The Cognition of Creativity

Nathaniel Barr, PhD
“Creativity is a process of thought, rational, fact-based knowledge, and emotional feelings that result in some form of change: a product, concept, invention, service, or some outcome that is both novel and useful.”

• Fox and Fox (p. 119)
Creativity

The term ‘cognition’ refers to all processes by which the sensory input is transformed, reduced, elaborated, stored, recovered, and used. It is concerned with these processes even when they operate in the absence of relevant stimulation, as in images and hallucinations... Given such a sweeping definition, it is apparent that cognition is involved in everything a human being might possibly do; that every psychological phenomenon is a cognitive phenomenon.
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Given such a sweeping definition, it is apparent that cognition is involved in everything a human being might possibly do; that every psychological phenomenon is a cognitive phenomenon.”

• Ulric Neisser, 1967, Cognitive Psychology
The Pillars of Cognition (and thus Creation)

- Perception
- Memory
- Attention
- Emotion
- Thinking
“Humans are animals that specialize in thinking and knowing, and our extraordinary cognitive abilities have transformed every aspect of our lives. In contrast to our chimpanzee cousins and Stone Age ancestors, we are complex political, economic, scientific and artistic creatures, living in a vast range of habitats, many of which are our own creation.”

• Cecelia Hayes
Meliorism

“humans can, through their interference with processes that would otherwise be natural, produce an outcome which is an improvement over the aforementioned natural one”
Understanding your mind

Interfering with the natural way you think

Improvement of performance
“Creativity is just connecting things. When you ask creative people how they did something, they feel a little guilty because they didn’t really do it, they just saw something. It seemed obvious to them after a while.”

TwistedSifter.com
Creative insights occur by making unusual connections… All of our existing ideas have creative possibilities. Creative insights occur when they are combined in unexpected ways or applied to questions or issues with which they are not normally associated.

Arthur Koestler describes this as a process of bi-association: when we bring together ideas from different areas that are not normally connected, so that we think not on one place as in routine linear thinking but on several planes at once. Creative thought involves breaching the boundaries between different frames of reference.

## Dual-process theories of cognition

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Acoustic energy

- Elephants (5–12000)
- Human (20–20000)
- Cat (45–64000)
- Dog (67–45000)
- Owl (200–12000)
- “Typical” frogs (50–4000)
- Ultrasonic frogs (2000–48000)
- Noctuid moths (20000–50000)
- Bat (2000–20000)
- Porpoise (75–150000)
Electromagnetic energy
Conscious experience is an active reconstructive process

- What you see, hear, and experience does not directly correspond to the stimuli in the world
Different sensory modalities lead to different perceptions

- Stimulus
  - Auditory Nerve
  - Optic Nerve
- Olfactory Nerve
  - Smell
- Auditory Nerve
  - Sound
- Optic Nerve
  - Sight
Synaesthesia

- Union of the senses
- Stimulation of one sense activates another unstimulated sense
• Grapheme- colour

• Perception of colour with both numbers and letters

• Colours are consistent over time

• Colours are often specific such as “yellow-ochre” or “stop sign red”

• Most common form of synesthesia
• Object-personality

“Three is pure blue, the same color as E. Three is male; definitely male. Three is such a jerk! He only thinks of himself. He does not care about any other numbers or anything. All he wants is to better himself and he’ll use any sneaky, underhanded means necessary…”
Lexical-gustatory

"Whenever I hear, read, or articulate (inner speech) words or word sounds, I experience an immediate and involuntary taste sensation on my tongue. These very specific taste associations never change and have remained the same for as long as I can remember."
• Sound-color synesthesia
What the Hell Is Synesthesia and Why Does Every Musician Seem to Have It?

By Ryan Dombal, January 31, 2014 at 10:15 a.m. EST
• For Duke Ellington, a D note looked like dark blue burlap while a G was light blue satin. When Pharrell Williams listened to Earth, Wind & Fire as a kid, he saw burgundy or baby blue. For Kanye West, pianos are blue, snares are white, and basslines are dark brown and purple. Orange is a big one for Frank Ocean.

• All of these artists—along with Stevie Wonder, Billy Joel, Mary J. Blige, Blood Orange's Dev Hynes, and more—have synesthesia, a condition in which a person's senses are joined. They hear a certain timbre or musical note and see a color, or smell a perfume and hear a sound, or see a word and taste a flavor.

• According to Carol Steen, the co-founder of the American Synesthesia Association, there are more than 60 permutations of synesthesia, and recent studies have suggested around 4% of us have it in some form.
Funkadelic
“Maggot Brain”

So for me that’s listening to music

Seeing a Song: Painting What She Hears

Great Big Story
Daniel Tammet (from Wikipedia)

- Synaesthete: each positive integer up to 10,000 has its own unique shape, colour, texture and feel; experiences a synaesthetic and emotional response for numbers and words

- Polyglot: knows 10 languages, learned conversational Icelandic in a week

- Memory expert: holds the European record for reciting pi from memory to 22,514 digits in five hours and nine minutes

- Writer, essayist, translator: *Born on a Blue Day, Embracing the Wide Sky, Thinking in Numbers*, several essays for large publications

- Creator of a language: Mänti is a constructed language that Tammet created in 2006
How can we increase the odds of having autonomous creative insights?
Unique cases

• How to improve our own ability to spontaneously make creative connections?
“Memory is a gift of nature, the ability of living organisms to retain and to utilize acquired information or knowledge…

Memory is a trick that evolution has invented to allow its creatures to compress physical time.

Owners of biological memory systems are capable of behaving more appropriately at a later time because of their experiences at an earlier time, a feat not possible for organisms without memory.”

- Endel Tulving
1926

THE ART OF THOUGHT

GRAHAM WALLAS
Wallas’ stages in creative thinking

- (i) preparation (preparatory work on a problem that focuses the individual's mind on the problem and explores the problem's dimensions),

- (ii) incubation (where the problem is internalized into the unconscious mind and nothing appears externally to be happening),

- (iii) intimation (the creative person gets a "feeling" that a solution is on its way),

- (iv) illumination or insight (where the creative idea bursts forth from its preconscious processing into conscious awareness);

- (v) verification (where the idea is consciously verified, elaborated, and then applied).
American Psychology Professor (started by studying sociology)

Flow

Sociocultural Model of Creativity

*Creative Person*
*Creative Press*
*Creative Product*

Mihaly Csikszentmihalyi 1934-
Socio-cultural model of creativity

Person

- Draws and expands upon the great novelties in the domain to create an innovative product.
- Usually takes to learn the knowledge and skills within the domain.
- Submits the creative product to the field for evaluation.
Deep/Broad Knowledge Structures

“Jules Henri Poincaré (29 April 1854 – 17 July 1912) was a French mathematician, theoretical physicist, engineer, and philosopher of science. He is often described as a polymath, and in mathematics as The Last Universalist by Eric Temple Bell, since he excelled in all fields of the discipline as it existed during his lifetime.”
Hereditary Genius (Galton, 1869)

More than just book learnin’
A hallmark feature of human intelligence is its adaptability, the ability to invent and rearrange conceptions of the world to suit changing goals and environments. One consequence of this flexibility is the great diversity of languages that have emerged around the globe. Each provides its own cognitive toolkit and encapsulates the knowledge and worldview developed over thousands of years within a culture. Each contains a way of perceiving, categorizing and making meaning in the world, an invaluable guidebook developed and honed by our ancestors. Research into how the languages we speak shape the way we think is helping scientists to unravel how we create knowledge and construct reality and how we got to be as smart and sophisticated as we are. And this insight, in turn, helps us understand the very essence of what makes us human.

“around the world people communicate with one another using a dazzling array of languages—7,000 or so all told—and each language requires very different things from its speakers. For example, suppose I want to tell you that I saw Uncle Vanya on 42nd Street. In Mian, a language spoken in Papua New Guinea, the verb I used would reveal whether the event happened just now, yesterday or in the distant past, whereas in Indonesian, the verb wouldn’t even give away whether it had already happened or was still coming up.”

• Boroditsky, 2011
“In Russian, the verb would reveal my gender. In Mandarin, I would have to specify whether the titular uncle is maternal or paternal and whether he is related by blood or marriage, because there are different words for all these different types of uncles and then some (he happens to be a mother’s brother, as the Chinese translation clearly states). And in Pirahã, a language spoken in the Amazon, I couldn’t say “42nd,” because there are no words for exact numbers, just words for “few” and “many.””

- Boroditsky, 2011
No two people see the external world in exactly the same way. To every separate person a thing is what he thinks it is -- in other words, not a thing, but a think.

- Penelope Fitzgerald
“Memory is a gift of nature, the ability of living organisms to retain and to utilize acquired information or knowledge.”

• Tulving, 1995
Diversifying experience

• “Active involvement in an unusual experience”
  • Ritter et al. (2012)
Cultural Borders and Mental Barriers: The Relationship Between Living Abroad and Creativity

William W. Maddux
INSEAD

Adam D. Galinsky
Northwestern University

Despite abundant anecdotal evidence that creativity is associated with living in foreign countries, there is currently little empirical evidence for this relationship. Five studies employing a multimethod approach systematically explored the link between living abroad and creativity. Using both individual and dyadic creativity tasks, Studies 1 and 2 provided initial demonstrations that time spent living abroad (but not time spent traveling abroad) showed a positive relationship with creativity. Study 3 demonstrated that priming foreign living experiences temporarily enhanced creative tendencies for participants who had previously lived abroad. In Study 4, the degree to which individuals had adapted to different cultures while living abroad mediated the link between foreign living experience and creativity. Study 5 found that priming the experience of adapting to a foreign culture temporarily enhanced creativity for participants who had previously lived abroad. The relationship between living abroad and creativity was consistent across a number of creativity measures (including those measuring insight, association, and generation), as well as with masters of business administration and undergraduate samples, both in the United States and Europe, demonstrating the robustness of this phenomenon.

Keywords: creativity, culture, living abroad, cognition, negotiations
"Going Out" of the Box: Close Intercultural Friendships and Romantic Relationships Spark Creativity, Workplace Innovation, and Entrepreneurship (Lu et al., 2017, JAP)

The present research investigates whether close intercultural relationships promote creativity, workplace innovation, and entrepreneurship—outcomes vital to individual and organizational success. We triangulate on these questions with multiple methods (longitudinal, experimental, and field studies), diverse population samples (MBA students, employees, and professional repatriates), and both laboratory and real-world measures...

Going out with a close friend or romantic partner from a foreign culture can help people “go out” of the box and into a creative frame of mind.
Diversifying experiences enhance cognitive flexibility

Simone M. Ritter, Rodica Ioana Damian, Dean Keith Simonton, Rick B. van Baaren, Madelijn Strick, Jeroen Derks, Ap Dijkstra

Journal of Experimental Social Psychology
Volume 48, Issue 4, July 2012, Pages 961–964

Past research has linked creativity to unusual and unexpected experiences, such as early parental loss or living abroad. However, few studies have investigated the underlying cognitive processes. We propose that these experiences have in common a “diversifying” aspect and an active involvement, which together enhance cognitive flexibility (i.e., creative cognitive processing). In the first experiment, participants experienced complex unusual and unexpected events happening in a virtual reality. In the second experiment, participants were confronted with schema-violations. In both experiments, comparisons with various control groups showed that a diversifying experience – defined as the active (but not vicarious) involvement in an unusual event – increased cognitive flexibility more than active (or vicarious) involvement in normal experiences. Our findings bridge several lines of research and shed light on a basic cognitive mechanism responsible for creativity.
ACTIVITY

What is a diversifying experience you had that gave you a new and useful perspective?
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Analogical Reasoning

“an important special case of role-based relational reasoning, in which inferences are generated on the basis of patterns of relational roles”

• Holyoak, 2012
Creative and Not

• All analogies must have common relations amongst elements

• …but can vary in the extent to which superficial similarity exists between them

• Within vs. Cross domain
Analogical reasoning task

Within-domain

[Diagram showing relationship between bracelet, ring, wrist, and finger]
Analogical reasoning task

Cross-domain

Flock + Goose

Constellation + Star

Image of geese and constellations
“Scientists use analogies to form a bridge between what they already know and what they are trying to explain, understand, or discover. In fact, many scientists have claimed that the use of certain analogies was instrumental in their making a scientific discovery and almost all scientific autobiographies and biographies feature an important analogy that is discussed in depth.”

- Dunbar & Fugelsang, 2004
Thomas Kuhn
(1922 - 1996)
The *in vivo*/*in vitro* approach to cognition: the case of analogy

Kevin Dunbar and Isabelle Blanchette

A new way of investigating cognition is proposed that combines naturalistic (*in vivo*) and experimental (*in vitro*) methods into a single approach. Investigating analogical reasoning by scientists ‘live’ at laboratory meetings (*in vivo*) we found that the types of analogies they use change with their goals. Unlike subjects in many cognitive ‘reminding’ experiments, scientists frequently used structural similarities in their analogies, as opposed to superficial similarities. By subsequently using the *in vitro* approach, we found that the use of structural information was associated with being asked to generate analogies and with the use of complex scenarios. Similar results are obtained in other areas of reasoning such as hypothesis testing and causal reasoning.
SHORTCUT
HOW ANALOGIES REVEAL CONNECTIONS, SPARK INNOVATION, AND SELL OUR GREATEST IDEAS

JOHN POLLACK
Author of The Pun Also Rises
Creative Cognition in Social Innovation (Jiang and Thagard, 2014)

• “solutions by means of reasoning, association, analogy, and conceptual combination”

• Prison reform
• Facebook
• Teach for America
• Hospice care
• Partnership housing
• Microfinance
if an atom were expanded to the size of a cathedral, the nucleus would be only about the size of a bee.
An **analogy** is a literary device that creates a relationship based on parallels or connections between two ideas. By establishing this relationship, the new idea is introduced through a familiar comparison, thus making the new concept easier to grasp. Jul 19, 2015

**Analogy in Literature: Definition & Examples - Video & Lesson ...**
study.com/academy/lesson/analogy-in-literature-definition-examples-quiz.html
Any proposition consists of a structure and some variables. An analogy to that proposition replaces the original variables in order to illuminate the structural relationship between its elements. I contend that artists do this all the time; they make analogies to the external world that illuminate its structure.
“My mama always said, life was like a box a chocolates. You never know what you’re gonna get.”

-Forrest Gump
My 11-year old's birthday card to me.

#blessed

Lifes a waterslide where you die at the end...

you are here
“Life is like a game of cards. The hand that is dealt you represents determinism. The way you play it is free will.”

- Jawaharlal Nehru (P.M. of India, 1947-64)
Reasoned connections: A dual-process perspective on creative thought

Nathaniel Barr, Gordon Pennycook, Jennifer A. Stolz and Jonathan A. Fugelsang

Department of Psychology, University of Waterloo, Waterloo, Canada

A divide exists in the creativity literature as to whether relatively more or less executive processing is beneficial to creative thinking. To explore this issue, we employ an individual differences perspective informed by dual-process theories (DPTs) in which it is assumed that people vary in the extent to which they rely on autonomous (Type 1) or controlled processing (Type 2). We find that those more willing and/or able to engage Type 2 processing are more likely to successfully make creative connections in tasks requiring the unification of disparate elements and the novelty of generated items, but not in some other indices of creativity, namely, cognitive flexibility and fluency. Implications for the role of executive processing in creative thinking are discussed in the context of DPTs. We situate the ability to make remote connections alongside other advanced higher order thinking capabilities that are unique to humans.

Keywords: Creativity; Analogical reasoning; Dual-process theories; Cognitive style; Cognitive ability.
Brain-based Evidence

As creativity of analogies increases, frontopolar activation increases.
Brain-based Evidence

“the frontopolar cortex (Brodmann's area 10)... is disproportionately larger in humans relative to the rest of the brain than it is in the ape's brain...”

• Dreher, 2008

“...some researchers suggest that [analogy] is the crucial cognitive mechanism that most distinguishes human cognition from that of other intelligent species.”

• Gentner & Smith, 2012
Brain-based Evidence

“It is perhaps not coincidental that the most advanced reaches of the evolved human brain should mediate function at the most advanced reaches of human cognition.”

• Green et al., 2006
ACTIVITY

Generate a creative analogy for what it is like to teach people a new language
“…what is really singular about humans [is that [we] gain control of [our] lives in a way unique among lifeforms on Earth—by rational self-determination”

-Stanovich, 2004
Questions?
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