# CHAPTER 15
# Creativity

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Creativity is the ability to produce work that is novel (i.e., original, unexpected), high in quality, and appropriate (i.e., useful, meets task constraints) (Lubart, 1994; Ochse, 1990; Sternberg, 1988a, 1999c; Sternberg & Lubart, 1995, 1996). Creativity is a topic of wide scope that is important at both the individual and societal levels for a wide range of task domains. At an individual level, creativity is relevant, for example, when solving problems on the job and in daily life. At a societal level, creativity can lead to new scientific findings, new movements in art, new inventions, and new social programs. The economic importance of creativity is clear because new products or services create jobs. Furthermore, individuals, organizations, and societies must adapt existing resources to changing task demands to remain competitive.

This chapter attempts to provide readers with a basic understanding of the literature on creativity. It first reviews alternative approaches to understanding creativity. Then it reviews alternative approaches to understanding kinds of creative work. Finally, it draws some conclusions.

Creativity may be viewed as taking place in the interaction between a person and the person's environment (Amabile, 1996; Csikszentmihalyi, 1996, 1999; Feldman, 1999; Feldman, Csikszentmihalyi, & Gardner, 1994; Sternberg, 1985a; Sternberg & Lubart, 1995). According to this view, the essence of creativity cannot be captured just as an intrapersonal variable. Thus, we can characterize a person's cognitive processes as more or less creative (Finke, Ward, & Smith, 1992; Rubenson & Runco, 1992; Weisberg, 1986), or the person as having a more or less creative personality (Barron, 1988; Feist, 1999). We further can describe the person as having a motivational pattern that is more or less typical of creative individuals (Hennessey & Amabile, 1988), or even as having background variables that more or less dispose that person to think creatively (Simonton, 1984, 1994). However, we cannot fully judge that person's creativity independent of the field and the temporal context in which the person works.

For example, a contemporary artist might have thought processes, personality, motivation, and even background variables similar

to those of Monet, but that artist, painting today in the style of Monet or of Impressionism in general, probably would not be judged to be creative in the way Monet was. Artists, including Monet, have experimented with Impressionism, and unless the contemporary artist introduced some new twist, he or she might be viewed as imitative rather than creative.

The importance of context is illustrated by the difference, in general, between creative discovery and rediscovery. For example, BACON and related programs of Langley, Simon, Bradshaw, and Zytkow (1987) rediscover important scientific theorems that were judged to be creative discoveries in their time. The processes by which these discoveries are made via computer simulation are presumably not identical to those by which the original discoverers made their discoveries. One difference derives from the fact that contemporary programmers can provide, in their programming of information into computer simulations, representations and particular organizations of data that may not have been available to the original creators. However, putting aside the question of whether the processes are the same, a rediscovery might be judged to be creative with respect to the rediscoverer but would not be judged to be creative with respect to the field at the time the rediscovery is made. Ramanujan, the famous Indian mathematician, made many such rediscoveries. A brilliant thinker, he did not have access in his early life to much of the recent literature on mathematics and so unwittingly regenerated many discoveries that others had made before him.

## Alternative Approaches to Creativity

### *Mystical Approaches to the Study of Creativity*

The study of creativity has always been tinged – some might say tainted – with associations to mystical beliefs. Perhaps the earliest accounts of creativity were based on divine intervention. The creative person was seen as an empty vessel that a divine being would fill with inspiration. The individual would then pour out the inspired ideas, forming an otherworldly product.

In this vein, Plato argued that a poet is able to create only that which the Muse dictates, and even today, people sometimes refer to their own Muse as a source of inspiration. In Plato's view, one person might be inspired to create choral songs, another, epic poems (Rothenberg & Hausman, 1976). Often, mystical sources have been suggested in creators' introspective reports (Ghiselin, 1985). For example, Rudyard Kipling referred to the "Daemon" that lives in the writer's pen: "My Daemon was with me in the Jungle Books, Kim, and both Puck books, and good care I took to walk delicately, lest he should withdraw.... When your Daemon is in charge, do not think consciously. Drift, wait, and obey" (Kipling, 1985, p. 162).

The mystical approaches to the study of creativity have probably made it harder for scientists to be heard. Many people seem to believe, as they believe for love (see Sternberg, 1988b, 1988c), that creativity is something that just does not lend itself to scientific study because it is a more spiritual process. We believe it has been hard for scientific work to shake the deep-seated view of some that, somehow, scientists are treading where they should not.

### *Pragmatic Approaches*

Equally damaging for the scientific study of creativity, in our view, has been the takeover of the field, in the popular mind, by those who follow what might be referred to as a pragmatic approach. Those taking this approach have been concerned primarily with developing creativity, secondarily with understanding it, but almost not at all with testing the validity of their ideas about it.

Perhaps the foremost proponent of this approach is Edward De Bono, whose work on *lateral thinking* – seeing things broadly and from varied viewpoints – as well as other aspects of creativity has had what appears to be considerable commercial success (e.g., De

Bono, 1971, 1985, 1992). DeBono's concern is not with theory, but with practice. Thus, for example, he suggests using a tool such as "Positive-Minus-Interesting" (PMI) to focus on the aspects of an idea that are pluses, minuses, and interesting. Or he suggests using the word "po," derived from hypothesis, suppose, possible, and poetry, to provoke rather than to judge ideas. Another tool, that of "thinking hats," has individuals metaphorically wear different hats, such as a white hat for data-based thinking, a red hat for intuitive thinking, a black hat for critical thinking, and a green hat for generative thinking, in order to stimulate seeing things from different points of view.

DeBono is not alone in this enterprise. Osborn (1953), based on his experiences in advertising agencies, developed the technique of brainstorming to encourage people to solve problems creatively by seeking many possible solutions in an atmosphere that is constructive rather than critical and inhibitory. Gordon (1961) developed a method called synectics, which involves primarily seeing analogies, also for stimulating creative thinking.

More recently, authors such as Adams (1974, 1986) and von Oech (1983) suggested that people often construct a series of false beliefs that interfere with creative functioning. For example, some people believe that there is only one "right" answer and that ambiguity must be avoided whenever possible. People can become creative by identifying and removing these mental blocks. Von Oech (1986) also suggested that to be creative we need to adopt the roles of explorer, artist, judge, and warrior in order to foster our creative productivity.

These approaches have had considerable public visibility, and they may well be useful. From our point of view as psychologists, however, most of these approaches lack any basis in serious psychological theory as well as serious empirical attempts to validate them. Of course, techniques can work in the absence of psychological theory or validation. However, the effect of such approaches is often to leave people associating a phenomenon with commercialization and to see it as less than a serious endeavor for psychological study.

### *The Psychodynamic Approach*

The psychodynamic approach can be considered the first of the major twentieth-century theoretical approaches to the study of creativity. On the basis of the idea that creativity arises from the tension between conscious reality and unconscious drives, Freud (1908/1959) proposed that writers and artists produce creative work as a way to express their unconscious desires in a publicly acceptable fashion. These unconscious desires may concern power, riches, fame, honor, or love (Vernon, 1970). Case studies of eminent creators, such as Leonardo da Vinci (Freud, 1910/1964), were used to support these ideas.

Later, the psychoanalytic approach introduced the concepts of adaptive regression and elaboration for creativity (Kris, 1952). *Adaptive regression*, the primary process, refers to the intrusion of unmodulated thoughts in consciousness. Unmodulated thoughts can occur during active problem solving but often occur during sleep, intoxication from drugs, fantasies or daydreams, or psychoses. *Elaboration*, the secondary process, refers to the reworking and transformation of primary process material through reality-oriented, ego-controlled thinking. Other theorists (e.g., Kubie, 1958) emphasized that the preconscious, which falls between conscious reality and the encrypted unconscious, is the true source of creativity because thoughts are loose and vague but interpretable. In contrast to Freud, Kubie claimed that unconscious conflicts actually have a negative effect on creativity because they lead to fixated, repetitive thoughts. More recent work has recognized the importance of both primary and secondary processes (Noy, 1969; Rothenberg, 1979; Suler, 1980; Werner & Kaplan, 1963).

Although the psychodynamic approach may have offered some insights into creativity, psychodynamic theory was not at the center of the emerging scientific psychology.

The early twentieth-century schools of psychology, such as structuralism, functionalism, and behaviorism, were devoting practically no resources at all to the study of creativity. The Gestaltists studied a portion of creativity – insight – but their study never went much beyond labeling, as opposed to characterizing the nature of insight.

Further isolating creativity research, the psychodynamic approach and other early work on creativity relied on case studies of eminent creators. This methodology has been criticized historically because of the difficulty of measuring proposed theoretical constructs (e.g., primary process thought), and the amount of selection and interpretation that can occur in a case study (Weisberg, 1993). Although there is nothing a priori wrong with case study methods, the emerging scientific psychology valued controlled, experimental methods. Thus, both theoretical and methodological issues served to isolate the study of creativity from mainstream psychology.

### *Psychometric Approaches*

When we think of creativity, eminent artists or scientists such as Michelangelo or Einstein immediately come to mind. However, these highly creative people are quite rare and difficult to study in the psychological laboratory. In his American Psychological Association address, Guilford (1950) noted that these problems had limited research on creativity. He proposed that creativity could be studied in everyday subjects using paper-and-pencil tasks. One of these was the Unusual Uses Test, in which an examinee thinks of as many uses for a common object (e.g., a brick) as possible. Many researchers adopted Guilford's suggestion, and "divergent thinking" tasks quickly became the main instruments for measuring creative thinking. The tests were a convenient way of comparing people on a standard "creativity" scale.

Building on Guilford's work, Torrance (1974) developed the Torrance Tests of Creative Thinking. These tests consist of several relatively simple verbal and figural tasks that involve divergent thinking plus other problem-solving skills. The tests can be scored for fluency (total number of relevant responses), flexibility (number of different categories of relevant responses), originality (the statistical rarity of the responses), and elaboration (amount of detail in the responses). Some of the subtests from the Torrance battery include

1. Asking questions: The examinee writes out all of the questions he or she can think of based on a drawing of a scene.
2. Product improvement: The examinee lists ways to change a toy monkey so children will have more fun playing with it.
3. Unusual uses: The examinee lists interesting and unusual uses of a cardboard box.
4. Circles: The examinee expands empty circles into different drawings and titles them.

A number of investigators have studied the relationship between creativity and intelligence – at least as measured by IQ. Three basic findings concerning creativity and conventional conceptions of intelligence are generally agreed upon (see, e.g., Barron & Harrington, 1981; Lubart, 1994). First, creative people tend to show above-average IQs – often above 120 (see Renzulli, 1986). This figure is not a cutoff but rather an expression of the fact that people with low or even average IQs do not seem to be well represented among the ranks of highly creative individuals. Cox's (1926) geniuses had an estimated average IQ of 165. Barron estimated the mean IQ of his creative writers to be 140 or higher based on their scores on the Terman Concept Mastery Test (Barron, 1963, p. 242). It should be noted that the Concept Mastery Test is exclusively verbal and thus provides a somewhat skewed estimate of IQ. The other groups in the Institute for Personality Assessment (IPAR) studies, that is, mathematicians and research scientists, were also above average in intelligence. Anne Roe (1952, 1972), who did similarly thorough assessments of eminent scientists before the IPAR group was set up, estimated IQs for her participants ranged between 121 and 194, with medians between 137 and 166.

depending on whether the IQ test was verbal, spatial, or mathematical.

Second, an IQ above 120, does not seem to matter as much to creativity as it does when an IQ is below 120. In other words, creativity may be more highly correlated with IQ below an IQ of 120, but only weakly or not at all correlated with it above an IQ of 120. [This relationship is often called the threshold theory. See the contrast with Hayes's (1989) certification theory discussed below.] In the architects' study, in which the average IQ was 130 (significantly above average), the correlation between intelligence and creativity was −.08, not significantly different from zero (Barron, 1969, p. 42). However, in the military officer study, in which participants were of average intelligence, the correlation was .33 (Barron, 1963, p. 219). These results suggest that extremely highly creative people often have high IQs, but not necessarily that people with high IQs tend to be extremely creative (see also Getzels & Jackson, 1962).

Some investigators (e.g., Simonton, 1994; Sternberg, 1996) have suggested that very high IQ may actually interfere with creativity. Those who have very high IQs may be so highly rewarded for their IQ-like (analytical) skills that they fail to develop the creative potential within them, which may then remain latent.

Third, the correlation between IQ and creativity is variable, usually ranging from weak to moderate (Flescher, 1963; Getzels & Jackson, 1962; Guilford, 1967; Herr, Moore, & Hasen, 1965; Torrance, 1962; Wallach & Kogan, 1965; Yamamoto, 1964). The correlation depends in part on what aspects of creativity and intelligence are being measured, how they are being measured, and in what field the creativity is manifested. The role of intelligence is different in art and music, for instance, than it is in mathematics and science (McNemar, 1964).

An obvious drawback to the tests used and assessments done by Roe and Guilford is the time and expense involved in administering them, as well as the subjective scoring of them. In contrast, Mednick (1962) produced a 30-item, objectively scored, 40-minute test of creative ability called the Remote Associates Test (RAT). The test is based on his theory that the creative thinking process is the "forming of associative elements into new combinations which either meet specified requirements or are in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution" (Mednick, 1962). Because the ability to make these combinations and arrive at a creative solution necessarily depends on the existence of the combinations (i.e., the associative elements) in a person's knowledge base, and because the probability and speed of attainment of a creative solution are influenced by the organization of the person's associations, Mednick's theory suggests that creativity and intelligence are very related; they are overlapping sets.

Moderate correlations of .55, .43, and .41 have been shown between the RAT and the WISC (Wechsler Intelligence Scale for Children), the SAT verbal, and the Lorge-Thorndike Verbal intelligence measures, respectively (Mednick & Andrews, 1967). Correlations with quantitative intelligence measures were lower ($r = .20 - .34$). Correlations with other measures of creative performance have been more variable (Andrews, 1975).

This psychometric approach for measuring creativity had both positive and negative effects on the field. On the positive side, the tests facilitated research by providing a brief, easy to administer, objectively scorable assessment device. Furthermore, research was now possible with "everyday" people (i.e., noneminent samples). However, there were also some negative effects. First, some researchers criticized brief paper-and-pencil tests as trivial, inadequate measures of creativity; larger productions such as actual drawings or writing samples should be used instead. Second, other critics suggested that no fluency, flexibility, originality, or elaboration scores captured the concept of creativity. In fact, the definition and criteria for creativity are a matter of ongoing debate, and relying on the objectively defined statistical rarity of a response with

regard to all of the responses of a subject population is only one of many options. Other possibilities include using the social consensus of judges (see Amabile, 1983). Third, some researchers were less enchanted by the assumption that noneminent samples could shed light on eminent levels of creativity, which was the ultimate goal for many studies of creativity (e.g., Simonton, 1984). Thus, a certain malaise developed and continues to accompany the paper-and-pencil assessment of creativity. Some psychologists, at least, avoided this measurement quagmire in favor of less problematic research topics.

### *Cognitive Approaches*

The cognitive approach to creativity seeks understanding of the mental representations and processes underlying creative thought (see Lubart, 2000–2001). By studying perception or memory, one would already be studying the bases of creativity; thus, the study of creativity would merely represent an extension, and perhaps not a very large one, of work that is already being done under another guise. For example, in the cognitive area, creativity was often subsumed under the study of intelligence (see Sternberg, Chap. 31). We do not argue with the idea that creativity and intelligence are related to each other (Lubart, 2003; Sternberg & O'Hara, 1999). However, the subsumption has often been so powerful that researchers such as Wallach and Kogan (1965), among others, had to write at length on why creativity and intelligence should be viewed as distinct entities. In more recent cognitive work, Weisberg (1986, 1988, 1993, 1999) has proposed that creativity involves essentially ordinary cognitive processes yielding extraordinary products. A similar point has been made by Perkins (1981). Weisberg attempted to show that the insights depend on subjects using conventional cognitive processes (e.g., analogical transfer) applied to knowledge already stored in memory. He did so through the use of case studies of eminent creators and laboratory research, such as studies with Duncker's (1945) candle problem. This problem requires participants to attach a candle to a wall using only objects available in a picture (candle, box of tacks, and book of matches). Langley et al. (1987) made a similar claim about the ordinary nature of creative thinking.

As a concrete example of this approach, Weisberg and Alba (1981) had people solve the notorious nine-dot problem. In this problem, people are asked to connect all of the dots, which are arranged in the shape of a square with three rows of three dots each, using no more than four straight lines, never arriving at a given dot twice, and never lifting their pencil from the page. The problem can be solved only if people allow their line segments to go outside the periphery of the dots. Typically, solution of this task had been viewed as hinging upon the insight that one had to go "outside the box." Weisberg and Alba showed that even when people were given that insight, they still had difficulty in solving the problem. In other words, whatever is required to solve the nine-dot problem, it is not just some kind of extraordinary insight.

There have been studies with both human subjects and computer simulations of creative thought. Approaches based on the study of human subjects are perhaps prototypically exemplified by the work of Finke, Ward, and Smith (1992) (see also contributions to Smith, Ward, & Finke, 1995; Sternberg & Davidson, 1994; Ward, Smith, & Finke, 1999). Finke and his colleagues have proposed what they call the *Geneplore model*, according to which there are two main processing phases in creative thought – a generative phase and an exploratory phase. In the generative phase, an individual constructs mental representations referred to as preinventive structures, which have properties promoting creative discoveries. In the exploratory phase, these properties are used to come up with creative ideas. A number of mental processes may enter into these phases of creative invention, such as retrieval, association, synthesis, transformation (see Tversky, Chap. 10), analogical transfer (see Holyoak, Chap. 6), and categorical reduction (i.e., mentally reducing objects

or elements to more primitive categorical descriptions). In a typical experimental test based on the model (Finke & Slayton, 1988), participants will be shown parts of objects, such as a circle, a cube, a parallelogram, and a cylinder. On a given trial, three parts will be named, and participants will be asked to imagine combining the parts to produce a practical object or device. For example, participants might imagine a tool, a weapon, or a piece of furniture. The objects thus produced are then rated by judges for their practicality and originality. Morrison and Wallace (2002) found that judged creativity on such a task correlated strongly with the individuals' perceived imagery vividness.

In work on convergent creative thinking that required participants to think in unusual ways, we presented 80 individuals with novel kinds of reasoning problems that had a single best answer. For example, they might be told that some objects are green and others blue, whereas still other objects might be grue, meaning green until the year 2000 and blue thereafter, or bleen, meaning blue until the year 2000 and green thereafter. Or they might be told about four kinds of people on the planet Kyron, blens, who are born young and die young; kwefs, who are born old and die old; balts, who are born young and die old; and prosses, who are born old and die young (Sternberg, 1981, 1982; Tetewsky & Sternberg, 1986). Their task was to predict future states from past states, given incomplete information. In another set of studies, 60 people were given more conventional kinds of inductive reasoning problems, such as analogies, series completions, and classifications. However, the problems had premises preceding them that were either conventional (dancers wear shoes) or novel (dancers eat shoes). The participants had to solve the problems as though the counterfactuals were true (Sternberg & Gastel, 1989a, 1989b).

In these studies, we found that correlations with conventional kinds of tests depended on how novel or nonentrenched the conventional tests were. The more novel the items, the higher the correlations of our tests with scores on successively more novel conventional tests. Thus, the components isolated for relatively novel items would tend to correlate more highly with more unusual tests of fluid abilities than with tests of crystallized abilities. We also found that when response times on the relatively novel problems were componentially analyzed, some components better measured the creative aspect of intelligence than did others. For example, in the "grue-bleen" task mentioned previously, the information processing component requiring people to switch from conventional green-blue thinking to grue-bleen thinking, and then back to green-blue thinking again, was a particularly good measure of the ability to cope with novelty.

Computer simulation approaches, reviewed by Boden (1992, 1999), have as their goal the production of creative thought by a computer in a manner that simulates what people do. Langley, Simon, Bradshaw, and Zytkow (1987), for example, developed a set of programs that rediscover basic scientific laws. These computational models rely on heuristics – problem-solving guidelines – for searching a data set or conceptual space and finding hidden relationships between input variables. The initial program, called BACON, uses heuristics such as "if the value of two numeric terms increase together, consider their ratio" to search data for patterns. One of BACON's accomplishments has been to examine observational data on the orbits of planets available to Kepler and to rediscover Kepler's third law of planetary motion. This program is unlike creative functioning, however, in that the problems are given to it in a structured form, whereas creative functioning is largely about figuring out what the problems are (see Runco, 1994). Further programs have extended the search heuristics, the ability to transform data sets, and the ability to reason with qualitative data and scientific concepts. There are also models concerning an artistic domain. For example, Johnson-Laird (1988) developed a jazz improvisation program in which novel deviations from the basic jazz chord sequences are guided by harmonic constraints (or tacit principles of jazz) and random choice

when several allowable directions for the improvisation exist.

### *Social-Personality and Social-Cognitive Approaches*

Developing in parallel with the cognitive approach, work in the social-personality approach has focused on personality variables, motivational variables, and the sociocultural environment as sources of creativity. Researchers such as Amabile (1983), Barron (1968, 1969), Eysenck (1993), Gough (1979), MacKinnon (1965), and others noted that certain personality traits often characterize creative people. Through correlational studies and research contrasting high and low creative samples (at both eminent and everyday levels), a large set of potentially relevant traits has been identified (Barron & Harrington, 1981; Feist, 1999). These traits include independence of judgment, self-confidence, attraction to complexity, aesthetic orientation, openness to experience, and risk taking.

Proposals regarding self-actualization and creativity can also be considered within the personality tradition. According to Maslow (1968), boldness, courage, freedom, spontaneity, self-acceptance, and other traits lead a person to realize his or her full potential. Rogers (1954) described the tendency toward self-actualization as having motivational force and being promoted by a supportive, evaluation-free environment. These ideas, however, seem at odds with the many studies that have linked creativity and mental illness (e.g., Kaufman, 2001a, 2001b; Kaufman & Baer, 2002; Ludwig, 1995). If full creative potential is truly linked with self-acceptance and other positive traits, then one would not expect to find so many eminent creative individuals to have such maladjusted and poor coping strategies (Kaufman, 2002; Kaufman & Sternberg, 2000).

Focusing on motivation for creativity, a number of theorists have hypothesized the relevance of intrinsic motivation (Amabile, 1983, 1996; Crutchfield, 1962; Golann, 1962), need for order (Barron, 1963), need for achievement (McClelland, Atkinson, Clark, & Lowell, 1953), and other motives. Amabile (1983, 1996; Hennessey & Amabile, 1988) and her colleagues conducted seminal research on intrinsic and extrinsic motivation. Studies using motivational training and other techniques have manipulated these motivations and observed effects on creative performance tasks, such as writing poems and making collages.

Finally, the relevance of the social environment to creativity has also been an active area of research. At the societal level, Simonton (1984, 1988, 1994, 1999) conducted numerous studies in which eminent levels of creativity over large spans of time in diverse cultures have been statistically linked to environmental variables. These variables include, among others, cultural diversity, war, availability of role models, availability of resources (e.g., financial support), and number of competitors in a domain. Cross-cultural comparisons (e.g., Lubart, 1990) and anthropological case studies (e.g., Maduro, 1976; Silver, 1981) have demonstrated cultural variability in the expression of creativity. Moreover, they have shown that cultures differ simply in the amount that they value the creative enterprise.

The social-cognitive and social-personality approaches have each provided valuable insights into creativity. However, if you look for research that investigates both social-cognitive and social-personality variables at the same time, you would find only a handful of studies. The cognitive work on creativity has tended to ignore the personality and social system, and the social-personality approaches tended to have little or nothing to say about the mental representations and processes underlying creativity.

Looking beyond the field of psychology, Wehner, Csikszentmihalyi, and Magyari-Beck (1991) examined 100 more recent doctoral dissertations on creativity. They found a "parochial isolation" of the various studies concerning creativity. There were relevant dissertations from psychology, education, business, history, history of science, and other fields, such as sociology and political science. However, the different fields tended to use different terms and focus on different

aspects of what seemed to be the same basic phenomenon. For example, business dissertations used the term "innovation" and tended to look at the organizational level, whereas psychology dissertations used the term "creativity" and looked at the level of the individual. Wehner, Csikszentmihalyi, and Magyari-Beck (1991) described the situation with creativity research in terms of the fable of the blind men and the elephant. "We touch different parts of the same beast and derive distorted pictures of the whole from what we know: 'The elephant is like a snake,' says the one who only holds its tail; 'The elephant is like a wall,' says the one who touches its flanks" (p. 270).

### *Evolutionary Approaches to Creativity*

The evolutionary approach to creativity was instigated by Donald Campbell (1960), who suggested that the same kinds of mechanisms that have been applied to the study of the evolution of organisms could be applied to the evolution of ideas. This idea has been enthusiastically picked up by a number of investigators (Simonton, 1995, 1998, 1999).

The basic idea underlying this approach is that there are two basic steps in the generation and propagation of creative ideas. The first is *blind variation*, by which the creator generates an idea without any real idea of whether the idea will be successful (selected for) in the world of ideas. Indeed, Dean Simonton (1996) argued that creators do not have the slightest idea as to which of their ideas will succeed. As a result, their best bet for producing lasting ideas is to go for a large quantity of ideas. The reason is that their hit rate remains relatively constant through their professional life span. In other words, they have a fixed proportion of ideas that will succeed. The more ideas they have in all, the more ideas they have that will achieve success.

The second step is *selective retention*. In this step, the field in which the creator works either retains the idea for the future or lets it die out. Those ideas that are selectively retained are the ones that are judged to be novel and of value, that is, creative. This process, as well as blind generation, are described further by Cziko (1998).

Does an evolutionary model really adequately describe creativity? Robert Sternberg (1997, 2003) argued that it does not, and David Perkins (1998) also had doubts. Sternberg argued that it seems utterly implausible that great creators such as Mozart, Einstein, or Picasso were using nothing more than blind variation to come up with their ideas. Good creators, like experts of any kind, may or may not have more ideas than other people have, but they have better ideas, ones that are more likely to be selectively retained. The reason they are more likely to be selectively retained is that they were not produced in a blind fashion. This debate is by no means resolved, however, and is likely to continue into the future for some time to come.

Perkins (1995, 1998) argued that the analogy between biological evolution and creativity is oversimplified. In particular (Perkins, 1998), biological evolution relies on massive parallel search for mutations (millions of bacteria, for example, are mutating every second), whereas humans do not. At the same time, humans can do fairly extensive searches, such as when they seek out new antibiotics.

Were it the case that an understanding of creativity required a multidisciplinary approach, the result of a unidisciplinary approach might be that we would view a part of the whole as the whole. At the same time, though, we would have an incomplete explanation of the phenomenon we are seeking to explain, leaving dissatisfied those who do not subscribe to the particular discipline doing the explaining. We believe that traditionally this has been the case for creativity. More recently, theorists have begun to develop confluence approaches to creativity, which we now discuss.

### *Confluence Approaches to the Study of Creativity*

Many more recent works on creativity hypothesize that multiple components must

converge for creativity to occur (Amabile, 1983; Csikszentmihalyi, 1988; Gardner, 1993; Gruber, 1989; Gruber & Wallace, 1999; Lubart, 1994, 1999; Lubart, Mouchiroud, Tordjman, & Zenasni, 2003; Mumford & Gustafson, 1988; Perkins, 1981; Simonton, 1988; Sternberg, 1985b; Sternberg & Lubart, 1991, 1995, 1996; Weisberg, 1993; Woodman & Schoenfeldt, 1989). Sternberg (1985b), for example, examined laypersons' and experts' conceptions of the creative person. People's implicit theories contain a combination of cognitive and personality elements, such as "connects ideas," "sees similarities and differences," "has flexibility," "has aesthetic taste," "is unorthodox," "is motivated," "is inquisitive," and "questions societal norms."

At the level of explicit theories, Amabile (1983, 1996; Collins & Amabile, 1999) described creativity as the confluence of intrinsic motivation, domain-relevant knowledge and abilities, and creativity-relevant skills. The creativity-relevant skills include

1. a cognitive style that involves coping with complexities and breaking one's mental set during problem solving;
2. knowledge of heuristics for generating novel ideas, such as trying a counterintuitive approach; and
3. a work style characterized by concentrated effort, an ability to set aside problems, and high energy.

Gruber (1981, 1989) and Gruber and Davis (1988) proposed a developmental *evolving-systems model* for understanding creativity. A person's knowledge, purpose, and affect grow over time, amplify deviations that an individual encounters, and lead to creative products. Developmental changes in the knowledge system have been documented in cases such as Charles Darwin's thoughts on evolution. Purpose refers to a set of interrelated goals, which also develop and guide an individual's behavior. Finally, the affect or mood system notes the influence of joy or frustration on the projects undertaken.

Csikszentmihalyi (1988, 1996; Feldman, Csikszentmihalyi, & Gardner, 1994) took a different "systems" approach and highlighted the interaction of the individual, domain, and field. An individual draws upon information in a domain and transforms or extends it via cognitive processes, personality traits, and motivation. The field, consisting of people who control or influence a domain (e.g., art critics and gallery owners), evaluates and selects new ideas. The domain, a culturally defined symbol system such as alphabetic writing, mathematical notation, or musical notation, preserves and transmits creative products to other individuals and future generations. Gardner (1993; see also Policastro & Gardner, 1999) conducted case studies that suggest that the development of creative projects may stem from an anomaly within a system (e.g., tension between competing critics in a field) or moderate asynchronies between the individual, domain, and field (e.g., unusual individual talent for a domain). In particular, Gardner (1993) analyzed the lives of seven individuals who made highly creative contributions in the twentieth century with each specializing in one of the multiple intelligences (Gardner, 1983): Sigmund Freud (intrapersonal), Albert Einstein (logical-mathematical), Pablo Picasso (spatial), Igor Stravinsky (musical), T. S. Eliot (linguistic), Martha Graham (bodily-kinesthetic), and Mohandas Gandhi (interpersonal). Charles Darwin would be an example of someone with extremely high naturalist intelligence. Gardner pointed out, however, that most of these individuals actually had strengths in more than one intelligence and that they also had notable weaknesses in others (e.g., Freud's weaknesses may have been in spatial and musical intelligences).

Although creativity can be understood in terms of uses of the multiple intelligences to generate new and even revolutionary ideas, Gardner's (1993) analysis goes well beyond the intellectual. For example, Gardner pointed out two major themes in the behavior of these creative giants. First, they tended to have a matrix of support at the time of their creative breakthroughs. Second, they tended to drive a "Faustian bargain," whereby they gave up many of the pleasures people typically enjoy in life to attain

extraordinary success in their careers. However, it is not clear that these attributes are intrinsic to creativity, per se; rather, they seem to be associated with those who have been driven to exploit their creative gifts in a way that leads them to attain eminence.

Gardner (1993) further followed Csikszentmihalyi (1988, 1996) in distinguishing between the importance of the domain (the body of knowledge about a particular subject area) and the field (the context in which this body of knowledge is studied and elaborated, including the persons working with the domain, such as critics, publishers, and other "gatekeepers"). Both are important to the development, and, ultimately, the recognition of creativity.

A final confluence theory considered here is Sternberg and Lubart's (1991, 1995) *investment theory of creativity*. According to this theory, creative people are ones who are willing and able to "buy low and sell high" in the realm of ideas (see also Lubart & Runco, 1999; Rubenson & Runco, 1992, for use of concepts from economic theory). Buying low means pursuing ideas that are unknown or out of favor but that have growth potential. Often, when these ideas are first presented, they encounter resistance. The creative individual persists in the face of this resistance, and eventually sells high, moving on to the next new or unpopular idea.

Preliminary research within the investment framework has yielded support for this model (Lubart & Sternberg, 1995). This research has used tasks such as

1. writing short stories using unusual titles (e.g., "the octopus' sneakers"),
2. drawing pictures with unusual themes (e.g., "the earth from an insect's point of view"),
3. devising creative advertisements for boring products (e.g., cufflinks), and
4. solving unusual scientific problems (e.g., how we could tell if someone had been on the moon within the past month?).

This research showed creative performance to be moderately domain specific and to be predicted by a combination of six distinct but interrelated resources: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment.

Concerning the confluence of components, creativity is hypothesized to involve more than a simple sum of a person's level on each component. First, there may be thresholds for some components (e.g., knowledge), below which creativity is not possible regardless of the levels on other components. Second, partial compensation may occur in which a strength on one component (e.g., motivation) counteracts a weakness on another component (e.g., environment). Third, interactions may also occur between components, such as intelligence and motivation, in which high levels on both components could multiplicatively enhance creativity.

In general, confluence theories of creativity offer the possibility of accounting for diverse aspects of creativity (Lubart, 1994). For example, analyses of scientific and artistic achievements suggest that the median-rated creativity of work in a domain tends to fall toward the lower end of the distribution and the upper – high creativity – tail extends quite far. This pattern can be explained through the need for multiple components of creativity to co-occur in order for the highest levels of creativity to be achieved. As another example, the partial domain specificity of creativity that is often observed can be explained through the mixture of some relatively domain-specific components for creativity, such as knowledge, and other more domain-general components, such as, perhaps, the personality trait of perseverance. Creativity, then, is largely something that people show in a particular domain.

## Alternate Approaches to Understanding Kinds of Creative Contributions

Generally, we think of creative contributions as being of a single kind. However, a number of researchers on creativity have questioned this assumption. There are many ways of distinguishing among types of creative contributions. It is important to remember, though, that creative contributions

can be viewed in different ways at different times. At a given time, the field can never be sure of whose work will withstand the judgments of the field over time (e.g., that of Mozart) and whose work will not (e.g., that of Salieri) (Therivel, 1999).

Theorists of creativity and related topics have recognized that there are different types of creative contributions (see reviews in Ochse, 1990; Sternberg, 1988c; Weisberg, 1993). For example, Kuhn (1970) distinguished between normal and revolutionary science. Normal science expands upon or otherwise elaborates upon an already existing paradigm of scientific research, whereas revolutionary science proposes a new paradigm (see Dunbar & Fugelsang, Chap. 29). The same kind of distinction can be applied to the arts and letters.

Gardner (1993, 1994) also described different types of creative contributions individuals can make. They include

1. the solution of a well-defined problem,
2. the devising of an encompassing theory,
3. the creation of a "frozen work,"
4. the performance of a ritualized work, and
5. a "high-stakes" performance. Each type of creativity has as its result a different kind of creative product.

Other bases for distinguishing among types of creative contributions also exist. For example, psychoeconomic models such as those of Rubenson and Runco (1992) and Sternberg and Lubart (1991, 1995, 1996) can distinguish different types of contributions in terms of the parameters of the models. In the Sternberg–Lubart model, contributions might differ in the extent to which they "defy the crowd" or in the extent to which they redefine how a field perceives a set of problems.

Simonton's (1997) model of creativity also proposes parameters of creativity, and various kinds of creative contributions might be seen as differing in terms of the extent to which they vary from other contributions and the extent to which they are selected for recognition by a field of endeavor (see also Campbell, 1960; Perkins, 1995; Simonton, 1997). However, in no case were these models intended explicitly to distinguish among types of creative contributions.

Maslow (1967) distinguished more generally between two types of creativity, which he referred to as primary and secondary. Primary creativity is the kind of creativity a person uses to become self-actualized - to find fulfillment in him- or herself and his or her life. Secondary creativity is the kind of creativity with which scholars in the field are more familiar – the kind that leads to creative achievements recognized by a field.

Ward, Smith, and Finke (1999) noted that there is evidence to favor the roles of both focusing (Bowers et al., 1990; Kaplan & Simon, 1990) and exploratory thinking (Bransford & Stein, 1984; Getzels & Csikszentmihalyi, 1976) on creative thinking. In focusing, one concentrates on pursuing a single problem-solving approach, whereas in exploratory thinking one considers many such approaches. A second distinction made by Ward and his colleagues is between domain specific (Clement, 1989; Langley, Simon, Bradshaw, & Zytkow, 1987; Perkins, 1981; Weisberg, 1986) and universal (Finke, 1990, 1995; Guilford, 1968; Koestler, 1964) creativity skills. Finally, Ward and his colleagues distinguish between unstructured (Bateson, 1979; Findlay & Lumsden, 1988; Johnson-Laird, 1988) and structured or systematic (Perkins, 1981; Ward, 1994; Weisberg, 1986) creativity, where the former is displayed in systems with relatively few rules, and the latter, in systems with many rules.

There are tens of thousands of artists, musicians, writers, scientists, and inventors today. What makes some of them stand out from the rest? Why will some of them become distinguished contributors in the annals of their field and others be forgotten? Although many variables may contribute to who stands out from the crowd, certainly creativity is one of them. The standouts are often those who are doing particularly creative work in their line of professional pursuit. Are these highly creative individuals simply doing more highly creative work than their less visible counterparts, or does the creativity of their work also differ

in quality? One possibility is that creative contributors make different *decisions* regarding *how* to express their creativity. This section describes a propulsion theory of creative contributions (Sternberg, 1999b; Sternberg, Kaufman, & Pretz, 2002) that addresses this issue of how people decide to invest their creative resources. The basic idea is that creativity can be of different kinds, depending on how it propels existing ideas forward. When developing creativity in children, we can foster different kinds of creativity, ranging from minor replications to major redirections in their thinking.

Creative contributions differ not only in their amounts but also in the types of creativity they represent. For example, both Sigmund Freud and Anna Freud were highly creative psychologists, but the nature of their contributions seems in some way or ways to have been different. Sigmund Freud proposed a radically new theory of human thought and motivation, and Anna Freud largely elaborated on and modified Sigmund Freud's theory. How do creative contributions differ in quality and not just in quantity of creativity?

The type of creativity exhibited in a creator's works can have at least as much of an effect on judgments about that person and his or her work as does the amount of creativity exhibited. In many instances, it may have more of an effect on these judgments.

Given the importance of purpose, creative contributions must always be defined in some context. If the creativity of an individual is judged in a context, then it will help to understand how the context interacts with how people are judged. In particular, what are the types of creative contributions a person can make within a given context? Most theories of creativity concentrate on attributes of the individual (see Sternberg, 1999b). However, to the extent that creativity depends on the interaction of person with context, we would also need to concentrate on the attributes of the individual and the individual's work relative to the environmental context.

A taxonomy of creative contributions needs to deal with the question not just of in what domain a contribution is creative but of what the type of creative contribution is. What makes one work in biology more creative or creative in a different way from another work in biology, or what makes its creative contribution different from that of a work in art? Thus, a taxonomy of domains of work is insufficient to elucidate the nature of creative contributions. A field needs a basis for scaling how creative contributions differ quantitatively and, possibly, qualitatively. For instance,

1. *Replication.* The contribution is an attempt to show that the field is in the right place. The propulsion keeps the field where it is rather than moving it. This type of creativity is represented by stationary motion, as of a wheel that is moving but staying in place.
2. *Redefinition.* The contribution is an attempt to redefine where the field is. The current status of the field thus is seen from different points of view. The propulsion leads to circular motion such that the creative work leads back to where the field is but as viewed in a different way.
3. *Forward Incrementation.* The contribution is an attempt to move the field forward in the direction it already is going. The propulsion leads to forward motion.
4. *Advance Forward Incrementation.* The contribution is an attempt to move the field forward in the direction it is already going, but by moving beyond where others are ready for it to go. The propulsion leads to forward motion that is accelerated beyond the expected rate of forward progression.
5. *Redirection.* The contribution is an attempt to redirect the field from where it is toward a different direction. The propulsion thus leads to motion in a direction that diverges from the way the field is currently moving.
6. *Reconstruction/Redirection.* The contribution is an attempt to move the field back to where it once was (a reconstruction of the past) so it may move onward from that point, but in a direction different from the one it took from that point onward.

The propulsion thus leads to motion that is backward and then redirective.

7. *Reinitiation.* The contribution is an attempt to move the field to a different as yet unreached starting point and then to move from that point. The propulsion is thus from a new starting point in a direction that is different from that the field previously has pursued.
8. *Integration.* The contribution is an attempt to integrate two formerly diverse ways of thinking about phenomena into a single way of thinking about a phenomenon. The propulsion thus is a combination of two different approaches that are linked together.

The eight types of creative contributions described previously are largely qualitatively distinct. Within each type, however, there can be quantitative differences. For example, a forward incrementation can represent a fairly small step forward or a substantial leap. An initiation can restart a subfield (e.g., the work of Leon Festinger on cognitive dissonance) or an entire field (e.g., the work of Einstein on relativity theory). Thus, the theory distinguishes contributions both qualitatively and quantitatively.

## Conclusions and Future Directions

In sum, creativity, which has often been viewed as beyond study, is anything but. Creativity can be understood about as well as any psychological construct, if appropriate methods are brought to bear upon its investigations. The history of creativity theory and research is long and interesting. It represents a diversity of attempts to understand the phenomenon. More recently, scholars have recognized that creativity can be of multiple kinds and have tried to understand these different kinds. A full account of creativity would need to take into account not just differing amounts of creativity but differing kinds. These kinds would include creativity that accepts current paradigms, creativity that rejects them, and creativity that synthesizes them into a new whole.

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