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What is a creative idea?

FORMAL DEFINITIONS AND COGNITIVE IMPLICATIONS

Introduction

- Perspectives on creativity: the "four P's" -
  - Creativity as *Process*
  - Creativity as *Person*
  - Creativity as *Product*
  - Creativity as *Persuasion*
- Underlying all perspectives: the creative *idea*
  - Creative processes generate creative ideas
  - Creative persons engage in those creative processes
  - Creative products contain creative ideas
  - Creative products persuade others that the person is creative

Introduction

- Here creative ideas are broadly taken to encompass
  - Discoveries and inventions (finding and devising)
  - Solutions and problems (problem solving and problem finding)
  - Behavioral and ideational combinations (tinkering, play, fantasy)
- But what makes any of these ideas "creative"?
  - This question is *not* a question of measurement
  - Rather this is a question of *meaning* ("defining our terms")
  - If we don't know what we're talking about, how can it be measured?
    - E.g., Newton's $F = ma$ independent of measurement system

Introduction

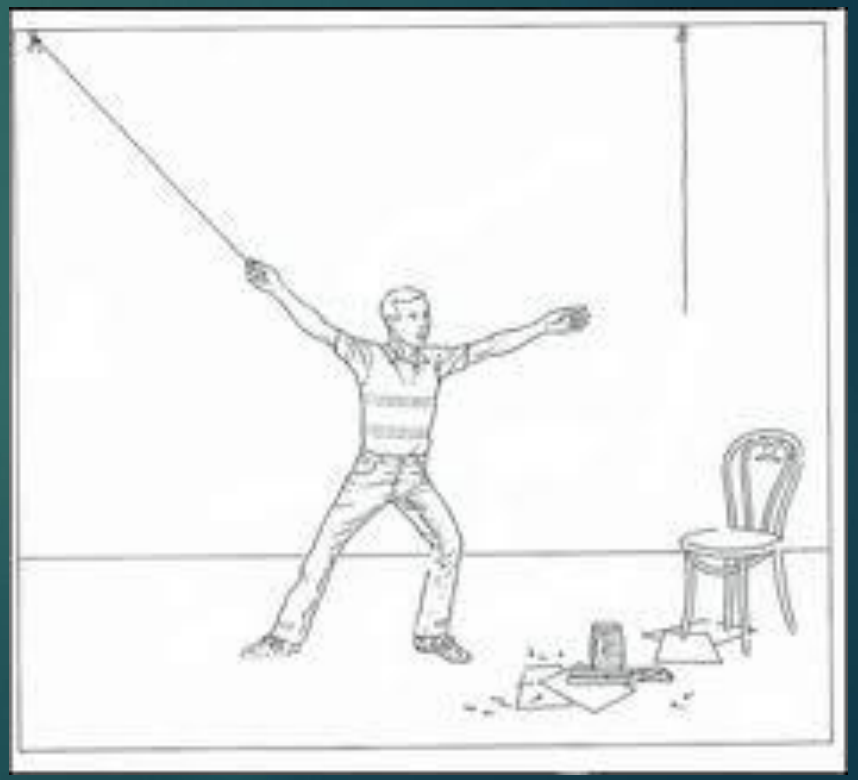
- Types of definitions: two- and three-criteria
  - Two-criteria definition:
    - An idea is creative if it's novel and useful
    - The so-called "standard definition" (Runco & Jaeger, 2012)
  - Three-criteria definitions:
    - 1. novel, 2. valuable, and 3. surprising (Boden, 2004)
    - 1. novel, 2. appropriate, useful, correct, or valuable, and 3. heuristic rather than algorithmic tasks (Amabile, 1996)
      - Cf. "reasonable" versus "unreasonable" problems (Perkins, 2000)
    - 1. new, 2. useful, and 3. nonobvious (US Patent Office)
      - where "nonobvious" is determined by someone having ''ordinary skill in the art"
      - cf., the Apple *gold* iPhone 5s

Introduction

- Questions regarding foregoing definitions:
  - Qualitative versus quantitative criteria?
    - dichotomous or continuous?
  - Additive versus multiplicative integration?
    - Simple or complex?
  - Personal versus consensual assessment?
    - little-c versus Big-C creativity?
- These three questions will be addressed in what follows …

Personal creativity: Definitions

- Let us begin with the set *X* consisting of *k* ideas that can be potentially generated by a given individual in a given time period (e.g., a particular experimental session):
  - $x_1, x_2, x_3, \ldots x_i, \ldots x_k$
  - e.g., the Maier (1931) "two-strings" problem
  - poles, clamps, pliers, extension cords, chairs, etc.
  - $k = 7$



Personal creativity: Definitions

- Each of these ideas are described by three parameters:
  - *personal **initial** probability* p_i, where $0 \leq p_i \leq 1$ $(0 \leq \Sigma\, p_i \leq 1)$
    - If $p_i = 0$, then x_i will not be evoked without an incubation period
    - requiring the right "priming" stimulus (e.g., Maier's "Hint 1")
  - *personal **final** utility* u_i, where $0 \leq u_i \leq 1$ $(0 \leq \Sigma\, u_i \leq k)$
    - Utility may be dichotomous or quantitative
      - Former illustrated by Maier's two-string problem (or DNA code)
      - Latter illustrated by Edison's search for incandescent bulb filament
  - *personal **prior** obviousness* v_i, where $0 \leq v_i \leq 1$ $(0 \leq \Sigma\, v_i \leq k)$
    - Prior knowledge of the utility value (e.g., Maier solutions 1-3)
    - Middling levels indicate various degrees of "hunch" or "FOK"
    - Ideas that obviously have zero utility will be ignored

Personal creativity: Definitions

- Therefore, *personal creativity* associated with x_i given by
  - $c_i = (1 - p_i)u_i(1 - v_i)$,
    - where $0 \leq c_i \leq 1$ (i.e., 0 = zero creativity and 1 = maximal creativity)
  - u_i = *personal utility*, just as before
  - $(1 - p_i)$ = *personal originality*,
    - where $0 \leq (1 - p_i) \leq 1$ (i.e., low probability = high originality)
  - $(1 - v_i)$ = *personal surprisingness*,
    - where $0 \leq (1 - v_i) \leq 1$ (i.e., 0 = no surprise and 1 = Eureka!)
- literally "little-c" creativity:
  - a personal, quantitative, and multiplicative definition
- N.B.: "novelty" partitioned into "originality" plus "surprise"?

Personal creativity: Implications

- The *maximization* of ideational creativity
- The *distribution* of ideational creativity
- The *origins* of ideational creativity

Personal creativity: Implications - Maximization

- Creativity maximizes (or $c_i \rightarrow 1$) as
  - originality maximizes, i.e., as $(1 - p_i) \rightarrow 1$,
    - or, equivalently, as the initial subjective probability $p_i \rightarrow 0$
    - Conversely, as $(1 - p_i) \rightarrow 0$ or as $p_i \rightarrow 1$, then $c_i \rightarrow 0$
      - regardless of the other criteria: Zero originality automatically means zero creativity
    - Hence, ideas that require an *incubation* period are more creative than ideas that quickly come to mind as solutions in set *X*
    - This definition thus resolves the debate about the necessity of incubation
    - However, the duration of that incubation period is ignored because that parameter is totally dependent on chance (aka "opportunistic assimilation")
    - Consider the first Eureka experience of Archimedes:
      - taking a bath earlier rather than later should not determine the solution's creativity


EUREKA!

Personal creativity: Implications - Maximization

- Creativity maximizes (or $c_i \rightarrow 1$) as
  - utility maximizes, i.e., as $u_i \rightarrow 1$
    - *IF* u_i is a quantitative measure
      - e.g., alternative incandescent bulb filaments
        - production cost, resistance, robustness, duration, brightness, etc.
      - N.B.: possibility of "satisficing" where $0 << u_i < 1$ (i.e., "good enough")
    - But if u_i is a dichotomous zero-one (0 or 1) measure, then
      - creativity $c_i \rightarrow 1$ only if $u_i = 1$,
      - but if $u_i = 0$, then creativity is zero, i.e. $c_i = 0$, regardless of originality and surprise
        - e.g., a bank safe made out of ordinary soap bubbles

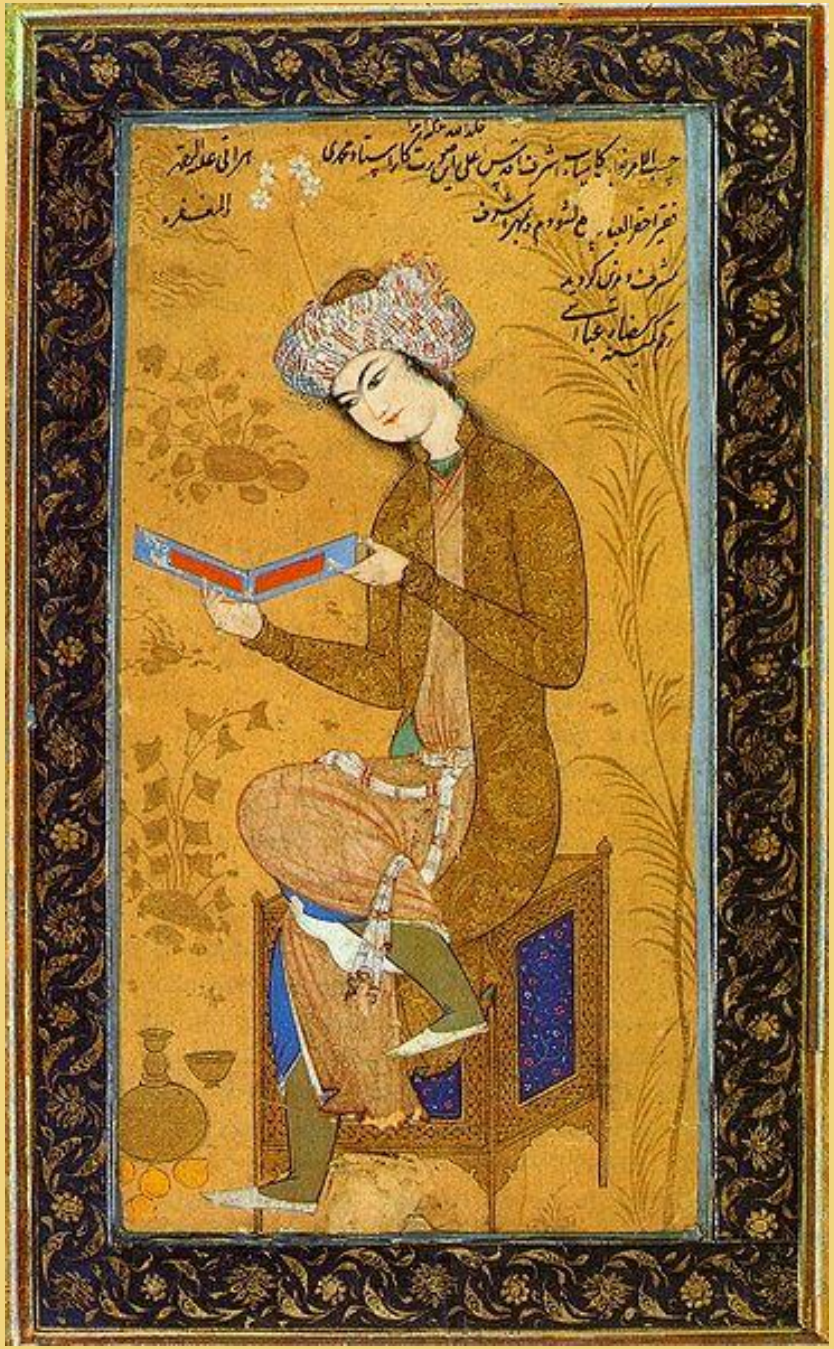
Personal creativity: Implications - Maximization

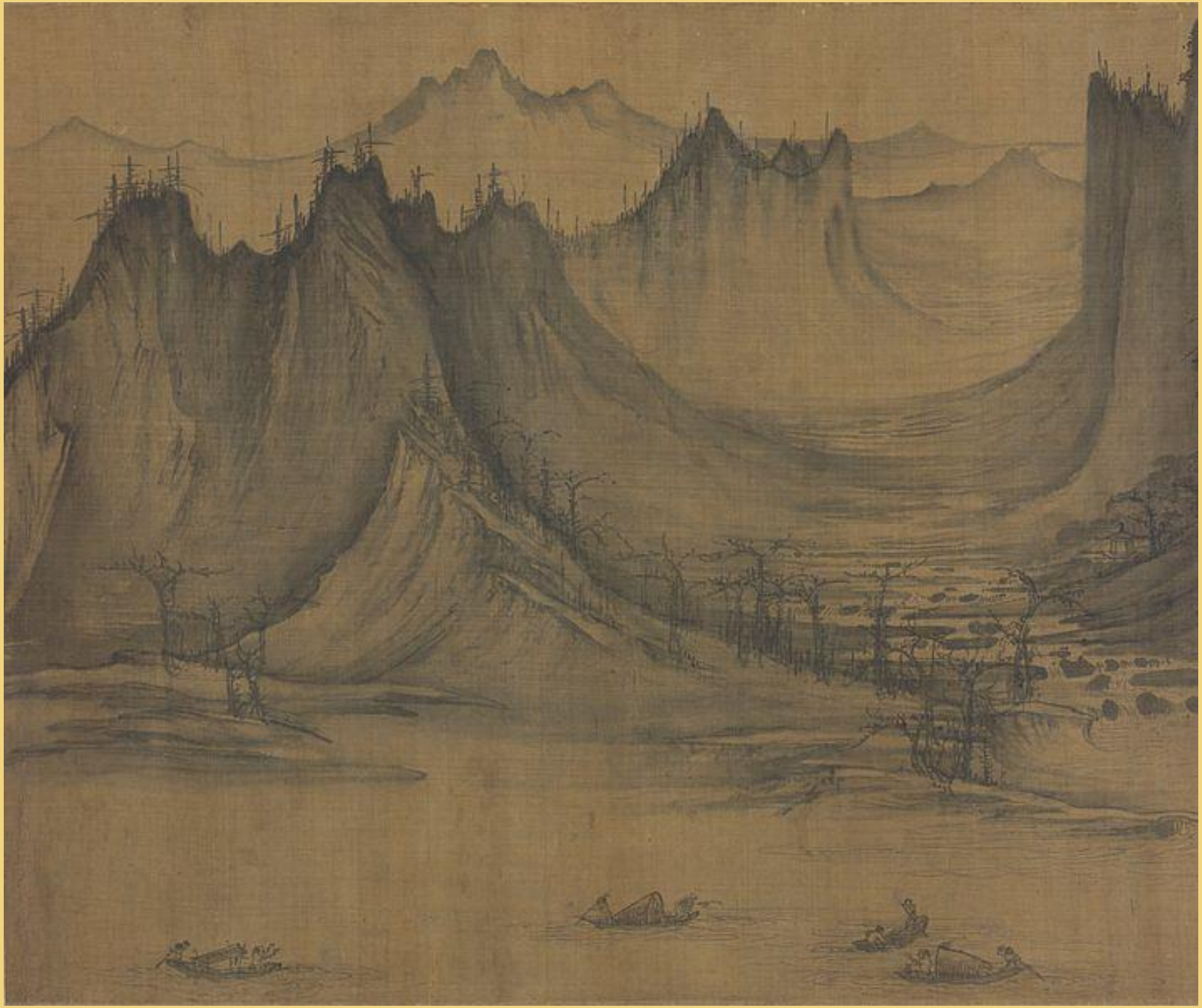
- Creativity maximizes (or $c_i \rightarrow 1$) as
  - surprisingness maximizes, i.e., as $(1 - v_i) \rightarrow 1$
    - or, equivalently, as prior knowledge of the utility minimizes, or $v_i \rightarrow 0$
    - that is, the extent to which we know in advance whether x_i will work
    - Therefore, to the extent that idea x_i is expertise driven, then creativity must decline; cf. the distinctions between
      - algorithmic versus heuristic tasks (Amabile, 1996)
      - reasonable versus unreasonable problems (Perkins, 2000)
    - N.B.: if you know in advance exactly how to obtain an idea with maximal utility, then the resulting idea cannot be creative even if its probability is low
      - e.g., solving the equation $y = ax^2 + bx + c = 0$ using the quadratic formula

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

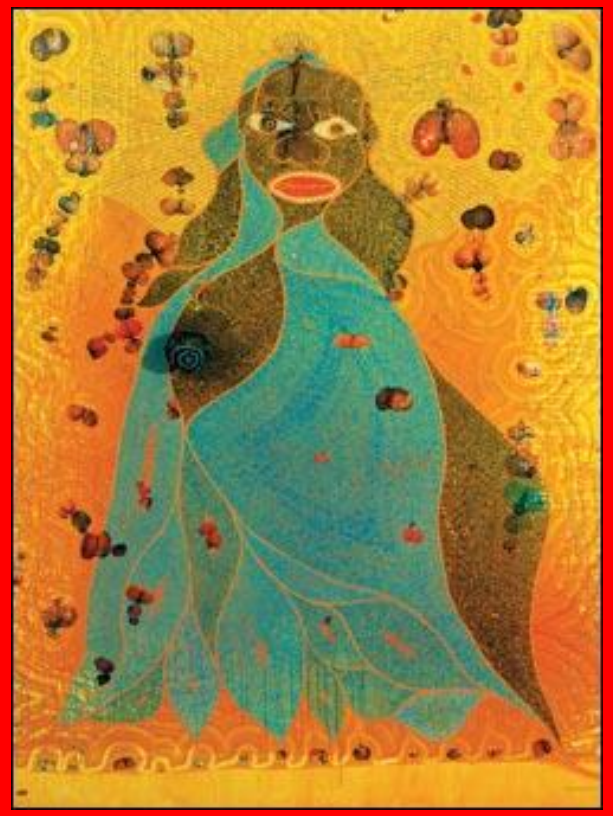
Personal creativity: Implications - Maximization

- Special note: When personal creativity is not maximized at $c_i = 1$, then its three components can assume a wider range of values
- This variability allows for tradeoffs, such as sacrificing utility for the sake of originality and surprisingness
- Examples:
  - Laboratory: the pliers-pendulum solution to the two-strings problem has "an element of surprise and a change in meaning since the tool changes to a weight and the string, which was too short, suddenly becomes too long and must be shortened" (Maier, 1940, p. 52)
  - Real-world
    - Creativity in Eastern versus Western civilizations
    - Avant-garde and "shock" art





versus

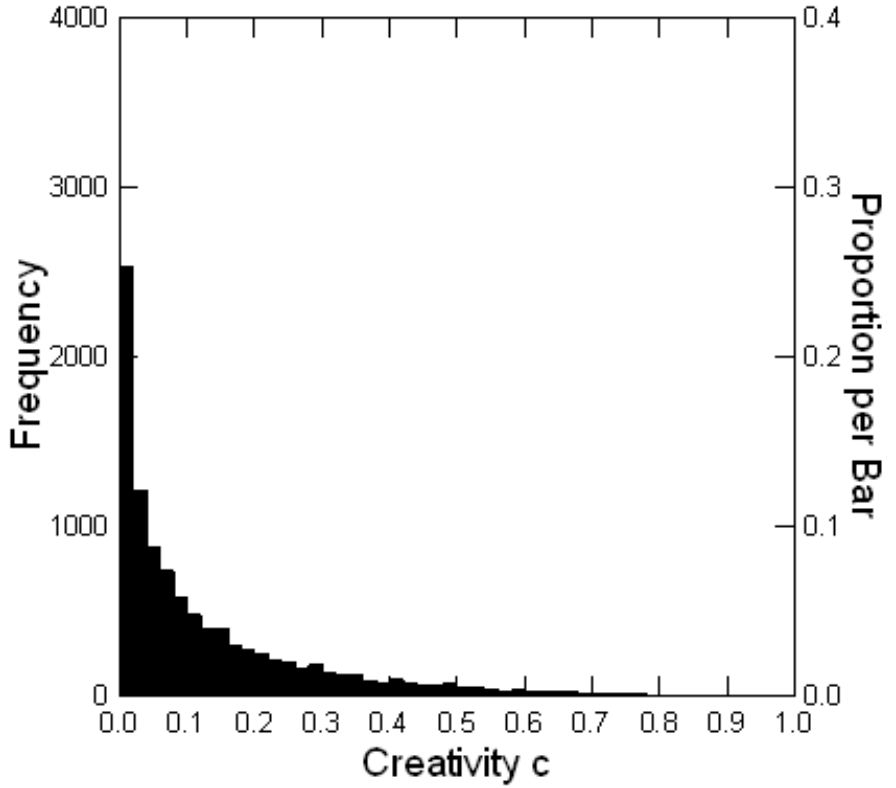


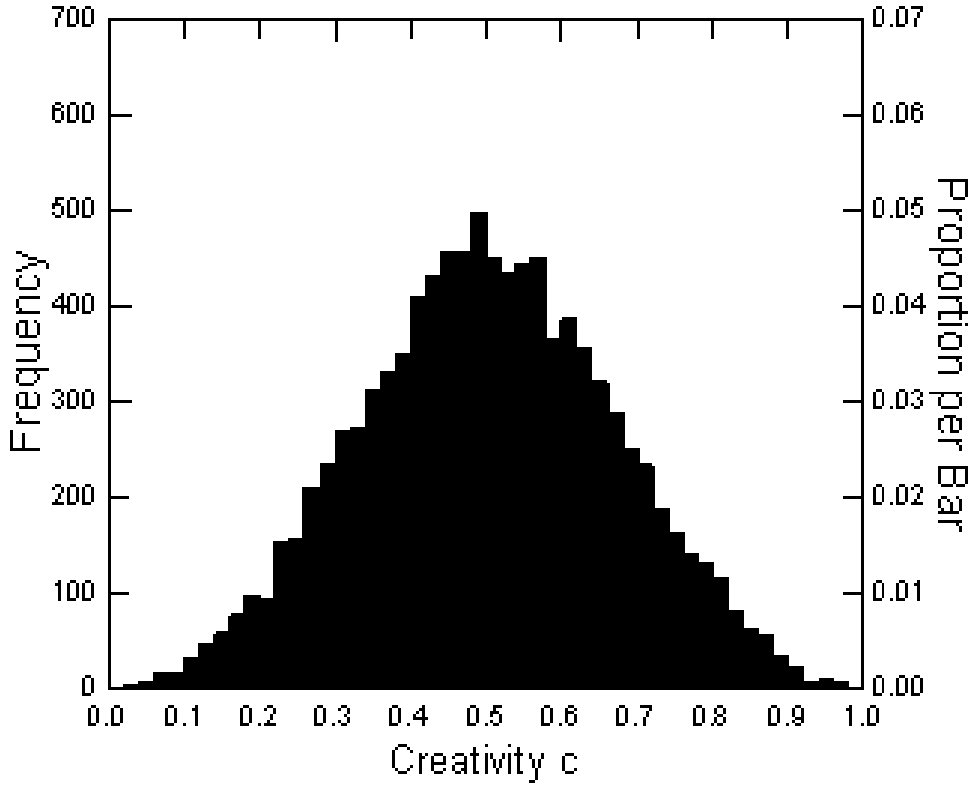
- Credits:
  - Riza Abbasi (c. 1565–1635): *Youth Reading*
  - Xu Daoning (ca. 970–1051/53): *Fishermen's Evening Song* (segment)
- Discredits:
  - Chris Ofili (1968-): *The Holy Virgin Mary*
  - Andres Serrano (1950-): *Piss Christ*
  - Miley Cyrus (1992-): Wrecking *Ball* (still)

Personal creativity: Implications - Distribution

- According to $c_i = (1 - p_i)u_i(1 - v_i)$, creativity is the *multiplicative* function of three *quantitative* variables: originality, utility, and surprisingness
- It necessarily follows that highly creative ideas should be very rare, and non-creative ideas should be commonplace
- That is, while an idea has to rate high on all three criteria to be creative, it only has to be low on just one of the three criteria to be non-creative
- This outcome contrasts with what would obtain were the three criteria where integrated in an additive rather than multiplicative manner
- Illustration: a simple Monte Carlo simulation (Simonton, 2012)
  - Randomly generated 10,000 ideas, where *p*, *u*, and *v* were given uniform distributions

Multiplicative versus Additive (creativity rare versus common)





N.B.: These distributions are not dependent on the distributions of the three components (cf. the central limit theorem)

Personal creativity: Implications - Origins

- Given how rare highly creative ideas must be, where do they come from? How can they be generated?
- Answer: Donald Campbell's (1960) blind-variation and selective-retention theory of creativity (BVSR or BV+SR)
- Problem: Campbell defined neither "creativity" nor "blindness"
  - This failure led to abundant criticism: How can creativity be blind?
  - Moreover, critics often mistakenly believed that BVSR
    - required an *analogy* with Darwin's evolutionary theory
    - demanded that ideas be generated *randomly*
- Hence, to avoid misconceptions, let's begin with *sightedness* (Sternberg, 1998), proving that it is *inversely* related to creativity!

Personal creativity: Implications - Origins

- Sightedness:
  - For any given idea x_i
    - $s_i = p_i u_i v_i$, where $0 \leq s_i \leq 1$, or in words:
    - Sighted ideas are highly probable, highly useful, and highly probable because they are already known in advance to be useful
    - These ideas thus represent routine or "reproductive" thinking
    - e.g., almost all of the solutions in the two-string experiment
    - N.B.: importance of v_i (cf. "lucky guesses" in biased coin flips)
  - For the entire set of solutions X
    - $S = 1/k \, \Sigma p_i u_i v_i$, where $0 \leq S \leq 1$

Personal creativity: Implications - Origins

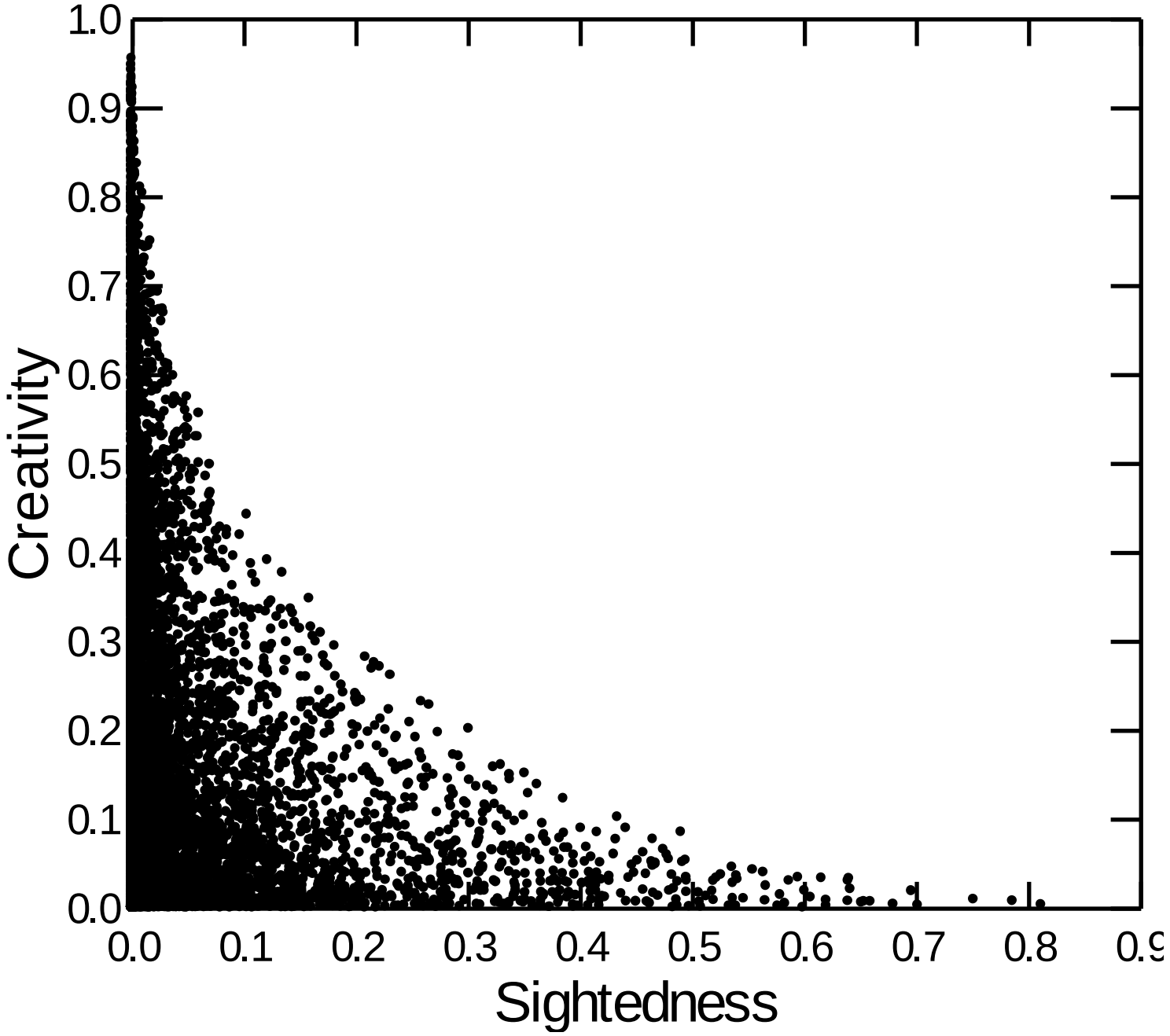
- Sightedness:
  - The inverse of sightedness is "blindness"
    - $b_i = 1 - s_i$ for idea x_i , and
    - $B = 1 - S$ for ideational set X
    - Blind ideas have low initial probabilities, low final utilities, or low prior knowledge values, or any combination of low values
    - Hence, although an idea only has one way of being sighted, it has multiple ways of being blind: blind ideas are heterogeneous
    - e.g., a habitual response that fails because the person is ignorant that a behavior that worked in the past does not apply to a new situation (i.e., $p_i = 1$ but $u_i = v_i = 0$)
    - Hence, a *bipolar continuum*:
      - From $b_i = 1$ to $s_i = 1$ or from $B = 1$ to $S = 1$

Personal creativity: Implications - Origins

- Special note on "blindness"
  - Blindness *does not* require randomness
    - All randomness is blind but not all blindness is random
    - Random ideas are just a subset of all blind ideas
  - Systematic processes or procedures can yield ideas where $s_i << .5$
    - e.g., radar sweeps and search grids
    - e.g., BACON the discovery program
  - Hence, BVSR does not necessarily operate in a manner analogous to genetic mutation and recombination as in evolutionary theory (although it may)
  - Blindness does *not* require equiprobability, albeit blindness usually does increase with equiprobability (viz. $S \rightarrow 0$ as $p_i \rightarrow 1/k$ for all i)

Personal creativity: Implications - Origins

- Now, when sightedness maximizes, then creativity must minimize
  - viz. as $s_i \rightarrow 1$, then p_i, u_i, and v_i all $\rightarrow 1$, and hence $c_i \rightarrow 0$ for any i
  - i.e., regardless of the idea's utility, highly sighted ideas cannot be highly creative: it's simply *impossible*!
- In contrast, when blindness maximizes, then
  - the expected value (M_c) of c_i increases,
  - the variance of c_i (σ_c) increases
  - the maximum possible creativity (or c-max) increases
  - the skewness of the joint creativity-sightedness distribution increases
  - all four increases at an accelerating rate, as seen in the following Monte Carlo simulation (Simonton, 2012):


Creativity
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Sightedness

Personal creativity: Implications - Origins

- Therefore, BVSR is absolutely required to isolate the few highly creative ideas from the numerous useless ideas
  - i.e., to separate the wheat from the chaff
  - especially given that the grains are biggest where the chaff is more voluminous!
- In other words, the function of BVSR is to establish $v_i = 1$ for all x_i in X, enabling the person to learn the previously unknown utility values
- Presumably, on that basis, whenever $v_i = 1$ but $u_i = 0$, then the post-BVSR probability of x_i is set to 0, and deleted from X, reducing the size of k perhaps to just $k = 1$, containing the single best idea (e.g., the quadratic formula replaces all ad hoc solutions, such as factoring)

Personal creativity: Implications - Origins

- Big question: What enables a person to engage in BVSR?
  - Cognitive processes
  - Personality characteristics
  - Experiential factors

Personal creativity: Implications - Origins

- Big question: What enables a person to engage in BVSR?
  - Cognitive processes
    - Remote association (but *not* the RAT)
    - Divergent thinking (fluency, flexibility, and originality, but not elaboration)
    - Disinhibition (reduced latent inhibition; when moderated by *g*)

Personal creativity: Implications - Origins

- Big question: What enables a person to engage in BVSR?
  - Cognitive processes
  - Personality characteristics
    - Openness to experience (not just general intelligence)
    - Persistence (in the face of failure)
      - Thomas Edison: "Success is 10 percent inspiration and 90 percent perspiration."
      - Michael Faraday: "The world little knows how many thoughts and theories which have passed through the mind of a scientific investigator have been crushed in silence and secrecy by his own severe criticism and adverse examinations; that in the most successful instances not a tenth of the suggestions, the hopes, the wishes, the preliminary conclusions have been realized."

Personal creativity: Implications - Origins

- Big question: What enables a person to engage in BVSR?
  - Cognitive processes
  - Personality characteristics
  - Experiential factors
    - Long-term effects (correlational studies)
      - e.g., multicultural experiences
    - Short-term effects (laboratory experiments)
      - e.g., unconventional, incongruous, or unexpected stimuli

So, at this point in my talk you may be asking …

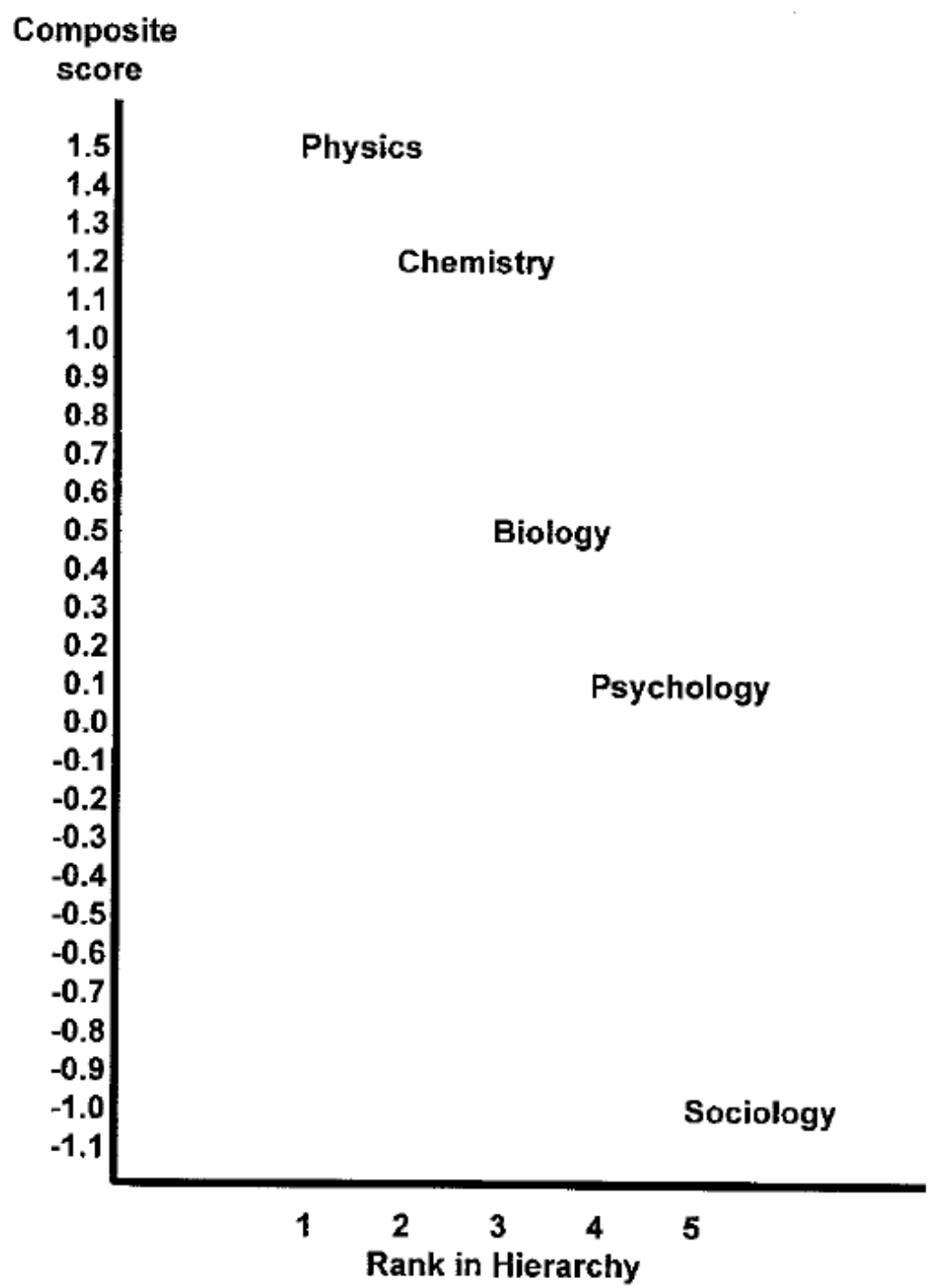

ARE WE THERE YET !?!
MATT GROENING

Unfortunately, not really …

- What happened to the fourth P, creativity as Persuasion?
- What about the distinction between personal and consensual assessment? Little-c versus Big-C Creativity?
- This analysis requires now requires that we introduce the judgments of others, such as colleagues in the sciences or audiences in the arts
- For example, consensual or Big-C creativity assigned to idea x_i can be defined as $C_i = 1/n \, \Sigma \, c_{ji}$,
  - where $0 \leq C_i \leq 1$,
  - n is the size of the field ($250 \leq n \leq 600$), and
  - c_{ji} is the assessment of the jth field member ($j = 1, 2, 3, \ldots n$)

Unfortunately, not really …

- Yet, complicating Big-C assessment still further, we have to allow for variation around the mean, in which case, we must include
  - $\sigma^2(c) = 1/n \, \Sigma \, (c_{ji} - C_i)^2$, the variance in creativity evaluations
  - Because the variance is inversely related to field consensus, we get
    - High-consensus fields where $\sigma^2(c) \rightarrow 0$,
      - and hence $c_{ji} \approx C_i$ for all field members
    - Low-consensus fields where $\sigma^2(c) \rightarrow 1$,
      - and thus $c_{ji} \neq C_i$ for most field members
      - including the idea's originator!
  - e.g. in the sciences …


Composite score
1.5
1.4
1.3
1.2
1.1
1.0
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0.8
0.7
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0.5
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0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
-0.9
-1.0
-1.1
Physics
Chemistry
Biology
Psychology
Sociology
1
2
3
4
5
Rank in Hierarchy

Unfortunately, not really …

- Moreover, recent research suggests that this hierarchy can be extended into the humanities and even the arts
- Placement in this hierarchy has implications for the role that BVSR plays in the creativity,
- and hence consequences for the relevant cognitive processes, personality characteristics, and experiential factors
- Hence, it is best to just say …


"That's all Folks!"