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Taking the U.S. Patent Office Criteria Seriously: A Quantitative Three-Criterion Creativity Definition and Its Implications

Dean Keith Simonton
University of California, Davis

Although creativity has recently attracted considerable theoretical and empirical research, researchers have yet to reach a consensus on how best to define the phenomenon. To help establish a consensus, a definition is proposed that is based on the three criteria used by the United States Patent Office to evaluate applications for patent protection. The modified version uses the criteria of novelty, utility, and surprise. Moreover, creativity assessments based on these three criteria are quantitative and multiplicative rather than qualitative or additive. This three-criterion definition then leads to four implications regarding (a) the limitations to domain-specific expertise, (b) the varieties of comparable creativities, (c) the contrast between subjective and objective evaluations, and (d) the place of blind variation and selective retention in the creative process. These implications prove that adding the third criterion has critical consequences for understanding the phenomenon. Creativity is not only treated with superior sophistication, but also paradoxes that appear using the most common two-criterion definition readily disappear when the third criterion is included in the analysis. Hence, the conceptual differences between two- and three-criterion definitions are not trivial.

Although creativity has been frequently identified as a neglected research topic in psychology (e.g., Guilford, 1950; Sternberg & Lubart, 1996), in recent years the subject has attracted appreciable attention (Hennessey & Amabile, 2010). This expansion of scientific interest is apparent in recent review articles (e.g., Hennessey & Amabile, 2010; Runco, 2004), handbooks (e.g., Kaufman & Sternberg, 2006, 2010; Rickards, Runco, & Moger, 2009), textbooks (Kaufman, 2009; Runco, 2007; Sawyer, 2006; Weisberg, 2006), and even the second edition of a multi-volume encyclopedia (Runco & Pritzker, 2011). Associated with this expansion has been an impressive proliferation of creativity theories (Kozbelt, Beghetto, & Runco, 2010; Lubart, 2001; see also Hennessey & Amabile, 2010). All this scientific growth is well and good, but I would argue that creativity researchers have not devoted sufficient attention to the single most fundamental problem in the field: What do we mean by "creativity" in the first place?

Correspondence should be sent to Dean Keith Simonton, Department of Psychology, One Shields Avenue, University of California, Davis, CA 95616-8686. E-mail: dksimonton@ucdavis.edu

This is not to say that the term creativity is never defined. On the contrary, a very large number of alternative definitions crop up in the research literature (Plucker, Beghetto, & Dow, 2004). By far the most common statement entails some version of the two-criterion definition: Creativity requires (a) novelty or originality and (b) utility or usefulness (Mayer, 1999, Table 22.1; e.g., Simonton, 1999b; Sternberg & Lubart, 1999). To be creative, an idea must both be new and work. Other researchers favor some kind of a three-criterion definition. Kaufman and Sternberg (2011) asserted, for example, "a creative response is novel, good, and relevant" (p. xiii). Alternatively, Boden (2004) required that a creative idea be novel, valuable, and surprising. Her third criterion echoes Bruner's (1962) much earlier statement that the creative act entails "effective surprise." As Bruner's definition implies, it is not always easy to discern the number of criteria being applied because sometimes criteria are conflated. This conflation is also apparent in Amabile (1983) who provided "a conceptual definition of creativity that comprises two essential elements," namely "a product or response will be judged as creative to the extent that (a) it is both a novel and

appropriate, useful, correct, or valuable response to the task at hand, and (b) the task is heuristic rather than algorithmic'' (p. 33; see also Amabile, 1996, p. 35). Here the two most common criteria are combined into one, whereas a third criterion is added as the second criterion.

Although not all researchers are explicit about this point, these criteria are often presumed to apply to quantitative attributes of an idea or product (Huber, 2000; Simonton & Damian, in press). Even the greatest creative geniuses can exhibit uneven output that ranges from hackwork to masterworks. As a case in point, not all William Shakespeare's sonnets are uniformly creative, and some of these 154 poems may not even be creative at all (Simonton, 1990). The last two sonnets, in particular, never show up in even the most inclusive anthologies but only in collections identified as the poet's ''complete'' works (or poems or sonnets). Inclusion for scholarly completeness is not the same as inclusion for creative greatness.

Once we apply our definition to two or more quantitative attributes, we must then consider how those attributes are combined. The most suitable solution is to assume that the attributes contribute according to a multiplicative rather than additive function. For instance, Simonton and Damian (in press) defined creativity by the product $C = O \times A$, where C = creativity, O =originality, and A =adaptiveness, and where all three variables are assessed along a ratio scale (i.e., with a true zero point such as height or weight). That means that if the idea lacks either originality or adaptiveness, then creativity remains zero even if the other attribute is exceedingly large. The possibility of $O = 0$ would be illustrated by the invention of the wheel in the 21st century (which has already ''been there, done that'' thousands of years ago); the possibility of $A = 0$ is indicated by inventing an airplane made entirely of cinderblocks (which will not get off the runway no matter what the propulsion system). In contrast, if we used an additive definition like $C = O + A$, then a reinvented wheel and a cinderblock airplane would both be extremely creative. The former would still be highly adaptive, the latter highly original.

I believe it is most unfortunate that researchers have not settled on a single definition of the very phenomenon on which they conduct so much research. Alternative definitions are by no means interchangeable, and some definitions have dramatically contrasting consequences about the nature of the creative process, the creative person, and the creative product. It is for this reason why I will put forward the present definition of creativity. This definition will impose three criteria that are applied to quantitative attributes of an idea or response. I will then indicate the implications of this definition. As will be seen, some fundamental debates about the nature of creativity hinge on whether we adopt this new definition.

QUANTITATIVE THREE-CRITERION DEFINITION

In truth, the new definition is merely a modified and elaborated version of a very old one: the three criteria used by the United States Patent Office to determine whether an invention can come under patent protection (see http://www.uspto.gov/inventors/patents.jsp). Specifically, an invention must be shown to be new, useful, and nonobvious.[1] The first two stipulations are familiar features of two-criterion definitions, and the ''nonobvious'' criterion is comparable to the surprise criterion in Boden's (2004) semantically similar three-criterion definition. Because the words surprise and surprising are much less awkward than nonobviousness and nonobvious, we will slightly modify the Patent Office criteria to the adjectives new, useful, and surprising, and the corresponding nouns novelty, utility, and surprise. An idea then displays creativity to the extent that it is new, useful, and surprising. The third criterion also has some semantic congruence with Amabile's (1983, 1996) stipulation that creative tasks be heuristic rather than algorithmic: Algorithmic tasks are far less surprising than are heuristic tasks. This contrast is also found in Perkins's (2000, p. 22) distinction between *reasonable* problems that ''can be reasoned out step by step to home in on the solutions'' (e.g., anagrams) and *unreasonable* problems that ''do not lend themselves to step-by-step thinking. One has to sneak up on them'' (e.g., all true insight problems). Only the latter suggests that the creator experiences an ''Aha!'' or eureka moment that certifies the surprise.

The Patent Office applies its criteria in a qualitative manner. That application makes sense because the Office has to make a discrete decision: Either the patent is awarded or the application is denied. Partial protection is impossible. Nevertheless, it is clear that novelty, utility, surprise, and the resultant creativity can all be considered quantitative aspects of a given idea. For the purposes of demonstration, let us suppose that all four of these quantitative variables are represented as positive decimal fractions. Thus, creativity might range from 0 to 1, where the latter represents the highest possible score (e.g., a probability of unity that the idea would be universally credited as creative). This decision is for convenience only, and does not change the inferences to be drawn later. The only essential requirement is that all four variables are ratio scales having a zero point that indicates when a required quality is absent.

Given the foregoing, we can now define creativity as $C = NUS$ (or $N \times U \times S$), where N, U, and S indicate novelty, utility, and surprise, respectively. Under this

[1]Huber (2000) pointed out that the Patent Office definition has been used by previous researchers, including de Bono in 1992 and Torrance in 1988. Few have followed their example.

formulation, a maximally creative idea, where $C = 1$, occurs when all three attributes are maximized, that is, $N = U = S = 1$. However, an idea lacks any creativity if one or more of the three attributes are zero. Hence, although there is only one way for an idea to be maximally creative, there are multiple ways that an idea might lack creativity. For instance, the idea might be useful but very mundane and obvious, even algorithmic (i.e., $N = 0$, $U = 1$, and $S = 0$). The answer to a simple arithmetic problem is of this nature, like multiplying a pair of any two integers. Alternatively, these values might be inverted (i.e., $N = 1$, $U = 0$, and $S = 1$), in which case the novel and surprising idea might be labeled as "crazy" rather than creative. The "word salads" of the hebephrenic schizophrenic offer an example. In comparison, a conspiracy theory of a paranoid might be novel and useless but not very surprising (i.e., $N = 1$, $U = 0$, and $S = 0$) once the delusional premise is known (e.g., that the psychotic believes that he is Jesus Christ and that the Devil himself is trying to prevent the Second Coming). Insane ideas are not all insane in the same manner. As will be seen shortly, some intriguing results emerge when one or more attributes assume values between 0 and 1.

Although I might claim that the above definition has some modest quantity of novelty, and perhaps even a certain amount of surprise, I still have to show that it has a high degree of utility. Otherwise, the creativity definition will not be creative by my own definition! That utility comes from its implications.

FOUR IMPLICATIONS

Below I discuss four implications that are in varying degrees novel, useful, and surprising. More specifically, these implications document the utility of the proposed definition in two distinct ways. First, they show that the definition's implications often diverge from the implications of alternative definitions. In particular, it will become quite apparent that the three-criterion definition has important implications that differ markedly from the most common two-criterion definition. Second, the implications will be illustrated with concrete examples. These illustrations will render the definition less abstract in application. I hope, too, that they will help convince other creativity researchers of the value of adopting the advocated definition.

The four implications concern (a) the inescapable limitations to domain-specific expertise, (b) the many varieties of otherwise comparable creativities, (c) the inevitable contrasts between subjective versus objective evaluations of creative ideas, and (d) the essential place of blind variation and selective retention in the creative process.

Limitations to Domain-Specific Expertise

The Patent Office definition makes it explicit that the third criterion—nonobviousness—is determined by someone who has "ordinary skill in the art," that is, someone who has the relevant expertise (http://www.uspto.gov/web/offices/pac/mpep/documents/2100_2141_03.htm). One of functions of patent examiners is to decide whether a given invention represents an obvious extension or adaptation of a prior invention already under patent protection. By the same token, we will hold that as surprise approaches zero (i.e., as $S \rightarrow 0$) to the degree that the idea was generated by domain-specific expertise. Such ideas are then the products of routine, reproductive, or algorithmic thinking (cf. Amabile, 1996; Maier, 1931; Weisberg, 1995; Wertheimer, 1945/1982). This means that no matter how useful and novel an idea might be, it will still have zero creativity if it has zero surprise. Stated more formally, whenever $S = 0$ then $C = 0$ even if $N = U = 1$.

Researchers have often debated whether creativity depends on domain-specific expertise (e.g., Ericsson, 1999; Kaufman & Baer, 2002; Kozbelt, 2008; Simonton, 2000, 2007). Given the proposed definition, such expertise has an ambivalent relation with creativity.

On the one hand, it is certainly true that some amount of domain-specific knowledge and skill are required to evaluate the usefulness of a given idea. One has to know considerable chemistry to judge the utility of a new chemical hypothesis, like the ring structure of benzene proposed by Friedrich August Kekulé in 1865. To a lesser extent, expertise is also necessary to generate the idea in the first place. That is, the idea usually represents a combination of ideas that already belong properly to the domain (Simonton, 2004a, 2010a). Any theory in classical physics had to adhere to certain fundamental principles, such as Newtonian mechanics and Maxwell's electromagnetic equations.

On the other hand, even in the case of idea generation, expertise cannot be absolute. Most often, the creator has to "think outside the box" delimited by domain-specific knowledge and skill. To solve certain anomalous problems that arose in classical physics, Albert Einstein had to introduce novel and useful ideas that were not routinely provided in the traditional toolkit of theoretical physicists. More importantly, by definition, expertise cannot determine surprise. If a new and useful idea is entirely generated by prior knowledge and skill, then it will prove obvious instead. To be sure, our definition also allows surprise to vary in degree. Thus, a creator's expertise might guide her sufficiently to formulate a vague but insufficiently justified "hunch" (cf. Platt & Baker, 1931). If this conjecture turns out to be true, it will be less surprising than a "random guess" or "shot in the dark." Even so, she will be more "pleasantly surprised"

than if the idea were the absolute product of pure expertise.

This essential ambivalence helps us fathom a deep paradox about creative persons. If creativity were wholly a function of domain-specific expertise, then we would expect the greatest creators in a domain to be those who are the most focused on mastering all the knowledge and skills associated with the domain. The greater the depth of specialization, the higher is the assumed level of creativity. In addition, the most prominent creators would waste not the smallest moment on even appreciating domains of creativity outside their narrow expertise. Yet the contrary appears to be the case. Whether creativity is assessed psychometrically or behaviorally, it is positively correlated with (a) openness to experience (Carson, Peterson, & Higgins, 2005; Gough, 1979; Harris, 2004; McCrae, 1987), (b) voracious reading and breadth of interests (Gough, 1979; Roe, 1953; Simonton, 1984), (c) exceptional intra- and extra-domain versatility (Cassandro, 1998; Cassandro & Simonton, 2010; Simonton, 1976, 2000; Sulloway, 1996; White, 1931), and (d) avocations well outside the chosen domain of creative achievement (Root-Bernstein et al., 2008; Root-Bernstein, Bernstein, & Garnier, 1995; Simonton, in press). Also telling is the tendency for creativity to be linked with defocused attention, reduced latent inhibition, or some comparable relaxing of the cognitive filters (Ansburg & Hill, 2003; Eysenck, 1995; Mendelsohn, 1976; Peterson & Carson, 2000; Peterson, Smith, & Carson, 2002). Highly creative persons will attend to the irrelevant even if part of the expertise acquired by a domain expert is to learn what to pay attention to and what to ignore as irrelevant. But surprising ideas are more likely to result when something deemed irrelevant turns out to be highly relevant, as episodes of insight and serendipity amply illustrate (Cannon, 1940; Roberts, 1989). The famed eureka episode that Archimedes experienced when the water overflowed the bathtub could not possibly have been anticipated as relevant to the problem he was trying to solve.[2] The happenstance could also have easily been overlooked if he continued to concentrate on a solution exclusively based on his patently awesome expertise in mathematics and mechanics. Relevance is only valuable for obvious solutions.

Now suppose we remove the third criterion and simply define creativity as the product of novelty and utility. Then most of what was just said becomes invalid. Instead, expertise bears an unequivocally positive relation with creativity. Anytime someone uses domain-specific knowledge and skill to produce a new and useful idea, the result can be deemed just as creative as someone who generated an idea with equal novelty and utility but without the advantage of applying acquired expertise. Successful adaptations and innovations would thus have the same status (cf. Kirton, 1976). To illustrate, the unexpected null result of the famous Michelson-Morley interferometer experiment can be explained by both the Lorentz-Fitzgerald contraction and Einstein's special theory of relativity. In fact, the equations the two explanations produce are strictly equivalent (and thus equally novel and useful). Still, the former account emerged from within classical physics, retaining doctrines such as the ether, and thus was decidedly post hoc, whereas relativity theory was based on principles that challenged or ignored some central premises of classical physics, and enjoyed the additional asset that Einstein apparently conceived his theory without the Michelson-Morley findings in mind (Hoffman, 1972). Even though Einstein's explanation was far less dependent on domain-specific expertise—indeed, the original paper famously contains no references whatsoever to the relevant literature—the three-criterion definition sees his contribution as more creative.

Varieties of Comparable Creativities

Although an idea can be maximally creative in only a single way, the vast majority of creative ideas are distributed somewhere between the extremes of zero and unity. That is, although ideas might range from little or no creativity ($C \rightarrow 0$) to breakthrough creativity ($C \rightarrow 1$), most ideas of any importance will probably fall somewhere in the middle (e.g., $0.25 \leq C \leq 0.75$). Given this continuous distribution, it becomes possible for ideas to be equally creative in radically different ways: One idea can differ strikingly from another in relative novelty, utility, and surprise but still be just as creative as the other idea. Hence, an idea with the values $N = 0.5$, $U = 1$, and $S = 0.5$ is just as creative as an idea with the values $N = 1$, $U = 0.5$, and $S = 0.5$, for $C = 0.25$ in both instances. In a certain sense, a three-criterion multiplicative definition permits each creator to exhibit creativity in his or her own (creative) manner.

Allowance for divergent emphases is also crucial for comprehending creativity in other civilizations. For example, creators in individualistic cultures, such as modern European civilization, tend to place more emphasis on novelty, whereas those in collectivistic cultures, such as traditional Chinese civilization, tend to put more value on usefulness (Erez & Nouri, 2010; Simonton & Ting, 2010). Yet the solutions appearing in those cultures can still be deemed comparably creative. Prototypical solutions would just exhibit a different mix. Traditional non-European cultures might not boast creators nearly as audacious (nor as self-absorbed) as found in European cultures, but those cultures also do not

[2]Galileo provides an even more striking example: His discovery of the lunar mountains was largely contingent on his prior artistic training in chiaroscuro (Simonton, in press).

accumulate numerous novels, poems, paintings, or compositions that are only intelligible to an elite set of cognoscenti (cf. Martindale, 2009). As an example, just compare a typical product of Western Abstract Expressionism, such as Jackson Pollock's *No. 5, 1948*, to a masterpiece of Song Dynasty monochrome landscape painting, such as Xu Daoning's *Fishermen's Evening Song*. Pollock's work is far more individualistic, novel, and surprising than is Xu's, but the latter's work is probably more useful in a broad aesthetic sense—a painting whose appeal is likely more universal and timeless.

Admittedly, the second implication of the third-criterion definition also holds for a two-criterion definition. The only difference between the two is that the varieties of otherwise equivalently creative ideas become much greater. Some creators or cultures might place more emphasis on novelty, others on utility, and still others on surprise. The spontaneous idiosyncrasies of some contemporary pop artists like Lady Gaga might point up the consequences of making surprise the central characteristic. When she once did a photo session sans makeup and flamboyant accessories, it was surprising but not novel.

Subjective versus Objective Evaluations of Creative Ideas

In the preceding section, the three- and two-criterion definitions can yield similar implications but with a difference in complexity and nuance. Allowing creative ideas to vary in novelty, utility, and surprise rather than just novelty and utility just adds an important refinement. The same can be said for the next implication. Up to this point, we have failed to make a critical distinction between subjective and objective—or personal and social—conceptions of the three criteria. For the Patent Office, all criteria are defined objectively. Examiners do not take the applicant's word for it, but rather scrutinize closely the patent application to determine whether the invention is novel, useful, and nonobvious. If otherwise, an applicant might easily patent a reinvented wheel or a cinder-block airplane. Yet, surely, most inventors who file for patent protection believe that their inventions satisfy these same criteria *for them* (excepting for an occasional opportunist hoping to slip something past the examiners).[3]

The crux then is this: *N, U*, and *S* actually have at least two sets of values, one subjective and the other objective. The former are provided by the creator's personal experience, the latter by the objective expertise of others, such as a patent examiner, a journal editor, jury member, or some other judge or set of judges, including the field at large (Csikszentmihályi, 1999; Simonton, 2011a). This contrast echoes Boden's (2004) distinction between P-creativity, which has psychological importance to the person, and H-creativity, which has "historical" significance to society, such as a patented invention. This distinction is also reflected in the frequent distinction between "little-c" (everyday) and "Big-C" (genius-grade) creativity (Simonton, 2010b; cf. Kaufman & Beghetto, 2009).

This division between the subjective (personal or psychological) and objective (social or historical) take on the three criteria means that that the ultimate assessment of an idea's creativity depends on the perspective taken. Not only can the subjective diverge from the objective evaluation, but there also can be more than one subjective assessment: one creator can make a different judgment than another does. This divergence of opinion applies both to the overall attribution of creativity and to the separate criteria on which that attribution is based. Although this implication works for both two- and three-criterion definitions, the latter definition provides yet another criterion on which such appraisals can differ. Two ideas might be comparable in novelty and utility but differ substantially in surprise. Let me give a historic example.

For nearly a century, research on scientific discovery and technological invention has been fascinated with what has come known as the *multiples* phenomenon (Merton, 1961; Simonton, 2010a; see also Kroeber, 1917; Ogburn & Thomas, 1922). This event occurs when two or more creators independently and sometimes even simultaneously come with the same creative idea. Although critics will often argue that the separate ideas are seldom really equivalent (e.g., Schmookler, 1966), the fact remains that genuine instances do exist (Lamb & Easton, 1984; Simonton, 1979). An unequivocal example is the Pelton water wheel that solved a practical problem in 1870s California gold mining (Constant, 1978). This solution was independently created by two different inventors. Because the two inventions are indistinguishable, they are useful to the exact same degree. Both inventors also viewed their respective ideas as novel solutions to an important problem. Yet for one inventor (Hesse) the device was a more or less obvious extension of a previous invention, and so he did not even bother to apply for patent protection. That obviousness did not apply to the other inventor because his starting point was very different, and his key insight relied on a serendipitous event not unlike that of Archimedes (involving splashing water), thus rendering his equivalent product surprising as well as novel and useful—and accordingly patentable. Pelton's invention was more subjectively creative, but only because it was more personally surprising. This true story would have no point under the two-criterion definition.

[3]Although most "creativity tests" rely on social rather personal judgments—in the sense that someone else calculates a creativity score based on objective performance—sometimes a measure depends on self-assessments (e.g., Richards, Kinney, Lunde, Benet, & Merzel, 1988).

Blind Variation and Selective Retention

Unlike the first implication, the second and third implications might be viewed as just incremental improvements on the two-criterion definition (Sternberg, 1999). Therefore, I will close by working out one more implication that is similarly unique to the three-criterion definition. The implication concerns Campbell's (1960) blind-variation and selective-retention (BVSR) theory of creativity. This theory has provoked considerable debate for the past 50 years (Simonton, 2011b), some researchers denying its usefulness (e.g., Dasgupta, 2010; Gabora, 2010; Kronfeldner, 2010; Sternberg, 1998; Thagard, 1988) and others defending and even extending its utility (e.g., Cziko, 1998; Kantorovich, 1993; Nickles, 2003; Perkins, 1998; Simonton, 1999a, 2010a). Nonetheless, this controversy must adopt an entirely different form if we switch from a two- to a three-criterion definition. Under the latter definition, BVSR becomes an unavoidable component of creative thought (cf. Simonton, 2011b). To see how this is so, we first need to define what we mean by a "blind variation."

In Campbell's (1960) original view, creativity required the generation of novel "thought trials" that were then subjected to a selection process that weeded out all ideas that lacked usefulness. Variation provided the novelty, and selection gauged the utility. BVSR was needed because the variations are generated in ignorance of their utilities, so that the latter values have to be determined after the fact, by a generate-and-test or trial-and-error procedure. Unfortunately, Campbell's definition of variation blindness was somewhat vague and confusing (Simonton, 2011b). Much of the debate that ensued was the direct consequence of this conceptual problem. Happily, a recent BVSR opponent argued that blindness should be conceived in the same way that Sober (1992) defined what counts as an "undirected" variation in evolutionary biology (Kronfeldner, 2010). Although this critic believed that this definition provided a decisive argument against BVSR, Simonton (2010a, 2011b) has shown that blind variations can indeed be defined precisely via the same formalism. Furthermore, Simonton (2011a) has generalized the definition to handle any number of thought trials that might be evoked during the creative process. Below I give a slightly modified and simplified version of the latter definitional generalization.[4]

Assume that we have k potential thought trials or "ideational variants" in a given situation (e.g., a problem-solving occasion), where $k \geq 2$. For instance, these variants might constitute alternative solutions to the classic two-string problem, some of which will work and others will not (Maier, 1931). The ith thought trial is characterized by three parameters: (a) the probability of its generation p_i ($0 \leq p_i \leq 1$); (b) the probability of its selection u_i ($0 \leq u_i \leq 1$); and (c) the initial expectation that this variant will prove acceptable by the utility criterion, or v_i ($0 \leq v_i \leq 1$), where the expectation is based on either a priori (logic) or a posteriori (empirical) grounds. Generalizing from Sober (1992), variants are sighted insofar as we can assume that u_i implies p_i by means of v_i. The probability of a thought trial should be directly contingent on our previous knowledge that it will prove useful. Useless ideas will have a probability of zero if we *know beforehand* that they are useless. If the process is sighted, the most useful ideas will be tried first and the rest ignored.

It should be evident that these three parameters closely parallel the three criteria in the Patent-Office inspired definition: (a) the most probable ideas will feature less novelty; (b) the most useful ideas will have a higher probability of selection; and (c) the ideas with the highest expectation of selection prior to the generate-and-test episode will be those that are the least surprising. Because both sets of values are positive decimal fractions, we can then propose that $N_i \approx (1 - p_i)$, $U_i \approx u_i$, and $S_i \approx (1 - v_i)$, where the three criteria have been given indexes to distinguish among the k thought trials. I have imposed approximation symbol "$\approx$" in lieu of the equal sign "$=$" just to allow for some "slip and slop" in the creative process. For example, although the probability of selection should correspond to the utility, the correlation may not be perfect due to various cognitive tendencies, such as the confirmation bias (Nickerson, 1998; Wason & Johnson-Laird, 1972). In any event, by simple substitution we can define the creativity of the ith idea as $C_i \approx (1 - p_i)u_i(1 - v_i)$, where $0 \leq C_i < 1$ (the second inequality because if $p_i = 0$ the idea will not be generated). The question then becomes how to isolate the creative variant in the set of k ideas.

First note that this last question is raised only if we do not already possess a variant with the parameters $p_i \approx u_i \approx v_i \approx 1$, which demarcates a routine, reproductive, or algorithmic idea that has an extremely high probability of generation because it has a high expectation of surviving selection owing to its already known utility. Still, as previously seen, such a variant claims the lowest possible creativity ($C_i \approx 0$). In the absence of a straightforward, expertise-driven, highly "sighted" idea, we have to search for those useful ideas whose utilities are unknown (i.e., variants of the type $u_i \approx 1$ but $v_i \approx 0$).

Therein lies the crux: Variants with the values $u_i \approx 1$ but $v_i \approx 0$ cannot be distinguished from those with the values $u_i \approx 0$ but $v_i \approx 0$ without going through trial-and-error cycles. Regardless the variant's odds of generation, we cannot winnow the wheat from the chaff without engaging in BVSR. Whenever $v_i \approx 0$, we are dealing with a "blind variation," a thought trial that may or may not yield a useful result. To be sure, it might hold that

[4]The main change from Simonton (2011a) is that q_i has been replaced by v_i.

$0 < v_i << 1$, in which case the expectation—a mere hunch or informed guess—is still not strong enough to guarantee the variant's utility. The creator must continue to engage in BVSR just to make sure that the conjecture is correct. The greater the magnitude of blindness in the variation, the stronger is the need for a selection process—and the higher the creativity of any idea that survives selection.[5]

I have just proved that the three-criterion definition of creativity necessitates the operation of BVSR. Ideas that do not need BVSR for their identification are not creative, whereas creative ideas can only be separated from unknowingly useless ideas via some generate-and-test procedure. Even if a highly useful idea has a relatively high probability of generation, it will remain creative because $C_i \rightarrow 1$ as $v_i \rightarrow 0$ (i.e., a tradeoff relation exists between the probability and the expectation). Now consider what happens when we replace our three-criterion definition with the two-criterion definition. The variant parameter v_i is then deleted from the creativity definition, giving us the truncated $C_i \approx (1 - p_i)u_i$. The most creative ideas are those that feature low probabilities of generation yet still enjoy high utility values, regardless of whether we possess any advance knowledge of those utility values prior to checking out the ideas using BVSR. By obliterating the requirement that the idea be surprising or nonobvious, we introduce a paradox. How can a variant with a low probability be considered sighted if it has a high utility? Truly sighted thought trials must have probabilities that positively correlate with their utilities (Simonton, 2012).

The only route around this paradox is to assume that the probabilities are not necessarily based on the utilities, an assumption that presupposes that the creator is to some degree ignorant of the utilities. The latter presupposition demands that we introduce v_i as the third parameter, and thus attach the third criterion S. Comparing the two- and three-criterion definitions thus provides a reductio ad absurdum argument on behalf of BVSR. Campbell's (1960) half-century-old position has been reinforced by way of the proposed definition.

CONCLUSION

The purpose of this analytical exercise is to establish that creativity researchers really need to "define their terms" before going any further.[6] Trying to make scientific advances in our understanding of the phenomenon is futile if we cannot even reach a consensus on what is meant by a "creative idea." After all, the creative idea is an essential component of what we mean by the "creative process" (that generates the idea), the "creative person" (who produces the idea), and the "creative product" (which contains the idea). Moreover, if any consensus is reached, it is preferable for researchers to settle on the best definition possible. Yet at present, most investigators seem content to evoke one specific two-criterion definition: An idea is creative if it is (a) novel or original and (b) useful or adaptive. In opposition, I have argued for a definition explicitly inspired by the criteria that the U.S. Patent Office imposes in deciding on whether to award patent protection to an invention. This definition adds a third criterion, namely, nonobviousness, or what we have less awkwardly referred to as surprise. An idea is only creative if it can be credited with novelty, utility, and surprise. Just as important, these three criteria must be applied in a quantitative rather than qualitative manner and their joint contribution determined using a multiplicative rather than additive function.

The switch from a two- to a three-criterion definition is not a trivial academic issue. To indicate the value of the latter definition, I examined four implications. Although two of these implications mostly showed how three criteria offered more sophisticated analyses of creativity, the other two implications indicated that the third criterion made a substantial difference in how we view the phenomenon. In particular, domain-specific expertise and BVSR both have diametrically opposed explanatory functions depending on whether we require creative ideas to be surprising. In both cases, the explanatory functions under the three-criterion definition appear more reasonable in comparison to those derived under the two-criterion definition.[7]

[5]Kronfeldner (2010) argued that sightedness but not blindness can be considered a continuous variable. This argument depends on the arbitrary assumption that blind variations must be exactly analogous to undirected mutations, an analogy that Campbell (1960) never maintained nor believed was necessary (see also Simonton, 2011b). We can formally define a blind-sighted continuum in which variant sets range from the utterly blind to the totally sighted (Simonton, 2011a). Blindness is thus inversely related to sightedness on a continuous scale.

[6]One of the central reasons why the discipline of psychology is "softer" than the "hard" sciences is that the discipline not only lacks consensus regarding theory and method, but also psychological concepts tend to be less precisely defined (Simonton, 2004b). Perhaps the only advantage of this conceptual vagueness is that it is much easier for psychologists to confirm their hypotheses than is the case for scientists in the physical and biological sciences (Fanelli, 2010). We can always reinterpret what we meant to say to convert a disconfirmation into a confirmation. Whether this is the best way for creativity research to progress as a science, I leave to the reader to decide (but first see Plucker, Beghetto, & Dow, 2004).

[7]I have not even mentioned a fourth potential implication of adopting a three-criterion definition: It may enhance creativity research in the cognitive neurosciences (for reviews, see Dietrich & Kanso, 2010; Sawyer, 2011). Although the empirical findings are so far somewhat mixed, it might facilitate inquiries when the phenomenon is more precisely defined. Of special importance is explicitly making surprise an essential component (see, e.g., Bowden & Jung-Beeman, 2003).

Whenever someone proposes something new in science, some amount of skepticism and criticism is to be anticipated. That reaction is right and good insofar as novelty does not have to correlate positively with utility, as already pointed out in the previous section. Even so, the recommended definition has a long history in a major governmental institution—one that faithfully executes a federal responsibility written into the Constitution of the United States of America (Article 1, Section 8). This status implies that all three criteria should be taken seriously. I might even confess that the three-criterion definition is neither new nor nonobvious, but merely useful. Ultimately, however, it does not matter in this case: Utility alone should suffice to ensure its high probability of selection.

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