Feature Review

Circling Creativity

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There is something tantalizingly circular in the study of creativity. Creative processes produce creative conceptual or physical products; creative people produce more or better creative products. And what makes something creative? A creative product is one that people consider creative.

This circularity has been partly penetrated. Guilford (1950, 1968), who is often credited for having sparked much of the current interest in creativity research within psychology, essentially identified the two core components of our current understanding of a creative product: novelty and value. The problem is that while novelty can be perhaps objectively defined within a domain, value seems hopelessly subjective. In some domains where the problems are well defined, value may be amenable to some objective criteria, but in other domains, like the arts, there remains an apparently unavoidable role for subjective judgment.

Perhaps it is this inherent subjectivity that gives the whole field of creativity research an elusive quality that seems to leave scientists and scholars constantly stuck at the starting line, forever wrestling with the foundational question: What is creativity? To make matters worse, creativity creates problems of breadth, as well as depth. Whether trying to list personality variables that influence the probability of creativity (Sternberg & Lubart, 1992) or analyzing the sociological context in which creativity exists (Csikszentmihalyi, 1988), people who think deeply about the essence of creativity seem bound to discover that the problem is an expansive, all-encompassing one, which raises issues of cognition, personality, social psychology, philosophy, and history.

Creative Cognition: Theory, Research, and Applications, by R.A. Finke, T.B. Ward, and S.M. Smith. Cambridge, MA: MIT Press, 1992. 239 pp. + viii. $24.95.

Forks, Phonographs, and Hot Air Balloons: A Field Guide to Inventive Thinking, by R.J. Weber. New York: Oxford University Press, 1993. 277 pp. + xiv. $25.00.

CASE STUDIES OF INVENTIONS

One way that some scholars have leaped over the what-is-creativity question is by studying exclusively the works and lives of individuals whose creativity is a matter of high cultural consensus: Michelangelo and Einstein, Mozart and Shakespeare. Robert Weber takes a similar strategy in his whimsically titled and grippingly written book: *Forks, Phonographs, and Hot Air Balloons: A Field Guide to Inventive Thinking*. He analyzes famous inventions such as Velcro and the Wright brothers' airplane, often drawing on concepts of mental processing from cognitive science (such as the role of heuristics in thinking). But Weber makes an important extension to this strategy: He relates the principles uncovered in his analyses of famous inventions to his analyses of "everyday" inventions: "Invention is not a rarefied activity undertaken only by the genius in the laboratory. Instead, when given the chance, it can be an everyday activity for each of us" (p. 23).

Weber gives many examples of everyday invention. One that I especially appreciated was his description of one of my own everyday inventions: using a safety pin to overlap and attach closed window drapes so as to avoid being awakened by that pesky sliver of light that would otherwise appear in early morning. I even pack a safety pin for just this purpose when I travel across time zones and anticipate wanting to sleep beyond the local dawn; until I read Weber's book, I thought I was the only one guilty of leaving little pinpricks in hotel drapes, but of course the question arises whether these examples of everyday resourcefulness are really inventions.

In his analysis of everyday inventions, as in his analysis of famous inventions, Weber relies on our shared intuitions about creative products. The power of his book and his contribution may lie partly in his having restricted his domain of study to invention, thus excluding purely aesthetic products. Weber argues that inventions may be need-driven, device-driven, or play-driven. He describes the invention of eighth-grader James R. Wollin: "James has trouble getting peanut butter out of a jar, particularly the last of it. His invention is the Jar of Plenty, a jar with a double lid—one on the top and one on the bottom" (p. 18). Weber suggests that, as in this example, children's inventions are typically need-driven, whereas great inventors' products are often play-driven. Weber might have recognized more play-driven inventions by children if he had used a child's metric of valuable invention; products built during play may be valued much more highly by the children than by the adult observers, thus qualifying as inventions. Alternatively, Weber might be more correct than not; children's inventions that adults might consider play-driven may appear need-driven to a child. My 5-year-old son recently turned a grocery bag into a "life-support system" with various novel peripherals constructed out of odds and ends. When I asked my son about his source of inspiration, he told me it was something he "needed for space travel." I wonder if the distinction between need- and play-driven inventions might break down upon closer examination for adults as well.

Velcro and the phonograph were inventions after their time, according to Weber. This interesting claim comes from his analysis of the component heuristics of invention. In the case of Velcro, he argues, the scale heuristic (changing the size of components in an existing invention), the dimensionality heuristic (changing the dimensionality of the components in an existing invention), and the matching heuristic (changing the basis of matching or linking between components) could have been combined suitably to transform a standard hook and eye into the invention we know as Velcro years before the discovery. Weber proposes many other heuristics and offers example inventions to make his arguments; this analysis is at times compelling and, because of its specificity, is likely amenable to future

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experimental testing. It would also be valuable to pit Weber's hypothesized heuristics against other explanations for the timing of various famous inventions; for instance, could Velcro's late arrival be due to technological development? Changes in scale (making things smaller) seem heavily constrained by the availability of new materials.

EXPERIMENTAL APPROACHES TO CREATIVITY

Three approaches have dominated the study of creativity within psychology: case studies, the psychometric approach, and, more recently, the cognitive science approach. Case studies may provide rich data and insights (Gruber & Barrett, 1974; John-Steiner, 1985; Terr, 1987), but lack the scientific objectivity gained through replicability; the psychometric approach may be relatively objective and replicable, but tends to produce rather barren analyses—as if the creativity is squeezed out of the very topic under investigation. It is fortunate that the cognitive science approach offers the potential of overcoming both the relative sterility of the psychometric approach and the extreme subjectivity of the case study approach. The cognitive science framework demystifies creativity by identifying and measuring cognitive mechanisms employed during creative thinking (Boden, 1991; Gardner, 1982). Increasingly, cognitive science is influencing the other approaches to creativity. For instance, Weber, who uses a case study methodology, applies conceptual tools from cognitive science in his analysis of invention (also see Weber & Dixon, 1989). Similarly, Baer, in his 1993 book *Creativity and Divergent Thinking,* frames the classic issues in psychometric approaches to creativity (e.g., whether creativity is a general capacity that influences an individual's performance across many domains or a widely diverse collection of skills and knowledge each contributing to creative performance in only a single domain) in terms of cognitive science concepts such as connectionism and symbol processing.

Ronald Finke, Thomas Ward, and Steven Smith take a thoroughly cognitive science approach in their 1992 book *Creative Cognition: Theory, Research, and Applications*. The Geneplore model they introduce grew out of an innovative research paradigm developed by Finke a few years ago (Finke, 1990). In Finke's creative research on visual discovery, subjects are typically given a small set of visual forms (circles, letters, simple shapes) to combine mentally. They are usually permitted to rotate, shrink, enlarge, and move the forms in their minds until they have a recognizable pattern. Thus, a subject might combine a circle, square, and rectangle to invent a record player, by appropriately placing the circle next to the rectangle inside the square (originally reported in Finke & Slayton, 1988). An important point is that these "discoveries" are not determined by the parts. They cannot be anticipated, by either the subjects or the experimenters, without going through the mental imagery task; for any one set of parts, a wide range of discoveries is generated by subjects. Finke and his colleagues extended this laboratory technique by asking subjects to attempt to invent novel objects rather than to discover recognizable objects. Thus, a novel "hamburger maker" was invented by one subject using a sphere, half-sphere, and cylinder (originally reported in Finke, 1990). Finke et al. argue that the same basic technique can be used to induce "conceptual syntheses." In this case, subjects are instructed to interpret the forms as representing abstract concepts, although the results of these experiments are generally less compelling than the results of the other studies.

The authors' Geneplore model of creativity consists of two processing stages: a generative phase followed by an exploratory phase. In the generative phase, mental representations called "preinventive structures" are constructed. In the next phase, these structures are explored for possible interpretations. Dividing the creative process into two basic stages, generating and selecting, is a recurring theme in the cognitive science literature on creativity. Finke et al. point out that during the generating stage, it is necessary to suspend, at least partially, the selecting stage or the generating will never happen.

Finke, Ward, and Smith describe experiments in which they have manipulated various features of the invention task and then asked judges to rate the creativity of the resulting inventions. From their results they propose general principles of creative cognition: An invention is most likely when component parts are restricted; restricting the interpretive domain increases the likelihood of discovering a creative invention; an invention is more likely to be creative when preinventive forms are generated before one knows what the interpretive category will be; and it is best to use preinventive forms that one generated oneself. Some of these principles seem counterintuitive when applied to more general and real-world examples of creative inventions. For instance, could it really be that function often follows form? This claim—which I believe needs further scrutiny and experimental investigation before it is accepted (for instance, could the influence of function sometimes be outside awareness?)—is reminiscent of Weber's notion of play-driven invention, and it leads us to a recent argument about the evolution of human intelligence.

SOME NEW DIRECTIONS

Evolutionary Theories

G.F. Miller, in his 1993 doctoral dissertation, made the startling claim that human creativity (and much of what we consider "human intelligence") evolved as a "protean courtship device." Miller's argument rests on the concept of runaway sexual selection, a positive-feedback process that builds elaborate adaptations for courtship rather than for survival (Fisher, 1930). Individuals may initially favor mates who display features correlated with survival ability or fertility, such as plumage quality, song complexity, or dancing ability in many bird species, but those preferences can take on a life of their own, driving exponential growth in the favored feature, as in the peacock's tail or the nightingale's song.

Hominid brain encephalization showed just such an exponential growth. Miller suggested that our ancestors happened to favor mates who were more psychologically entertaining than average, rather than just those who had brightly colored hair or unusual size, perhaps because tactical unpredictability and creativity were especially important in competition for survival among socially intelligent hominids. Over time, the runaway process built human creativity out of the pressures of courtship. The more creative we became, the more creativity we demanded in our mates. This theory may be testable at the genetic level because of advances in understanding genetic correlates of runaway sexual selection, such as greater variability among individuals than is found for attributes due to stabilizing natural selection (Møller & Pomiankowski, 1993). If experiments confirm that there is a large amount of genetic variability for creativity, this might explain why we see such large individual differences in creativity. However, an alternative account of our perception of individual differences could be that we give tremendous weight to relatively small differences in creative ability, and thus overestimate the degree of individual difference in creativity relative to other human characteristics.

Miller's thesis suggests that human creativity became relatively liberated from mundane survival functions and became an evolutionary end in itself, such that creative displays were valued for their novelty and diversity rather than their utility, and such that our ability to judge something as creative has evolved in conjunction with our ability to be creative. In particular, according to Miller, the mental mechanisms used for internal selection of creative material are the same mechanisms used for judging the creative artifacts and displays made by other people. Perhaps this explains the tantalizing circularity and subjectivity of creativity research. Miller's thesis jibes with the common distinction in the literature between mental processes that generate material and those processes that select material once it is generated (similar to the two-step process in the Geneplore model). It also jibes with the emphasis on the social nature of creativity and the seemingly inherent subjectivity of judging creativity. Sternberg and Lubart (1992), in their investment theory of creativity, argue that creative people are engaging in a kind of complex social prediction in which they offer products that are novel but will be appreciated by other people soon. This sort of social prediction may be exactly what the internal selection mechanisms have been externally selected to accomplish: predict the novelty, but also appreciable value, of a creative product offered to a potential mate. If these judgments are in fact a result of specifically evolved mechanisms used in internal and external selection of interesting material, future research should be able to demonstrate cross-culturally universal judgment criteria for creativity and experimentally separable cognitive mechanisms for each criterion.

Shared and Private Mental Codes

Although our creative products may eventually be used for social gain of some sort (Csikszentmihalyi, 1988; G.F. Miller, 1993; Sternberg & Lubart, 1992), our ability to create may be limited by the presence of other people. The penchant for solitude many creative individuals display during creation may partly reflect the disadvantage of using linguistic manipulation in the generative phases of creative thinking. Mental imagery is commonly reported by highly creative individuals as essential to the early stages of creative thinking (see Finke, 1993; A.I. Miller, 1986; Shepard, 1978, 1988). Shepard (1988) commented: "Many of the greatest scientists have emphasized that the processes that led to their inventions, discoveries, and theories were neither linguistic nor mathematical and, indeed, even when they knew that they had reached the crucial insight, they often had to struggle in order to cast their insight into the communicable form of words or mathematical symbols" (p. 180). In contrast to mental imagery, symbol systems and languages are shaped through a process of social communication such that they become both relatively stable and relatively shareable across individuals and time. This shareability of language and symbol systems necessarily reduces the analogical and dynamic qualities—and, correspondingly, the richness and flexibility—of more private imagistic forms of representation (Freyd, 1983, 1993).

In addition, the solitude that creative individuals often demand may provide an environment in which it is possible to suspend temporarily the selection stages of creative thinking, allowing the earlier generative stages to flourish. This possibility might also relate to the role of altered states of consciousness in creative thinking, in which mental mechanisms of generation are relatively dissociated from the ego functions of critical thinking and behavior selection. Future research might evaluate the role of mental imagery and other aspects of solitude, and the role of symbolic thinking and other aspects of social facilitation, comparing the generative phase of creative thinking with later phases of selection. Weber claims that some important device-driven inventions, like the fork, grew out of the little improvements and small inventions of many people over time. Are such communal inventions identifiably different from more sudden and solitary creations?

Dynamic Representations as a Medium for Creative Cognition

Building on the Geneplore model of Finke et al., Teresa Pantzer and I have recently proposed that dynamic mental representations are the medium of creative visual synthesis (Freyd & Pantzer, in press). We observed that some simple static patterns, like arrows and triangles, can produce a compelling sense of directionality. This observation suggested the possibility that the phenomenal sensation of directionality is based on a dynamic mental representation (Freyd, 1987, 1993).

The dynamic properties of static form may influence both the generative and the exploratory aspects of creative invention. If the preinventive structures of the generative phase are highly directional, the ease of mental synthesis increases. And if the components are dynamic, they may lend themselves more easily to movement and other transformations. Directionality may also lead to constraints on creative combinations as a result of the inherent dynamics of the stimuli. Finke (1990) has noted that, when interpreting preinventive forms, subjects often report that they imagine using the forms or interacting with them in dynamic ways, in order to gain insight into how to best interpret the forms. Some of this dynamic interaction may result directly from the dynamic mental representations underlying the perceived directionality of static forms. Just as "pattern goodness" affects how easily one might recognize an emergent pattern in imagery (see Finke et al., p. 53), the emergent dynamic properties of creative combinations may influence interpretation in the exploratory phase. In other cases, the nature of the dynamics might suggest particular interpretations by virtue of knowledge of kinds of motion (Freyd, 1993). These possibilities can be tested by using forms varying in dynamic qualities in the visual synthesis paradigm developed by Finke and his associates.

If it is the case that appreciation of creative products involves the observer's use of creative processes, as I have argued, the role of dynamics in creativity might go deeper. Theories of aesthetics have often emphasized the importance of motion and dynamics in creative products. Arnheim (1988) pointed out, for instance, that Matisse's *La Danseuse* (which does not directly represent a common object or scene) manages through form alone to create a powerfully dynamic image. Where Arnheim noted dynamics in art, most observers would presumably experience directionality, or even "pointing," within the static picture. I predict that an observer has systematic shifts in memory for position of the form in the direction of pointing (Freyd, 1993). These memory shifts may occur between recurring eye fixations on points of dynamic interest such that the observer is repeatedly experiencing representational surprise at the discrepancy between the remembered and experienced reality of a dynamic element. In turn, this representational surprise might relate to aesthetic excitement. Just as painters may exploit the more perceptual processes of dynamic representations, fiction and poetry writers, filmmakers, and composers may well exploit other sorts of dynamic changes in memory. The observer of the artistic creation might, in essence, be expected to extrapolate into the future from any given point in the creative product, and thus the artist's job is, in part, to invoke creative processes of generation, not just of selection, in the observer.

On creativity in science, Shepard (1988) observed: "An important part of the process of scientific imagination is a kind of internal 'analog' simulation of possible events in the world . . . such a process makes use of perceptual mechanisms that have, through evolutionary eons, deeply internalized an intuitive wisdom about the way things *transform* in the world" (p. 180; italics added). The relative power of dynamic representations in mental imagery, as opposed to the more symbolic, shareable languages of thought (Freyd, 1983, 1993), may relate to the often-made observation that mental imagery has a special status among the cognitive mechanisms of creativity (Finke, 1993; A.I. Miller, 1986; Shepard, 1978, 1988).

WORKING CREATIVELY WITH CIRCULARITY

Creativity is of great interest and centrality to folk conceptions of psychology—comparable to topics like intelligence and language in popular interest—but creativity as a research topic has eluded mainstream psychological acceptance. Some authors have assumed that creativity suffers from mystification—that as scientists we do not quite believe in this process of creation in which something is made from nothing (Boden, 1991). I noticed recently that a major bookstore had a prominent display of books on creativity, but all of these books were popular psychology; in contrast, the selection of books on creativity within the academic psychology section was paltry. Certainly the 1980s and 1990s have marked a trend in cognitive psychology away from the 1970s ideals of sterile flow charts and perfectly controlled but barren studies of simple cognitive tasks, to ever-richer topics and more ecologically valid research strategies; this is an admirable path for cognitive psychology to take, and one that has presumably helped bring creativity back into greater visibility. Nonetheless, creativity research has not yet been fully integrated into mainstream experimental psychology.

I think the deep obstacle remains the subjectivity of definition, the inherent circularity of creativity. In order to recognize creativity, we must use our creative faculties; these faculties allow us to select products that are novel and valuable. In some sense, we cannot escape circling creativity in this way; however, Weber and Finke et al. demonstrate that the paradoxes and circularities of creativity can be partially penetrated by identifying and investigating components like heuristics (Weber) and stages (Finke et al.). Weber and Finke et al. also firmly plant their approaches in the ubiquity and everydayness of creativity, showing the reader that without creativity and invention, we would not have either the world of technology with which we are familiar nor our everyday novel interchanges with other people. With these recent contributions, research in the cognitive components of creativity may have a bright future. Investigating the cognitive mechanisms of creativity in social behavior, such as parenting or leadership, is just one area of research expansion suggested by these approaches. Are the sorts of visual-spatial processes identified by Finke et al., or the heuristics of invention described by Weber, applicable to social behavior? If so, I predict that we might get hints of causal relationships between the intense sociality, elaborated sexuality, extreme creativity, and faculties of mental imagery in our species.

Weber and Finke et al. demystify the subject, giving researchers a way to conceptualize and to investigate cognitive mechanisms of creativity, but they do not remove the creativity itself because both research approaches retain a role for subjective judgment in recognizing creativity. If G.F. Miller (1993) is right—and I think he is right enough on this point—we may have to accept that research into human creativity is more circular than research into other capacities, because the evolution of creativity was itself a more circular process, more open to subjective caprice and freer from environmental demands, but that need not make the research any less interesting or the topic any less important. Perhaps the circularity of creativity is analogous to the circularity of beauty: They both evolve as a result of a statistical consensus of taste that itself evolves through its association with the creative or the beautiful (G.F. Miller, 1993). But the circularity does not keep flowers, peacocks, Beethoven, or creative psychology from stunning us with novelty and value.

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