experience of 'writer's block' (Flaherty, 2004), an experience familiar but not actively encountered in this project except fleetingly where creative flow dipped to low levels, in general the difficulty developing pleasing musical ideas tended to correlate with periods where motivation to succeed was also extremely low. There was not so much an experience of frustration at difficult points, as resigned misery. At times, 'cognitive flexibility and persistence' (Gutnick et al, 2012) was dulled to the point of negligibility.

However, whilst perfect circumstances may not have been established at any point in this project, constraint and even difficulty did lead to creative insight and creative elevation and flow. On more successful occasions, creative elevation, or the experience by which a high degree of germinality is experienced in the development of musical ideas, occurred quite spontaneously, often in the face of uncertainty or even disinterest. On numerous occasions, the translation and documentation of musical ideas—the programming of sound events and related signal processing—led to results deviating from that originally envisaged, but in pleasingly unexpected ways. The sensation of following the composition rather than dictating it is perhaps the simplest way of articulating the distinction between creative elevation and creative flow or peak experience. Whilst progress may be difficult, sometimes the musical ideas seem to come alive by themselves and determine their own development and direction. Such experiences occurred in conjunction with creative flow and high levels of creative enjoyment, but also occurred unexpectedly during periods of creative uncertainty, pressure and stress.

Summary and conclusions

Considering the notion of creative transference, and the extent to which creative expertise can be translated across creative domains, initial assumptions about the inhibition of creativity as a consequence of the practical challenges of professional life may well be somewhat misplaced. Whilst of course there is an inevitable compromise over autonomy in the vast majority of pro-

fessions and life circumstances, and consequent reduction in time available for many activities, personal creativity is ultimately a matter of choice not of circumstances. One of the most significant realisations resulting from this project is simply that many of the same patterns of thinking and doing I associate with compositional activity, I also associate with approaches to other non musical activity. Quite simply, I have transferred aspects of the way I work musically into other activities, and manage to accept long periods of time between explicit acts of musical composition because I retain the ability to develop musical ideas with complete freedom, and have avenues to direct my predisposition towards aesthetic manipulation and communication of concepts and ideas in many other areas.

Whilst opportunities for play—creativity for creativity's sake—may become scarce for many reasons, they never entirely disappear. As with creativity, play is a matter of choice not of circumstance, and whilst the inhibitory factors depressing playfulness may well be acute to the point of being insurmountable on occasions, there can be value in deliberate acts of play from a personal well-being perspective. Indeed, there simply not being the time may be the very reason to make time. Whilst some creative activities in this project proved to be negative or to incorporate at least difficulty, there was in general benefit evident in the creative routine perceived in overall terms. From positive reflection of a creative event providing an obvious boost to mood, the background anticipation of forthcoming compositional activity also developed a structured framework for musical thinking and ideation. From aimlessly imagining musical thoughts, more focused and more playful musical thinking developed throughout the project. Perhaps most importantly, there was a sense of creative identity being rediscovered and reaffirmed.

Ultimately, this project became a journey of personal rediscovery, reflection and evaluation. Whilst not enamoured by much of the resulting musical ideas, there are, nevertheless, a number of elements to which the prospect of future return is enticing. Identifying, pleasingly, that the core of my own creative being remains marked by creative optimism and confidence, when things did not go well, external factors remained quick to be identified and blamed, whilst corresponding success was routinely internalised and claimed in a very personal way. Even in the case of the creative low point in the project, where some degree of recovery was required, the experience has no substantial impact on the perception of subsequent creative activity. There being no expectation necessarily that outcomes would always be positive, there was never a fear of negative outcomes and any subsequent 'avoidance motivation' (Icekson et al, 2014) stemming from this.

Reflecting on the questions introduced earlier in this text:

- What happens if you impose limitations on creative activity?

Constraint is inevitable and can provide either a positive or a negative influence on creative activity. Limitation can also be conceived of in different

ways. The limitation of composing purely for piano simply opens freedom to focus compositional thinking in other areas, whilst the liberation of computer-based sound resources nevertheless limits scope for simple choices during the creative process. Limitation necessitates adaptation and subversive approaches to convention in order to reach new territory. Lack of time forces speed of thought, lack of motivation leads to laziness, shortcutting and patterned behaviour, and lack of materials forces appropriation and modelling of ideas; all of which can lead to new ideas that may not have emerged under less constrained conditions. Nevertheless, impose the perfect negative cocktail of constraints on creative conditions, and the impact can inhibit all connection with creative activity and invert all usual associative experiences.

- Why are there limitations on creative activity?

Limitations, or at least boundaries, are necessary both to define the creative activity and to determine the framework through which it can be subsequently evaluated. From the perspective of this project, compositional methods returned both to familiar patterns of working and to known sound sources and musical language. Perhaps the ultimate limitation being that of creative self, whilst this is hoped to be full of as yet undiscovered possibility, the familiarity of personality, or creative idiolect, is a necessary and inevitable commonality in all creative activity.

- Are creative inhibitors real?

Beyond practical inhibitory factors, and those conceptually with potential to enrich as much as compromise creative activity, lie the most erosive and destructive; the imagined. Albeit experienced very much as an almost concrete cognitive barrier, the mental capacity to even open thought processes to creative ideas can be hugely disrupted given appropriate external pressures. Whilst creative flow is effortless and even rejuvenating, creativity requires energy to begin. Physical fatigue itself is not necessarily problematic, and indeed can contribute towards development of more relaxed states of mind, but mental fatigue can be extremely difficult to overcome with anything other than sleep. Consequently, whilst invisible, the most inhibitive factors encountered during the course of this project were not time, routine, or the commitment to publication, but were always those related to the level of creative energy available. Where personal circumstances provide opportunity carve out time for creative pursuits, there may also need to be supplementary attention to the maintenance of creative energy and motivation.

- What are the implications of creative inhibition?

From a personal perspective, the implications of creative inhibition related to the loss of motivation or even negative creative experience, are trou-

bling. That an activity such as the composition of music could move from being an effortless, accessible, and relished endeavour, to become a marginalised, difficult and even traumatic experience depending on the circumstances involved, is at least a disappointing point to reflect upon. Nonetheless, the affirmation experienced through more a structured compositional routine provides more than sufficient compensation. The implication of creative inhibition is simply adaptation. Solutions will be found to limit negative creative experience not by avoiding the activity, but by altering the process. The parameters will be loosened and a focus on rejuvenating playfulness in creative methods will be explored. Not for the sake of creativity, but for the sake of play. Whilst there may well be a close association between creativity and nightmares (Hartmann & Kunzendorf, 2013), to live without creative practice would be unthinkable.

> "Creative work is not a selfish act or a bid for attention on the part of the actor. It's a gift to the world and every being in it. Don't cheat us of your contribution. Give us what you've got."
> — Steven Pressfield (2002)

Bibliography

Benedek, M, Franz, F, Heene, M & Neubauer, A. C (2012) *Differential effects of cognitive inhibition and intelligence on creativity*, Personality and Individual Differences, Vol 53, Issue 4, September 2012, pp. 480–485.

Bateson, P & Martin, P (2013) *Play, Playfulness, Creativity and Innovation*, Cambridge University Press.

Biskjaer, M. M & Halskov, K (2013) *Decisive constraints as a creative resource in interaction design*, Digital Creativity, Vol. 25, Issue 1, pp. 27-61.

Carson, S. H., Higgins, D. M. & Peterson, J. B (2003) *Decreased Latent Inhibition Is Associated With Increased Creative Achievement in High-Functioning Individuals*, Journal of Personality and Social Psychology, Vol. 85, No. 3, pp. 499 –506.

Csikszentmihalyi, M (2014*) Flow and the Foundations of Positive Psychology: The Collected Works of Mihaly Csikszentmihalyi*, Springer Press.

Csikszentmihalyi, M & Sawyer, K (1995) *Creative Insight: The Social Dimension of a Solitary Moment*, pp. 73-98, in Csikszentmihalyi, M (2015) The Systems Model of Creativity: The Collected Works of Mihaly Csikszentmihalyi, Springer.

Deliège, I. & Wiggins, G. Eds. (2006) *Musical Creativity: Multidisciplinary Research in Theory and Practice*, Unit for Research in the Psychology of Music Irene Deliege, Geraint A. Wiggins Psychology Press.

Gutnik, D, Walter, F, Nijstad, B. A & De Dreu, C. A. W (2012) *Creative performance under pressure: An integrative conceptual framework*, Organizational Psychology Review, Vol. 2, No. 3, pp. 189-207.

Flaherty, A. W (2004) *The Midnight Disease: The Drive to Write, Writer's block and the Creative Brain*, houghton Mifflin Books.

Hartmann, E & Kunzendorf, R (2013) *Thymophor in Dreams, Poetry, Art and Memory: Emotion Translated into Imagery as a Basic Element of Human Creativity*, imagination, Cognition and Personality, Sage Journals, Vol. 33, no. 1, pp. 165-191.

Icekson, T, Roskes, M & Moran, S (2014) *Effects of optimism on creativity under approach and avoidance motivation*, Frontiers in Human Neuroscience; 8: 105.

Lieberman, N. J (1977) *Playfulness: Its Relationship to Imagination and Creativity*, Academic Press.

Nowell, A (2016) *Childhood, Play and the Evolution of Cultural Capacity in Neanderthals and Modern Humans*, The Nature of Culture, Vertebrate Paleobiology and Paleoanthropology pp 87-97.

Odena, O (Ed) (2012), *Musical Creativity: Insights from Music Education Research*, Ashgate Publishing Ltd.

Paul, E. S.& Kaufman, S. B (2014) *The Philosophy of Creativity: New Essa*ys, Oxford University Press.

Pressfield, S (2002) *The War of Art: Break through the Blocks and Win Your Inner Creative Battles*, Black Irish Entertainment LLC.

Rosso, B. D (2014) *Creativity and Constraints: Exploring the Role of Constraints in the Creative Processes of Research and Development Teams*, Organization Studies, Vol. 35, no. 4, pp. 551-585.

Russ, S. W & Wallace, C. E. (2013) *Pretend Play and Creative Processes*, American Journal of Play 6.1 (Fall 2013): 136-148.

Russ, Sandra W. (2014). *Pretend play in childhood: Foundation of adult creativity*. Washington, DC, US: American Psychological Association, ix, 241.

Sacks, O. (2011) *Musicophilia: Tales of Music and the Brain*, Picador.

Spielberg, S. (1977) Close Encounters of the Third Kind, Columbia Pictures Corporation.

Taylor, M (Ed) (2013) *The Oxford Handbook of the Development of Imagination*, Oxford University Press.

Wilson, C & Brown, M (2015) *Ambiguity, Uncertainty and Flexibility: Perspectives of Creative Value, Utility and Authenticity*, KIE Handbook of Creativity.

Correspondence
Christopher Wilson
Learning Enhancement Manager, BMus (Hons), MPhil, PG Cert HE, SFHEA
University of Derby, UK
Email: c.j.wilson@derby.ac.uk

Michael Brown BSc (Hons)
Senior Lecturer in Music, MA, PGCE, AMusLCM, FHEA
University of Derby
United Kingdom
Email: m.brown2@derby.ac.uk

Authors' Brief Bios

Chris Wilson is the Learning Enhancement Manager at the University of Derby in the UK and an active composer and educator. He is a classically trained violinist, composer and practitioner in the technological arts, and has published, and presented internationally on the subjects of creativity, artistry, project management, and education. With a musical teaching career He now leads university projects and works with national and international organisations in the development of creative learning and teaching practice.

Michael Brown is the Programme Leader for the BA (Hons) Music degree in the College of Arts, at the University of Derby in the UK. He holds diplomas in both Art and Music, a BSc (Hons) degree in Software Engineering, Mathematics and Music, and a Masters degree in Contemporary Composition, which combine to serve his interest in computer creativity. He is a Principal Researcher with over twenty-five years of teaching experience, an active artist, composer and musician. As well as maintaining his professional role, he is a member of the American Creativity Association and has presented his research in multimodal creativity internationally.

CHAPTER FOURTEEN

INTELLIGENCE AND CREATIVITY RECONSIDERED

RICK KANTOR

Establishing a distinction between Creativity and Intelligence was a top priority in the early days of creativity research and study. Why, the argument went, was there a need to establish Creativity as a unique field of study if there was a direct correlation to Intelligence (Runco, 2007, p. 2)? Wouldn't a person's intelligence quotient (IQ) tell you how creative they were?

In fact, Getzels and Jackson's early research seemed to suggest that Intelligence and Creativity were not clearly distinct (Runco, 2007, p. 3). Our own personal experiences with so-called 'eggheads', as the extremely intelligent were called back in the days Dr. Guilford was cheering on the nascent field of Creativity, might have suggested the research was flawed. Those brilliant scientists and professors, with pen protectors in their shirt pockets, were often so focused on their own research that creative skills and temperaments like openness, flexibility, tolerance of ambiguity, and non-conformity were as unlikely to be found in those days as females in charge of the scientific research.Thankfully, times have changed and that imperfect research of Getzels and Jackson has been reconsidered. The Threshold theory became the third rail of creativity theory, the universally accepted research results about how creativity and intelligence intersect (Sternberg, 1999, p. 47). It posits that a minimum level of basic intelligence—as measured by IQ--is required for creativity, the nexus of novel and useful, to be possible. Below an IQ of 80 there simply isn't enough brainpower to fire the creative engine. Further study by Sternberg, Kaufman and Pretz (Kaufman & Sternberg, 2006, p. 15) found that 'creatives' seemed to have above average IQ's. Higher IQ's; however, did not yield higher creativity. An IQ of 120 appeared to be the maximum number at which greater intelligence no longer affected creativity. Simonton and Sternberg added that extreme IQ—up in the Mensa stratosphere of gifted intelligence—was actually detrimental to creativity (Kaufman & Sternberg, 2006, p.15). Qualifications were noted, that which aspects of creativity and intelligence were being measured did affect the intelligence—creativity relationship.

We might summarize this, as Runco does, by saying "intelligence is necessary but not sufficient for creative achievement"(Runco, 2007, p. 7).This tidy consensus about the distinction between creativity and intelligence gave

the green light for Creativity as a field to advance on its own: to receive research funding and begin it's painfully slow march toward acceptance as a bona fide stand alone field of study; a science; a skill set that could be taught. This progress was less a parade than an incremental step by step fight for respectability from resistant academics and scientists who doubted that there could be rigor in such a field. To this day, skeptics are not uncommon.

Thanks to the pioneering, inspired, and dedicated work of Dr. E. Paul Torrance ways were found to test creativity along the matrices of flexibility, fluidity, elaboration and originality (Kaufman & Sternberg, 2010, p. 418). The importance of Dr. Torrance's work cannot be over emphasized. Now creativity could enter the classroom, to be valued as an attribute, a kind of intelligence worth testing in children. If there was any downside to the seismic push Dr. Torrance gave to understanding creativity, it might it be that the TTCT (Torrance Tests of Creative Thinking) allowed others to confirm their suspicions that some people are just born creative, unlike the rest of our 'normal', conformist society. A few other correlates, like the necessary intelligence, were uncovered as well in our attempts to analyze this amorphous, ephemeral, stochastic capacity called creativity. It should be noted here that most assumed creativity was synonymous with ideation, originality and unexpected, spontaneous thought. It would be some years before other necessary types of creative thought would be recognized. The work of Dr. Gerard Puccio (www.foursight) and Min Basadur (www.basadur) elaborated on Osbourne's Creative Problem Solving model succinctly. They described the four styles of creative thought needed to maximize creative processing of an issue: clarifying the task, idea finding, developing the solution, and implementing it. The brilliance of this theory was it gave a powerful answer to the majority of people who, to this day, insist, "I'm just not creative", meaning to say that they are not effective ideators. Every homo-sapien, at least those with an IQ above 80, is either creative or they're dead. Ask any caveman. Or cavewoman. We could explore endless other variables affecting cognition and creative performance. For instance, low emotionality or alexithymia seems to inhibit fantasy and imagination. This led Averill to conclude that creativity can be found on the Venn diagram where cognition and emotion meet (Kaufman & Sternberg, 2006, p. 205). Generosity, curiosity and motivation are co-factors in creativity as well, but do not appear to have a correlation to intelligence. This, in an abbreviated, incomplete nutshell, is the role of intelligence in creativity circa 2002, the date of the Sternberg, Kaufman and Pretz study (Kaufman & Sternberg, 2006, p. 15).

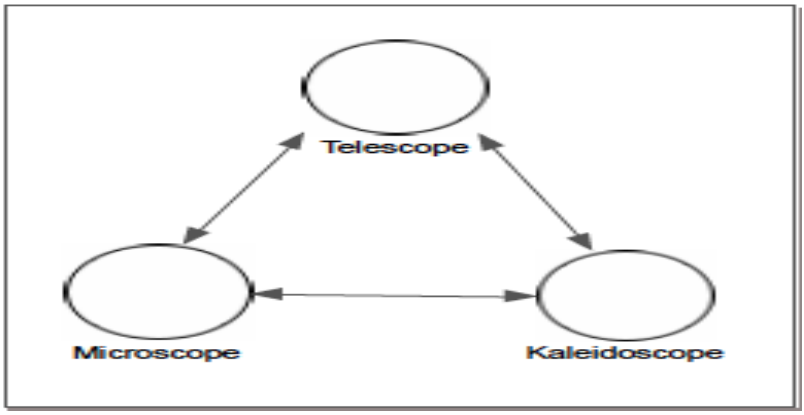
Then something happened. The world turned upside down, and was catapulted at warp speed into the future. The digital revolution took hold on a massive scale. The first dot com bubble burst in 2001 only to spread its seed further and farther as the wins of globalization found fertile fields everywhere. The Internet changed everything that had anything to do with information: sales marketing, research, science, creativity, arts, engineering, education, healthcare, human resources, and business. The list goes on. The pace

of change rendered old ways of doing things ineffective. The shelf life of products decreased dramatically as the need for new products skyrocketed, Customer tastes changed faster than lipstick colors. A new transparency allowed comparative analysis, resulting in new awareness's and dissatisfactions (the Arab Spring and income inequality come to mind). Some companies, like Apple, managed to get ahead of the curve. They presented new satisfactions before we even knew we were dissatisfied: digital music that put 1000 songs in our pockets and suitcases, phones that were computers, and social media that connected us in ways we weren't always sure we wanted. By 2010 the writing was on the wall. The famous (at least in Creativity circles) 2010 study by IBM of 1500 CEO's found creativity to be the number one predictor of corporate success (www.03.ibm), the leading quality that HR must now add to the top of a list that included TQM, Six Sigma, Lean, GTD and productivity, EQ emotional intelligence, to name a few. For anyone familiar with Bloom's taxonomy or Maslow's hierarchy, IBM only confirmed what we already knew: creativity is actualization at its peak, whether individual or organizational. To the extent we are creative with novel and useful expressions of products, services and relationships of every kind, we are maximizing our ability to be generative, happy, and, to the applause of shareholders at stockholder meetings, profitable. All Hail Creativity and Innovation! Perhaps it is my own contrarian streak or those creative qualities within me that like complexity and ambiguity, resisting premature closure for neat answers after having won the hard fought battle for creativity's ascendancy and respectability. But I find myself the unlikely voice asking, "What about Intelligence? Perhaps the nature of intelligence and of knowledge has changed and so too its relationship to Creativity?" Do we need to know more today to be intelligent enough to be creative? Does that magical 120 IQ number need to be ratcheted up as our knowledge now doubles every 12 months soon to be every 12 hours? (www.industrytap.com)The corollary to this question opens the gate to trot out another old Creativity warhorse: is creativity domain specific or domain general (Baer in Kaufman & Stern, 2010, pp. 321-341)? Are there creative skills, processes and personality constructs that extend beyond domain borders that render an individual a 'creative'? Or do we need to be more deeply immersed in the industry to have the technical, state of the domain knowledge to be able to know what both novel and useful look like?

To use colloquial language, is creativity 'thinking outside the box', or inside the box? Or as Chris Bilton suggests, do we need to be on the edge of the box (Bilton, 2007, p. 6)?Today's organizational approach that cleverly avoids having to enter into this Mobius strip of a question is the almighty, collaborative team. Rather than telling HR they must roundup a stable full of modern-day Renaissance (Wo)Men, modern day da Vinci's who are as brilliant intellectually as they are creative and artistically talented, companies today buy conference tables and surround them with a team of specialists. No one person today can possibly embody the requisite depth of knowledge in any specialty within a field and still have time to eat and exercise, let alone

achieve mastery in other areas of knowledge. As Aaron Shields smartly observed, the team is today's Renaissance (Wo)Man (www.cultbranding)This suggests to me that new heights of intelligence—that amalgam of many intellectually intense, specialized types of knowledge—are needed to produce the novel and useful 'stuff' we call creative. But, does all that heightened intelligence have anything to do with creative aptitude? Or are you surrounding that table with geniuses in their specialized fields (if not overall IQ scores)—whose heightened intellects are, as Sternberg discovered, limiting their creative capabilities (Kaufman & Sternberg, 2006, p. 15)?This question is intensified by the speed at which the world rotates now (this is of course, a symbolic metaphor only, unlike global warming) which threatens to topple it from its axis! Consider the unfortunate timing of Einstein, the first name on the genius list for most of us. Even in his own time, way back in the 20th-century (or "the 19's" as some millennial's refer to the last century) his genius couldn't keep up with the changing Domain. His intellectual genius was in field theory physics. But when the field moved on to quantum-mechanical theories of matter he was left behind like a gas guzzling Cadillac in an era of Tesla electric cars.How de-motivating this must have been for Mr. Einstein: genius one day, yesterday's news the next. At least he had a good long run leading the field. How long do you suppose that supremacy could last today? Since motivation has been unequivocally shown to be a critical factor in creative performance, thanks to the work of Dr. Amabile (Ruscio & Amabile, 1999, p. 2), how do we sustain intrinsic motivation in our teams, our organizations, and ourselves in the face of such a rapidly changing field?

How do we use today's information overload and rapid pace to build a systemic, sustainable architecture of creative accomplishments? What type of structure can effectively process all the information we need to maintain our organization's market dominance amidst the seeming chaos? How can we retain our diverse, specialized, and motivated teams that can find opportunity in constant change?Pondering the scope of this problem, a triangular shaped diagram took shape in my mind. I call it:



"The 3 Scopes of Organizational Intelligence": the telescope, the microscope and the kaleidoscope.

The Microscope: Intelligence today is highly specialized in every field. The technological knowledge requirements alone disqualify most people over 50. Over 40? 30? This is unlikely to reverse itself—although robotics solutions (such as those being used in surgery) may be our required assistants. Our workers will be schooled not as generalists (goodbye liberal arts, as we're already seeing) but as niche experts. There simply isn't enough time to master more fields of knowledge. This kind of silo-ing could well produce its own Tower of Babel within our companies, in spite of free cafeterias encouraging" weak ties" and informal networks; or the clever positioning of restrooms to force cross-fertilization among our specialist worker bees in need of a bio break. ***The Kaleidoscope***: these are our creative generalists, individuals who see commonalities where others don't. They are the bridges, the connectors, the 'zero-gravity thinkers' (Rabe, 2006, p. 59). They are the artists, the provocateurs, and the Technicolor generalists in a black-and-white world of specificity. If they don't exist within your company, import them! These are the minds that catalyze, synthesize, generalize, open eyes, de-compartmentalize, resize and revise. Although their intelligence is likely above average, their IQ numbers probably hover around they're bowling scores at a modest 110 to 120!

Invoking the Japanese proverb, "You can either dig one hole 50 feet deep or 50 holes 1 foot deep" these creative kaleidoscopic folks finished digging their 50 holes long ago. With new shovels, they'll continue to dig into fresh soil—while our 'microscopes' keep tunneling deeper and deeper. Putting the Kaleidoscope and the Microscope together can yield fantastically creative results… that are sometimes not at all useful. Or their creation may be obsolete before it's completed. Enter…***The Telescope:*** (or if the silo effect in your organization is especially intense this may need to be a *Periscope*!). According to the Oxford dictionary the telescope "is designed to make distant objects appear nearer, containing an arrangement of lenses or of curved mirrors and lenses, by which rays of light are collected and focused and the resulting image magnified" (www.oxford dictionaries). If the taxi industry had a telescope, UBER wouldn't have a valuation today of $62.5 billion (www.wired); the New York Times would have a Buzz Feed division, and Hollywood would be the world's biggest video game designer.

The telescope, like the microscope, is a conduit of intelligence but strictly focused outside the organization, not only at the rest of the domain but also to the world at large. It can focus on the competition but if it's doing its job spotting trends and capturing more global forces and intelligence there is no real competitive threat.

Futurist Faith Popcorn (www.faithpopcorn) is a high-powered telescope. Long before there were personal computers or the Internet of information, Ms. Popcorn's teams were calculating the column inches in local newspapers devoted to new topics. This rudimentary technique allowed her team to quantify what consumers would be caring about tomorrow. If this sounds massively antiquated, it is in tool only, not in the essential nature of its information.

For creativity and intelligence to work synergistically to anticipate tomorrow's needs and build those creative solutions, telescopes and futurists need to be beaming continuous feeds of information. Transforming that information into tomorrow's novel and useful products and services is the five-step task of your organization.

This is best described by productivity expert, best selling author and information visionary David Allen (www.getting things done):

- Capture-collect what has your attention
- Clarify-process what it means
- Organize—put it where it belongs
- Reflect-review frequently
- Engage-simply doHow does an organization provide itself with this comprehensive external intelligence, this state of the moment knowledge? Just as forward thinking organizations like General Mills have a Chief Creativity Officer, organizations must have dedicated departments for global intelligence and trends (www.forbes).

In researching "Chief Information Officer" and "Chief Intelligence Officer", the results are disappointing though not surprising. These 'telescopes' are singularly focused on events within their domain. There is even a professional group called "Strategic and Competitive Intelligence Professionals". Wikipedia describes competitive intelligences as "organizational functions responsible for the early identification of risks and opportunities in the market before they become *obvious*." The description explains, "Organizations which employ intelligence officers include armed forces, police, civilian intelligence agencies, customs agencies and private corporations" (Wikipedia, Intelligence Officer).

Further, "one of the major activities involved in corporate competitive intelligence is use of ratio analysis, using key performance indicators (KPI). Organizations compare annual reports of their competitors on certain KPI and ratios which are intrinsic to their industry" (Wikipedia, Competitive Intelligence). Researching the descriptors of these intelligence and information functions the word "creative" does not appear even once. The militaristic, competitive, zero-sum game approach seems to preclude the kind of information that visionary creatives could use. This is not the telescopic scan of the universe that would adequately supply useful, current information to our highly intelligent, expansively creative teams. Intelligence is a crucial component of creativity but it is not sufficient. Creativity is a critical capacity for every organization today, but it is not sufficient.

Real-time knowledge of the forces shaping our planetary reality, customer preferences, and rapidly shifting lifestyle possibilities is necessary… but it is not sufficient, either. If, however, your organization is structured to integrate the specialized intelligences of its human capital; it practices and promotes creativity; and builds active networks of knowledge and awareness of the outside world that is constantly recalibrating, then you are poised for con-

tinuous reinvention and success. This is the kind of creativity that is both systemic and sustainable.

The relationship of Creativity and Intelligence has been an essential question to be grappled with ever since 1950 when Dr. Guildford's address to the Psychological Association launched renewed efforts to build a bona fide field of Creativity study (Kaufman & Sternberg, 2010, pp. 416-417). Today, more than ever, our organizations' abilities to integrate Creativity and Intelligence ubiquitously into everything they do will determine their ability to thrive as they continually reimagine their missions in a fast changing world.

My name is Rick Kantor and I live to see creativity happen in the world. Our workplaces and schools can be the incubators for great flights of thinking that can be tomorrow's innovative successes.

Creativity and entrepreneurship have been the twin passions of my life, which if you live long enough and productively will be called a career. I've learned a few things along the way, which I'm privileged to share now through teaching, consulting, workshops and speaking. My Masters in Creativity and Innovation from Drexel University in 2015 was preceded by a Fine Arts BFAdegree from Sonoma State University in California and a Bachelors in Psychology and modern dance from Oberlin College. Currently, I'm thrilled to be an adjunct instructor for Creativity in the Workplace for Drexel University graduate students and undergraduate entrepreneurs.

I've designed products for the gift, novelty and stationery market, started lifestyle furniture stores in New York City, ran my own faux-finish decorative painting business in New York; served as a marketing and business consultant to David Allen, best-selling author of, "Getting Things Done". My 1991 start-up company, Pony Express Creations, Inc. achieved that rare 'American Dream' success story of creating a single, best-selling product, with no money or business degree, and growing it into a successful international business. As the leading manufacturer of original novelty headwear, Halloween products and wigs, we manufactured iconic designs for every major theme park worldwide, and designed the first hat collection for Cirque du Soleil.

I live north of San Francisco with my husband and labradoodle, am a qualified yoga practitioner and teacher, currently enjoy cross fit; I'm an avid art enthusiast, maker, and collector; for a time produced Broadway musical theatre. I currently serve as Secretary of the American Creativity Association. My purpose is to be a catalyst for tomorrow's creative products services and companies. I know that your creativity is as critical to the survival of the planet as it is to building a thriving organizational culture and a vibrant fulfilling life.

References

Allen, D.: Getting Things Done. Retrieved April 12, 2016 from getting thingsdone.com/fivesteps.

Baer, J. (2010). *Is creativity domain specific?* In Kaufman, J. & Sternberg, R. (2010). *The Cambridge Handbook of Creativity.* New York, N.Y.: Cambridge University Press.

Basadur, M. Retrieved April 14, 2016 from www.basadur.com/howwedoit/ The Basadur profile/tabid/83/default.aspx.

Bilton, C. (2007). *Management and Creativity, from creative industries to creative management.* Malden, MA: Blackwell Publishing.

Faith Popcorn's Brain Reserve. Retrieved April 17, 2016 from www.faithpopcorn.com.

General Mills hires a Chief Creative Officer. Retrieved April 17, 2016 from www.forbes.com/sites/michael/ec/2014/09/23/general-mills-hires-a-chief-creative-officer-is-this-crazy-or-the-future/#44330ff25abc

IBM 2010 Global CEO Study: Creativity selected as most crucial factor for future success. Retrieved may 10, 2015 from: https://www-03.ibm.com/press/us/en/pressrelease/31670.wss

Industry tap into news. *Knowledge doubling every 12 months, soon to be every 12 hours.* Retrieved April 15, 2016 from www.industrytap.com/knowledge-doubling-every-12-months-soon-to-be-every-12-hours/3950.

Kaufman, J. & Sternberg, R. (2006). *The International Handbook of Creativity.* New York, N.Y.: Cambridge University Press.

Kaufman, J. & Sternberg, R. (2010). *The Cambridge Handbook of Creativity.* New York, N.Y.: Cambridge University Press.

Oxford Dictionary. Retrieved April 16, 2016 from www.oxforddictionaries.com/us/definition/american_english/telescope.

Puccio, G. Retrieved April 14, 2016 from www.foursightonline.com

Rabe,C.B. (2006). *The Innovation Killer, how what we know limits what we can imagine—and what smart companies are doing about it.* New York: Amacom Books.

Runco, M.A. (2007), *Creativity theories and themes: research, development, and practice.* Burlington, MA: Elsevier Academic Press.

Ruscio, J. & Amabile, T. (1999). *Talent Development III,* pp. 119-132. Tucson, AZ: Great Potential Press, Inc.

Shields, A. (Aug. 2008). *Creativity in the Workplace.* Retrieved March 2014 from www.cultbranding .com.

Sternberg, R.J. (1999). *Handbook of Creativity.* New York, N.Y.: Cambridge University Press.

Wired, retrieved April 17, 2016 from www.wired.com/2015/12/airbnb-confirms-1-5-billion-funding-round-now-valued-at-25-5-billion/

Wikipedia Intelligence Officer. Retrieved April 13, 2016 from https://en.wikipedia.org/wiki/intelligence_officer

Wikipedia Competitive Intelligence. Retrieved April 13, 2016 from https://en.wikipedia.org/wiki/Competitive_intelligence.

Correspondence

Rick Kantor, MS
6975 Eagle Ridge Road,
Penngrove, CA 94951, USA
& Drexel University Adjunct Faculty in Creativity and Innovation
Email: rick@rickkantor.com

Author's Brief Bio

Art and entrepreneurship are the twin life-long passions that drive Rick's current academic study in the field of Creativity. His 2015 Masters Degree in Creativity and Innovation from Drexel University, under the guidance of Fredricka Reisman, compliments an Oberlin College BA in Psychology and a Bachelor of Fine Arts from Sonoma State University. His successful business ventures have included designing novelty products and stationery for the gift market, a New York City decorative painting and faux finishing company, lifestyle furniture stores in Manhattan, an international Halloween and novelty hat corporation, and a natural materials design showroom and distributorship in Northern California. He has worked as a consultant to the David Allen Company and David Allen, best-selling author of "Getting Things Done." Rick is an avid art collector, art maker, yoga practitioner, public speaker, and inspirational volunteer to young schoolchildren. His diverse and eclectic background uniquely informs his current creative consulting work, executive coaching and public speaking engagements. Rick thrives on being the creative catalyst of great flights of productive inspiration for individuals and com-

panies alike. He currently serves as the Secretary for the American Creativity Association.

CHAPTER FIFTEEN

LEARNING CREATIVELY IN A STUDENT-MANAGED FUND

MAURA ANN DOWLING

Abstract

The Archway Investment Fund (AIF) at Bryant University was designed to blend financial theory and practice in an undergraduate program where students managed $500,000 which has now grown to just over $1mil. Finance is easy to teach from a strategic standpoint. However, to activate a creative and differentiated awareness on the part of the student is a worthy challenge. In fact the students' earliest instruction of finance has to be overcome for this to happen. Applying a creative learning process where the answers to questions are not merely derived through mathematical operations but rather inquiry, individual concerns and communal structures takes both Archway finance classes into zones of ambiguity that surprise and delight students and faculty. This paper will detail learning practices and outcomes of this program.

Keywords: creativity, finance, learning, extrinsic, intrinsic, motivation

The Archway Investment Fund at Bryant University—An Overview

> *"Money should be of service to us, rather than rule over us."* Pope Francis (Fares 2015 p.68)

Nestled between the state capitals of Boston in Massachusetts and Providence in its home state of Rhode Island, Bryant University is located on an enclosed suburban campus in Smithfield in the northeastern United States. Bryant is a private co-ed university comprised of the College of Business, the College of Arts and Sciences, and the School of Health Sciences. One of the largest undergraduate concentrations for the Bachelor of Science in Business Administration is finance.

When combined with the International Business program's finance concentration the Department of Finance typically graduates more undergraduates than any other undergraduate program at Bryant. The Department of Fi-

nance is part of the AACSB accredited College of Business at Bryant. AACSB is The Association to Advance Collegiate Schools of Business, is an international accreditation body. In AACSB's Eligibility Procedures and Accreditation Standards for Business Accreditation it states in the January 31, 2016 Preamble:

> The business environment is undergoing profound changes, spurred by powerful demographic shifts, global economic forces, and emerging technologies. At the same time, society is increasingly demanding that companies become more accountable for their actions, exhibit a greater sense of social responsibility, and embrace more sustainable practices. These trends send a strong signal that what business needs today is much different from what it needed yesterday or will need tomorrow….In today's increasingly dynamic environment, business schools must respond to the business world's changing needs by providing relevant knowledge and skills to the communities they serve. They must innovate and invest in intellectual capital; they must develop new programs, curricula, and courses.

In 2005, Dr David Louton, Professor of Finance, with the support of Bryant University's administration, faculty, alumni and staff led the formation of an innovative undergraduate finance program called the Archway Investment Fund (AIF). This program educates students through learning about financial theory and investment practice by managing a fund of just over $1mil of university assets. The Archway Investment Fund is a nine-credit program that serves as a capstone experience for students interested in asset management.

In this program students learn the basic techniques of security analysis and portfolio management. Additionally, investment professionals present to the students and have generously made themselves available as advisors to the AIF faculty. The AIF students and faculty jointly interview new candidates to enter the AIF program. This process admits 58 new students each year—29 in each of the spring and fall semesters. This is typically less than 10% of the finance concentrators and finance minors in a given year. Applications vary in number reflecting an acceptance rate range of 35% to 50% of applicants. The number of applications is likely affected by the reputation of the program's selectivity.

There are two finance course pre-requisites and one co-requisite. The prerequisites are Finance 201: Introduction to Financial Management and Finance 312: Investments. Before entering the sophomore-level Finance 201 students will have taken Global Foundations of Organizations and Business 100, two accounting courses and mathematics which includes basic statistics. A co-requisite for the first course in the AIF program is one course of: financial modelling, forecasting or financial statement analysis.

While the AIF program was conceived by Dr. Louton as a mini-career experience with the Chartered Financial Analyst (CFA) designation as a likely next-step, it isn't always the case that students will follow this path. Some are interested in the Certified Financial Planner® path (CFP®) and many others are entering the program because they are curious about the field of

investment management and do not yet know where their career path will take them.

The AIF program is known for its selectivity and its real-world aspects which provide learners an experience of hands-on professional investment management. It is likely that some students simply enter the program to learn how to make money in the financial markets. In a concrete sense, if learners' mental models are challenged in the program and they are led to develop a shared vision then students are practicing creativity and systems thinking, which are holistic and truth-seeking approaches. This could make the AIF program more universal and less specifically vocational, which, paradoxically, can strengthen the AIF program as a vehicle for deeper learning.

The Structure of the Archway Investment Fund Program

While the scholastic year governs much of life on campus – AIF students operate with the calendar year in mind. This is the applied practice of investment management on a calendar-year basis in an academic-year institution. All AIF students enter through the first course called *Finance 450: Security Analysis*. Some students, based on graduation dates or other reasons, will exit after this three-credit class concludes. Most students will continue to the six-credit *Finance 454: Portfolio Management* course where they take over active management of over $1mil of university assets.

Calendar Year Investment Project in an Academic Year Institution		
Spring Semester January to May	**Summer May to September**	**Fall Semester September to December**
Finance 450 is Security Analysis which is 3 credit hours. Admits 29 new students to the program and is the prerequisite for Portfolio Management. Finance 454 is Portfolio Management which is 6 credit hours. Generally the range has been 13-24 students in this class who have elected to proceed from Finance 450.	AIF's Unmanaged Period The spring portfolio remains invested and/or spring Portfolio Management students place limit orders or covered options as protective strategies as needed on securities in the portfolio.	Succession Plan The spring semester's Security Analysis students now become the Portfolio Management students and 29 new students enter the program through the new fall Security Analysis course. And this repeats each semester.

Figure 1: Archway Investment Fund Calendar Year Structure

Student Learning Styles

Preparing for a specific business discipline makes intuitive sense at a business school for undergraduate students. Higher education is paid for privately or with student loans in the United States, so the pragmatism of business education aimed at specific career goals can be based on personal financial considerations. However, the transformational act of becoming educated is not the same as targeted vocational preparation. A university education applied to the strategic goal of a professional designation or job may inhibit the students' deeper learning which includes feelings, values, emotions, culture and creative awareness at a minimum. And there is no reason that this deeper learning cannot be part of a finance practicum such as a student-managed fund.

There is no need for the practicum to be limited to students who want to make a career of investment management because that is simply a literal interpretation of the practicum – it is strategic rather than creative. Perhaps this is not intuitive. It is, I believe, an important distinction for a financial education program after the Dot-com and housing bubbles demonstrated how destructive some financial industry mental models are to society. A possible next step may be to explore ways to expand this type of learning opportunity to more than 59 qualified students per year. In addition if the AIF program is based on career goals, the student applicants may put themselves in a situation of stating career goals prematurely or falsely.

Ken Bain, Ph.D. speaks of this in his book *What the Best College Students Do* when he says "Social, economic, political, and cultural forces compel (college students today) to follow a surface or strategic approach to their studies" (Bain 2012, p. 258). Bain takes his readers through a differentiated model of three learning styles revealed from the work of social scientists and researchers which are summarized in Figure 2 below. Bain's description of the strategic versus deep approach provides an important connection with creativity.

Learner's Style	Descriptions of the Learner's Style
Surface Learners	(They) usually focus only on passing the exam, not on ever using anything they read (Bain 2012, p. 35-36).
Strategic Learners	(They) primarily intend simply to make good grades, often for the sake of graduate or professional school. These people will usually shine in the classroom and make their parents proud of their high marks. In many ways, they look like deep learners, but their fundamental concern is different. They focus almost exclusively on how to find out what the professor wants and how to ace the exam. If they learn something along the way that changes the way they think, act, or feel, that's largely an accident. They never set out to do that. They simply want the recognition that comes from graduating with honors … Although making the dean's list sounds great, strategic learners seldom become risk-takers because they fear something new or extra might mess up their grade point average. Thus, they rarely go off on an intellectual journey through those unexplored woods of life, riding their curiosity into a wonderland of intellectual adventure and imagination. They approach college with a checklist rather than with any sense of awe and fascination. As a result, these students often learn procedurally rather than conceptually, following the steps to a calculus problem but understanding little of the ideas behind it because they never intend to do so…As a result they can't transfer that problem-solving to a different example involving the same concepts. Strategic learners can plug the right number into the correct formula on a chemistry or physics exam, or put the right words in a properly constructed essay, but it all has little influence on how they think, act, and feel…Later in life, they may become, at best, what some Japanese theorists called "routine experts," learning all the procedures of their work but seldom becoming inventive. When the problems of life don't follow the norm, routine experts seldom adjust. They have difficulty handling new situations and rarely become pathbreakers, the people who invent new ways of thinking and doing (Bain 2012, p. 36-37).
Deep Learners	To take a deep approach means to take control of your own education to decide that you want to understand, to create something new, to search for the meaning that lies behind the text, to realize that words on a page are mere symbols, and that behind those symbols lies a meaning that has a connection with a thousand other aspects of life and with your own personal development. Such (deep learning) intentions are intertwined with motivation, growing out of an internal drive but also feeding it with an important fuel and direction… (Deep learners) created an education for themselves that would make a difference in their own lives and thinking (Bain 2012, p. 38-39)

Figure 2: Learning Styles

While the most effective approach for creativity is deep learning – students and their teachers are often unaware of this intention, or the lack of it. In the halls of learning a conversation about "the good students" may in fact be referring to solid strategic learners combined with a few unrecognized deep learners. The point of education is not to reward performance. The point of education is deep learning. In a subject like finance, the strategic learning can be unintentionally fostered through financial mathematical procedure like the calculus problem Bain describes above in Fig. 2.

Learning creatively is the cornerstone of Ken Bain's book. And he states on page 6 that his book is about people who "pursued the development of the dynamic power of the mind, and that end-not academic honors or simply surviving college—became their primary goal". This is not about folks "who made the grade". Bain wanted "to know how people did *after* they left school, and he and Marsha Bain selected people to follow "*only if they obviously learned deeply and subsequently became those highly productive individuals who continued to grow and create*." (Emphasis is mine.) He continues on the same page:

> We sought men and women who enjoyed a challenge, whether in learning a new language or solving a problem, people who recognized when old ways would not work, who were comfortable with the strange and challenging, who had fun finding new solutions, and who were at ease with themselves.

While this last quote is meant to describe the qualities of the individuals studied by Bain—it also provides a wonderful working definition for creatives. My purpose in using Bain's work in this paper is to contrast his description of learning deeply and creatively with learning strategically in finance in a student-managed fund.

Strategic Learning in Service to Differentiated Awareness

Using Bain's descriptions we can observe that the strategic learner is *extrinsically* motivated. The motivation is the course grade, the completion of a checklist or mastering procedures as a tactic. In investment management the extrinsic motivation can be an absolute return or return relative to a market index. The investment policy of the AIF program thus far has been to beat the benchmark of the S&P 500 index on a risk-adjusted basis. The risk-adjustment is not specified – it could be on a stand-alone basis or a relative basis. Deeper learning here can be comparing different forms of risk, how they are derived and what their shortcomings are versus long-term intrinsic value of the portfolio holdings. The strategic teacher and student may be satisfied with performance. Deeper learning would go beyond performance – and indeed would at times *require underperformance*. A bubble in the stock market is when the prices of certain assets outpace their true intrinsic value. Ironically, being wrong *with* the market is more comfortable socially than being different *from* the market. The Efficient Market Hypothesis (EMH)

theorizes that the study of individual companies, in general, cannot lead to returns that beat the market (Horan et al. 2014, p. 6).

This EMH theory is a recipe for surface learning and what can, by extension, be termed *surface investing*. This has already been challenged by Warren Buffet in a particular theory and practice debate held at Columbia University in 1984 (Hagstrom, 2014, p. 155-156). This is important reading for students of finance who are willing to traverse from strategic learners to deep learners. Finance is a language which borrows from mathematics and yet they are distinct subjects. Mathematics is older and more expansive. Logic in theoretical mathematics holds that if there is an exception to a statement, then the statement is not true. While in finance, like economics, this rigor is mitigated by the social system qualities permitting anomalies to theory without actually invalidating the theory.

The earliest finance instruction in university is based on the mathematical modelling of time-value of money. Whether through a brief history of finance and the work of John Burr Williams (Hagstrom 2014, p. 65) or Irving Fisher (Horan et al. 2014, p. 135) the calculation of present value and future value of financial assets is the cornerstone of finance. Next studied is the relationship between the timing, size and risk of cash flows used to calculate values. In seeking to create a concentrated mathematically-based curriculum, reliance on quantitative assessment may foster surface and strategic learning unintentionally. This is due to the idea that when mathematics is applied there is one right answer, one right technique. And this is simply not true. An enormous amount of judgment and reflection is part of valuation. It is not merely formulaic. This is where the concept of routine experts used by Bain is apt for finance.

Famed investor Warren Buffett and his business partner Charlie Munger are deep learners. They blend mental models in their life and work (Hagstrom, 2014, p. 142-143). Reading about Buffett and Munger opens the door for finance students to begin to gain a differentiated awareness of their own extrinsic motivations, cultivate intrinsic convictions and fan their innate curiosity. After all, performance is not evidence of deep learning. Intrinsic motivation is.

Creative Structure by Robert Fritz

In Robert Fritz' creativity model A-2-1-3-B he intentionally marks the "not workable" with the back-step from 1 to 2 (Fritz, 2014). A is current reality—the goal is truth about current reality at any time. And the movement—what he terms the "path of least resistance" is the path created by holding the structural tension of the truth (current reality) and the vision for the creative process at "B" which is distinctly contrasted with "A" through a number of stages of development—including forward movement (workable) and back-

wards movement (not workable). This is a simple and profound symbolic abstraction of the creative process.

Systems thinking expert and author Peter Senge refers to Fritz' work as supportive of personal mastery going beyond competence and skill (Senge, 2006, p. 131). The creative life is lived not through reactivity. It is intrinsically motivated and *created*. This meshes with Bain's description of the deep learner.

This doesn't mean that competition is shunned. Winning or competing is agreeably embraced—it is not however the reason for creating (Fritz, 2014). Creating is the reason. And a "win" is simply an outcome rather than a goal. To shape oneself or one's project to win is strategic and extrinsically motivated. This is incredible learning for a university business student in an asset management project like the AIF. It permits creative risk-taking with learning combined with reflection through the differentiated stages of Fritz' model.

Portfolio management is about framing the future in contemplation of the past, while remaining open to the truth about current reality. When managing a portfolio, the manager will review the past, seek to be truthful about the present and reasonably forecast the future value of the assets which comprise the portfolio holdings. And this system is creative and truth-seeking as expressed by Robert Fritz (Senge, 148). Here is what this model looks like applied to portfolio management:

We are at point A (present) and wish to move to point B (a vision about the portfolio), and we move there by steps of contrast which take us forward and backward through structural tension in relation to B:

A ----- 2 ----- 1 ----- 3 ----- B

A ←==========→ B

Figure 3: Robert Fritz' Model of Structural Tension

In this model, steps are taken and the AIF student arrives at 1. In a dedication to truth, new information may make the student realize that they are at 2 (not as close to B as thought at 1). The movement from 1 to 2 is still progress because *it is part of the system structure of moving toward the vision of B*. From 2 (through dedication to truth about current reality) the student moves to 3. And with a deeper understanding of what is workable and not workable (movement of higher or lower contrast with B) the student arrives at B. B may be partly dictated by a constraint such as a due date for a presentation. Nonetheless the student recognizes that contrast with where they are and where they want to be creates the tension they must learn to hold. What drives the movement from A to B is what determines whether or not the learning will be strategic or deep.

Beliefs get in the way of movement from A to B. An example might be "a talented person can get to B, and I am not talented". Fritz calls this a *concept* (Fritz, 2003, p. 176). And the skill of creating he argues lies not in attempting to change concepts or beliefs but rather with the practice of placing your attention on what you want to create. In Fritz's words:

> Often in life, our aspirations outpace our abilities. When this is the case, the issue is not you or your beliefs but your level of skill. So, by developing your skills, you will eventually be able to accomplish your goals. When your aspirations outpace your abilities, as you engage in the process, there will be moments when you will fail. There will be moments when you look like a blithering idiot. If you make the subject matter you rather than your current ability, you would not be as honest as you need to be when you are bad at something. What is the reason you look so bad? Is it some deep-seated negative belief? Or is it the simple truth that your aspirations are larger than your current ability, and you need to learn how to be competent (Fritz, 2003, p. 154).

When I taught the AIF *Finance 454: Portfolio Management* class from January 2012 through December 2013 I had very little experience teaching undergraduate students who did not have the conceptual depth of my post-graduate professional CFP® students. The undergraduates, in general, are more willing to embrace mathematical modelling while less willing to explore its meaning. And the CFP® students were more willing to explore the meaning, yet terrified of the notation and operation of mathematical symbols. I needed to grow as a teacher to teach undergraduates.

What I noticed with the undergraduates was they wanted to "beat the benchmark" or didn't believe it was possible. In beating the benchmark they were happy with a small margin of risk-adjusted return in excess of the benchmark as proof of a major accomplishment. And this is after managing for just three months. The benchmark was the extrinsic master of the AIF program. Indeed this was the stated purpose in the AIF policy.

In 2013, in each of the spring and fall semesters a young student asked to speak with me after class. The question they both asked was simple: "Is beating the benchmark even possible?" I am not sure it is the right question in the way it is framed as "the dragon a knight must slay". In both cases it seemed to me that learning the power of principal protection in asset management was more important. To each of these students I gave a riddle – look at the performance of the S&P 500 and look at the annual returns over at least a five year period (this would include 2008 and 2009 at that time). Then model an investment of $1,000 in those returns sequentially on an annual basis. Then come up with another sequence of five year returns that would average a lower return but in fact return more money than the S&P 500 sequence.

By the time they came back a week later they practically bounced into class with the mathematical principal they saw: for every 1% you lose, you need more than 1% positive return to get back to even. Therefore, principal protection is the first order of business, not beating the benchmark. And not

losing requires the ability to express one's human values in forming personal conviction and communicating that to peers. In other words, valuation requires human values. And this is where creativity comes in. When the investment problem is posed in a one-sided way such as: "beat the benchmark on a risk-adjusted basis", the word "beat" is the strategic term that reduces the student's ability to express their human values in a way that makes education transformational. Figure 4 is a simplified model of what these two students learned and shared with their fellow portfolio managers:

Invest $1000 and sustain this loss:	And here is what you have after period 1:	And then with this return you will come close to regaining your loss:	After the loss and sequential gain here is the period 2 value:	Then the average annual return for periods 1 and 2 is this:
Lose 5%	$950	Gain 6%	$1,007	.5%
Lose 10%	$900	Gain 12%	$1,008	1%
Lose 25%	$750	Gain 34%	$1,005	4.5%
Lose 50%	$500	Gain 100%	$1,000	25%

Figure 4: Returns Example

Notice above that the average annual return for "lose 50% and gain 100%" is 25% and yet no money is made for the investor. While in any of the other three scenarios, the average return is significantly less than 25% and yet the return is above the initial amount invested. Compounding returns will encompass this result, but for undergraduates, these nuances are not picked up by strategic learners.

This is even more important when the benchmark becomes the extrinsic ruling concept that forces extreme limits on the students' own visions for managing the portfolio. And this makes the learning system strategic, rather than deep. As the student seeks to move toward a vision of "beating the benchmark on a risk-adjusted basis" the tension on the early inculcation of the mental model of market efficiency is increased and powerlessness sets in. This is also a challenge for academic faculty members who hold this tension system in their minds. Based on academic research the students and faculty believe they are powerless to beat the benchmark, and yet the vision in the AIF policy is "beating the benchmark on a risk-adjusted basis". The tension this creates for the students is Robert Fritz' ***oscillating structure*** (Fritz 2002, p. 144):

A ←
==========
➔ B

Belief: *"You can't have what you want"* ← ========== =➔	**Student Portfolio Managers**	Vison ← ========== ➔
Tension that resists movement from A to B There is a belief that "beating the benchmark" isn't possible in a sustained and meaningful way.	**The contrast between A and B is resolved in the middle**	Tension that assists movement from A to B ***Students' vision is anchored extrinsically*** Vision is shaped extrinsically in contemplation of "beating a benchmark"

Figure 5: Oscillating Structure of Robert Fritz

In an oscillating structure finance students can spend the three month semester not realizing they can "create something new" as Ken Bain says in his deep learning description from Figure 2. Peter Senge outlines Robert Fritz' three strategic thinking traps which maintain or reinforce the above oscillating structure (Senge 2006, p. 146-7). Here the thinking traps are applied to a student managed fund:

1. Allow the vision to erode. This involves moving the vision goalpost back toward the center to reduce the tension it creates on the powerless belief that you can't have what you want. The conclusion on the part of the student is that you cannot *really* beat the benchmark.

2. Create artificial conflict through negative motivation. This can happen through repeatedly changing asset allocation policy to "protect" the portfolio performance from either students or teachers with different investment management philosophies as the project matures. The underlying structure will still create oscillation through an extrinsic goal rather than a higher purpose orientation.

3. The use of willpower to attain the vision. This yields a short term push and a celebration on the goal of beating the benchmark while not focusing on the transitions between teams of portfolio managers who each influence the *portfolio system long term*. The unintended consequence is "willpower leaves the underlying system of structural conflict unaltered." (Senge 2006, 147)

The equilibrium of the above oscillating structure is in the middle and the final contrast created between A and B is low (or negative!). None of Fritz' three thinking traps above will represent deep learning – they are all forms of strategic learning in an oscillating structure.

What change can be made to the underlying structure of the oscillating system? This is what Fritz calls an "advancing system". And in the case of a student managed fund like the AIF it would look like this:

Student Portfolio Managers	Vison A ← ========== =→ B
The contrast between A and B is incremental and expands as skills and shared vision develop	Tension assists movement from A to B based on intrinsic values and skill development of learners. Both students and faculty acknowledge they are both learners and both teachers. Vision is shaped by identifying and expressing the students' shared values about long-term investment intrinsic quality. Skill development serves the shared vision. Each outgoing portfolio management team shares with the incoming portfolio management team to consciously develop AIF culture.

Figure 6: Advancing Structure of Robert Fritz

When an AIF student moves past extrinsic motivation for selecting a company or an Exchange Traded Fund for purchase in both AIF classes, they are invited to re-frame their thinking. Now, as a teacher I have a shot at helping students see the art of finance as larger than the science of measurement of discounted cash flows, or volatility metrics. Those tools do not recede into the background – instead the whole reason for using the science of measurement and estimation shifts to an intrinsic goal for the student: their shared values expressed and their learning serves this human intrinsic motivation cultivation. As they express their intrinsic values in an area where they thought they were limited to an extrinsic market and/or volatility measure they are transformed by this mental model of the advancing structure. If they see the beauty of their values as important, the questions mount and naturally the transformation of the student's inner awareness through hands-on reflective practice in finance education. This cultivates shared vision among the student portfolio managers. Peter Senge says this about motivation through shared vision:

> Shared vision fosters risk taking and experimentation. When people are immersed in a vision, they often don't know how to do it. They run an experiment. They change direction and run another experiment. Everything is an experiment, but there is no ambiguity. It's perfectly clear why they are doing what they are doing. People aren't saying "Give me a guarantee that it

> will work." Everybody knows that there is no guarantee. But the people are committed nonetheless (Senge 2006, p. 195).

The advancing structure has tension resolved *without the powerlessness*. As Senge says, success is not guaranteed. And as Bain says the deep learner creates something new through internal motivation (Bain 2012, p. 39). Inquiry naturally evolves in service to the vision where the teacher is also a student and the students are also teachers. In this way the AIF students create community through deep learning and shared vision.

When the oscillating structure is identified and the advancing structure revealed, this combination, with readings and experiences, fosters new and unexpected ideas. When the students come into the AIF many of them hold ideas about *transactions* rather than long term investments. After they read about different approaches to investing, explore the idea of being part of an organization when they are an investor and complete a company site visit of their choosing they begin to see the AIF and their part in it differently. A number of tasks are given to be worked on in small groups or pairs with an opportunity to redo the exercises as new learning occurs. They become comfortable with ambiguity. They look forward to mentoring new students in the program. They support one another's learning and are willing to ask challenging questions in a kind and thoughtful way. They are changing from strategic learners to deep learners without that particular vocabulary. They become a learning community. This is delightfully unexpected by them. It wasn't what was on their mind coming into a student-managed fund.

Creative Learning in Finance – AIF Practices and Outcomes

> "Thinking is that cool faculty which brings clarity and objectivity—but provides no valuing; sensation describes the physical world—but provides no valuing; intuition suggests a wide range of possibilities—but provides no valuing. Only feeling brings a sense of value and worth; indeed, this is its chief function. Without feeling there is no value judgment. To lose one's feeling function is thus to lose one of the most precious human faculties, perhaps the one that makes us most human. We can understand the term feeling more accurately if we define it as the capacity to value or give worth to something." (Johnson 1993, p. 3-4)

In 2015, Dr Asli Ascioglu, Professor of Finance at Bryant became the new coordinator for the Archway Investment Fund. She is opening up the program to environmental, social, and corporate governance investing (ESG). This aligns with the AACSB Accreditation Standards mentioned earlier. While benchmarking is part of the investment education process the students' deep learning takes precedence *over fund performance*. She invited me to teach the first course in the AIF program, *Finance 450: Security Analysis,* for this academic year. Helping students transition from regular university classes to the AIF is quite different from working with students who have already

been in the program for a semester. This is the class where valuation of publically-traded companies is the cornerstone of the curriculum. Creating the context for valuation in terms of the markets, stocks and bonds as well as the cultivation of conscious conviction for buying, selling and holding securities is an opportunity for deep learning. Once again I am back in the learner's role as a teacher. Student outcomes are described within my learning-teaching journey below.

Portfolio Management: January 2012 through December 2013

When stepping into the role of teacher of the second AIF course *Finance 454: Portfolio Management,* I learned by listening that the students wanted to buy only individual company stocks. The portfolio turnover was low as they took on the challenge of forming group objectives and opinions about business values, and macroeconomics. They considered how each company fit together and how each hold, sell or buy would be decided on intrinsic merits. As they felt their views come together they gained skill and ease in discussing different investment opinions. Moreover, with grace and acceptance they found they need not abandon their own views in the presence of differing opinions about the future by visiting investment professionals. (Note: ESG investing was not yet part of the AIF.)

My approach was to facilitate inquiry and small steps toward a systems approach to managing the aggregate portfolio with a willingness to differentiate the portfolio from the S&P 500 benchmark. In the fall of 2011 the approach of the AIF program was the natural starting point of dividing the students into sector groups which were then managed as separate mini-portfolios, each compared to a sector index in the form of an Exchange Traded Fund. The program evolved over time naturally with new guest speakers, student initiative and rotating instructors.

In spring 2014 the founder of the AIF program stepped back into the portfolio management class and I began to reflect on my experience in the AIF program. I was the first financial professional (and the first woman) to teach in the program. It seemed that some of what made the program attractive to students could be used in earlier finance classes to deepen their conceptual understanding of long-term investment in a way that brought out the themes of the conscious investing. That work is ongoing for me.

Security Analysis: September 2015 through May 2016

My first task for this new class was to find a book that would be informative and provide a useful curriculum structure. I also wanted the book to be approachable and practical. *Strategic Value Investing*: *Practical Techniques of Leading Value Investors* by Stephen M. Horan CFA, Robert R. Johnson, CFA and Thomas R. Robinson, CFA is enjoyably readable by the AIF stu-

dents. This book gives a historical overview of the field of valuation including the structure of time-value of money, Benjamin Graham, and his most famous student, Warren Buffett. The book does not go into ESG investing—however as a student of Buffett—the background on his investment approach gave me the platform to discuss corporate governance which has been a key focus for him. Then, with other materials and program speakers this topic of ESG investing has been extended.

My next step was to ask the students to consider a business as an organization that matters to its local community and see beyond the idea that you could harvest a price movement in the market. For the first time in the AIF, students were required to do their own company site visits. And in the spring semester the students are required to do two—one of which must be an ESG company. Some students in the fall semester approached the site visit as an intriguing idea and some approached it quite passively. In the final presentation last semester, the students who I thought had approached it the most passively actually chose to speak about it at their final presentation. They made the analogy that if you buy a house, you would take a tour of it—so why not a company? The "intangibles" of organizations seem to be coming alive for them. No longer is a stock just a slip of paper or a digital blip on a screen. The final presentation for the first AIF class is new. It served as an orientation for entering AIF members and also included snacks from two different companies—one ESG and the other not. The learning outcomes for this presentation are consolidation of learning gains, sharing of a learning orientation, creating a shared vision and a significant workable step toward the major presentation they will do as portfolio managers in the next class.

A significant transition in the students' thinking about transactions versus ownership came about as they read Warren Buffett's writing about his mistake in continuing to hold the New Bedford, Massachusetts' based company Berkshire Hathaway in 1964 (Buffett 2014, p. 24). Then Buffett contrasted his investment mental model gleaned from his teacher Benjamin Graham to the later influence of Charlie Munger in helping him continue his evolution as an investor (Buffett 2014, p. 26). The Buffett writings are the most popular reading assignments. We also sampled chocolate from See's Candy and read about how Buffett almost missed making this "wonderful" business acquisition (Buffett 2014, p. 27). I was happy to highlight a company begun by a woman—Mary See. In the second semester, I gave out the See's chocolate earlier—to accompany the site visit assignment. My learning continues as I observe the students' growing curiosity. And as they begin to express their investment values their self-consciousness melts away.

At each stage of the first AIF class students are referenced to where we are in terms of the five disciplines of systems thinking below (Senge 2006, p. 381-387):

The Five Disciplines Applied to Security Analysis
1. Personal Mastery: Revisit the mathematical structure of discounted cash flow, and begin the practice of application through absolute valuation and relative valuation with reflection. Estimation takes time. Introduce Fritz' creativity model of A to B. 2. Mental Models: Modern Portfolio Theory (MPT), Capital Asset Pricing Model (CAPM), exploring the practices and reasoning of the long-term holding period of Warren Buffett. Investigating market history. Growth and value investing styles. Create an atmosphere of multiple mental models. 3. Building Shared Vision: Learning the views of the current AIF PM's and then having the new students determine where they agree and disagree reflectively until they write their own views to guide their management period. They develop their own investment objectives to put into practice as a group of future portfolio managers. They write their definitions of surface, strategic and deep investing intentions mirroring Bain's learning style definitions. This opens the way to include the important intangibles like ESG according to their interests. 4. Team Learning: Rather than simply dividing the students into S&P 500 sector groups – pair the teams covering sectors into Contrast Sectors. Learn by contrast about the value drivers of multiple sectors by sharing knowledge and skill. 5. Systems Thinking: Take two weeks to have students reflect on their personal investment interests with readings and then set aside consciously to prepare for the final step: work as a group of 27-29 students who come together to write an Investment Objective they are willing to put into practice together as portfolio managers.

Figure 7: The Five Disciplines Applied to Security Analysis

A Natural Critical Learning Environment

Ken Bain arrived at six major conclusions about teaching of which I am going to mention the one that most stirred me to reflect on my teaching in finance in general and in the AIF program specifically:

> While the methods vary, the best teachers often try to create what we call a "natural critical learning environment." In that environment, people learn by confronting intriguing, beautiful or important problems, authentic tasks that will challenge them to grapple with ideas, rethink their assumptions, and examine their mental models of reality. These are challenging yet supportive conditions in which learners feel a sense of control over their education; work collaboratively with others; believe that their work will be considered fairly and honestly; and try, fail, and receive feedback from expert learners in advance of and separate from any summative judgment of their effort. (Bain 2004, p. 18)

Bain continues with four key points: (1) Knowledge is Constructed, Not Received and (2) Mental Models Change Slowly, (3) Questions are Crucial and (4) Caring is Crucial (Bain 2004, p.26-31). This is the opportunity with a hands-on student-managed fund. Allowing students to consider multiple mental models and explore what models of reality they are willing to create and put into practice. Time is needed, even in a short semester, to reflect on the models selected. Allowing students to explore the anomalies to financial theory gives them the freedom to question. And providing students the opportunity to move from an oscillating structure to an advancing structure permits the students to put their own feelings and values into the project, which is *priceless*. The greatest act of caring is allowing students to cultivate conviction, take action, draw their own conclusions and reflect on this creative and collaborative learning orientation. This is a viable path to discovering what is workable and what is not. This is sustainable creative learning that supersedes procedural and vocational approaches in investment education.

Conclusion

The key outcome of the AIF program is the practice of deep learning as described by Ken Bain. This is created through the use of systems thinking as described by Peter Senge and awareness of the underlying structures that Robert Fritz has termed oscillating and advancing. Strategic learning is a form of oscillation because it is procedural and extrinsically motivated. Deep learning is an advancing system. As a learner, whether student or teacher, you create the path *through* your feelings, you examine your values, create a vision and create the skills to expand the contrast between A and B. Deep learning is learning creatively. Fritz' creative process makes the learning transferable and truth-seeking. This is what a university education can be in a student-managed fund.

In the "banking" concept of education "it is people themselves who are filed away through lack of creativity, transformation, and knowledge" (Freire 2000, p. 72). The term "intellectual capital" is uninspired compared to a "creative practice". The earth's environment is discussed as a silent business stakeholder (Mackey & Sisodia 2014, p. 139) which indicates that significant changes are needed globally in business and finance. This is recognized by the AACSB in their changes to their Accreditation Standards of business schools. Therefore the global challenges that require deep learning are here as part of our global current reality. Creative learning and recognition of deep learning seem to be both urgent and constructive.

References

AACSB International 2016, *Eligibility Procedures and Accreditation Standards for Business Accreditation,* Available from: www.aacsb.org.

Bain, K 2004, *What the best college teachers do*, Harvard University Press, Cambridge, MA.

Bain, K 2012, *What the best college students do*, The Belknap Press of Harvard University Press, Cambridge, MA.

Buffett, WE 2014, *Special Letters from Warren & Charlie RE: Past, Present and Future*, Available from: http://www.berkshirehathaway.com

Fares, D 2015, *The heart of Pope Francis*, trans. R Hopcke, The Crossroad Publishing Company, New York.

Fritz, R 2003, *Your life as art*, Newfane Press, Newfane, VT.

Fritz, R 2014, *The Art of the Creative Process*, workshop notes from Kripalu Center for Yoga & Health, August 4-8, 2014, Stockbridge, MA.

Freire, P 2000, *The pedagogy of the oppressed*, 30th edn, Bloomsbury, New York.

Hagstrom, RG 2014, The Warren Buffett way, 3rd edn, John Wiley & Sons, Hoboken, NJ.

Horan, SM, Johnson, RR & Robinson, TR 2014, Strategic value investing: practical techniques of leading value investors, McGraw-Hill Education, New York.

Johnson, RA 1993, The fisher king & the handless maiden: understanding the wounded feeling function in masculine and feminine psychology, HarperCollins, New York.

Mackey, J & Sisodia, R 2014, Liberating the heroic spirit of business: conscious capitalism, Harvard Business Review Press, Boston.

See's Candy of Carson, California n.d., *Meet the Family*. Available from: www.sees.com/about-us/sees-family/. [17 April 2016]

Senge, PM 2006, The fifth discipline: the art and practice of the learning organization, rev edn, Currency Doubleday, New York.

Acknowledgements

The author is an alumna of the Creativity Fellows Program which was funded by the Davis Educational Foundation through the Center for Teaching and

Learning at Bryant University. The author is grateful to AIF colleagues Asli Ascioglu Ph.D., A. Can Inci Ph.D., David Louton Ph.D., Peter Phillips, CFA, CAIA, and CF colleagues Terri Hasseler, Ph.D. and Robert Shea, Ph.D.

Correspondence

Maura Ann Dowling, Lecturer
Bryant University, United States
Email: mdowling@bryant.edu

Author's Brief Bio

Maura Ann Dowling is a Lecturer in the Finance Department at Bryant University. She is a Certified Financial Planner (CFP ®) and holds a Financial Planning Certificate from the Executive Development Center at Bryant. She has over 20 years' experience as a financial planner and has taught CFP ® courses in five states. She holds an MA in Economics from Brown University and a BA and an MA in Mathematics from SUNY Potsdam. Maura was a Vice President, Director and Wealth Management Consultant in industry. In the Finance Department at Bryant she has taught in the Archway Investment Fund Program, supervised students in the International Business Program and taught in the Honors Program. She is a member of the American Creativity Association and the Society for Organizational Learning.

CHAPTER SIXTEEN

SEVEN DECADES CRACKING THE CREATIVITY CODE, MANY MORE TO GO

JAMES C. KAUFMAN

Abstract

In this commentary on the chapters, I discuss the good work being done in the field of creativity (both in this book and elsewhere), pointing out both highlights and challenges to be faced in the future.

In reading the terrific chapters in this volume, I am reminded of the struggles and joys of studying creativity. We've been tackling this topic for more than seven decades and we will likely still be trying to unravel and answer its questions for decades to come. As the chapters in this book highlight, there is exciting and ongoing scholarship being done both on traditional issues and newer approaches.

It's an exciting time to be a creativity researcher. There is some core agreement about how to define creativity itself, with most scholars agreeing that creativity is comprised of both novelty and task appropriateness (Barron, 1969; Guilford, 1950, Stein, 1953). Sometimes we add additional components such as high quality (Sternberg, Kaufman, & Pretz, 2002), value (Hennessey & Amabile, 2010), or surprise (Simonton, 2012). Other theories extend to how we study creativity, such as the four P's (person, press, product, and process; Rhodes, 1962) or the five A's (actor, action, artifact, audience, and affordances; Glăveanu, 2013), or take into account level of eminence (Kaufman & Beghetto, 2009) or the idea of creativity across domains (Kaufman & Baer, 2004).

One eternal question is how we can make ourselves or others more creative. Perhaps the topic of most interest to laypeople and the media, it is also the one that attracts the most speculation, quick conclusions, and unestablished claims. It is much easier to say that doing something easy and effortless will make someone creative than to actually conduct research demonstrating that specific techniques or exercises actually work. It is refreshing to read several chapters that try to empirically test the value of different ways to increase creativity. Pringle, Sowden, Deely and Sharma (this volume), for example, study how being able to shift between different types of thinking can increase creativity. Lennox, Wilson, and Brown (this volume) discuss the

role that intuitive thinking plays in creativity. The way that constraints and limitations can actually increase creativity is often under looked; indeed, most laypeople likely think that creativity would flourish best with absolutely no restraints. Yet the truth is more nuanced. Brown and Wilson (this volume) detail the value of constraints in creativity, and Wilson and Brown (this volume) further explore how the best balance of challenge and constraints can lead to creative work. Azevedo, Morais, Martins, and Cramond (this volume) write about the Future Problem Solving Program International, a hands-on program for children and adolescents that boosts creativity and is rooted in several classic schools of thought. Finally, Donaldson (this volume) provides a valuable look at how common tools and techniques to increase creativity actually stack up against actual theory and research.

Despite the tendency by laypeople to assume that creativity is restricted to the arts, researchers know that creativity can be found everywhere. Goff and Guzik (this volume) discuss the many different ways and domains in which creativity can emerge. Patterson and Kerrin (this volume) explore creativity (or innovation) in the workplace, and Kapoor, Tagat, and Cropley (this volume) analyze malevolent creativity across different domains, challenging another traditional notion—that creativity has to be a good and benevolent thing. Tsai (this volume), taking a slightly different approach, examines different creative styles for problem solving.

The chapters in this book study core concepts from creativity's history, challenge assumptions about what creativity entails, and propose new ideas about how we might better understand and improve creativity. I am excited to see these chapters reach an audience. As I think about how I hope creativity continues to grow over the years, I look toward further expansion. Just as this book reflects contributions from several different countries, I believe that there will be more and more work on creativity from around the world. I also hope to see more collaborations with other disciplines. It's hard work, often requiring learning new jargon and techniques, and can be frustrating when essential creativity research is overlooked (or reinvented) by different fields that aren't aware of what has come before. But being able to learn from each other – from other cultures and other fields—can lead to exciting new perspectives and ideas. I have often espoused the power of academic bilinguals (Kaufman & Kaufman, 2015), researchers who are trained and understand multiple fields. Being able to "speak" the language of different fields (whether neuroscience or engineering or business or education) is a rare ability.

It can be frustrating to study creativity. Scientifically valid work gets lost in an ocean of amusing-but-pointless activities, apocryphal anecdotes, questionable experts who can talk loudly, and misinformation. The benefits, though, can be amazing. Being able to help people get in touch with their own creativity (or even simply recognize that they are creative; Beghetto & Kaufman, 2007) is one of the great joys. Supporting creative people who may get lost in a system that values test scores and obedience is a noble cause. Find-

ing groups of scholars who also see the importance of studying this area—like the people represented in this book—helps renew us and allow us to continue the good fight. It's been seven decades; here's to many more.

References

Barron, F. (1969). *Creative person and creative process*. New York: Holt, Rinehart & Winston.

Beghetto, R. A., & Kaufman, J. C. (2007). Toward a broader conception of creativity: A case for "mini-c" creativity. *Psychology of Aesthetics, Creativity, and the Arts, 1,* 73–79.

Glăveanu, V. P. (2013). Rewriting the language of creativity: The Five A's framework. *Review of General Psychology*, *17*, 69-81.

Guilford, J. P. (1950). Creativity. *American Psychologist, 5,* 444–454.

Hennessey, B. A. & Amabile, T. M. (2010). Creativity. *Annual Review of Psychology, 61*, 569-598.

Kaufman, J. C. (2016). *Creativity 101.* New York: Springer.

Kaufman, J. C., & Baer, J. (2004). The Amusement Park Theoretical (APT) Model of Creativity. *Korean Journal of Thinking and Problem Solving, 14*, 15-25.

Kaufman, J. C., & Beghetto, R. A. (2009). Beyond big and little: The Four C Model of Creativity. *Review of General Psychology, 13*, 1-12.

Kaufman, J. C., & Kaufman, A. S. (2015). It can be very tempting to throw out the baby with the bathwater: A father-and-son commentary on ''Does IQ really predict job performance?'' *Applied Developmental Science, 19*, 176-181.

Rhodes, M. (1962). An analysis of creativity. *Phi Delta Kappan, 42,* 305–311.

Simonton, D. K. (2012). Taking the US Patent Office creativity criteria seriously: A quantitative three-criterion definition and its implications. *Creativity Research Journal, 24*, 97-106.

Stein, M. (1953). Creativity and culture. *Journal of Psychology*, *36*, 311-322.

Sternberg, R. J., Kaufman, J. C., & Pretz, J. E. (2002). *The creativity conun drum.* Philadelphia: Psychology Press.

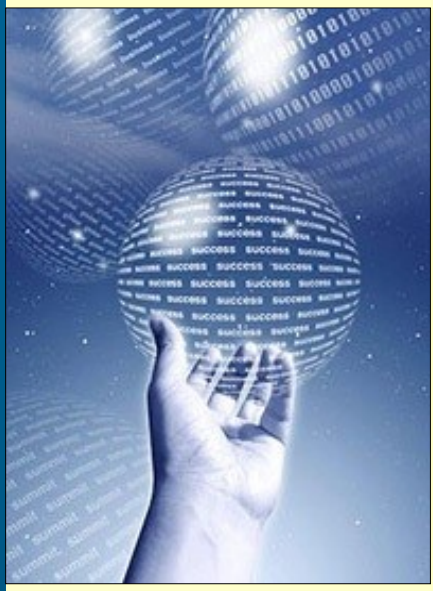
Correspondence
James C. Kaufman
Neag School of Education
University of Connecticut, USA

Author's Brief Bio

Dr. James C. Kaufman is a Professor of Educational Psychology at the University of Connecticut. An internationally recognized leader in the field of creativity, he is the author/editor of more than 26 books, including Creativity 101 and the Cambridge Handbook of Creativity. Kaufman is the president of American Psychological Association's Division 10, which is devoted to creativity and aesthetics. He is the founding co-editor of Psychology of Popular Media Culture and co-founded Psychology of Aesthetics, Creativity, and the Arts, both published by APA. He has won numerous awards, including the Torrance Award from the National Association for Gifted Children, the Berlyne and Farnsworth Awards from APA, and Mensa's research award.

Innovation in Big Data, Data Mining and Data Analytics Solutions

We at Data Nubes focus on innovative and comprehensive Big Data, Data Analytics, Data Mining, Business Intelligence, and Operations Research related projects and solutions. We fuse business and technology and focus on comprehensive Data Solutions that are based on sound business, science, and engineering components.



APPLICATION SEGMENTS

Application segments we provide solutions for include:

Compliance & Quality Assurance, Production Planning, Inventory Planning & Control, Distribution Planning, Lean Manufacturing, Financial Planning, Financial Analysis, Business Control & Risk Analysis, Forecasting, Project & Document Management

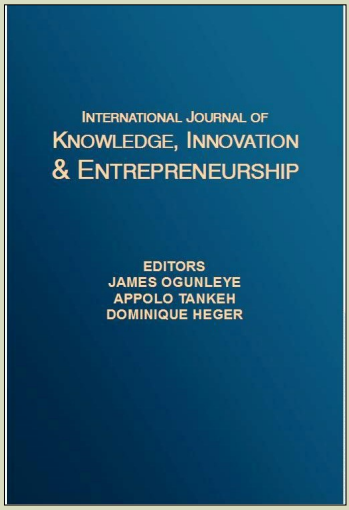
We offer customized Big Data, Data Analytics, Data Mining, Business Intelligence, and Operations Research solutions. For Big Data projects, we help customers establish the business goals to extract actual value, design the necessary Big Data ecosystem (including the Cloud), conduct proof of concept (POC) studies, design/develop MapReduce applications, as well as address any security/ performance/scalability/availability concerns.

Please visit our website for more detail information about our services:
www.datanubes.com

2017 KIE Conference Associated Journal

Now in its third year, the *International Journal of Knowledge, Innovation and Entrepreneurship* is dedicated to the advancement of studies in knowledge, innovation and entrepreneurship and provides a forum for the publication of high quality papers in these coverage areas. IJKIE has been around as a collection of occasional papers for over seven years. As a journal, the IJKIE medium term goal is to become a leading journal in the coverage fields.

www.ijkie.org



Coverage fields and subfields

The journal welcomes competitive and high-quality articles from the following and related fields:

Knowledge Management, Information Management and Systems Organisation and Work Based Learning, Innovation and Creativity, Technology Innovation - Big Data & Business & Predictive Analytics, Artificial Intelligence, Business Intelligence, Data Mining, Discovery & Science, Organisation/Management Innovation, Entrepreneurial Creativity, Servant-Leadership in Enterprise, SME Finance, Risk & Strategy, Supply Chain Management, HR for Entrepreneurship & Social Entrepreneurship

Peer review process

Each paper is reviewed by the editors and, if it is judged suitable for this publication, it is then sent to at least three independent referees for double blind peer review. Based on their recommendation, as well as consultation between relevant Editorial Board members the editors then decide whether the paper should be accepted as is, revised or rejected.

Frequency of Publication

April,
August &
December

ISBN 978-1-85924-276-6