

Creativity, Automaticity, Irrationality, Fortuity, Fantasy, and Other Contingencies:

An Eightfold Response Typology

Simonton, D. K. (2016). Creativity, automaticity, irrationality, fortuity, fantasy, and other contingencies: An eightfold response typology. *Review of General Psychology, 20*, 194-204.
To be delivered as the 2017 Arthur W. Staats Lecture for Unifying Psychology, Annual Convention of the American Psychological Association, Washington DC.

The Typology Requires Three Parameters

- These parameters all describe an individual's response to a given situation, whether that response be a thought or behavior
 - E.g., a commuter blocked by a washed-out road



The Three Parameters:

- First, the response's *initial probability* p , where $0 \leq p \leq 1$
 - Also may be called the “initial response strength” of a thought or behavior at the moment a person first encounters a given situation
 - In either case,
 - if $p = 0$, then that thought or behavior is not immediately available to the individual, but will require a considerable amount of “incubation” before emission
 - if $p = 1$, then that thought or behavior will be available at once, as the very first and instantaneous response
 - if $p \approx .5$, then that thought or behavior will be available during the particular situation, but only after a little thought while remaining in that situation

The Three Parameters:

- Second, the response's *actual utility* u , where $0 \leq u \leq 1$
 - The inclusive term “utility” is taken to encompass such alternatives as useful, valuable, appropriate, meaningful, adaptive, correct, valid, etc. (depending on the given situation)
 - If u is *qualitative*, then $u = 0$ if useless and $u = 1$ if useful
 - If u is *quantitative*, then depending on the situation, u may indicate
 - the *proportion* of pre-set criteria satisfied (e.g., Edison's light bulb),
 - the *probability* of acceptance as a legitimate response, or
 - the *benefit-cost ratio* scaled to a 0-1 metric [e.g., $BCR = b/(b + c)$]
 - A response where $0 < u < 1$ permits variable degrees of *satisficing* rather than full optimization (aka $u = 1$)
 - Finally, “actual” means the utility after the response is *actually* generated and tested, the ultimate justification

The Three Parameters:

- Third, the utility's *prior knowledge value* v , where $0 \leq v \leq 1$
 - v is closely related to the “justification” requirement of knowledge as “justified true belief” (JTB) in classic epistemology, but where that justification can be quantitative rather than qualitative
 - If any claimed knowledge about u is totally justified, then $v = 1$
 - If any claimed knowledge about u has no justification whatsoever, then $v = 0$
 - If any claimed knowledge about u has partial justification, then $v \approx .5$
 - Justification can be either empirical (a posteriori) or logical (a priori)
 - In former case, the knowledge was acquired through bottom-up *induction*
 - In the latter case, the knowledge was acquired through top-down *deduction*
 - Cf. knowledge as “true opinion, combined with reason.” – Plato, *Theaetetus*

The Three Parameters:

- Pairwise, the parameters can assume orthogonal values
 - To illustrate,
 - if $u = 0$, then still $0 \leq v \leq 1$ (response *uselessness* may or may not be known in advance)
 - if $u = 1$, then still $0 \leq v \leq 1$ (response *usefulness* may or may not be known in advance)
- However, given the three parameters together, then two rational constraints would normally result
 - If $v \rightarrow 1$ and $u \rightarrow 0$, then $p \rightarrow 0$ (i.e., responses known to be useless get low probabilities)
 - If $v \rightarrow 1$ and $u \rightarrow 1$, then $p \rightarrow 1$ (i.e., responses known to be useful get high probabilities)
 - where “ \rightarrow ” indicates “approaches” or “nears”
 - But, as seen shortly, people aren’t always rational!

Eightfold Typology of Potential Responses

- To simplify, let us assume that all parameters approach either 1 or 0
- But given their independence, we obtain eight possible combinations of parameter values (even if not all are equally probable)
- The resulting response “types” can then be organized according to the following table, with each type to be discussed in turn

Eightfold Typology of Potential Responses

Outcome	Initial Probability	Actual Utility	Prior Knowledge
Routine, reproductive, or habitual responses (e.g., supreme expertise)	$p \rightarrow 1$	$u \rightarrow 1$	$v \rightarrow 1$
Fortuitous responses (e.g. the “lucky guess”)	$p \rightarrow 1$	$u \rightarrow 1$	$v \rightarrow 0$
Irrational perseveration (e.g., repeated failure)	$p \rightarrow 1$	$u \rightarrow 0$	$v \rightarrow 1$
Problem finding (e.g., expert expectation violation)	$p \rightarrow 1$	$u \rightarrow 0$	$v \rightarrow 0$
Irrational suppression (e.g., not doing what’s good for you)	$p \rightarrow 0$	$u \rightarrow 1$	$v \rightarrow 1$
Creative or productive responses (i.e., original, useful, and surprising)	$p \rightarrow 0$	$u \rightarrow 1$	$v \rightarrow 0$
Rational suppression (e.g., response extinction)	$p \rightarrow 0$	$u \rightarrow 0$	$v \rightarrow 1$
Mind wandering and behavioral exploration (e.g., fantasy and play)	$p \rightarrow 0$	$u \rightarrow 0$	$v \rightarrow 0$

Routine, Reproductive, or Habitual Responses

Outcome	Initial Probability	Actual Utility	Prior Knowledge
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Routine, Reproductive, or Habitual Responses

- These responses are highly useful, and enjoy a high likelihood because the individual already and truly knows that they are useful
- Such responses make up the knowledge and skill that allows each and every one of us to adapt readily to our world both at home and work
- Often these thoughts or behaviors adopt the form of *if-then* statements: “if *this* happens, then do *that*” – e.g.,
 - “*if* you encounter an emergency, *then* call 911”
 - “*if* the dependent variable’s distribution displays a strong positive skew, *then* subject that variable to a logarithmic transformation”
- Cf. rule-based expert systems, such as MYCIN (about 500 rules)

Routine, Reproductive, or Habitual Responses

- Hence, “routine” rather than “original” (Bartlett, 1958),
- “reproductive” rather than “productive” (Wertheimer, 1945/1982),
- or just plain “automatic” or “habitual” (James, 1892)

Routine, Reproductive, or Habitual Responses

- Although true automaticity presumes that $p = u = v = 1$, habitual responses need not feature such perfection to prove useful
- Even expert systems introduce “certainty factors” that posit values less than unity (e.g., .8 in Rule 037 of MYCIN)
- We can define a measure of response *sightedness* $s = puv$
 - i.e., the multiplicative function of probability, utility, and prior knowledge
 - If $s = 1$, sightedness perfect; if $s = 0$, then sightedness absent; but also
 - $s = .08$ if $p = .2$, $u = .8$, and $v = .5$; very unsighted (or largely “blind”)
 - $s = .729$ if $p = u = v = .9$; highly sighted, but not completely so
 - $s = .504$ if $p = .8$, $u = .9$, and $v = .7$; about halfway between sighted and blind
 - If $s > .5$, then functional? (cf. Ty Cobb’s .367 lifetime batting average)

Fortuitous Responses

Outcome	Initial Probability	Actual Utility	Prior Knowledge
Routine, reproductive, or habitual responses (e.g., supreme expertise)	$p \rightarrow 1$	$u \rightarrow 1$	$v \rightarrow 1$
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Mind wandering and behavioral exploration (e.g., fantasy and play)	$p \rightarrow 0$	$u \rightarrow 0$	$v \rightarrow 0$

Fortuitous Responses

- Response is highly probable and highly useful, and yet the person's prior knowledge of that utility approaches if not equals zero
- Two kinds of examples
 - The “lucky guess” based on an uninformed response bias
 - E.g., hiker comes to fork in road and just decides when in doubt, turn right
 - Cross-domain transfer of expertise (such as career changes where $v \ll 1$)
 - E.g., Dwight D. Eisenhower as army general, university president, and US chief executive
- N.B.: It was to avoid the intrusion of fortuity that *justification* was added to “true belief” to yield “justified true belief”
 - i.e., these parameters often define an “unjustified true belief” about u

Irrational Perseveration

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Irrational Perseveration

- First of two kinds of high probability but low utility responses
- Also, first of two forms of irrational thought or behavior
- A response retains a high probability even though the individual knows full well that the response has a low if not zero utility
 - E.g., a response continues to have a high likelihood despite the fact that the ratio of benefits to costs nears zero
- Cf. “The definition of insanity is doing the same thing over and over and expecting different results” (often attributed to Albert Einstein)
 - E.g., the compulsive gambler who “just can’t help himself”

Problem Finding

Outcome	Initial Probability	Actual Utility	Prior Knowledge
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Problem Finding

- Initial probability remains high, while both the utility and prior knowledge value are low if not zero
- Thought or behavior has a high probability because it is believed to be highly useful as well, but that belief proves unjustified in fact, because the genuine prior knowledge of the actual low utility is nil or nearly so
- Hence, the individual has inadvertently discovered a boundary on his or her expertise
 - E.g., when reinforcement in a Skinner box when the organism's reinforcement schedule comes under stimulus control (viz. no light implies no food pellet)
 - E.g., “anomalies” in Thomas Kuhn's theory of scientific revolutions (such as the failed 1887 Michelson-Morely interferometer experiment)

Irrational Suppression

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Irrational Suppression

- First of the remaining four types of responses that all share one attribute: They each feature low initial probabilities of generation
- Second of two forms of irrationality: the counterpart to irrational perseveration
- To wit, refusing to do what you know is good for you
 - E.g., someone who after quadruple bypass surgery still refuses to take the physician's recommended medications to reduce risk for another heart attack
- Confession: This is my favorite irrational behavior!
- N.B.: However odd, irrational suppression has a surprising relation with creativity, which we turn to next

Creative or Productive Responses

Outcome	Initial Probability	Actual Utility	Prior Knowledge
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Creative or Productive Responses

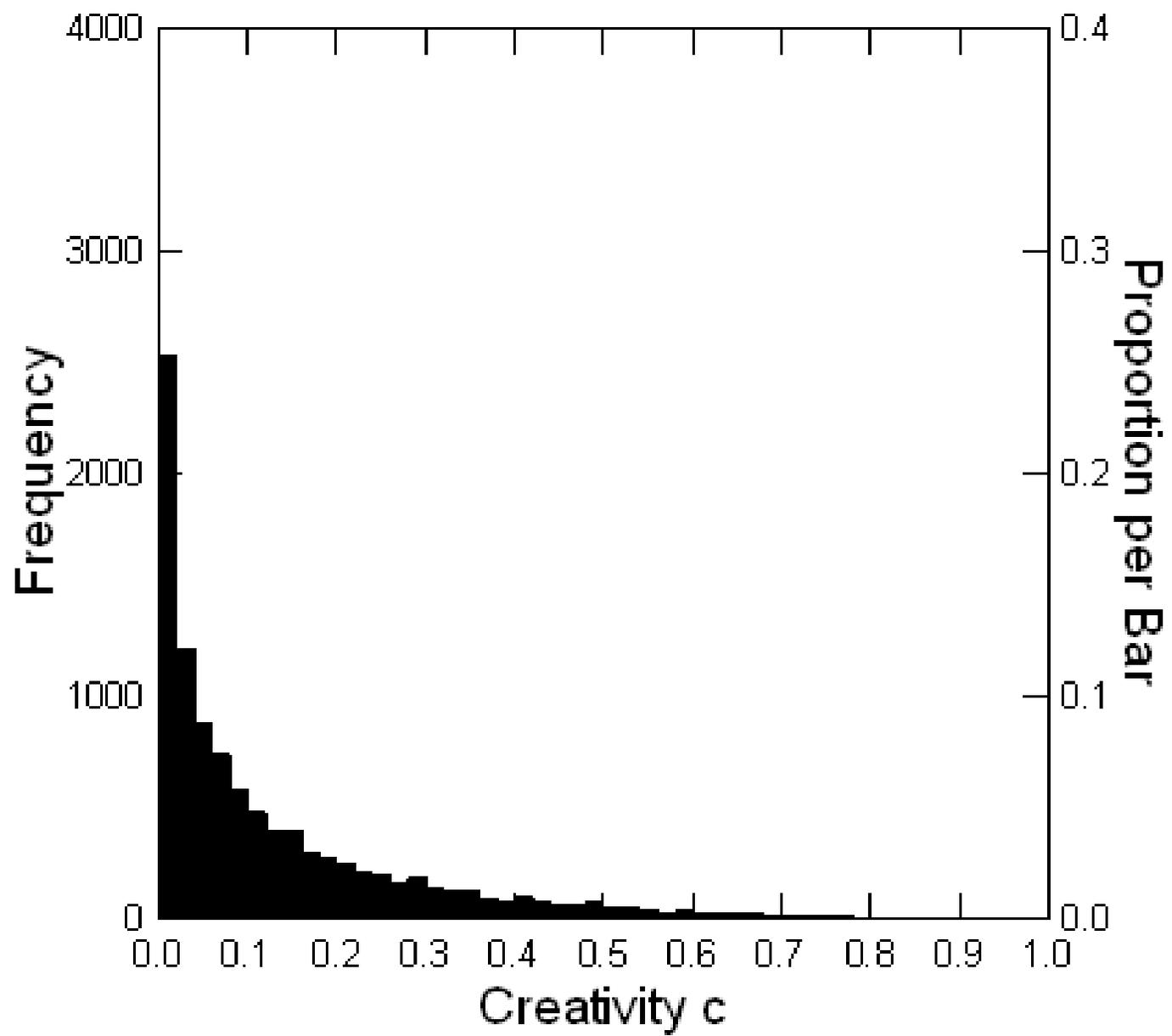
- It was an attempt to find a rigorous definition of creativity that led to this typology in the first place; researchers had not reached a consensus about the number of criteria or whether those criteria were personal or consensual
- The majority of researchers seem to favor the so-called “standard definition,” namely that “Creativity requires both originality and effectiveness”
- However, a minority argued for three criteria, most notably
 - Margaret Boden (2004): novel, valuable, and **surprising**
 - US Patent Office (1952): novel, useful, and **nonobvious**
- These three criteria were then formalized in terms of the three parameters
 - Personal creativity $c = (1 - p)u(1 - v)$, where $0 \leq c \leq 1$
 - Here $(1 - p)$ defines response *originality*,
 - and $(1 - v)$ defines response *surprise* (viz. the amount of new knowledge acquired)
 - i.e., $(1 - 0) = 1 =$ “surprising,” $(1 - 1) = 0 =$ “obvious,” $(1 - .5) \approx .5 =$ “hunch” or “educated guess”

Creative or Productive Responses

- Five implications of the three-criteria definition:
 - *First*, because the three criteria are combined via multiplicative rather than additive integration, each criterion becomes a necessary but not sufficient basis for creativity (i.e., if any factor equals zero, then their product is zero)
 - This result contrasts strikingly with additive integration (e.g., a hot air balloon constructed entirely of solid steel-reinforced concrete would still be creative)
 - *Second*, if $u > 0$ and $v < 1$, then c maximizes when $p = 0$
 - Hence, although incubation is not required for $c > 0$, those responses that require incubation will be more creative than those that don't (mutatis mutandis); e.g.,
 - if $u = .8$ and $v = .5$, but $p = .4$, then $c = .24$ [= $(1 - .4)(.8)(1 - .5)$]
 - if $u = .8$ and $v = .5$, but $p = 0$, then $c = .40$ [= $(1 - 0)(.8)(1 - .5)$]
 - But the duration of incubation is not specified as having any consequence
 - E.g., The first Eureka experience of Archimedes

Creative or Productive Responses

- Five implications of the three-criteria definition (continued):
 - *Third*, given multiplicative integration, then highly creative responses must be far more rare than noncreative responses
 - The resulting inverse-power distribution does not depend on the distribution of the parameters themselves (normal, rectilinear, skewed, etc.)
 - e.g., the Monte Carlo simulation ...

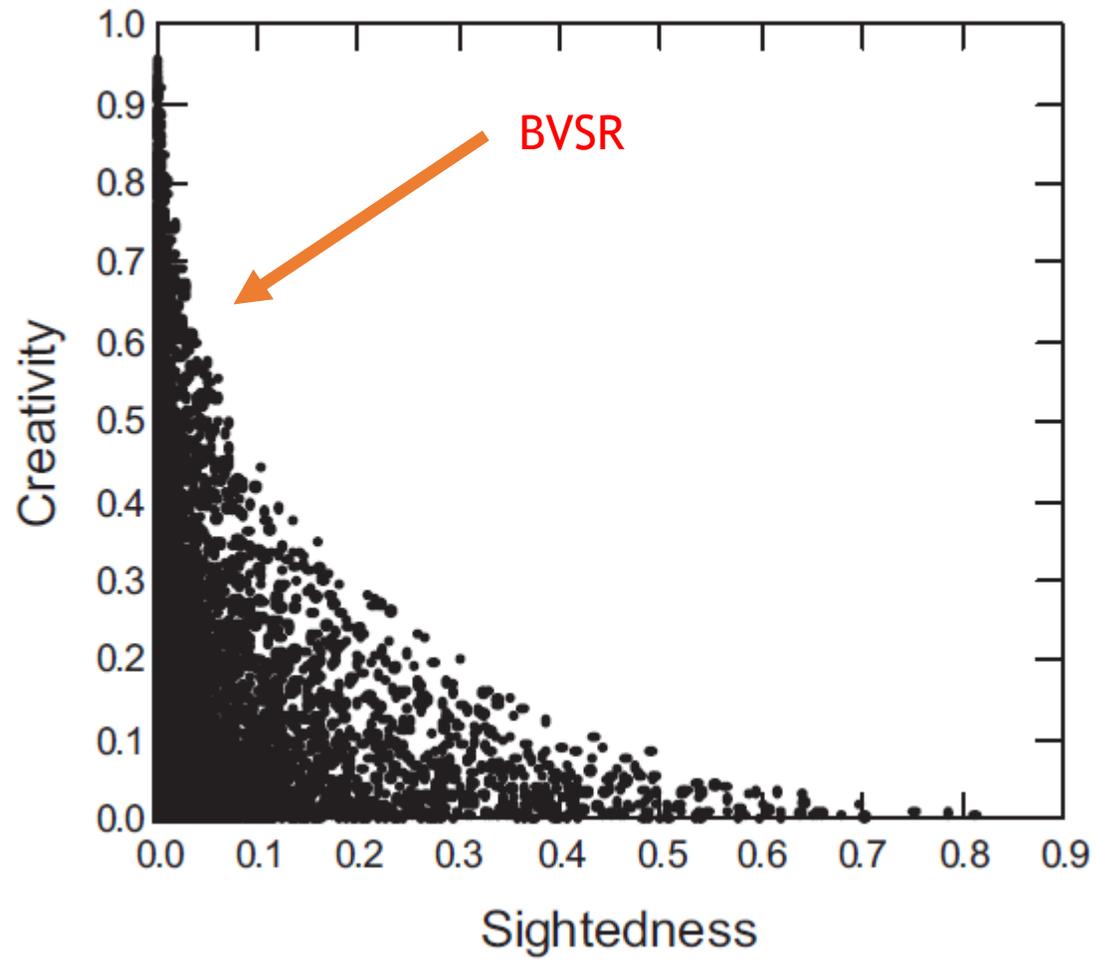


Creative or Productive Responses

- Five implications of the three-criteria definition (continued):
 - *Fourth*, if the third criterion v is omitted, the resulting two-criteria “standard definition” makes no logical or psychological sense
 - If we assume that the integration is still multiplicative, then we get $c = (1 - p)u$
 - But now creativity becomes absolutely indistinguishable from irrational suppression!
 - Even worse, how is it even possible for a high utility response to have a low probability?
 - Unless the person is irrational, the only possible answer is that the prior knowledge of the utility was low or zero
 - After all, if the utility is high, and the prior knowledge of that utility also high, then the probability must also be high, yielding a routine, reproductive, or habitual response
 - Yet that admission requires that v be added as a third factor!
 - Q.E.D.

Creative or Productive Responses

- Five implications of the three-criteria definition (continued):
 - *Fifth* and last, Donald Campbell's (1960) "blind variation and selective retention" (BVSR) is absolutely mandatory to identify creative responses
 - To begin with, it must be obvious that as sightedness increases creativity must decrease
 - More formally, as $s \rightarrow 1$, $c \rightarrow 0$ [i.e., as $puv \rightarrow 1$, $(1-p)u(1-v) \rightarrow 0$]
 - In words, habitual responses cannot be creative; it's mathematically and logically impossible
 - However, it is less obvious what happens to creativity as sightedness goes to zero
 - In fact, as $s \rightarrow 0$ (i.e., as blindness $b \rightarrow 1$, where $b = 1 - s$), then the following results obtain:
 - The maximum possible c increases a nonlinear accelerating function
 - The variance of c increases, also in a nonlinear accelerating function
 - The minimum possible c remains constant at zero
 - The distribution of c becomes increasingly skewed, where $f(\text{low-}c) \gg f(\text{high-}c)$
 - Hence, BVSR is required to sift the (biggest kernels of) wheat from the (most abundant) chaff
 - Q.E.D. ... but to provide a graphic representation, again using a Monte Carlo simulation ...



Rational Suppression

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Rational Suppression

- Another form taken by expertise: Besides automatically knowing what to do, expertise involves knowing what *not* to do
 - E.g., Hippocratic Oath's "first, do no harm" assumes that the physician knows the risks associated with medicines and surgical procedures
 - Or, "*if* the boss seems in a bad mood, *then* don't ask for a raise!"
- Many *if-then* statements have both positive and negative forms: e.g.,
 - Golden Rule: "Do unto others as you would have them do unto you"
 - Silver Rule: "Do *not* do to others as you would *not* want them to do to you."

Rational Suppression

- However, unlike routine, reproductive, or habitual responses, which often emerge through reinforcement (for as $uv \rightarrow 1, p \rightarrow 1$), rational suppression may involve direct extinction (for as $u \rightarrow 0$ and $v \rightarrow 1$, then $p \rightarrow 0$); but top-down processes can operate as well
- Finally, just like problem finding, rational suppression has an important place in creativity
 - In particular, BVSR incorporates *pre-selection* whenever possible
 - i.e., those responses already known to be useless need not be generated and tested
 - This stipulation is why so many researchers have been misled into believing that creativity requires sightedness rather than blindness
- The eighth response type also has a critical relation with creativity ...

Mind Wandering or Behavioral Exploration

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Mind Wandering or Behavioral Exploration

- The three-criteria creativity definition raises as profound question: How does an individual generate responses where $u \rightarrow 1$ but $p \rightarrow 0$ and $v \rightarrow 0$?
 - After all, the latter two parameter values are jointly essential to obtain $c \rightarrow 1$, and thus get creativity to maximize
 - Yet careful examination of the eightfold typology must reveal only a single apparent option: the very last—the eighth
 - All of the others are ruled out of court because either $p \rightarrow 1$ or $v \rightarrow 1$ or both (as holds for the habitual responses)
 - To be sure, if u approaches zero, then c will also approach zero
 - Yet because v also approaches zero, a high utility response cannot be excluded by any process or procedure that yields responses with unknown utilities

Mind Wandering or Behavioral Exploration

- This last response type encompasses two main possibilities, depending on whether the response represents a thought or behavior
 - *Thoughts*—mind wandering, broadly defined to encompass fantasy, daydreams, imageless thought, primary process, cognitive disinhibition, and the “default mode network”
 - *Behaviors*—behavioral play, including tinkering, exploration, “fool’s experiments,” frottage, aleatoric composition, etc.
 - But the latter can also include systematic and heuristic searches so long as $p \approx v \approx 0$
 - E.g., generating and testing every possible combination of a set of parameters

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Discussion

- The typology encompasses many interesting and important responses
 - Especially, creativity, automaticity, rationality, fortuity, fantasy, and play
 - Also two forms of irrationality:
 - irrational perseveration and irrational suppression
- Although does not necessarily accommodate all conceivable thoughts and behaviors, it can be said with 100% confidence (viz. $v = 1$) that the typology includes all possibilities defined by the parameter triad, a triad essential for defining any response, human or not
 - E.g., same parameters applicable to Skinnerian operant conditioning
 - Learning through reinforcement means that if $u = 1$, then $p \rightarrow 1$ and $v \rightarrow 1$
 - Extinction indicates that if $u = 0$, then $p \rightarrow 0$ and $v \rightarrow 1$ (“ \rightarrow ” changes over time to)

Discussion

- The typology also indicates the interconnections among the types
 - E.g., with respect to creativity
 - On the one hand, automaticity antithetical to creativity, because as $s \rightarrow 1$, $c \rightarrow 0$
 - On the other hand, the following types conducive to creativity
 - Problem finding, which identifies the boundaries of life or work expertise
 - Rational suppression, which filters out potential solutions already known to have $u \rightarrow 0$
 - Mind wandering or behavioral exploration, which provides thoughts or behaviors in which both $p \rightarrow 0$ and $v \rightarrow 0$, but which by happenstance $u \rightarrow 1$
- Yet because the three parameters are actually all quantitative rather than qualitative, responses can be more finely differentiated; e.g.
 - Functional adaptations, where $p = .8$, $u = .9$, and $v = .7$, yielding $s = .504$
 - Mundane creativity, such as $c = (1 - .2)(.8)(1 - .5) = .32$

Discussion

- But what about extremely high creativity?
 - If creativity maximizes when $p = v = 0$, then how can one obtain a thought or behavior where $c = 1$ whenever $u = 1$? Is maximal creativity then impossible?
 - Hence arises the critical role of serendipity!
 - “luck that takes the form of finding valuable or pleasant things that are not looked for” (Merriam-Webster) where “valuable” or “pleasant” implies $u \rightarrow 1$
 - Classic example: Alexander Fleming’s *Penicillium notatum*
 - Yet serendipity can be logical rather than empirical!
 - In working out the implications of a set of assumptions, inferences may arise that could not possibly have been searched for or even anticipated
 - E.g., How my quest for a rigorous definition of creativity yielded a typology of everyday thought and behavior: converting a research specialty into a general psychology
 - thus yielding an analytical framework with broad applications ...

... as just presented in this talk!

