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Creativity, Intelligence, and Personality: A Critical Review of the Scattered Literature

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ABSTRACT. The authors examined the relations among intelligence, personality, and creativity. They consider the concept and definition of creativity in conjunction with the qualifications that researchers in the field have suggested. The present authors briefly refer to historiometric studies but focus on psychometric intelligence and its relations to tests of divergent thinking (DT) and ratings of creativity. The authors consider the relation between personality and creativity in the context of Eysenckian 3-factor and 5-factor models of personality and with reference to DT tests and ratings of creativity. The authors also present recommendations for the future study of creativity.

Keywords: creativity, divergent thinking, fluency, intelligence, originality, personality

THE CULTURAL VALUE PLACED ON CREATIVITY in the arts, sciences, technology, and political endeavors is immense. Creative people have received adulation throughout history (Nettle, 2001). Some researchers have argued that creativity constitutes humankind's ultimate resource (Toynbee, 1964). Social and technical innovation rely heavily on creative people and processes (Runco, 2004). Yet, despite creativity's undisputed importance, psychological research regarding creativity remains an academic backwater.

Numerous researchers have commented on the relative paucity of either good creativity studies (Guilford, 1950; Sternberg & Lubart, 1999) or parsimonious theories that explain the origin and manifestation of creative behavior in certain individuals. The cause of this neglect may be attributable in part to the historical background of the construct or, more particularly, to problems with definition and therefore measurement. Perhaps what has set back the field for so long has been the relative absence of comprehensive and high-quality measures

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of creativity. However, growth in agreement on definitions, widely accepted models of personality, and the appropriate use of tests of divergent thinking (DT) point toward a positive future for creativity research.

In this article, we attempted to comprehensively and critically review the contribution of differential psychology to the creativity research literature. Our aim was to attempt to determine by review, rather than by meta-analytic procedures, the extent to which psychometrically assessed intellectual and personality traits relate to and explain everyday creativity.

Historical Background

The perception of creativity as the original product of an individual is a predominantly Western one. From this perspective, creativity usually is seen as a trait or gift that is a normally distributed, probably partly genetically determined property of individuals. Early perceptions of creativity were dominated by the story of creation in Genesis. From there, the concept of creation as originality and utility influenced subsequent interpretations of the properties of creative products. This contrasts with an Eastern view of creativity as the expression of personal truth or self-growth (Lubart, 1999). Eastern perspectives of creativity focus on discovery, so that the idea of creation ex nihilo is impossible for Eastern cultures that emphasize harmony and balance (Boorstin, 1992). Eastern cultures have tended to view creativity as a process of understanding and enlightenment. However, the Western perspective has dominated creativity research and academic psychological literature.

The earliest conceptions of creativity[1] drew on mystical interpretations (Sternberg & Lubart, 1999). Many ancient Greeks believed that inspiration and creation resulted from divine intervention (Ludwig, 1995). From this perspective, creativity was "associated with mystical powers of protection and good fortune" (Albert & Runco, 1999, p. 18). A consequence of this concept of creativity has been that people considered it beyond measurement and comprehension, and that consequence has left a legacy overshadowing some attitudes toward creativity research today.

Eventually, the Greeks began to reduce their emphasis on divine intervention by the highest gods, instead considering creativity related to each individual's Daimon, or guardian spirit. By the time of Aristotle, creativity was seen as a natural event that conformed to natural law, even if it did involve "an association with madness and frenzied inspiration" (Albert & Runco, 1999, p. 18). The possible relation between psychopathology and creativity is now a popular lay notion and an active area of research (Lloyd-Evans, Batey, & Furnham, 2006). Gradually, people associated creative acts with the abilities and dispositions of the individual person.

Creativity as an Individual Difference Variable

As creativity became associated with the properties of individuals, researchers such as Galton (1869/1962) began investigations of heredity genius, and the

London School (i.e., differential movement) sought to elucidate the most basic component of creative thought production: fluency (H. L. Hargreaves, 1927). The grounding of the investigation of creativity in the camp of individual ability differences (i.e., creativity as a component of ability or intelligence) more than 100 years ago led to the construct's being considered a predominantly intellectual trait of individual difference. For this reason, researchers have considered creativity to be the "prodigal stepbrother to research on intelligence" (Sternberg, 1988, p. 7). However, researchers also began to assess creativity from the perspective of personality theories and processes. Interest in cognitive psychology led to investigations of the creative problem-solving process (e.g., Finke, Ward, & Smith, 1992; Newell, Shaw, & Simon, 1962).

There has been considerable interest in the situational factors that promote or inhibit creativity at the level of individuals and teams (e.g., Amabile, 1996). Researchers have studied the neurobiology and function of creatives and creative thinking (e.g., Folley & Park, 2005; Martindale, Hines, Mitchell, & Covello, 1984), and the studies appear promising, although researchers still wrestle with the definition and measurement of creativity. The final frontier for creativity research lies in efforts to integrate and understand this diverse field of research. For this reason, some researchers have proposed confluence or syndrome approaches to creativity (e.g., Mumford & Gustafson, 1988).

The major issue that has obfuscated and scattered scientific creativity research has been the definition and use of the term *creativity*. It is not a technical word invented to describe the psychological attributes or processes that result in creation. Rather, it is an expression that is useful to artists, scientists, and lay people (Wehner, Csikszentmihalyi, & Magyari-Beck, 1991). This usefulness means that the term has been applied in such a diverse manner that it has almost ceased to mean anything. Together, the issues relating to the cultural underpinnings of the term, the root of the notion of creativity in the divine, and the universal usage of the word have combined to produce a field that Glover, Ronning, and Reynolds (1989) described as "a degenerating research programme" (p. 7).

Defining Creativity

Prentky (2001) suggested that "what creativity is, and what it is not, hangs as the mythical albatross around the neck of scientific research on creativity" (p. 97). As a psychological concept, creativity has resisted unequivocal definition or clear operationalization (Parkhurst, 1999; Runco, 2004). Rhodes (1961/1987) suggested that definitions relate to four different potential research areas: (a) the person who creates, (b) the cognitive processes involved in the creation of ideas, (c) the environment in which creativity occurs or environmental influences, and (d) the product that results from creative activity.

Advocates of the creative-person approach seek to identify the general and specific abilities, motives, and traits that result in a person who produces creative

products (e.g., Carroll, 1993; H. J. Eysenck, 1993, 1995; Gough, 1979). Besides the psychometric approach, notable humanist researchers (e.g., Maslow, 1971; Rogers, 1954) have examined creativity in a framework of individual motivation. Such efforts have been influential in creativity research, but we do not explore them in this article because the primary focus of this review is on studies that used an empirical approach to assessing creativity. Researchers addressing the intellectual facets of the creative person tend to adopt a psychometric methodology. The researchers studying personality traits of creative people tend to adopt the more traditional framework of a 3-, 5-, or 16-factor model.[2] Advocates of the creative-process approach try to delineate the cognitive and behavioral means by which creative ideas are produced (e.g., Finke et al., 1992; Mednick, 1962). This approach is more in the tradition of cognitive psychology. Researchers who investigate the creative environment search for the physical and social conditions in which creativity is likely to unfold (e.g., Csikszentmihalyi, 1999; Simonton, 1984). These researchers are often applied psychologists interested in encouraging creativity. Last, advocates of the product approach try to specify the attributes of products that lead to a person being labeled as creative (e.g., Sternberg, Kaufman, & Pretz, 2002).

The theoretical perspective of creativity researchers usually defines how they try to assess the construct. Those who emphasize a person-centered view of creativity usually assess creativity with reference to personal attributes, such as intelligence or personality (e.g., Guilford, 1950). Also, some researchers take an abnormal or clinical view of creativity, seeing it as the result of unusual personality processes. Those who emphasize a process-centered view often assess creativity with reference to thought processes such as problem-solving (Mednick, 1962). Those who emphasize the role of the environment focus on the climate for creativity (e.g., Simonton, 1977, 1984).

Thus, we can consider cognitive, personality, humanistic, social, environmental, and psychoanalytical[3] psychologies of creativity. It is certain that eventually the neurobiology of creativity will be explored (e.g., Reuter et al., 2005). Each approach inevitably concentrates on the issue of creativity differently, devising its own theories, methods, and investigative paradigms. Therefore, this neglected field is also deeply fragmented, indicating the need for a comprehensive review. This fragmentation and methodological variance makes any meta-analytical approach to creativity problematic.

Despite conceptual and empirical fragmentation, there now appears to be some reasonable definitional agreement in the field. Barron (1955) first proposed the new-and-useful definition of creativity, which appears to have gained wide acceptance (Mumford, 2003; Runco, 2004). However, such a definition has still been criticized and modified.

Parkhurst (1999) indicated the new-and-useful perspective of creativity requires development because the current definition is not stringent enough to enable differentiation between what is creative and what is not. He proposed the following definition of creativity:

> the ability or quality displayed when solving hitherto unsolved problems, when developing novel solutions to problems others have solved differently, or when developing original and novel (at the least to the originator) products. (p. 18)

However, this definition still fails to account explicitly for the role of social appraisal in judgments about what constitutes creativity or creative problem-solving (e.g., Csikszentmihalyi, 1999).[4]

Although the new-and-useful account of creativity is relatively parsimonious, there have been recent movements to incorporate a multicomponential perspective into creativity assessment. In that perspective, creativity in the individual is seen as the result of a complex interaction between the person and the environment, ultimately leading to a creative product (Csikszentmihalyi, 1988; Mumford & Gustafson, 1988). Although these componential accounts possess a greater breadth and depth in their treatment of the creativity complex, they still do not provide an understanding of what is creative. Instead, they indicate the conditions in which creativity will occur. We suggest, by definition, that identifiable creativity in a product is a result of a syndrome involving the following:

1. Attributes of the product itself that are novel and useful with respect to a particular sociocultural group
2. Attributes of the persons who generated the product
3. Attributes of the persons assessing the creativity of the product or output
4. Attributes of the environment (for creators and assessors), including the following: source of evaluation, source of support or resources, and source of stimulation or inspiration

Inevitably, such a complex definition poses major problems for measurement. Definitions of creativity have evolved to incorporate numerous issues (e.g., the role of the environment, the role of subjective evaluation). Most definitions still refer to the core concepts of novelty and utility. However, there are a number of qualifications for the new-and-useful definition of creativity: First, perceiving creativity as the original product of an individual is a predominantly Western perspective. Second, there is debate about what constitutes a product. Abstract ideas (i.e., theories) have been treated as products (Runco, Plucker, & Lim, 2001), and researchers have analyzed products not created during an experiment or investigation of creativity (Baer, Kaufman, & Gentile, 2004).

Third, there is uncertainty about whether *new* must mean unique or preeminent. Some commentators have argued that a product need only be new for the creator (Boden, 2004; Rogers, 1954; Thurstone, 1952), whereas others have asserted that society must determine whether a product is new and useful (Csikszentmihalyi, 1999; Stein, 1953).[5] There is the issue of whether any person can produce something that is entirely novel (Boden); instead, the requirement of surprise may prove a more fitting criteria. There is also the issue of whether

novelty is essential in science, where advancement is predominantly normal as opposed to revolutionary (Kuhn, 1970). Fourth, as a requirement of novelty may be inappropriate for some scientific endeavors, a requirement of usefulness may not prove a fitting criterion for the arts.[6]

Fifth, judgements concerning novelty and utility inevitably involve social appraisal (Amabile, 1983, 1996; Csikszentmihalyi, 1988, 1999). This circumstance raises issues about the selection of appropriate judges and about whether contemporary studies of eminent creativity are possible, given that the gatekeepers of a field may not allow an individual to contribute to their domain (Csikszentmihalyi, 1999). There are also issues about the nature of consensus. Must the judges unanimously agree to the creativity of a product, or is there an acceptable cutoff point? Must these consensual judgments be valid over time and across cultures to fulfill the basic criteria? Sixth, the relation of creative abilities and dispositions to specific domains (e.g., art or science) is highly arguable (Baer, 1998; Kaufman & Baer, 2004; Plucker, 1998).

Perhaps the most fundamental qualification for the understanding of the creativity construct involves the distribution of creativity throughout the general population. When creativity is assessed psychometrically (i.e., as a cognitive ability or a personality or motivational trait) or with judgments of everyday products, it conforms to a normal distribution: a trait. When creativity is assessed in terms of real-life production or eminence, the distribution is skewed toward great achievement from a few creators (Lotka, 1926; Moles, 1968; Price, 1963). This discrepancy may, in part, be resolvable by adopting a multicomponent or syndrome approach to creativity.

There is growing agreement among researchers with the idea that creativity in the individual relies on multiple components (Amabile, 1983, 1996; H. J. Eysenck, 1993, 1995; Guilford, 1950; Mumford & Gustafson, 1988; Woodman & Schoenfeldt, 1989). These components include cognitive ability, personality factors, cognitive style, motivation, knowledge, and the environment, as a source of both stimulation (Dodds, Smith, & Ward, 2002; Moss, 2002) and evaluation (Csikszentmihalyi, 1988, 1999). The interaction between the components and environment necessary for creative performance in different domains is complex. Therefore, examining correlates of trait or cognitive ability in isolation could be misleading and produce unreplicable results. This may be seen as the major cause of equivocal results in the field. However, an optimistic assessment may suggest that, despite the complexity and number of variables involved, agreement among the studies on individual difference correlates of creativity is surprisingly high.

Certain components may operate as facilitators in certain domains but inhibit creativity in others. An example is the personality trait neuroticism (N), which is elevated in artistic populations (Feist, 1998; Gotz & Gotz, 1973). Still, successful and possibly creative managers and leaders tend to be emotionally stable (e.g., Barrick & Mount, 1991; Salgado, 1998). The Big Five personality dimension of conscientiousness (C) is another, and it seems to contribute to scientific excellence but detract from artistic performance (Feist, 1998).[7]

For a long time, psychometricians and individual difference psychologists have posited that most personal characteristics conform to a normal distribution. When creativity is considered as resulting from the interaction of multiple individual difference traits (e.g., intelligence quotient [IQ], personality, motivation, DT), then it is not surprising that researchers using a single standardized measure of creativity (e.g., DT tests) find the phenomenon to be distributed normally. However, the synergistic interaction of individual difference traits, environment, and sociocultural milieu necessary to produce true eminence is, by definition, a rare occurrence often leading to a skewed distribution (Moles, 1968). If Albert Einstein had been born to Wolfgang Amadeus Mozart's parents (or vice versa), would he have achieved the status of musical rather than scientific genius? To understand the complex interaction between nature and nurture is particularly problematic for those studying creativity.

A similar argument may be made in the psychometric framework. Consider the chances that a single participant from a psychological experimental sample would obtain scores on a limited number of individual difference measures that corresponded to the recommended profile for a creative artist: for example, moderate-to-high IQ (H. J. Eysenck, 1993; Yamamoto, 1964), high DT scores (Guilford, 1950; Torrance, 1974), the ideal constellation of personality traits (high N, low extraversion [E], high openness to experience [O], and low C; Feist, 1998; Gelade, 1997), intrinsic motivation (Amabile, 1983, 1996), and self-confidence or self-efficacy (Tierney & Farmer, 2002). This example does not include other factors that may contribute to real-world creative achievement, such as birth order and developmental influences, general and domain-specific knowledge, access to resources, the availability of a suitable mentor, the overarching sociocultural milieu, and, although psychologists would often not want it so, luck or historical serendipity.

For psychometric work to proceed, the dependent variable requires unequivocal definition and a reliable and valid measure. At this requirement is where the problems for creativity researchers arise. Although the new-and-useful definition is widely accepted, researchers must still consider serious qualifications, unlike researchers in personality and intelligence who have well-established and validated (construct and criterion) measures. However, researchers may argue that the gradual development of relatively unanimous definitions and measures for the constructs of intelligence and personality has arisen after at least a century of research on intelligence (Spearman, 1904) and 60 years of psychometric research on personality (H. J. Eysenck, 1947).

However, creativity research has proven to be something of a backwater. It may be contended that rarely in science do concepts and constructs start with solid definitional foundations. Rather, through research and operationalization, the constructs slowly acquire meaning and unanimity. If this is the case, then creativity research may yet attain greater levels of agreement with regard to definition and, therefore, measurement (see the Appendix for selected quotations on the definition of creativity).

The Criterion Problem

Creativity has been conceptualized from a number of perspectives (e.g., Rhodes, 1961/1987). This variety has meant that there are virtually as many ways of assessing or measuring the construct as there are perspectives. Therefore, a significant issue in creativity investigations has involved the selection of parsimonious and valued criteria for creativity. Hocevar and Bachelor (1989) and Lubart (1994) have presented a taxonomy of the measures that were available to them, which consisted of eight categories: (a) DT tests; (b) attitudes and interest inventories; (c) personality inventories; (d) biographical inventories; (e) ratings by peers, teachers, and supervisors; (f) judgments of products; (g) ratings of eminence; and (h) self-reported creative activities. Some investigators have gone so far as to say that creativity investigations must be related to a specific, tangible product (Hocevar & Bachelor).

Sternberg et al. (2002) produced a thoughtful taxonomy of creative products. Their *propulsion model* of creative contributions proposed that creativity propels a field forward in some way. They hypothesized that there are eight types of creative contribution divided into three categories. The three major categories of creative contributions are those that (a) accept current paradigms and try to extend them, (b) reject current paradigms and try to replace them, and (c) try to synthesize paradigms.

There are a number of issues with these criteria. First, if researchers presume that creativity involves a product that possesses novelty and utility, then we preclude a number of tests and populations from investigation. Tests of DT would be inadmissible as evidence of creativity because the ideas generated during a testing administration are useful only to the creativity researcher. Abstract ratings of creative ideas (i.e., without specific reference to a product) would not suffice. Also, if creativity involves the generation of products that are given the label *creative* by society in general (e.g., Csikszentmihalyi, 1999), then researchers could not investigate populations yet to develop (i.e., children or students).

Many of the criterion issues may be resolved through careful construct and criterion validity studies. If a putative test of creativity has proven to consistently predict who will produce novel and useful products, then that measure may be called a *test of creativity* (even when used later in the absence of a product). Therefore, in this article, we assert that researchers should refer to a product during the validation process of a creativity instrument. Once that relation is established, the test may be used in isolation, having demonstrated predictive or criterion validity. Because of the multicomponential nature of creativity, it seems prudent to use a number of measures to adequately assess the construct (e.g., Wolfradt & Pretz, 2001).

Because of the generally accepted new-and-useful definition of creativity, one may expect researchers to use measures that consider both novelty and utility. However, this has seldom been the case. The diversity of instruments and

methods of measurement of creativity used throughout the literature has yielded problems. Can researchers compare the results of a study in which the criterion for creativity was outstanding lifetime achievement with the results of a study in which the criterion was a word fluency test? In truth and practice, the answer has often been yes. Despite this inappropriate mixing and matching, there has been a surprising degree of convergence in the results.

Creativity and Intelligence

Although some researchers argue that there remains no good operational definition of intelligence, excellent tests of this abstract concept or latent variable exist (Lubinski, 2004). A fundamental question in creativity research has been: To what extent may creativity be delineated from intelligence? Researchers have long questioned whether it is possible to be creative in the absence of high intelligence and vice versa. A considerable obstacle in resolving this issue concerns how intelligence and creativity researchers refer to each others' concepts (Feist & Barron, 2003; Snyderman & Rothman, 1987). For example, Spearman (1927) equated intelligence with reference to his neogenetic laws—creating something new. There are clear parallels with the new-and-useful definition of creativity.

We have demonstrated that creativity lacks a solid definitional foundation. Unfortunately, although intelligence research has begun to converge on a series of principles (e.g., Neisser et al., 1996), definitions of *intelligence* still range from a neural efficiency perspective (Jensen, 1998) to the ability to adapt the self to the environment (Sternberg, 1997). Definitional problems have not prevented intelligence researchers from developing some of the best psychometric measures in all of psychology (Deary, 2000).

Early Research

The earliest researchers studying the relation between creativity and intelligence used rudimentary definitions of the creativity construct, which then were related to ratings of intelligence or IQ tests of the day. Dearborn (1898) studied the imaginative responses of students and faculty at Harvard to inkblots, noting that intellectuals did not provide the most imaginative responses. Colvin (1902) and Colvin and Meyer (1906) studied inventiveness in English children and concluded that "logical power" bore "no pronounced relation to any type of imagination" (p. 91). Chassel (1916) studied a number of tests, some being similar to modern tests of IQ, requiring unusual and original responses to novel situations. She found that performance on the IQ tasks bore little relation to performance on the tasks similar to modern DT tests.

An early challenge to the supposition that IQ tests are a comprehensive measure of human cognitive function came from Simpson (1922). He argued that "creative tests" should be used in conjunction with tests of general intelligence

to provide "a more accurate statement of the worth of the individual" (p. 235), indicating that he saw the two areas as orthogonal. Andrews (1930) administered three tests of imagination and IQ tests to preschool children and found correlations between scores of imagination and IQ of $r = .15$, .02, and .03. McCloy and Meier (1931) gave "re-creative imagination" (p. 108) tests to schoolchildren. Participants responded to symbolism in abstract paintings. The quality of their responses correlated with IQ at $r = .22$.

The early investigations into the relation between creativity and intelligence suggested that the two concepts are not the same. The most intelligent individuals were not found to be the most creative, and correlations between creativity and IQ were fairly low, never exceeding $r = .30$, but they were more often about $r = .10$. That finding indicates that less than 10% of the variance in creativity scores can be explained by IQ. However, inconsistent definitions of both creativity and intelligence and the fairly primitive psychometric instruments involved in the studies suggest that making unequivocal conclusions is unwise. Creativity, imagination, and inventiveness were found to bear little relation to intelligence. Of course, many of these early studies were plagued by the traditional problems of the day: the design of the IQ tests, small sample sizes, and statistical analyses. Although we may not infer much theoretically, these early studies are important because they reflected the thinking at the time and have influenced subsequent research.

In the period between the two World Wars, Terman (1925–1959) used the then recently validated Stanford-Binet IQ test to identify children whose IQ scores were greater than 140. Terman administered a battery of intelligence, biometrical, personality, and achievement tests to a sample of 1,528 Californian schoolchildren (from an initial sample of 250,000). The most important finding from the study of the gifted children was that superior intellect did not necessarily result in eminent achievement. Of the 1,528 children, not one went on to make an eminent creative contribution, by the researchers' definition. Of the children excluded from the study, two were awarded Nobel prizes.[8]

In a summary of the studies, Terman and Oden (1940) argued, "The data reviewed indicate that, above the IQ level of 140, adult success is largely determined by such factors as social adjustment, emotional stability, and drive to accomplish" (pp. 83–84). In a later study, when the *Termites* (i.e., participants in Terman's studies of genius) had reached their 70s, Feldman (1984) found that those of the very highest IQ scores (180+) were not significantly more successful than those other Terman (1925–1959) participants who had IQs around 150. The work of early pioneers, many of whom, like Terman, had assumed that IQ would correlate strongly with creativity, indicated the opposite to be true. IQ could explain a little of the variance of the creativity complex, but other factors appeared to be important. Further, in terms of achievement, extremely high intelligence appeared to confer no advantage over high intelligence.

Up to 1984, the IQ tests used in creativity research were primarily based on early versions of the Stanford-Binet Tests (Terman, 1916). There are numerous

criticisms of these tests (Mackintosh, 1998), but their primary limiting factors with regard to creativity investigations were that (a) they yielded a single score, which was thought to correspond to *g* or general intelligence, and (b) they were not culture-free (Cattell, 1940). Later studies indicated that eminent scientists differed in their particular constellation of ability traits, with variations in verbal, mathematical, and spatial intelligence differentiating physicists, biologists, and social scientists (Roe, 1951a, 1951b, 1953). Thus, verbal ability may be more closely related to artistic creativity, and tests of mathematical reasoning may be more related to scientific creativity. More recent ability batteries often distinguish between verbal and performance measures, which may relate quite differently to creativity test scores.

Guilford's DT

The starting point for modern investigations of creativity concerned investigations of fluency as a component of intellectual ability (H. L. Hargreaves, 1927; Thurstone, 1938). H. L. Hargreaves administered a battery of fluency (*f*) tests, finding average correlations with IQ of $r = .30$. This finding indicates that fluency is related but not identical to *g*. Guilford (1950, 1967) expanded this avenue of research to produce DT tests. DT tests "require individuals to produce several responses to a specific prompt, in sharp contrast to most standardised tests of achievement or ability that require one correct answer" (Plucker & Renzulli, 1999, p. 38).

Fluency is predominantly a quantitative measure rather than a qualitative one. Much of Guilford's (e.g., 1950, 1967) work relied on simple quantitative counts of ideas rather than considering the quality (e.g., unusualness, quirkiness) of response as determined by a panel of raters. If both measures are used, a more comprehensive assessment results. Some of the contradictory and confusing results in this area may be attributable to the way in which fluency is measured.

Guilford was one of the first researchers to develop a taxonomy of human abilities that made creative thinking relatable to intelligence. Guilford's (1967) structure-of-intellect (SOI) model postulated three fundamental dimensions of intelligence: (a) operations (cognition, memory, divergent production, convergent production, evaluation), (b) content (figural, symbolic, semantic, behavioral), and (c) products (units, classes, relations, systems, transformations, implications). These dimensions are represented as a cube. When the 5 operations, 4 contents, and 6 products are crossed, the model yields 120 factors. In everyday terms, this made the SOI model unsuitable for applied work (e.g., training and development), but it enabled specific components of cognition to be related to creativity. Guilford and associates (Wilson, Guilford, Christensen, & Lewis, 1954) originally postulated 24 intellectual abilities related to creative thinking. These included (a) fluency of thinking, consisting of word, ideational, expressional, and associational fluency; (b) flexibility of thinking, consisting

of spontaneous and adaptive flexibility; (c) originality; (d) sensitivity to problems; and (e) figural and semantic elaboration (i.e., embellishment pictorially or verbally). Collectively, these factors were called *divergent thinking*.

Starting with Wilson, Guilford, Christensen, and Lewis (1954), who tested Air Force cadets and student officers, a series of studies, culminating in Guilford and Hoepfner (1966), isolated most of the DT factors in normal populations. It appeared that Guilford and his coinvestigators had been able to distinguish and measure different components of DT.

The next stage was to investigate the relation of these DT factors to creativity. Guilfordian DT tests were administered to three main populations: students, occupational samples, and eminent people. Lowenfeld and Beittel (1959) examined highly creative art students and found evidence for the role of five distinct attributes: fluency, flexibility, redefinition, sensitivity to problems, and originality, seemingly supporting Guilford's (1967) model. Drevdahl (1956) studied art and science students and found ratings of creativity correlated with Guilford's DT tests to the magnitude of $r = .33$. Tests of DT similar to those used by Guilford were administered to high school students and then related to teacher ratings of creativity (Merrifield, Gardner, & Cox, 1964; Piers, Daniels, & Quakenbush, 1960; Torrance, 1962). The correlations were positive but low, generally in the order of $r = .20$. In a test of a large sample of fifth-grade schoolchildren, Lauritzen (1963) found that a score for originality predicted teacher ratings of originality with a correlation of $r = .48$. The results of these studies (reviewed by Barron & Harrington, 1981) seemed to indicate that DT and creativity in student samples are related. Correlations were usually $r = .30$.

Researchers have also studied adult, nonstudent groups. In a study of 100 Air Force captains, Barron (1955) found correlations between three DT tests: unusual uses, plot titles and consequences, and rated originality. The tests correlated by $r = .30$, .36, and .32, respectively, with rated originality. Barron (1963) reported a positive correlation of $r = .55$ between rated originality and an aggregate DT score from eight different DT tests in the same sample of Air Force officers. Wallace (1961) used the DT tests with saleswomen. The key finding was that the saleswomen assigned to the group of high customer service obtained significantly higher mean scores on the DT tests than did the saleswomen assigned to the group of low customer service. Therefore, Wallace demonstrated that DT related to problem-solving for customers. Elliot (1964) also found that creative public relations personnel could be differentiated from their less creative peers on the basis of five of eight Guilford-type tests. The results of the studies of occupational groups augment the results of the studies of student groups: Creativity, explaining 10–25% of the variance in creativity scores, could definitely be said to contribute to real-world creative performance, no matter how it was defined.

However, the results of the eminence studies caused confusion rather than consolidation. When the DT tests were administered to eminent populations (i.e., those who had succeeded already in their occupations), the validity of the tests

seemed tenuous. MacKinnon (1961) found that architects who were creative, per their peers, could not be identified on the basis of their DT scores. Gough (1961) noted similar findings for research scientists. Rated creativity correlated with Guilford's (1967) unusual uses, consequences, and transformations at r = –.05, –.27, and .27, respectively. We note that these samples contained only approximately 45 participants.

The results of the DT investigations suggest that DT skills contribute to creativity in students and in occupational groups but do not differentiate highly creative individuals.[9] This possibility indicates that DT skills are part of creativity as a normally distributed trait but do not help to explain the difference between moderately and highly creative individuals. Thus, creative individuals possess DT skills, but we must look for other factors to explain the difference between the everyday creative individual and the eminent achiever.[10]

It seems that DT is a necessary but insufficient trait for achievement creativity. In normal individuals, fluency adds to perceptions of creativity by other people. However, eminent samples are a highly select population who must possess certain abilities over and above fluent DT to achieve success. This discrepancy may be partly resolved by looking to quality rather than quantity of responses to traditional DT tests.

Researchers have made various criticisms of Guilford's (1967) work. Guilford assumed that the different factors that compose the SOI model were orthogonal. Therefore, he used orthogonal as opposed to oblique-rotation procedures to isolate the different factors. However, critics have fundamentally disagreed with these factorial statistical procedures (Cattell, 1971; Horn & Knapp, 1973; Sternberg & Grigorenko, 2001). If these critics are credible, Guilford's SOI model is problematic.

In applied terms, even if the rotational analyses by Guilford in his numerous studies were unacceptable, the factors that Guilford isolated appear to explain some of the variance of rated creativity scores in noneminent samples. Guilford treated creativity as a subset of overall intelligence, with DT as one of the intellectual factors that constituted the structure of intellect. Other researchers began to question that idea and suggested that there should be a clear distinction between the traditional concept and measurement of intelligence and creativity, as identified by Guilford.

DT as a Criterion of Creativity

Until around the mid-1960s, DT was seen as a cognitive ability that was necessary but insufficient for creative achievement (Guilford, 1950). The next wave of researchers started to use various other creativity tests. However, these creativity tests were practically identical to those used by Guilford to measure DT.

In an early systematic and celebrated study, Getzels and Jackson (1962) administered five creativity measures to approximately 500 schoolchildren, which those researchers then correlated with tests of IQ (predominantly Stanford-Binet).

Their main aim was to identify two types of students and to examine the differences between them. The first group comprised those children who had high IQ scores and low creativity scores (the high-IQ group). The second group comprised children who had low IQ scores and high creativity scores (the high-C group).

We note the following about the study by Getzels and Jackson (1962): (a) The mean IQ of the students tested was 132. (b) The authors wished to compare high IQ (but low creativity) with high creativity (but low IQ). This meant that children who scored high or low on both tests were excluded from the final analysis. (c) The authors did not report many of the intercorrelations between measures, so it is difficult to ascertain the pattern of results. (d) The tests were administered in a classroom setting in a manner similar to that of IQ tests, which may have inhibited students' creative expression. The average correlation between the creativity measures and IQ was in the order of $r = .26$. When comparing the high-IQ group (M IQ = 150) with the high-C group (M IQ = 127), Getzels and Jackson found no differences in the scores of school achievement or achievement motive. The most striking differences were observed in the attitudes of the two groups, with the high-C group rated as more unconventional.

Following the study by Getzels and Jackson (1962), Wallach and Kogan (1965) conducted an investigation into IQ and DT with an aim to correct some of the errors that they perceived as encumbering Getzels and Jackson's investigation. Wallach and Kogan's study of schoolchildren was careful to induce a game-like quality to the administration of the DT creativity measures. They used five creativity measures not dissimilar to the Guilford tests, each scored for uniqueness and productivity[11] to yield 10 scores for creativity. They used 10 different tests of intelligence to assess IQ.[12] The tests were administered to the children individually. The average correlation among the 10 DT scores was $r = .40$, and the average correlation among the 10 IQ measures was $r = .50$, whereas the average correlation between the creativity and intelligence scores was $r = .10$. Wallach and Kogan noted that this finding was especially surprising, because the creativity measures relied in part on verbal intellectual skills.

Cropley (1968) used the same tests as Wallach and Kogan (1965) and replicated their findings in a group-administration setting. These findings suggested that creativity (as operationalized in DT tests) and intelligence are essentially independent concepts. Of course, this raises the important question of what correlation size indicates that two constructs are systematically related.

The studies also indicated that the prior experiments into the relation between creativity and intelligence may have been flawed. Before Wallach and Kogan's (1965) study, researchers conducted creativity assessments in examination-like conditions, similar to the conditions in which IQ tests are administered. They concluded that the inability to produce an environment conducive to creativity led to poor convergent and discriminant validity of creativity tests. This reflects the social and environmental psychological concern with situational variables that influence the creativity process. Thus, it may be argued that the testing situation influences

mood, which influences the creativity process (Kaufmann, 2003). However, the criticisms of Getzels and Jackson's (1962) study because of their use of DT tests as a criterion are just as relevant to the Wallach and Kogan investigations.

A review of the evidence of the importance of game-like conditions has indicated that there are no differences in the correlations between creativity and intelligence relating to the conditions of measurement (Hattie, 1977). Hattie (1980) administered five DT tests and a measure of IQ to 11-year-old students under both untimed, game-like conditions and timed, test-like conditions. The average correlation among the creativity variables was $r = .24$, and the average correlation between the creativity and intelligence measures was $r = .14$. The results of these two studies indicate that the social psychological characteristics of the environment may not matter as much as Wallach and Kogan (1965) asserted and that DT performance may be more trait-like than state-like. However, this finding requires replication with a wider variety of testing situations and participants. Also, it is necessary to ascertain, through standard manipulation check methods, the subjective perception of these different environments. This line of research largely has not been followed adequately, partly because it relates to the state–trait distinction, suggesting that environmental factors may induce mood states that influence trait measures.

Torrance (1967), a well-known researcher in the field, conducted an early meta-analysis of 388 correlations between intelligence measures and the Torrance Tests of Creative Thinking (TTCT; Torrance, 1966, 1974, 1990; Torrance & Ball, 1998). Torrance (1967) found a median correlation between the verbal DT tests and IQ of $r = .21$ and a median correlation of $r = .06$ for the figural DT tests. Guilford (1967) reported average correlations with IQ measures of $r = .22$ for verbal DT tests, $r = .40$ for symbolic DT tests, and $r = .37$ for semantic DT tests. Subsequent studies in the area continued to yield similar results. Wade (1968) studied 10th-grade students from selective schools. She reported a correlation between IQ and creativity, measured using Guilford DT tests, of $r = .37$. A combination of intelligence and creativity was able to explain twice the variance in scores of achievement than intelligence alone. These results indicate that DT skills and intelligence independently work to affect academic achievement, but this does not make them criteria of creativity.

In a large study, Richards (1976) administered elements of both Guilford's (1967) and Wallach and Kogan's (1965) DT tests to almost 500 naval officers. Data were available for three types of IQ test. The mean correlation between the battery of creativity tests and IQ tests was $r = .27$. The correlation between the different measures of creativity was $r = .64$. These results are not surprising. Guilford (e.g., 1967) originally designed the tests of DT as measures of a subset of intelligence. Therefore, correlations between DT and IQ in the order of $r = .20$ to $r = .40$ are to be expected irrespective of the nature of the IQ or DT test used.

As we suggested earlier in this article, one of the principal problems with research on the relation between creativity and intelligence has been the confusion

about the choice of a criterion and thus a measure of creativity. The experiments conducted using DT tests as a measure of creativity (e.g., Cropley, 1968; Getzels & Jackson, 1962; Wallach & Kogan, 1965) have been criticized (Amabile, 1996; Hudson, 1966; Lubart, 2003). Critics have suggested that DT tests measure aspects of creative intelligence but that they cannot also be stand-alone measures of creativity. This is especially true if creativity involves the production of socially valuable products. Probably because DT tests are relatively easy to administer and score, great attention has been placed on them. However, questions about the reliability of these measures remain, especially because verbal and figural versions of the test are not related significantly (Carroll, 1993).

Gilhooly, Wynn, and Osman (2004) have raised questions about the validity of DT tests as criteria for creativity. They suggested that participants involved in a DT test may rely on memory more than they rely on the generation of novel concepts. The studies indicated that DT tests, and especially DT tests that are administered over short periods of time, are largely measures of long-term memory (LTM) retrieval. Whereas most researchers would agree that LTM plays a role in the production of creative ideas, those researchers would be unlikely to consider LTM alone sufficient. However, studies that have used Guilford-like tests of DT may have measured exactly those traits. Similarly, it could be argued that LTM may be a common overlapping factor between scores on creativity tests and those on tests of intelligence, both relying partly on LTM retrieval.

The failure to clearly differentiate among intelligence, creative thinking skills, and creative achievement has made the interpretation of the vast bulk of the psychometric investigations of creativity problematic. This problem remains today in that disagreement still surrounds the selection of valid and reliable measures of trait creativity. Following the pioneering efforts of researchers such as Guilford (1967), Getzels and Jackson (1962), Torrance (1966, 1974, 1990; Torrance & Ball, 1998), and Wallach and Kogan (1965), most of the research efforts of the 1970s were explorative and then replicative. Most studies used the Guilford or Wallach and Kogan DT tests as their starting point and related the results of these tests to measures of intelligence (Vincent, Decker, & Mumford, 2002).[13]

Ratings of Creativity

An alternative to the use of DT tests as a criterion of creativity is the use of ratings of creativity: reliable ratings by observers of the trait creativity in others. Such measures may be vulnerable to greater bias than the scores by individuals on a DT test but possess far greater ecological validity. The use of rated creativity ensures that assessment takes into account the role of social judgment (e.g., Amabile, 1982). However, there are significant issues regarding the use of ratings of creativity: (a) Ratings may be attributable to global creativity or a number of creativity-relevant factors (Amabile, 1982, 1996). (b) Ratings may be provided with reference to a guiding definition or left entirely to the subjective judgment

of the assessor. (c) Ratings may be made with reference to people, products, or both. (d) The selection of appropriate judges is problematic. Should they be experts? Should they be familiar with the person or product? (e) There is an issue about the reliability of ratings over time, across raters, and across products.

Researchers at the Institute of Personality Assessment and Research (IPAR) at the University of California, Berkeley, studied eminent people and used socially constructed ratings[14] of creative potential and achievement. Among artists, the correlation between rated quality of work and IQ was .00 or slightly negative (Barron, 1963). For MacKinnon's (1961) studies of architects, the correlation between the Terman Concept Mastery Test (Terman, 1973) and rated creativity was $r = -.08$. Among mathematicians and scientists, the correlation between rated creativity and IQ was $r = .07$ (Gough, 1961). In a later study, Gough (1976) reported a correlation of $r = -.05$ between the Concept Mastery Test and creative achievement for research scientists and engineers.

Simonton's (1976) reanalysis of Cox's (1926) historiometric study of eminence indicated that rated IQ and ranked eminence did not correlate.[15] With the findings of the IPAR group, that finding indicates that when the criterion of creativity is socially or ecologically valid (as opposed to a DT test), there is little or no relation between IQ and creativity.[16] Barron (1963) and MacKinnon (1978) summarized the IPAR research. Across the total range of intelligence and creativity, both found a positive correlation of $r = .40$. However, above an IQ of 120, intelligence seems to explain little of the variance in creative achievement. This has become known as the *threshold theory of intelligence and creativity* (Guilford, 1967; Torrance, 1962; Yamamoto, 1964).

Threshold Theory of Intelligence and Creativity

The threshold theory of intelligence and creativity posits that at low IQ levels, there is little variation in the levels of creativity, with low IQ usually corresponding to low levels of creativity. At high levels of IQ, there is considerable variance in the range of creativity scores (Torrance, 1962). Yamamoto (1964), in a replication of Torrance, divided a sample of students into a high creativity group and a low creativity group. The results demonstrated that irrespective of the subject matter, highly creative students performed at a higher level than did less creative students when the effects of intelligence were controlled. In a summary of some of his earlier work, Guilford (1981) suggested a nonlinear relation between creativity and intelligence, with (a) a high correlation between IQ less than 120 and creativity and (b) a low correlation between IQ greater than 120 and creativity. Guilford explained this discrepancy on the basis of the levels of convergent and divergent thinking that may be used by problem solvers. Problem solvers with IQs less than 120 may make great use of their DT skills to reach an acceptable answer, whereas problem solvers with IQs greater than 120 may rely on their strong convergent thinking skills to reach an acceptable answer (Guilford, 1968).

However, Gilhooly et al. (2004) indicated that LTM also may play a role in this relation. Comparisons between MacKinnon's (1961) sample of architects, who had above-average intelligence, and Barron's (1963) sample of military officers, who had average intelligence, yield interesting findings. For the architects, the correlation between IQ and creativity was –.08, whereas for the military officers, the correlation was .33. From this perspective, intelligence can be seen as necessary for creative achievement, but not sufficient. In addition, attention must be paid to the domain of the endeavor, where trait creativity may be more important for some pursuits (e.g., science, engineering, mathematics) than for others (e.g., art, design). As Guilford (1967) noted, it is possible "for an individual to become distinguished in some areas of creative endeavour, such as inventing and composing, perhaps painting . . . without an exceptionally high IQ" (p. 168). However, for some domains, especially mathematics, the threshold theory does not apply. MacKinnon (1978) reported a correlation of $r = .31$ between creative life performance and IQ scores for mathematicians.

The threshold theory of intelligence and creativity appears to be supported by empirical data, although it requires explication and replication. In particular, researchers need to explore fully the nature of the threshold with reference to different creativity measures and participant populations. The primary implications of the research are that the assessment of individuals should account for both IQ and creativity factors. To ignore the role of creative thinking when assessing individuals, either in a developmental context or an assessment context, would be to discount some highly able individuals. Yet the majority of university and occupational application procedures (particularly in the United States) rely on measures of IQ almost exclusively (e.g., GMAT, SAT, MCAT).

If elevated IQ were to accurately predict creative eminence, then Terman's (1925–1959) gifted sample should have included many great creators (Feldman, 1984). As Torrance (1963) noted, "No matter what measure of IQ is chosen, we would exclude about 70% of our most creative children if IQ alone were used in identifying giftedness" (p. 182). This is a valid point because Terman missed two Nobel Prize winners (see Note 8). Until this stage, researchers had treated the concepts of intelligence and creativity primarily as unitary concepts, trying to relate the two. As the fields of intelligence and creativity research evolved, theorists began to posit a more comprehensive account of the relation between creativity and intelligence.

Role of Knowledge

In the 1960s, theorists tried to explain the complex relation between intellectual ability and creativity (Koestler, 1964; Mednick, 1962). Most accounts of how creative ideas are produced drew on the early work of James (1890) and Poincaré (1908/1970).

Mednick's (1962) associative basis of creative thinking suggested that creativity arose from the combination of associative elements and that mental

elements that are conceptually distant will be the most likely, on combination, to yield creative results. As Mednick suggested, "The more mutually remote the elements of the new combination, the more creative the process or solution" (p. 221). Mednick asserted that creative people could be distinguished from their less creative peers by their tendency to respond in an original manner to stimuli or response hierarchies. Mednick postulated that less creative people have a steep hierarchy or a less expansive set of possible responses to a stimuli question or idea. Therefore, when a situation demands the combination of ideas, the pool from which ideas may be drawn and combined is limited. Consequently, the combinations of ideas are not likely to be novel and will be exhausted quickly. Alternatively, the creative person's response hierarchy is flat. *Flat associative hierarchies* are those in which the probability of the evocation of a large number of associates is high. Thus, when new combinations are appropriate, the diversity of potential ideas is great, making the likelihood of creative combination greater. Mednick (1962) postulated that less creative people can provide stereotyped answers quickly because of the relative ease of association of highly related but limited associates. This possibility would affect long-term fluency because the potential pool of ideas would soon be exhausted. Mednick thought that creative people produce ideas much more slowly (because they are combining ideas that are conceptually distant and therefore take longer to be associated) but produce ideas for a longer period and with greater potential for novelty.

Mednick (1962) proposed that remote ideas may be brought together through serendipity, similarity, or mediation. Serendipitous ideas would occur as a result of unguided contiguity. The combination of ideas based on similarity occurs when associative elements are combined because they share similar features. Mednick felt the most important means of combining elements was mediation. In mediation, Idea X and Idea Y would be combined because they were both associated with Idea Z. Further, the probability and speed of creative solutions would depend on the condition of the problem solver. Individuals with a vast array of knowledge (i.e., crystallized intelligence) and good cognitive organization, structure, or processes would be better able to combine new elements. Researchers might argue that the condition of the problem solver refers to intelligence.[17] In effect, Mednick postulated that creativity arises from both intelligence and knowledge.

The Remote Associates Test (RAT; Mednick & Mednick, 1967) was designed as an easily administered paper-and-pencil measure of creativity. Test takers are required to provide a remote associate to sets of three presented words. Mednick and Andrews (1967) demonstrated correlations between the RAT and the Wechsler Intelligence Scale for Children as $r = .55$, with the SAT verbal as $r = .43$, and with the Lorge-Thorndike Verbal intelligence measure as $r = .41$.

However, there have been various criticisms of the RAT and its relation to creativity. First, the test items require the production of one correct answer, making the RAT a test of convergent thinking. Second, the test is unable to

distinguish between people with flat response hierarchies and those with steep response hierarchies because respondents need to find only one answer. Third, the test does not require the combination of ideas in new ways. The test takers are asked to find traditional associations to stimulus words. Fourth, the RAT items seem to require high levels of crystallized verbal knowledge (Mednick & Andrews, 1967).

Mednick (1962) hypothesized that there would be a difference of level, rather than style,[18] between the creative and uncreative. Therefore, creativity would be an extension of ordinary intelligence. Mednick's theories also depend on the quality and quantity of the information encoded by the individual. An individual with little stored knowledge (i.e., crystallized intelligence) would not be able to produce creative combinations, even with an extremely flat response hierarchy.

This indicates an important distinction between Mednick (1962) and Guilford (1967). Guilford's theories suggested that DT was sufficient for creative thinking because a problem solver has the mental machinery to think divergently. Mednick's theory is that people may have the cognitive mechanisms to combine ideas in ways that could be creative but that creativity will only occur if the quality of the ideas to be associated is high.

Cattell (1943, 1971) also made a distinction between mental processing and accumulated knowledge in his theory of fluid (*gf*) and crystallized (*gc*) intelligence. *Fluid intelligence* concerns information processing and reasoning ability. *Crystallized intelligence* represents the ability that an individual uses to gain, retain, structure, and conceptualize information. Crystallized intelligence is measured by tests of general knowledge and verbal comprehension, whereas fluid intelligence is assessed by tests of abstract reasoning. Both *gc* and *gf* are postulated to occupy a position just below that of general intelligence, which corresponds with *g* (Spearman, 1904). In addition to the three factors of *gc*, *gf*, and *g*.[19] Cattell (e.g., 1971) hypothesized that there are a number of primary abilities. The list of abilities is extensive but more applicable than Guilford's 120, 150, or 180 factors (Guilford, 1967, 1982, 1983). The primary abilities that Cattell thought particularly important for creativity were originality and ideational fluency.

Cattell and Butcher (1968) suggested that real-life creative endeavor was determined primarily by *g*, followed by *gf*. Crystallized intelligence was deemed less important. Cattell and Butcher neither distinguished between eminent and everyday creativity nor considered the relations between g, *gf*, and *gc* and specific domains of endeavor. Cattell and Butcher's theory of the relation between creativity and intellect directly opposes the study by Mednick (1962), who implied that creativity relied on the combination of ideas (knowledge or crystallized IQ).

In everyday creativity, crystallized knowledge probably is not particularly important. However, great creators in knowledge-intensive domains (e.g., science, engineering) must acquire a certain level of knowledge to advance in a field. However, there is most likely an inverted U-shaped relation between domain-specific

knowledge and scientific creativity. Low levels of knowledge do not afford the creator a sufficiently detailed knowledge of the field to advance it. Conversely, extremely high levels of knowledge are likely to lead to entrenchment (Sternberg, 1982) and an inability to conceive of the field in a radically different light. Second, perhaps *gf* and *gc* play different roles during the lifespan of a great creator. In an individual's early-period career, once a certain level of competence has been attained, *gf* is likely to be particularly important for abstract thinking and for problem solving to produce creative ideas. In the late-period career, when attention often turns to consolidation, *gc* would be essential.

Role of Specific Abilities

That creative people possess extraordinary abilities has been recognized since antiquity. The first indication that intellectual abilities need not be uniform for the attainment of creative eminence may be derived from the seminal historiometric study of 301 geniuses by Cox (1926). There are a number of methodological concerns surrounding Cox's study (H. J. Eysenck, 1995), yet her data suggest at least that IQ scores are not the same across domains. The estimated IQ scores for genius's adulthood range from 125 to 156 for soldiers and philosophers, respectively. That early study indicates that not all creators possess the same or even similar abilities. A related conclusion may be reached on examination of the Terman (1973) Concept Mastery Test[20] scores of contemporary creative achievers administered by the IPAR group and reported by MacKinnon (1978). As may be expected, verbal ability was highest in the creative writers group, with increasingly lower scores for scientists, architects, Air Force captains, and independent inventors. From this research, it seems clear that the verbal ability necessary for creative achievement varies across disciplines, although it should be noted that some of the sample sizes for the groups were particularly small. Unfortunately, no numerical test was administered to indicate that the differences in the scores achieved between these groups of participants were related to *g*.[21]

In one of the earliest systematic psychometric investigations, Roe (1951a, 1951b, 1953) examined the role of specific intellectual abilities and creative achievement. She administered specially designed tests of verbal, spatial, and mathematical intelligence to highly eminent scientists from different disciplines. She found, for example, that the verbal intelligence scores of theoretical physicists were significantly higher than the scores for experimental physicists. Roe expected that finding because of her hypothesis that theoretical physicists would be required to write more than their experimental colleagues. The studies of eminent scientists are an important contribution to creativity research that reveal that there are differences in the specific intellectual components required for creative achievement. Social scientists work primarily with verbal concepts and therefore scored highest on verbal ability, whereas physicists work with mathematical

concepts and therefore found the numerical tests undemanding. This research of eminent achievers highlights the importance of domain specificity and ability.

Confluence and Componential Models

Early researchers examined unitary concepts of intelligence and creativity. The studies of the 1980s and beyond are both scientifically and theoretically more sophisticated because the researchers tried to explain variance in creativity criteria by using a host of relevant independent variables. Perhaps of greatest importance was that DT became a predictor of creative achievement, not the criterion. This is an important advance in creativity research, highlighting how efforts to explain the construct have become increasingly sophisticated. The growth of this type of confluence approach suggests better understanding of creativity across domains in the future.

Hocevar (1980) examined the relative importance of a traditional measure of intelligence (Terman Concept Mastery Test; Terman, 1973) and three DT measures of ideational fluency, in relation to creative achievement in the fields of arts, crafts, performing arts, math, science, literature, and music, for a sample of undergraduate students. In this experiment, the ratings of creativity were drawn from behavioral inventories of creative abilities and achievements and then compared to DT abilities. The mean creativity score was the aggregate fluency score for the three DT tests used. The correlation between the mean creativity and intelligence scores was $r = .26$. The total score for ideational fluency correlated with an aggregate creativity achievement score at $r = .25$. The three DT measures intercorrelated between $r = .44$ and $r = .81$. It appears that intelligence and ideational fluency are distinct, because the correlations within the traits are high, whereas the correlations between the traits are low. However, the results from the study should be interpreted with care. First, the criterion of creativity, through ratings on an inventory of creative behaviors, relies on self-reported incidents of creative ability and achievement. Second, the creative behaviors and abilities that each participant listed are independent of quality. An achievement that a participant listed had not been assessed for quality or utility (e.g., Consensual Assessment Technique; Amabile, 1982). Rather, a quantitative approach was taken.

Kershner and Ledger (1985) compared 30 highly gifted children 9–11 years old with matched controls on measures of intelligence and DT. Those researchers tested Wallach's (1970) suggestion that flexibility, originality, and elaboration are largely measures of IQ. The supposition was that only fluency provides an accurate measure of DT. The results indicated that the scores for verbal originality were highly influenced by IQ. The gifted children held no advantage over the average children when it came to the scores for figural flexibility and fluency. That study raises an important issue in the study of creativity. Fluency and flexibility as measured by DT tests appear to be relatively independent of IQ. The study indicates that scores of originality are highly

dependent on intellectual endowment. This implication calls into question the validity and utility of Torrance's (1974) scoring system for DT-type tests, especially if the DT tests are to be used as measures of creative intelligence.

Rushton (1990) conducted three studies by using various tests of personality, intelligence, and creativity. Study 1 was of professors of psychology. He found that when the creativity score was produced from number of works published and number of citations,[22] the score correlated with a composite score of intelligence of $r = .40$. Study 2 was a survey of psychology researchers. The correlation between a composite measure of research effectiveness and a composite measure of intelligence was $r = .05$. Study 3 was a survey of 211 undergraduates. The participants were tested with some of the Wallach and Kogan (1965) DT measures and an IQ test. The mean IQ of the sample was 120. The total creativity score correlated with IQ at $r = .24$. These results suggest that the relation between creativity and IQ is not easy to predict.

Study 1 and Study 2 used professional research psychologists. Study 1 returned a correlation between IQ and creativity of $r = .40$, whereas Study 2 yielded a correlation of $r = .05$. However, methodological considerations may explain this difference. The criteria of creativity used were not the same for each study, making comparison difficult. We raise questions regarding the validity of the criteria of creativity selected,[23] the inconsistent assessment of intelligence, and the small sample size, which may have artificially inflated correlations between the variables.

Vincent et al. (2002) conducted a comprehensive study to assess the relation between DT and other cognitive capacities in 110 military leaders. The aim of the study was to examine the relations among intelligence, expertise (knowledge), and DT, insofar as they influenced creative problem solving and performance. A wide range of relevant factors were considered and then related clearly to a specific domain: military leadership. Vincent et al. assessed intelligence psychometrically with the verbal reasoning test of the Employee Aptitudes Survey. They assessed expertise with special reference to the domain of organizational leadership by using a rank-ordering exercise. They measured DT by using five items from the Consequences Test (Guilford, 1954). Responses were scored by using a variation of Hennessey and Amabile's (1988) Consensual Assessment Technique.

Also, Vincent et al. (2002) made assessments regarding the participants' problem-solving skills and leadership performance. Problem-solving skills were assessed by using an ill-defined, novel task in the form of a complex military problem. Participants suggested what they might do in the hypothetical situation. The questions focused on both idea generation and idea implementation. The researchers postulated idea generation to be an early-cycle problem-solving activity, whereas idea implementation was considered a late-cycle problem-solving activity (Basadur, 1997). Four observers rated the effectiveness of solutions. They also obtained a measure of leadership performance. For this, participants listed the number of medals, citations received, prior performance evaluations, promotions ahead of schedule, and admission to special training programs.[24]

Vincent et al. (2002) found intelligence and expertise to be correlated (r = .47). Both intelligence and expertise had a direct effect on DT. These results suggest that both *g* and *gc* (expertise) affected the production of socially meaningful consequences. This evidence supports Mednick's (1962) theory that creativity relies on a rich set of stored information. An important finding was that DT directly affected idea generation but not idea implementation. Expertise also produced a moderate effect on idea generation. That effect suggests that people are able to create viable problem solutions when they use both DT skills and acquired expertise. The generation of good solutions had a direct effect on the effective implementation of solutions.

That finding is not surprising because an implemented idea would likely be rated unfavorably if it was based on a poor generated idea. The results of the Vincent et al. (2002) study confirmed the path from idea implementation to organizational recognition (leadership performance). Vincent et al. suggested that DT is most important for early-cycle creative problem-solving. A more important finding was that DT had a stronger direct effect on idea generation than did intelligence. This finding suggests that DT measures "capture unique variance and do not simply represent a surrogate for intelligence or expertise. These findings, moreover, suggest that divergent thinking cannot be viewed as simply a subset of intelligence" (Vincent et al., p. 175).

Componential approaches to the understanding of creativity enable multifactor analyses of the creativity complex. Some multiple-component models lack empirical evidence, whereas the interpretation of the data for some models has been debated. Confluence models, such as that presented by Vincent et al. (2002), offer a better insight into the relation between intelligence, knowledge, and performance than that afforded by simple accounts of the relation between creativity and single variables. In taking into account the effects of late- and early-cycle problem solving, Vincent et al. were able to examine some aspects of the creation process.

Factor-Analytical Studies

Without a doubt, Carroll (1993) performed the most comprehensive investigation of psychometric creativity. The central theme to his survey of abilities in the domain of idea production concerned the correlations between different measures of creativity and the question of whether the correlations between them indicate the presence of a general creativity factor, what we call *c*. Carroll collated and refactored 42 data sets (out of a total of 121 data sets relating to idea production) containing different creativity tests. These tests were almost all open-ended—that is, they required a divergent response. Most simply, these tests could be broken down into fluency tests in which voluminous production is desired and originality tests in which unusualness, uniqueness, or quality was required.

Carroll (1993) reached the conclusion that creativity or originality "is linearly independent of many of the factors in other domains, or more generally, of what is

regarded as intelligence as measured by standard tests" (p. 427). He found factors such as verbal, visualization, and reasoning ability to be independent of creativity, although probably linked as second-order factors. The findings of the different data sets were not unanimous, but many seemed to indicate that creativity or originality is an independent orthogonal factor, but second- and third-order factors are also salient. That indication compelled Carroll to suggest, "It appears to require a considerable degree of general cognitive ability for an individual to be able to make high-scored responses to tests of [creativity or originality]" (p. 428).

The common elements of this creativity factor are that they require people to think fairly quickly and to write a series of responses fitting the requirements of a presented task or situation; that is, this factor indicates some element of quality. This factor was independent of a quantity or fluency factor, whereby respondents are required to write as many responses as possible. However, there is insufficient space in this article to fully explore the issue that, among others, there were independent factors for verbal fluency, creativity or originality, and figural fluency. As Carroll (1993) noted, it is important to consider that these factors are only those suggested by the available research. Inconsistencies in the tests used to assess different factors, types of scoring, and administrative environment could mean that future factor analytic studies may show slightly different distinct abilities in the domain of idea production.

Carroll's (1993) analyses indicate that creativity is not the same as intelligence but does require, in part, general mental abilities. These include speed of retrieval (especially in timed tests) to access stored knowledge (*gc*), fluid intelligence to manipulate retrieved information, and fine motor skills to write quickly. Perhaps most important, fluency was not found to be the same as originality.

On the basis of those who have criticized different scoring techniques to assess originality (versus fluency; e.g., D. J. Hargreaves & Bolton, 1972; Hocevar, 1980), the Carroll (1993) studies suggest that the best way to differentiate between fluency and originality is to provide different tests for these independent factors. Fluency tests such as the Thurstone (1938) Word Fluency test do not provide respondents with a particular opportunity for originality, whereas the Consequences Test (Guilford, 1954) does. Researchers are misguided in trying to find originality in the fluency tests (e.g., Torrance, 1974; see Figures 1 and 2).

Conclusion Regarding Intelligence

The earliest studies of the relation between IQ and creativity found that intellectuals were not assured of producing imaginative responses to open-ended stimuli (Dearborn, 1898). After more than 100 years of research, investigators still hold there to be some form of a dichotomy between IQ and creativity. However, we do not suggest that the relation between IQ and creativity has been mapped and explained. The study of IQ and creativity has been, at times, poorly defined and empirically approached. In some cases, DT measures were used as a

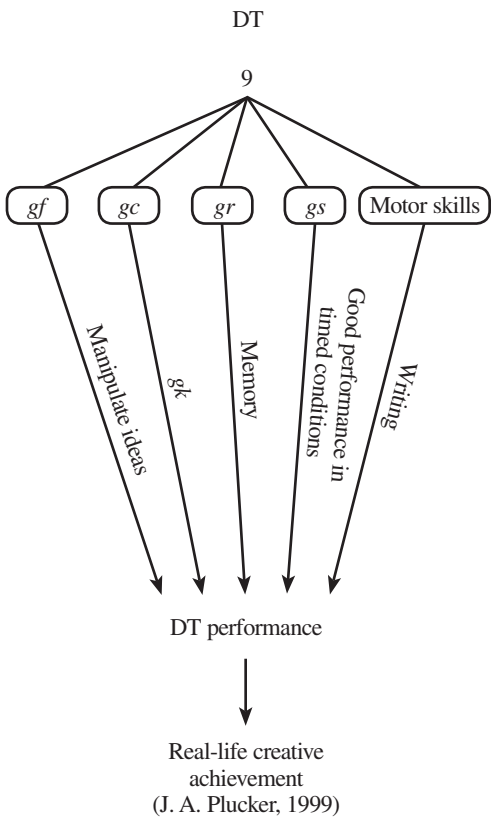

FIGURE 1. Relation of intelligence to divergent thinking (DT) test performance. *gf* = fluid intelligence; *gc* = crystallized intelligence; *gr* = retrieval; *Gs* = speed; *gk* = general knowledge.

measure of creative intelligence, whereas in others, researchers used DT scores as a criterion of creativity.

Researchers can argue that the overreliance on DT tests became a real problem unduly limiting the scope of creativity research while raising the specter of method bias in both theory and findings (Mumford, 2003b). Fundamental differences arise in the relation between intelligence and creativity depending on whether creativity is assessed via a DT test or creativity assessments by ratings.

The studies of the relation between creativity and intelligence indicate that the two constructs are modestly related. Correlations between the two are found in the range of r = .20–.40, suggesting that approximately 5–20% of the variance may be accounted for. Even with corrections for reliability, it is unlikely that these two traits will ever be thought of as synonymous, although they are clearly

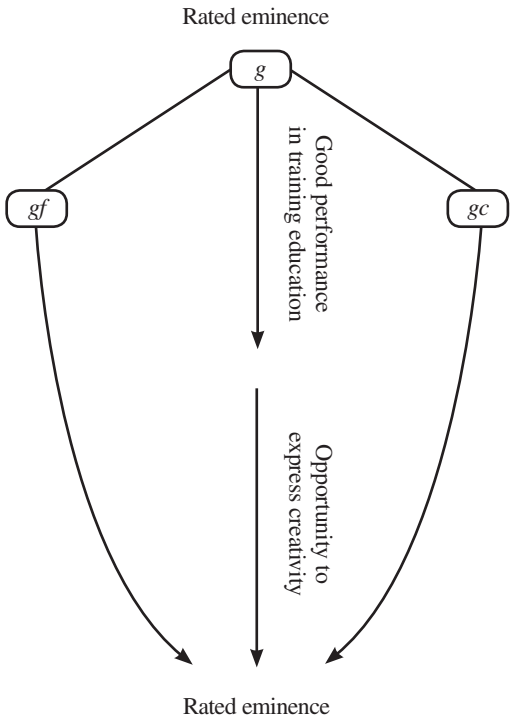

FIGURE 2. Relation of intelligence to rated eminence. *gf* = fluid intelligence; *g* = general intelligence; *gc* = crystallized intelligence.

related. It appears that creativity as fluency is more strongly related to IQ than is creativity as originality.

An explanation for the relation between creativity and intelligence may reside in the neurophysiology of intellect. It is likely that the efficient neural basis of intelligence (e.g., H. J. Eysenck & Barrett, 1985; Jensen, 1993) explains some of the variance in creativity test scores. Creativity tests are usually timed (especially DT tests). Under these conditions, neural efficiency contributes to an increase in DT performance. However, the results also indicate that neural efficiency alone is not sufficient to explain creative output. The confluence studies (e.g., Vincent et al., 2002) and meta-analyses (Carroll, 1993) have indicated that, alongside intellectual ability, a number of other traits can explain the variance in creativity criteria. A creativity test, especially one that involves timed paper-and-pencil subtests requiring participants to provide divergent responses, always relies in part on cognitive speed, retrieval of information from memory, fluid intelligence, and motor skills. The more similar to a test of power the assessment of creativity is, the greater is

the relation to intellect. However, it is most important that high scores on tests of these factors are necessary but insufficient for creativity.

This neurophysiological interpretation of the relation between IQ and creativity (when assessed by DT) can explain why intelligence is rarely correlated with rated creativity, largely because ratings are not assessed via paper-and-pencil tests and therefore do not give the opportunity to assess aspects of IQ (e.g., speed of retrieval). This raises a serious issue about common method of measurement bias. However, intelligence is likely to be important for rated creativity too. We argue that to demonstrate significant creativity (especially in terms of achievement or eminence), an individual must first reach a position where he or she has sufficient freedom to create (Hayes, 1989). For most domains, that involves training and education to a reasonably high degree, which in turn rely on a reasonably high IQ (Gottfredson, 1998). This reference to domain specificity is important. The role of IQ in relation to domains will likely differ. High IQ is a necessary but insufficient trait for success in science and engineering, but it is less likely to be important for achievement in the arts.

We surmise that IQ, although probably more specifically *gf*, provides the power for DT or the ability to find a job where creativity can be expressed readily. However, in addition to motivational and personality variables, a rich knowledge store (Mednick, 1962) provides the drive and the unusualness for creativity. However, as may be expected from a trait-based investigation, the social psychology of creativity has a sizeable effect. Test-taking conditions and cultural influences will make individuals more or less likely to proffer unusual ideas.

Recent approaches to the study of creativity have been componential, leading researchers to try to understand creative thinking and production in terms of the interrelation between specific variables. Confluence approaches such as those used by Vincent et al. (2002) have begun to show the relation between IQ and creativity specifically in a more comprehensive light. Researchers are beginning to explore the roles of intelligence, DT, and expertise (*gc*) in the expression of creative talent. Future researchers will undoubtedly begin to explore the relations between these different variables in different domains, with recognition of the influence of the cultural and administrative setting.

If there is one conclusion to be made from the research on IQ and creativity, it is that IQ or DT skills alone cannot account for much of the variance in creative achievement. Like the experimenters of the 1960s, 1970s, and 1980s, who were sure that something other than IQ could explain creative achievement, we now turn to investigations of the creative personality (see Table 1).

Creativity and Personality

Vigorous debates have regarded the number of dimensions that constitute personality (Costa & McCrae, 1992a, 1992b; H. J. Eysenck, 1991, 1992a, 1992b). Our review concentrates primarily on the relation between creativity and two major models

of personality: H. J. Eysenck's Gigantic 3 and Costa and McCrae's Big 5. We then present the lessons from that literature with reference to the creative process.

Feist (1998) suggested that personality research with regard to creativity has taken two forms. The first is the *between-groups* comparison. Here, two groups of people are compared (e.g., artists compared with scientists). In the second form of creativity research with regard to personality, researchers try to analyze *within-group* differences. In these cases, highly creative individuals from a domain are compared with their less creative peers. Such analyses are essential because the within-group variance in creativity is markedly different for artists and scientists (MacKinnon, 1965). Scientists were posited to have more pronounced variation in ratings of creativity because scientists may be involved in "very routine, rote, and prescribed" research (Feist, 1998, p. 291), besides the few scientists engaged in "revolutionary" work (Kuhn, 1970, p. 47). Alternatively, although artists can be used in routine work, "anyone who makes a living at art has to be more than one step above a technician" (Feist, 1998, p. 291).

The early studies of creativity and personality were characterized by the diversity of personality measures used. As in the study of creativity and intelligence, researchers have used different definitions of personality and have sought to assess the construct by using different measures. This diversity makes the interpretation of the constitution of the creative personality particularly difficult. Some interesting early studies used the California Personality Inventory (CPI; Gough, 1957). MacKinnon (1965) used expert ratings and the CPI to investigate the creativity of architects. To ascertain within-group differences, he compared expert-rated creative architects with their less creative peers. The key findings from MacKinnon's (1965) work were that the highly creative architects, in comparison with the noncreative architects, were less deferent and team oriented; more aggressive, dominant, and autonomous; and less socialized (responsible, self-controlled, tolerant, concerned with good impressions, and communal in attitude).

Domino (1974) also used the CPI in addition to the Edwards Personal Preference Schedule, Adjective Checklist (ACL; Gough & Heilburn, 1965, 1983) scored for creativity (Domino, 1970), Barron-Welsh Art Scale (Welsh & Barron, 1963), and the RAT (Mednick & Mednick, 1967) to assess the creativity of cinematographers versus matched controls. The main trend of his results was that cinematographers, in comparison with matched controls, exhibited a greater desire for status, need for achievement, self-acceptance, and need for change. The cinematographers scored lower than the controls on the scales for need for deference and need for order. When scored for creativity, the ACL differentiated the two groups, with the cinematographers scoring higher. Neither the Barron-Welsh Art Scale (Welsh & Barron) nor the RAT revealed any differences between the two groups. Early research using the CPI and other measures indicated that creative individuals tend to prefer autonomy and independence; that they are often less socialized than less creative individuals, with tendencies toward aggression or low agreeableness; and that they appear less concerned with convention or conscientiousness.

TABLE 1. A Sample of Representative Correlations Between Creativity and Intelligence

Researcher(s)	Sample	Measure(s)	Key findings
C. M. Cox (1926)	Eminent creative geniuses	Historiometric	*r* between IQ and ranked eminence = .16
D. K. Simonton (1976)	Reanalysis of Cox's data	Historiometric	No *r* between IQ and ranked eminence
E. G. Andrews (1930)	Preschool children	3 tests of imagination IQ	*M r* = .07
W. McCloy & N. C Meier (1931)	Schoolchildren	Quality of response to abstract symbolism IQ	*r* = .22
J. E. Drevdahl (1956)	Art and science students	DT Ratings of creativity	*r* = .33
H. G. Gough (1961)	Research scientists	DT Ratings of creativity	*M r* = –.02
D. W. MacKinnon (1961)	Architects	Rated creativity IQ	*r* = –.08
J. W. Getzels & P. W. Jackson (1962)	Schoolchildren	DT IQ	*M r* = .26
F. X. Barron (1963)	Aggregated IPAR findings	DT Ratings of creativity	*r* = .40
F. X. Barron (1963)	Air Force officers	Aggregate DT Ratings of creativity	*r* = .55
M. A. Wallach & N. Kogan (1965)	Fifth-grade schoolchildren	DT IQ	*r* between *M* creativity scores and *M* IQ scores = .10
E. P. Torrance (1967)	Meta-analysis	Torrance Tests of Creative Thinking (TTCT) IQ measures	*r* between IQ and (a) verbal DT = .21, (b) figural DT = .06

J. P. Guilford (1967)	Meta-analysis	DT IQ	*M r* between IQ and (a) verbal DT = .22, (b) symbolic DT = .40, (c) semantic DT = .37
S. A. Mednick & F. M. Andrews (1967)	College students	Remote Associates Test (RAT) IQ	Correlation between RAT and (a) WISC = .55, (b) SAT Verbal = .43, (c) Lorge-Thorndike verbal = .41
S. Wade (1968)	Schoolchildren	DT IQ	*M r* = .37
R. L. Richards (1976)	Naval officers	DT IQ	*M r* = .27
D. Hocevar (1980)	Undergraduates	DT IQ Creative behaviors checklist	*r* between M creativity and M IQ score = .26 *r* between Ideational Fluency and M creativity score = .25
J. R. Kershner & G. Ledger (1985)	Gifted children vs. matched controls	DT measures IQ	(a) Fluency is best measure of DT ability (b) Girls outperform boys on DT subscales
J. P. Rushton (1990)	Psychology professors	Creativity score (number of citations, works published, etc.) Composite rating of IQ	*r* = .40
	Researchers	Composite measures of research effectiveness IQ	*r* = .05
	Undergraduates	DT measures Multidimensional Aptitude Battery	*r* = .24

Note. IQ = intelligence quotient. DT = Guilford divergent thinking tests.

Eysenckian-Inspired Research

The concept of the Gigantic 3 (cf. for a detailed examination of the theory, see H. J. Eysenck & Eysenck, 1985) personality factors is inextricably linked to the work of H. J. Eysenck. H. J. Eysenck posited three orthogonal dimensions or superfactors in the description of personality: extraversion versus introversion (E), emotional stability versus instability or neuroticism (N), and psychoticism versus impulse control (P; H. J. Eysenck & Eysenck, 1976; S. B. G. Eysenck, Eysenck, & Barrett, 1985). These dimensions or superfactors are based on "constitutional, genetic, or inborn factors, which are to be discovered in the physiological, neurological, and biochemical structure of the individual" (S. B. G. Eysenck et al., 1985, pp. 42–43).

The concept that creativity involves the combination of disparate constructs is common throughout the literature (Koestler, 1964; Mednick, 1962; Rothenberg, 1971). H. J. Eysenck (1993, 1995) has argued that variations in P can be seen as the basis for creative thinking and also as the basis for a disposition to psychopathology, with high P scorers prone to unusual ideation and mental illness. H. J. Eysenck (1993, 1995) produced a model to explain how P and creativity were related. He argued that the process of overinclusive or illusive thinking characterizes both psychotic and creative thinking (H. J. Eysenck, 1993).

Researchers have examined the relation between creativity and psychopathology (Cattell & Drevdahl, 1955; Dellas & Gaier, 1970; Goertzel, Goertzel, & Goertzel, 1978; Heston, 1966; Jamison, 1989, 1993; Lloyd-Evans et al., 2006; Ludwig, 1995; Prentky, 1980, 1989, 2001; Sass, 2001),[25] and many of them have found evidence to support H. J. Eysenck's (1993) hypothesis that there are similarities between creatives and individuals with schizophrenia or sufferers of bipolar disorder.[26] Psychoticism (or schizotypy) is postulated to contribute to a creative thinking style, whereas bipolar disorder is postulated to contribute to creativity by predisposing sufferers to experience the extremes of affect.[27] For this reason, modern researchers have found the relation of schizotypal dimensions to creativity in different domains to vary (e.g., Nettle, 2006)[28].

Most of these researchers have concluded that there are signs of psychopathology (especially psychoses) among famous creators and have pointed to a link between creativity and psychopathology. H. J. Eysenck (1993) suggested that much of the debate about whether creative geniuses are psychotic could be resolved by disregarding the assumption that psychiatric abnormality is categorical rather than dimensional. According to H. J. Eysenck and Eysenck (1976), psychopathology can be conceptualized as an exaggeration or extension of underlying personality traits, an idea supported by the introduction of personality disorders in the *Diagnostic and Statistical Manual of Mental Disorders,* third edition (*DSM*-III; American Psychiatric Association, 1980) and continued with the *Diagnostic and Statistical Manual of Mental Disorders,* fourth edition (*DSM*-IV; American Psychiatric Association, 1994).

Accordingly, psychosis lies at the extreme end of the distribution of psychoticism, a hypothetical dispositional personality trait, which is conceived of as a continuum ranging from normal to psychotic. Psychoticism has been described as consisting of several characteristics, one of which is creativity. Other characteristics include aggressiveness, impersonal and antisocial behavior, coldness, egocentricity, impulsivity, unempathic behavior, and toughmindedness (H. J. Eysenck & Eysenck, 1976).

H. J. Eysenck (1993) assumed that creative people possess the personality characteristics of psychoticism (predisposition to psychosis) at a higher level than does the normal individual and that, if adequate control is missing or if they experience stressful situations, then they may develop psychosis. The personality characteristics of the high P scorers make them predisposed toward creativity. The coexistence of both (a) dominant or independent attitudes and (b) a cognitive style that allows for greater flexibility[29] ensures that high P scorers could be creative if they also possess the necessary motivational traits, cognitive variables, and an environment conducive to creative expression.

H. J. Eysenck's (1993) position can be summarized as follows. If (a) there is a link between psychosis and creativity and (b) psychoticism taps a unitary dimension underlying susceptibility to psychotic illness, then the important personality factor—which acts synergistically with trait creativity (DT) and which may, under favorable environmental conditions, lead to real-life creative achievement—is psychoticism. Researchers have found a correlation between psychoticism and trait creativity (e.g., Aguilar-Alonso, 1996; Merten & Fischer, 1999; Woody & Claridge, 1977) and also between psychoticism and achievement creativity (Gotz & Gotz, 1979a, 1979b; Rushton, 1990). However, researchers have failed to find significant relations between creativity and P (H. J. Eysenck & Furnham, 1993; Kline & Cooper, 1986; Martindale & Dailey, 1996).

H. J. Eysenck (1993) suggested that the common factor or factors underlying the relation between psychoticism and the creative process concern information-processing or attentional-deficit patterns in both creative people and people with psychosis. Close examination of the theories developed to explain the cognitive deficits in people with psychosis (Frith, 1979; Hemsley, 1991) and those relating to the cognitive aspects of creativity (Martindale, 1981, 1999) reveals many similarities. Meehl (1962) suggested that the typical characteristics of schizophrenia and schizotypal disorders are loosening of associations, ambivalence, social withdrawal, and inappropriate affect. These characteristics are highly similar to those of the creative person, who must produce novel ideas, show a tolerance for ambiguity, try to "defy the crowd" (Sternberg & Lubart, 1991, p. 1), and engage in what is often considered strange behavior (Goertzel et al., 1978; Ochse, 1990).

Most of the theorists studying the cognitive deficit in schizophrenia have proposed a deficit in selective attention mechanisms, which results in individuals with schizophrenia who are unable to inhibit irrelevant information from entering consciousness (Frith, 1979; Hemsley, 1991). This active inhibition proposition

(Tipper, 1985) may be contrasted with the passive decay theory of attention (Broadbent, 1958). This indicates that there is an attentional mechanism responsible for inhibiting irrelevant information, the normal variations of which can be used to explain trait creativity.

Many researchers have directly examined the hypothesis that a mechanism of reduced cognitive inhibition during selective attention is responsible for the widening of associative connections. Most of these researchers have used a negative-priming (Tipper, 1985) or latent-inhibition (LI; Lubow & Moore, 1959) paradigm to measure inhibition. Negative priming typically uses a modified version of the Stroop (1935) color-word ink-naming task and refers to the delay in responding to a current target object if the object had been a distracter to be inhibited on a previous display.

Researchers have demonstrated a reduced negative-priming effect in schizophrenic patients, providing evidence of reduced cognitive inhibition in people with schizophrenia (Beech, McManus, Baylis, Tipper, & Agar, 1991; Beech, Powell, McWilliam, & Claridge, 1989). This effect has also been found with the LI paradigm (Baruch, Hemsley, & Gray, 1988a). Wuthrich and Bates (2001) demonstrated that the relation of psychosis proneness to priming and that to LI are similar, suggesting that studies using these different methods can be contrasted.

Bullen and Hemsley (1984), by using a negative-priming word task and the Eysenck Personality Questionnaire (EPQ) as a measure of psychotic tendencies, found a significant negative correlation between P and the magnitude of the inhibitory negative-priming effect. High P scorers showed reduced cognitive inhibition compared to low P scorers. Those researchers did not obtain correlations between the negative-priming task and the other EPQ subscales. In a similar study, Baruch, Hemsley, and Gray (1988b) found that the greater the scores on Eysenck's P, the greater the reduction in LI. In an extension, Lubow, Ingberg-Sachs, Zalstein-Orda, and Gerwitz (1992) demonstrated that effect for both auditory and visual LI paradigms.

Beech, Bayliss, Smithson, and Claridge (1989) studied the effect of chlorpromazine (a drug routinely administered to reduce schizophrenic symptomatology) on negative priming. They found that, although negative priming was observed in both the drug and placebo conditions, the effect was stronger in the drug condition. This indicates that a drug that reduces the symptoms of schizophrenia also increases cognitive inhibition. This finding shows the relation between attentional deficits and the neurotransmitter dopamine, which is related to level of inhibition (Solomon et al., 1981). In the future, this relation would allow researchers to find the genes responsible for the coding of dopamine neurotransmitters, which by proxy would enable a genetic test for some of the cognitive elements of creativity.

Theories developed to explain the creative process have many similarities to the theories about schizophrenia. A number of authors have suggested that the creative process is associative. Mednick (1962) proposed that individuals who

demonstrate low creativity have a small number of strong, stereotyped associative responses to a given stimulus, compared with highly creative individuals. Wallach (1970) suggested that what is important in creativity is the generation of associates and that attention deployment is the process underlying this generation. Kasof (1997) showed that breadth of attention correlated positively with creative performance on a poetry-writing task, thereby demonstrating that part of an individuals' performance on a creativity task can be explained by attentional abilities. Martindale (1981, 1989, 1999) has demonstrated that creative people have a high resting level of activation and that they are oversensitive to stimuli. However, they also have a low level of inhibition, so that the more they are stimulated, the more their level of arousal drops, favoring creative performance. Again, the notions of reduced inhibition and mood fluctuation (arousal levels rising and falling) are common notions in the literature on schizophrenia.

Creative individuals may be able to attend to many aspects of a given stimulus and thus produce more and more varied associations. The similarity between the aforementioned theories and the notion of wide associative horizons that characterize schizophrenic cognition is clear. However, experimenters investigating this avenue of research have continued to repeat the errors of early creativity investigators: These later researchers have made little account of domain specificity, age, or gender during analyses.

A number of researchers have reported results supporting the aforementioned theories. MacKinnon (1962), in his study of architects, found that rated creativity correlated by $r = .50$ with a measure of unusualness of associations on a word-association test. Furthermore, the degree of unusualness of response was greatest with the most creative sample, with lower scores for the median and least creative groups, respectively. Similarly, Gough (1976) reported that the scores on two word-association tests, using a general word list and a scientific word list, correlated with rated creativity in a sample of engineering students and industrial reward scientists. These results have been replicated in other samples (Merten & Fischer, 1999; Miller & Chapman, 1983; Upmanyu, Bhardwaj, & Singh, 1996). Researchers have found comparable results in studies in which individuals with schizophrenia and creatives completed object-sorting tasks, with the creatives performing similarly to the individuals with schizophrenia (Andreasen & Powers, 1975; Dykes & McGhie, 1976).

A few researchers have contrasted the attentional and information-processing strategies of individuals with schizophrenia (and high P scorers) and creative individuals. Rawlings (1985) used the EPQ, two subscales of the Wallach-Kogan (Wallach & Kogan, 1965) DT test, and a dichotic shadowing task (as a measure of cognitive inhibition) with a group of undergraduate students. He found that performance on the shadowing task was positively correlated with DT scores and with psychoticism scores on the divided-attention condition. However, the pattern of results was reversed in the focused-attention condition, and the correlation between psychoticism and DT was not statistically significant.

Stavridou and Furnham (1996) tested a sample of 37 undergraduate participants by using the EPQ, the Wallach-Kogan (Wallach & Kogan, 1965) DT tests, and a negative-priming task as a measure of cognitive inhibition. They found that P was correlated with DT scores. High P scorers exhibited a reduced negative-priming effect when compared with low P scorers. Participants who scored highly on the DT tests showed a smaller negative-priming effect compared with low DT scorers, but this effect failed to reach statistical significance. Recent experimental researchers have indicated that participants rated as superior in creative ability also demonstrate low levels of latent inhibition in comparison with people not rated as creative (Carson, Peterson, & Higgins, 2003; Peterson & Carson, 2000). This evidence supports H. J. Eysenck's (1993) theory of creativity.

With the relation between psychoticism and creativity reasonably well established, we examine the generalizability of H. J. Eysenck's (1993) ideas. Researchers relating the Gigantic 3 to creativity have investigated the relation of Eysenckian personality to (a) DT, (b) ratings and selected occupational groups, and (c) confluence approaches. Woody and Claridge (1977) demonstrated a link between P and trait creativity. They administered to 100 undergraduates the EPQ and slightly modified versions of the five tests that constituted the Wallach-Kogan (Wallach & Kogan, 1965) creativity tests. The tests yielded scores for fluency and originality. Fluency scores for the five tests were all significantly correlated with P, with a range of correlation coefficients between $r = .32$ and $r = .45$. Originality scores were also significantly correlated with P, with a range of correlation coefficients between $r = .61$ and $r = .68$. There were no significant correlations between (a) the scores for the creativity tests and (b) either E or N.

Kline and Cooper (1986), however, published research that "cast doubt on the generality of the link between creativity and P" (p. 183). They wanted to test the supposition that P was more predictive of originality than fluency scores on DT tests (H. J. Eysenck & Eysenck, 1976; Woody & Claridge, 1977). Kline and Cooper gave 173 undergraduates the EPQ and the Comprehensive Ability Battery (CAB; Hakstian & Cattell, 1976). The CAB consisted of several measures of primary ability factors, including some to measure creativity: flexibility of closure, spontaneous flexibility, ideational fluency, word fluency, and originality. The results were surprising.

Only one significant correlation between the CAB and P was revealed: a correlation for male participants ($n = 77$) only on the word fluency measure (Kline & Cooper, 1986). There were no significant correlations between P scores and CAB measures for the female participants ($n = 96$). To explain why the results of this study were incongruent with the findings of Woody and Claridge (1977), Kline and Cooper suggested that, unlike the untimed tests of creativity used by Woody and Claridge, the CAB was timed. Wallach and Kogan's (1965) assertion that timed tests produce less creative responses may be at the heart of these discrepant findings on the nature of P and creativity. Wallach and Kogan also noted that the variance in IQ scores for the Kline and Cooper sample was greater than that of the students in the Woody and Claridge experiment.

Using a battery of creativity tests, Aguilar-Alonso (1996) found that P and E were significant correlates of DT measures of creativity. High P scorers were more verbally creative and flexible than low P scorers. Moreover, extroverts were more original, fluent, and flexible than introverts, but the neuroticism factor was uncorrelated.

Some researchers have examined Eysenckian personality and creativity by using ratings with particular occupational groups. Gotz and Gotz (1973, 1979a, 1979b) studied the personality characteristics of West German artists. Those investigations revealed that in the domain of the visual arts, N as measured by the Maudsley Personality Inventory (MPI; H. J. Eysenck, 1960) and the EPQ (H. J. Eysenck & Eysenck, 1975) is an important variable for researchers to consider. Gotz and Gotz's (1973) study indicated that gifted art students (n = 50) scored higher on N and introversion (I) scales than did 50 less gifted art students. Gotz and Gotz (1979a) studied professional artists and found them to have higher scores on P than did a group of control participants. In a follow-up study, Gotz and Gotz (1979b) compared the personality scores of highly successful professional artists and less successful professional artists. Those researchers found that successful artists scored significantly higher on the P scale than did less successful artists. No differences were found between the two groups on the E, N, or lie (L) scales.

Merten and Fischer (1999) selected creatives on the basis of occupation. Those researchers compared 40 actors and writers with 40 individuals with schizophrenia and 40 control participants. Participants took a word association test requiring common and uncommon responses (Merten, 1993, 1995), two tests of verbal creativity (Schoppe, 1975), and two story-writing tasks, which were used as measures of creativity. The EPQ was used as a measure of personality. Participants were also given a vocabulary test, Raven's (1956) Standard Progressive Matrices, and a measure of basic cognitive functioning (Reitan, 1992). The creatives scored higher on the P scale than did the control group. The creatives also produced the most original word associations of the three groups. The creatives did not produce any response repetitions in the common or unusual response conditions. This was considered an indication of the mental health of the creative group. However, we exercise caution when interpreting the results of this study. The criterion of creativity was not particularly stringent. The creatives group consisted of actors and writers. First, actors and writers may have different approaches to creativity. Therefore, the study may have failed to take domain-specificity into account. Second, there was no measure of the quality of the work of the actors or writers, making it difficult to ascertain whether they should be called *creative*.

In a study of adolescents, Sen and Hagtvet (1993) administered a battery of tests, which included measures of personality (MPI; H. J. Eysenck, 1960), DT (Torrance, 1966), and intelligence (Raven, 1963) and a study of values (Allport, Vernon, & Lindzey, 1960). Sen and Hagtvet also used examination marks as a

measure of academic achievement. Of the personality variables, only E correlated significantly with the composite creativity score ($r = .14$). When the sample was split to compare the scores of high scorers and low scorers on the creativity tests, the high creatives were found to be significantly more extroverted. We interpret these results cautiously because the criterion of creativity was not particularly comprehensive.

Martindale and Dailey (1996) used measures of personality (EPQ and NEO-PI; Costa & McCrae, 1985) and several measures of creativity. Martindale and Dailey failed to find any correlation between the measures of creativity and the P scale. The correlations between NEO openness to experience (O) and creativity scores all failed to reach significance. Significant correlations were demonstrated between the EPQ E scores and the creativity scores at the .05 level. Some marginally significant correlations were observed for the NEO E scores and creativity scores. The design of this investigation was comprehensive: Multiple measures of personality and creativity were used. However, the sample included only 37 participants, making generalization difficult.

Upmanyu et al. (1996) tested male graduate students in India. Upmanyu et al. were interested in testing a finding by Gough (1976) that moderately unusual responses on a word association test were more predictive of creativity than were extremely unusual responses. Gough (1976) did not control for psychic disturbance in his study, and because unusualness of response is a characteristic of schizophrenia, Upmanyu et al. wanted to test the relations between unusualness of response, DT scores, personality variables, and measures of psychic disturbance. Among other measures, they used the EPQ, a word association test (Kent-Rosanoff Word Association Test [K-R WAT]; Kent & Rosanoff, 1910), and figural and verbal DT tests (Torrance, 1966). To assess schizotypical tendencies, they used the MMPI-Psychopathic Deviate subscale (Hathaway & McKinley, 1967). Upmanyu et al. (1996) found that extremely unique word associations were positively associated with verbal creativity. However, atypical or moderately unusual responses were substantially related to verbal creativity. Extremely unique word associations were positively associated with P and psychopathic deviation. The authors suggested that the P scale contributes to creativity, in that it predisposes individuals to social anhedonia, social deviance, unconventionality, and mild antisocial behavior. They concluded that the findings supported the supposition of "a link between psychoticism, mild antisocial behaviour, and lack of conformity/unconventionality rather than the more specific clinical entity of psychopathic behaviour" (p. 527). However, we treat the results of that experiment with caution, because the criterion for creativity was DT test scores.

The relation between H. J. Eysenck's personality factors and creativity appears to be mixed in that no single dimension can be said to be the source of creativity. Most likely, this circumstance is due to domain-specific differences. Extraversion is seen to reliably correlate with performance measures of creativity (e.g., DT tests). However, introversion seems predictive of real-life artistic

endeavor, partly because artists spend much time on their own. Neuroticism appears important for artistic creativity, differentiating gifted artists from less gifted artists. In terms of real-life success (especially for artists), psychoticism appears influential.

The relation between creativity and H. J. Eysenck's psychoticism is not conclusive. The research on the Gigantic 3 suggests that it is not psychoticism alone that characterizes creativity. Instead, the results suggest that all three dimensions of Eysenckian personality contribute to creativity. Extraversion assists in DT performance and in occupations where social interaction is paramount. Conversely, introversion appears important to enable some creators to withdraw from distracting social activities. Similarly, introversion assists in domains where lengthy introspection is paramount, because extroverts are more likely to be distracted (M. W. Eysenck & Graydon, 1989). Neuroticism provides artists with the emotional sensitivity to appreciate and express ideas with emotional content. Last, psychoticism is related not only to attentional deficits that increase the likelihood that ideas and knowledge will combine in overinclusive, interesting ways but also to nonconformity, which assists the creator in defying the crowd (Sternberg & Lubart, 1991, 1992).

Five-Factor Model

During the 1980s and 1990s, popularity began to form around a new conceptualization of personality: the Big 5 or five-factor model (FFM) of personality (NEO; Costa & McCrae, 1985, 1989, 1992b). The FFM hypothesizes that there are five factors of personality: neuroticism (N), extraversion (E), openness to experience (O), agreeableness (A), and conscientiousness (C). Researchers started to examine the creative personality in relation to this new model. By the time this conceptualization of personality had become popular, the field of creativity research had evolved. Confluence studies had become the norm.

FFM and DT

McCrae (1987) found that DT was consistently associated with self-reports and peer ratings of O, but not with E, N, A, or C. However, he noted, "Creative ability does not inevitably lead to recognized creativity, and a variety of personality traits may be involved in being conceived as creative" (p. 1264).[30]

King, Walker, and Broyles (1996) examined the relations between creative ability, creative accomplishments, and an FFM. They gave 75 participants verbal DT tests, asked them to list their creative accomplishments over the previous 2 years, and had them take the 44-item Big Five Inventory (BFI; John, Donahue, & Kentle, 1991). The Pearson correlations indicated that verbal creativity was significantly correlated with E and O. There were significant correlations between creative accomplishments, O, and negative A. A regression

with all five personality factors, using verbal DT scores and then creative accomplishments as the independent variables, revealed a significant prediction for O alone. Martindale and Dailey (1996) failed to find correlations between scores on the O subscale from the NEO-Personality Inventory (NEO-PI) and creativity as measured by DT tests or fantasy story writing. They did find correlations between DT performance and E.

FFM, Ratings, and Selected Occupational Groups

An innovative study by Dollinger and Clancy (1993) required participants to create autobiographical story-essays using 12 photographs (Ziller, 1990). The instructions stated, "Photographs should describe who you are as you see yourself" (Dollinger & Clancy, p. 1066). Participants were also given the NEO-PI. The pictorial autobiographical stories were extensively coded, with a main rating of richness of self-depiction. A multiple regression to predict richness rating revealed that O had a significant beta weight. N and E fell just short of significance. When analyses were conducted to investigate gender differences, the richness of men's essays was predicted by O ($r = .28$), with the only significant facet being aesthetic openness ($r = .42$). These results were replicated for women. However, the O facet of ideas was also a significant correlate. The richness ratings for women were significantly correlated with the N (positive) and I domains.

Gelade (1997) gave the NEO-PI to a group of advertising and design creatives (commercial creatives) and a comparable group of professionals and managers in occupations that were not apparently creative (*noncreatives*).[31] Compared to the noncreatives, the commercial creatives were more neurotic (particularly in terms of angry hostility, depression, self-consciousness, impulsivity, and vulnerability), more extroverted (especially in terms of gregariousness and excitement-seeking), more open to experience (particularly in terms of fantasy, aesthetics, and feelings), and less conscientious (particularly in terms of overall competence, order, self-discipline, and deliberation).

Furnham (1999) administered the Barron-Welsh (Welsh & Barron, 1963) Art Scale and the NEO-PI. Participants provided three self-ratings of creativity (an estimate of the Barron-Welsh score, a rating of how creative they thought they were, and a rating of the frequency of creative hobbies). O was a significant predictor of the participants' estimate of their Barron-Welsh score, the self-rating of how creative they thought they were, and the rating of creative hobbies.

FFM and Confluence Studies

In a study using three measures of creativity, Wolfradt and Pretz (2001) investigated the relation between creativity and personality. The measures of creativity were the Creativity Personality Scale (CPS; Gough, 1979) of the ACL, a story-writing exercise for which the stimulus was a picture, and a list of hobbies.

The story exercise and the list of hobbies were rated by using the Consensual Assessment Technique (Amabile, 1982). They used a German version of the NEO-FFI to assess personality (Borkenau & Ostendorf, 1993). Participants were students from diverse academic fields. The CPS was predicted by high scores on O and E. The best predictor for hobby creativity was O. Creative story writing was predicted by O and by low scores on C. The results were also analyzed by field of study, with pure scientists scoring significantly lower on the three measures of creativity and O than did participants studying psychology or art and design. There were also gender effects, with women scoring higher on story and hobby creativity than did men.

George and Zhou (2001) adopted an interactional approach, investigating the roles of O and C and work environment on creative behavior. They demonstrated that the application of creative potential depends on several factors. They found that rated creative behavior was highest when individuals with high O were set tasks that had unclear demands or unclear means of achieving ends and were given positive feedback. George and Zhou's analyses of the role of C also yielded clear findings. They found that if individuals' supervisors monitored their work closely and their coworkers were unsupportive of creative endeavor, then high C inhibited creative behavior. If the findings of this study are generalized from the workplace to the laboratory, then it may explain why some studies have produced contradictory findings.

It may be that participants in laboratory studies have been influenced by the environment (e.g., experimenter attitude, exam-like conditions) and that these unaccounted-for variables have influenced the expression of creative potential. It may be that Wallach and Kogan (1965) were correct: The conditions of testing can affect creativity.[32] This methodological issue is restricted neither to these two studies nor to the study of the creative personality. The aforementioned research has illustrated that a vast array of creativity tests has been used. Some of those tests are well suited for the understanding of creativity as achievement (e.g., expert ratings of creative achievement or potential, frequency counts of awards and achievements), whereas some of the tests are well suited for the analysis of creativity as a trait (e.g., verbal and figural DT tests). Investigators have rarely used a full assortment of instruments and conclusions that take into account less commonly used measures.

Longitudinal and Meta-Analytical Research

To separate cause and correlation, longitudinal research is necessary. Furthermore, meta-analyses provide a powerful method to examine patterns in results. In an important meta-analysis, Feist (1998) investigated creative personality in the arts and sciences. To analyze the disparate collection of personality data, he converted the data from 83 experiments so that the different personality scores were all in the FFM format and effect sizes were measured by *d* (Cohen,

1988). Subsequent analyses were conducted by investigating three main comparisons: (a) scientists versus nonscientists, (b) creative scientists versus less creative scientists, and (c) artists versus nonartists.

For the scientists versus nonscientists, Feist (1998) analyzed 26 studies. The results indicated that O, E, and C differentiated scientists from nonscientists. He found that the confidence–dominance subcomponent was more important than the sociability subcomponent. With regard to C, "it is clear that relative to nonscientists, scientists are roughly half a standard deviation higher on conscientiousness and controlling of impulses" (Feist, 1998, p. 294). For creative scientists versus less creative scientists, 28 studies were meta-analyzed. The traits that most strongly distinguished the creative scientists from less creative scientists were E and O. Similar to the results from the comparison of scientists versus nonscientists, the confidence–dominance subcomponent of E contributed to the effect size, with no effect derived from the sociability subcomponent. A moderate effect size was noted for the direct expression of needs and psychopathic deviance subcomponents of C. For the artists versus nonartists samples, 29 studies were scrutinized. The traits that most clearly differentiated artists from nonartists were C and O, where artists were roughly half a standard deviation lower on C and half a standard deviation higher on O.

Feist (1999) summarized research on the influence of personality on creative achievement in the arts and in science. He found that some personality variables occurred in both groups. He found creative scientists and artists to be open to new experiences, less conventional and conscientious, and more self-confident, self-accepting, driven, ambitious, dominant–hostile, and impulsive. Artists were more affective, more emotionally unstable, less socialized, and less accepting of group norms than scientists. Scientists were more conscientious than artists. These findings suggest why it is has proven difficult to produce a comprehensive list of the personality characteristics of creative people.

Soldz and Vaillant (1999) reported the results of a 45-year study of 163 men. The researchers regularly assessed participants to measure factors as diverse as health, career functioning, social relations, mental health, political attitudes, childhood characteristics, and creative achievement. Participants were given the NEO-PI at a mean age of 67 years. NEO scores were then calculated for the men at the end of their college careers. The results of the study confirmed that O was significantly positively related to the ratings of creativity. O also demonstrated a significant relation to psychiatric therapy and depression. We advise caution in the interpretation of these results because the personality scores for the college years were estimated, and the participants were men only.

Feist and Barron (2003) reported the results of a 55-year longitudinal study. The sample consisted of 80 male graduates from 14 academic departments. Data were collected for the participants at age 27 years in 1950 and at age 72 years in 1995. The nature of the longitudinal data collation procedures meant that complete sets of data for all of the different measures were unavailable. The primary

interest of the study was to report on the prediction of creativity from early to late adulthood by using measures of intellect, potential, and personality. At age 27 years, intellect was measured by observer rating and measures from Thurstone's (1938) Primary Mental Abilities test. Observer ratings of potential were taken from at least nine raters, and the participants provided a self-rating. Observer ratings of personality were taken by using early versions of the ACL and trait ratings of the following characteristics: role flexibility, dominance, poise and balance, ingenuity, positive character integration, and deceitfulness and vitality. Participants also completed parts of the CPI (tolerance and capacity for status). Nine other CPI scales were retroactively prorated in 1953. The researchers administered the MMPI and took self-ratings of personality by using the ACL.

Data of 72-year-old participants were collected for creative achievement and personality. Creativity data were drawn from the book series *American Men and Women of Science* or from the participants' curriculum vitae (Feist & Barron, 2003). To allow comparisons across academic disciplines, awards and achievements for the sample were sent to full professors (n = 95) at major research universities. The professors rated the magnitude of achievement on a 10-point scale. Feist and Barron took the mean value for the most prestigious honor that the participant received and the total number of fellowships, honors, and awards that the participant received, z-scored them, and summed them. This process produced the Awards score. Personality measures were also taken at age 72 years. These were the CPI, the MMPI-2 (Hathaway & McKinley, 1989), and the ACL.

Observer-rated intellect at 27 years was related to originality at 27 years and also to lifetime creativity at 72 years (Feist & Barron, 2003). Tested intelligence was not so predictive, with only the spatial element demonstrating a significant correlation with creativity, in this case with creativity at 27 years. The measures of potential at 27 years strongly covaried with originality at 27 years and were moderately predictive of lifetime creative achievement. Hierarchical regression analyses revealed that, once intellect and potential had been accounted for and held constant, personality was able to add predictive power. At 27 years, personality variables predicted an additional 8% of the variance in concurrent creativity over that contributed by intellect and potential. At 27 years, measures of personality predicted an additional 20% of the variance in lifetime creative achievement over that contributed by intellect and potential.

Conclusion Regarding Personality

Woodman and Schoenfeldt (1989) have pointed out that studies of the personality characteristics associated with creativity have waxed and waned in popularity. Sternberg and Lubart (1999) suggested that this is because concentration has begun to focus on confluence approaches. Attempts have been made to delineate the core characteristics of the creative personality. Yet, despite the convergence of results, it has proven difficult to generalize the findings across

various fields of creative endeavor. The emergence of the FFM as an accepted classificatory system with cross-culturally validated measures does, however, mean that over the past few years the scattered studies have begun to grow into a more cohesive and consistent body of work. This accounts for only one side of the relation, because the same is not yet true for measures of creativity. Still, the continued adoption of the FFM as a widely accepted personality framework suggests that future studies of the creative personality should shed considerable light on the construct.

It is difficult to provide a parsimonious summary of the relations between creativity and personality. Different personality measures have been used alongside various conceptualizations of creativity. Therefore, we first examine the evidence for creativity as DT and then examine that for creativity as a product to shed light on the underlying processes that lead to creativity with regard to these criteria.

When the criterion of creativity used is a DT test,[33] the results tend to suggest that E is a consistent and significant correlate (e.g., Aguilar-Alonso, 1996; King et al., 1996; Sen & Hagtvet, 1993; Wuthrich & Bates, 2001). This finding is true whether the instrument is from the Gigantic 3 or the Big 5 (Martindale & Dailey, 1996). This persistence suggests that E confers an advantage in DT tests. Possible explanations for this are that DT tests are often administered in group settings, which are more conducive for an extrovert. Second, extroverts may perform better at DT tests because they seek stimulation (H. J. Eysenck & Eysenck, 1985) and an opportunity to take risks. The DT test environment provides an opportunity to do that. Effectively, the finding that E is related to trait creativity suggests that the neurobiology of extroverts predisposes them to active participation in the DT test process.

Some investigators have demonstrated relations between DT and the P scale of the EPQ (Aguilar-Alonso, 1996; Merten & Fischer, 1999; Woody & Claridge, 1977), but others have not noted such a correlation (Kline & Cooper, 1986; Martindale & Dailey, 1996; Rawlings, 1985). Researchers who have examined DT and the Big 5 have found evidence for the role of O (King et al., 1996; McCrae, 1987; Wuthrich & Bates, 2001). The data also suggest that the strength of correlation between P and O is increased when the measure of DT involves some measure of originality, rather than fluency alone (e.g., King et al.; Woody & Claridge).

Recent research indicates that the findings of the relations of P and O to various measures of creativity are mediated by the same or similar attentional processes. P has been consistently related to reduced cognitive inhibition (Baruch et al., 1988b; Bullen & Hemsley, 1984; Lubow et al., 1992), and new research indicates that O is also related to reduced cognitive inhibition (Peterson & Carson, 2000; Peterson, Smith, & Carson, 2002).

With regard to P, this circumstance indicates that part of why high P scorers perform well in DT tests (especially when assessed for originality) is that they

have defective filters for irrelevant stimuli (although impulsive nonconformity is also implicated). Therefore, more ideas enter consciousness and are thereby more likely to be combined in interesting ways to form creative ideas, in accordance with Mednick (1962) and Koestler (1964). The same may be postulated for O.

However, finding a link between O and attentional mechanisms raises serious questions about the relation of O to creativity. We postulate that O consists of two subfactors: one factor representing an *attitudinal openness* to new experiences and the second factor being, rather than a choice, an inability to inhibit irrelevant information, a *perceptual openness*. This suggests that to a certain extent, open people are more open to new ideas because they cannot effectively filter out irrelevant information.

Perhaps the greatest limiting factor in assessing the relative importance and influence of different personality variables on creativity has been the failure to consider the domain of endeavor (or the nature of the products being rated). There are three separate issues here. The first concerns the difficulty of producing categories of domains (e.g., art vs. science). Rarely are occupations solely focused on one domain (e.g., What domain does a scientist running a research program inhabit?). The second issue concerns the idea of domain specificity itself. Within one domain there may be several levels. For example, within the domain of the arts, is it sensible to consider an abstract sculptor the same as a poet or choreographer? The third issue concerns the allocation of students to specific domains when they have yet to start a profession. When assessing an adolescent or child who has yet to achieve, how is it possible to ascertain which categorical distinction to use?[34] A further issue may be that, although creativity is not a domain-transcending phenomenon, psychologists have sought a general model for creativity because large, all-encompassing models prove more satisfying (Baer, 1998).

When the criterion of creativity has been expert ratings of a product (e.g., story writing or quality of work), the relation between personality traits and creativity is less clear than when the criterion has been DT tests. Some studies have found creatives to score higher on the N scale, EPQ (Gotz & Gotz, 1973), and NEO (Dollinger & Clancy, 1993). The P scale of the EPQ has been shown to differentiate between successful and less successful artists (Gotz & Gotz, 1979b). Although the P scale of the Gigantic 3 has been a relatively consistent strong correlate in studies of creativity, doubt remains about whether this circumstance is because the scale assesses predisposition to disordered thought enabling ease of association, predisposition to social dominance and anhedonia, or both.

Equally unclear findings have come from studies that have used the NEO in conjunction with creativity measures that use ratings where the quality of rated products or work has been predicted by O (Dollinger & Clancy, 1993; Furnham, 1999; Soldz & Vaillant, 1999; Wolfradt & Pretz, 2001). A potential explanation of why O is implicated in rated products but not DT tests (especially when the DT tests are scored for fluency) exists: The products of DT tests are rarely

qualitatively judged. It is most common to take measures of fluency (number of responses). Because there is no judgment of quality in that measure, an individual high in O will not be discernible from an individual who is not. Rather, the test will select an individual with high ideational fluency, which is largely an aspect of intellect. For that reason, E is usually more predictive.

When the quality or ingenuity of a product is rated (and to a lesser extent when DT tests are scored for originality), qualitative judgments are performed regarding the novelty or utility of the product. In this scenario, a preference for the exploration of new ideas and for surprising behaviors (as measured by O) will be rated favorably by judges, leading to an attribution of the label *creative*. However, the relation between O and rated creativity may have more to do with reduced cognitive inhibition than with open-mindedness. If creativity involves associational processes (e.g., Mednick, 1962), then reduced cognitive inhibition would increase the chances that ideas are combined in interesting and novel ways to therefore be regarded as creative.[35]

Across all types of personality tests, E seems to be predictive of creativity. However, in the role of P and O, there appear to be subfactors at work; in the case of P (antisocial traits and reduced cognitive inhibition) and O (open-minded and reduced cognitive inhibition), the subfactors of E may be independently predictive. It may be that the sociability component of E has differential effects on creative performance from the neurobiological perspective. Essentially, sociable extroverts may engage in corroborative work and be more ready to share their ideas and work (McCrae, 1987), but the impulsive, risk-taking aspects of E may equally make extroverts more creative.

Last, the role of N indicates the importance of considering the domain of endeavor. N is probably inhibitive of creativity in science but essential for artistic achievement (Feist, 1998; Gotz & Gotz, 1979b). This provides another clue to some of the underlying processes of creative production. If N relates to heightened sensitivity to emotional stimuli (Watson & Clark, 1984) and art largely relates to the expression of emotions, then individuals with heightened sensitivity are more likely (if they have adequate training and skill) to both notice and communicate those emotional ideas in a work of art, which, in turn, will be rated as creative. Emotional stability may prove a desirable trait for scientists, first because dispassionate inquiry is encouraged, and second because many aspects of science (academia, in particular) involve constant criticism in the form of peer review.

Therefore, it seems certain that particular personality traits are important for explaining and predicting creativity. This circumstance may account for one quarter to one third of the variance in the causes of creative work. However, most personality researchers have assumed that underlying personality traits are domain general. This approach has resulted in mixed evidence concerning which personality traits are important in which circumstances. As we suggested earlier in this article, possessing certain traits, such as O or tough-mindedness (P), is probably necessary but insufficient for creativity as achievement. To ensure that

a person fulfills his or her potential, other requisite cognitive and situational variables need to be present, and they must fit the domain in which the ideas are to be produced and judged. DT is not a sufficient condition for creativity as achievement (see Table 2), and different personality traits have been found to relate to creativity dependent on the domain of the endeavor (see Tables 3–5).

Discussion

Despite researchers' efforts to understand creativity first in terms of IQ and then in terms of personality variables, a full understanding of creativity remains a complex, but hopefully not elusive, goal. In part, the difficulty has arisen not only because of the historical background of the construct but also because of difficulties of measurement. However, growing consensus with regard to definitions of creativity, the movement away from the use of DT tests as absolute criteria of creativity, and the tendency of researchers to consider the domain of endeavor and also to use multitrait, multimethod research all point toward a positive future for creativity research.

The most troubling aspects for modern researchers concern difficulty with definitions or conceptualizations of the key components. The definitions of creativity, intelligence, and personality are not immutable, nor are they universally accepted. With regard to the concept of creativity, authors have tried to impose qualifications, but without the support of the field, such recommendations matter little. In addition to definitional problems, the concept of creativity has been applied to people, products, processes, and situations. It would not be far from the truth to suggest that creativity researchers use their own idiosyncratic definition and methodologies. Whereas this makes the students of creativity relatively creative (because they produce work that is novel and potentially useful), it has been difficult for researchers to advance the field via the synthesis of different research efforts. Indeed, there may be a vicious circle in operation so that lack of progress inhibits both funding opportunities and development of core research groups, which, in turn, limits advancement.

Early researchers were concerned primarily with the relation of intelligence to creative accomplishments and sought to ascertain at what level of IQ a genius should emerge. They were sorely disappointed. IQ was found to be a necessary but insufficient factor for the development of creativity as lifetime achievement. Intellect seemed to account for only a portion of the variance, although differences were found to be dependent on the domain of endeavor. Following the advent of the DT test, research in creativity became popular. However, it was not long before the DT test was confused with creativity itself. This confusion encumbered the development of the field and forced far too narrow a conception of what creativity entails. The work of the IPAR group expanded on some of the earlier, narrow DT-as-creativity research by replacing DT tests as a criterion of creativity with ecologically valid ratings of creative potential and achievement.

TABLE 2. Creativity and the California Personality Inventory (CPI)

Researcher	Sample	Personality measure	Criterion of creativity	Key findings
D. W. MacKinnon (1965)	Architects	CPI	Ratings	In comparison with normal architects, creative architects were: (a) more aggressive, dominant, and autonomous; (b) less deferent and team-oriented; and (c) less socialized.
G. Domino (1974)	Cinematographers	CPI	Occupation	In comparison with matched controls, cinematographers were: (a) more concerned with status, achievement, and change; (b) more self-accepting; and (c) less deferent and less concerned with order.

The meta-analytical work of Carroll (1993) shed considerable light on a scattered field of research, establishing that there are effectively two main types of creativity: fluency (numerate production of ideas) and originality (novel and unusual responses that fulfill given criteria).

Researchers of the creative personality have tried to ascertain which personality variables predicted creative achievement or to chart the personality characteristics of eminent creators. Later, adherents to the FFM have tried to do the same. It appears that across the different personality and creativity measures used, the most common personality traits related to creativity are confidence or dominance traits, autonomy or independence traits, and openness to new ideas and experiences. Meta-analytical reviews have indicated that certain personality traits are more important for certain domains. To fully account for personality variables in creativity, we suggest that future researchers consider not only the domain of work but also the criterion of creativity used.

The failure to agree on definitions, operationalizations, criteria, and measures of intelligence and personality has left the field of creativity research in a relatively confused state. Often, researchers talk of creativity without regard to the eminence of the sample involved or the validity of the measure of creativity. Sometimes they combine diffuse criteria without explanation. Therefore, equivocal conclusions based on less than secure foundations must be deemed tentative.

Essentially, Carroll's (1993) analysis enables conclusions to be drawn, in accordance with a perspective that views creativity as both fluency and originality, with intellectual factors more closely allied with the first, and with personality processes more closely related to the second. Effectively, we argue that creativity as numerate production of ideas is related to intelligence (but also E). Here, the production of a host of ideas is largely based on *gf*, itself presumably a corollary of efficient neural pathways (H. J. Eysenck & Barrett, 1985; Jensen, 1993), and *gc*, from which ideas are drawn. However, creativity as originality rests largely on personality factors (predominantly O and P), which, through their relation to attentional processes, allow individuals who score highly on these tests to combine ideas in novel and interesting ways, using information that would be considered irrelevant by noncreative individuals. These traits may be viewed as fundamental to the creative individual. The relation of the other personality traits (e.g., N, E, A, and C) to O and P is important for creativity as well, but largely insofar as those traits help an individual to fit a specific domain of endeavor (see Table 6). For example, the creative salesperson most likely needs to be extroverted, the artist most likely needs to be somewhat neurotic, and the scientist most likely needs to be conscientious. Further, although it may be possible to describe the profile of the creative individual in terms of personality and intelligence, these factors rarely account for the motivation to perform creative acts that lead to the development of creative products. As Nicholls (1972) suggested, "If research evidence on eminent creators is taken as a guide, there is more justification for calling the tendency to become intrinsically involved in tasks creativity than there is for labelling divergent thinking creativity" (p. 723).

TABLE 3. Creativity and the Gigantic 3

Researcher(s)	Sample	Personality measure(s)	Criterion of creativity	Key findings
K. O. Gotz & K. Gotz (1973)	Gifted art students	MPI	Ratings	In comparison with less gifted art students, gifted art students scored: (a) higher on the neuroticism (N) scale and (b) lower on the extraversion (E) scale (i.e., introverted).
K. O. Gotz & K. Gotz (1979a)	Professional artists	EPQ	Occupation	In comparison with controls, professional artists scored higher on the psychoticism (P) scale.
K. O Gotz & K. Gotz (1979b)	Professional artists	EPQ	Ratings	In comparison with less successful professional artists, successful professional artists scored higher on the P scale.
E. Woody & G. Claridge (1977)	Undergraduate students	EPQ	Divergent thinking (DT) tests	Fluency correlated with P. Originality correlated with P.
P. Kline & C. Cooper (1986)	Undergraduate students	EPQ	Comprehensive Ability Battery (contained DT-like tests)	No *r* found between P and (a) flexibility of closure, (b) spontaneous flexibility, (c) ideational fluency, or (d) originality. *r* found between word fluency and P (males only).

H. J. Eysenck & A. Furnham (1993)	Undergraduate students	EPQ	Barron-Welsh Art Scale (BW)	No significant *r* between P and BW total score
A. K. Sen & K. A. Hagtvet (1993)	Adolescents	MPI	DT test	*r* found between composite creativity score and E.
A. Aguilar-Alonso (1996)	Mixed adult volunteers	EPQ	DT-like tests	*r* found between creativity scores and E and P.
C. Martindale & A. Dailey (1996)	Undergraduate students	EPQ	DT tests Fantasy story Remoteness of association	*r* found between creativity measures and E.
T. Merten & I. Fischer (1999)	(a) Actors and writers (b) Unselected participants (c) Schizophrenics	EPQ	DT tests	Creatives scored higher on P scale against controls.

Note. MPI = Maudsley Personality Inventory (H. J. Eysneck, 1960). EPQ = Eyseneck Personality Questionnaire (H. J. Eysenck & S. B. G. Eysenck, 1975).

TABLE 4. Creativity and the Five-Factor Model (P. T. Costa & R. R. McCrae, 1985)

Researcher(s)	Sample	Personality measures used	Criterion of creativity	Key findings
R. R. McCrae (1987)	Adult male volunteers	NEO Personality Inventory (NEO-PI)	DT	DT correlated with self-reported and rated openness to experience (O).
S. J. Dollinger & S. M. Clancy (1993)	College students	NEO-PI	Autobiographical Photographic essays scored for richness	O predicted *richness of self-depiction.* (a) Males—O (b) Females—O, high neuroticism (N) and low extraversion (E)
L. King et al. (1996)	Undergraduate students	Big Five Inventory (BFI)	Self-reported creative accomplishments	Verbal creativity correlated with E and O. Creative accomplishments correlated with O and low agreeableness (A).
C. Martindale & A. Dailey (1996)	Undergraduate students	NEO-PI	DT Fantasy story Remoteness of association	There was correlation between DT scores and E.
G. Gelade (1997)	Advertising and design *creatives* Matched controls	NEO-PI	Occupation	In comparison with controls, advertising and design *creatives* scored: (a) high on N, (b) high on E, (c) high on O, and (d) low on conscientiousness (C).

A. Furnham (1999)	Undergraduate students	NEO-PI	Barron-Welsh Art Scale (BW) Self-rated estimated BW score Self-rating of personal creativity Self-rating of creative hobbies	Openness predicted Self-rating of estimated BW score
U. Wolfradt & P. Pretz (2001)	Undergraduate students	German version of NEO	Creative Personality Scale (CPS) for the Adjective Check List (ACL) Story writing List of hobbies	CPS predicted by high O and E Scientists scored lower on the 3 measures of creativity and on O than students studying art and design or psychology. Story creativity predicted by high O and low C Hobby creativity predicted by high O
V. Wuthrich & T. C. Bates (2001)	Mixed adult and undergraduate students	NEO Personality Inventory-Revised	DT	DT correlated with high N, E, and O

Note. DT = Guilford divergent thinking tests.

TABLE 5. Creativity and Meta-Analytical and Longitudinal Research

Researcher(s)	Sample	Personality measure(s) used	Criterion of creativity	Key findings
G. J. Feist (1998)	Meta-analysis: (a) scientists vs. nonscientists (b) creative vs. less creative scientists (c) artists vs. nonartists	Converted to Five-Factor Model format		(a) High on openness (O), extraversion (E), and conscientiousness (C) (b) High O and E (c) High O and low C
S. Soldz & G. E. Valliant (1999)	Longitudinal study of males	Estimated NE college scores NEO scores at age 67	Ratings	Creative accomplishment predicted by high O

TABLE 6. Representation of Typical Profiles for Creativity in Different Domains

Trait	Artistic creativity	Scientific creativity	Everyday creativity
Intelligence			
Fluid	+	+ + +	+
Crystallized	+ +	+ + +	+
Personality			
N	+ + +	– –	–
E	– –	–	+ +
O	+ + +	+ + +	+ +
A	– –	–	+
C	– –	+ + +	+
P	+ + +	+ +	+

Note. N = neuroticism; E = extraversion; O = openness to experience; A = agreeableness; C = conscientiousness; P = psychoticism. Positive and negative signs indicate the strength and direction between the variables and range from – – – to + + +.

The areas of confluence models, meta-analytical studies, and longitudinal studies hold the key to discovering more about the creativity complex with regard to domains. It is necessary for researchers to examine how personality and intelligence relate to both other individual difference factors (i.e., psychopathology or motivation) and crucially situational factors.

Creativity is an important resource for both individuals and society as a whole, so thorough study should be paramount. At the applied level, how can creative people be identified, recruited, and developed? A great deal of real-world research, similar to the studies of the IPAR group, is required to augment and confirm the aforementioned academic studies.

We make a number of recommendations to help future researchers conduct more fruitful investigations. In general, we suggest these recommendations to ensure that the fragmented field of creativity research can be more easily synthesized. The definition of creativity that researchers use in a study should be clearly presented. Following the stating of definition, the assessment of creativity should relate to that definition. Hence, if researchers have taken the perspective that creativity is the production of socially valuable products that possess the characteristics of novelty and utility, then they should operationalize creativity in terms of ratings of a creative product.

The field requires classification. There have been recent important efforts to taxonomize creative products (Sternberg et al., 2002). The same is required for perspectives regarding the creative person, process, and environment. In particular, the field would benefit from a comprehensive taxonomization that incorporates the four Ps (Rhodes, 1961/1987). With such a taxonomy as a reference

point, researchers could synthesize studies with reference to that model. From definitional consensus, psychometrically robust measures of creativity could be developed. Clearly, the field requires a battery of tests similar to those offered in the field of intelligence. Thus, researchers may need tests of verbal, spatial, and numerical creativity and have fluid creativity versus crystallized creativity. This circumstance is important.

Even within the relatively extensively examined field of DT, different tests of DT are used, with researchers often assuming that they are measuring the same construct. Further research is required to investigate the relations of different criteria of creativity. For example, Carroll (1993) found that tests of creativity could be parsed into measures that assess fluency aspects and originality. At a broader level, Clapham (2004) found that measures of DT bore little relation to measures of creative interest inventories. She also replicated a finding by Carroll that there is little relation between verbal and figural DT abilities. These findings indicate that greater research efforts are required to examine interrelations between putative measures of creativity.

Creativity cannot be assessed by a single measurement, and most authors agree that creativity relies on the confluence of several factors (e.g., intellect, personality, thinking style, environment). Therefore, studies of creativity should take a multiple-components perspective and examine the relative importance of the different constituents. At the outset, we suggest that researchers try to assess creativity in relation to each of the four elements identified by Rhodes (1961/1987). Thus, a study of creativity in children could incorporate measures of intellect and personality (person), DT (process), and the classroom environment or teaching style in addition to a rating of the artifacts created by the children (product). Whereas this gold-standard approach may not be possible in many cases, researchers should acknowledge that these different areas should normally be considered in creativity studies. However, we recognize that this suggestion that multiple measures of the creativity construct be used should follow research examining the convergent and discriminant validity of different measures of creativity, as we suggested in the previous paragraph.

Researchers should consider the role of demographic and cultural differences in trying to generalize across studies. Questions still abound with regard to the nature of creativity in men and women, in younger and older individuals, and in different cultures. The study of intellect and personality with respect to demographic and cultural differences has been undertaken, often with controversial results. However, systematic studies of creativity in this light have yet to be initiated.

Future researchers should consider whether the creativity to be observed is that of eminent achievers or everyday individuals. There have been influential efforts to indicate that creativity may be studied throughout the spectrum from eminent to everyday (Richards, 1993). When products or achievements are to be rated, the experts chosen should be listed. When possible, the criteria of creativity should be related to real-world achievement to provide ecological validity.[36]

Ideally, the investigation of creativity should be multidisciplinary. Exciting contributions can be made through imaging studies (e.g., Folley & Park, 2005; Jausovec, 2000) on the neurobiological end of the psychological spectrum. Exciting inputs can be taken from educational, industrial, and organizational psychologists' studies on the applied end. We also suggest that attempts be made to triangulate the data from historiometric, psychometric, longitudinal, meta-analytical, and experimental studies.

The domain should be clearly specified. When possible, intradomain analyses should compare the scores of highly creative participants with those of less creative participants. Interdomain analyses will enable researchers to observe differences in creativity. This circumstance presents perhaps the most difficult issue to address adequately. At present, creative achievement appears to have been studied in the general bounds of the arts, science, and leadership. Future researchers may consider the extent to which these domains can be further subdivided and classified. We make this recommendation because without a heuristic to follow with regard to understanding the structure of domains, it will remain difficult for researchers to examine creativity in those domains.

Last, more longitudinal studies of the predictors of creative achievement are necessary. The vast bulk of creativity studies have correlational designs. Although this methodology is understandable because of the difficulties of longitudinal research, additional longitudinal studies will yield a greater understanding of the causal influence of intellectual and personality variables on creative achievement.

It would be foolhardy to assert that if future researchers implement these recommendations fully throughout the field of creativity, then the methodological and conceptual problems that plague the field will disappear. However, we assert strongly that if future researchers do not appreciate the complexity of creativity research, they will retrace some of their predecessors' faltering steps.

NOTES

1. This is a predominantly European perspective.

2. There has been interesting research on other personality constructs in relation to creativity (e.g., on need for achievement [McClelland, Atkinson, Clark, & Lowell, 1953]; on intrinsic motivation [Amabile, 1996]; and on need for cognition [Cacioppo & Petty, 1982]). To seek parsimony, we focus on the dominant models of personality psychology: the Eysenckian Psychoticism, Extraversion, and Neuroticism and five factor models.

3. There is a rich history of psychoanalytical research in creativity (e.g., Freud, 1908/1959) for which there is neither time nor space in this review to explore.

4. Amabile (1996) suggested a socially anchored definition of creativity: "Creativity can be regarded as the quality of products or responses judged to be creative by appropriate observers, and it can also be regarded as the process by which something so judged is produced" (p. 33). This definition acknowledges the importance of social evaluation. A product must be appraised with regard to originality and utility to be ascribed the status of creative. However, the definition does not escape the difficulty in accurately pinning down the elusive creativity construct. Who decides who makes an appropriate observer? History is full of accounts of

forgotten and neglected creative contributions, enough to suggest that seemingly appropriate observers may not always be able to recognize creativity.

5. The contention that a culture must agree that a product is creative has two serious implications for creativity research. First, individuals not recognized in their own lifetime (if at all) could not be deemed creative. Second, the vast majority of individuals (e.g., children) could not be studied, because they would fail to have achieved culturally accepted eminence. Thus, the extent to which a society values creativity is important. In many authoritarian states, artistic creativity has been censured and discouraged.

6. However, if the purpose of art is to evoke emotion, then those works that are deemed as most creative may be those that invoke the greatest affective response.

7. We note that in within-groups analysis, the most creative scientists were less conscientious.

8. William Shockley invented the transistor radio and Luis Alvarez made important contributions to the understanding of particle physics (Nobel Foundation, 2007).

9. DT tests are primarily measures of ideational fluency. In normal samples, the rapid production of ideas may differentiate between those considered creative and those rated as uncreative. In eminent samples, fluency alone is not sufficient for a participant to be considered creative.

10. A caveat to this supposition would involve an examination of the IQs of the groups studied. The student and occupational samples would have been more likely to possess IQ scores in the median range than would the creative architects and scientists. Thus, this finding refers to the threshold theory of creativity and intelligence.

11. Productivity is considered originality and fluency.

12. These included performance and verbal subsets of the Wechsler Intelligence Scale for Children and the School and College Ability Test (Wechsler, 1974).

13. For a thorough review of the relation between DT tests and intelligence, see Barron and Harrington (1981).

14. The IPAR procedure was exhaustive and required that the participants live and work with the raters for several days at a time. However, this procedure may have been a source of bias.

15. There have been important contributions to creativity research made by biographical and historiometric investigators. However, a detailed consideration of this research lies outside the means of this review.

16. Once a certain level of intellectual competence has been attained, there is little or no relation between IQ and creativity.

17. This is similar to Cattell's (1971) conception of fluid intelligence.

18. Creativity is considered a result of normal cognitive processes. However, studies of Einstein's brain have indicated that he may have possessed extraordinary brain architecture (Witelson, Kigar, & Harvey, 1999). The continuing marriage of neuroscientific techniques and traditional creativity research methodologies (Jausovec, 2000) may yet prove that in some cases of creativity, there are differences in style as well as level.

19. Jensen (1998) suggested that $gf = g$.

20. The Terman (1973) Concept Mastery Test is a measure that includes word knowledge, general information, and reasoning ability items. As such, it is predominantly a verbal intelligence test.

21. We note that test-taking strategy may have had a significant effect on these scores, because incorrect answers incurred a penalty.

22. The number of citations did not include self-citations from either independent studies or studies whose referent was the first author.

23. Neither the number of works published nor research effectiveness conforms to

the new-and-useful definition of creativity. It seems to be more of a measure of productivity than one of creativity.

24. We argue that these measures do not constitute an accurate assessment of leadership performance or potential.

25. A growing body of evidence supports the relation between creativity and psychopathology (cf. special issue of the *Creativity Research Journal,* 13:1). It is outside the capacity of this review to present that evidence here.

26. H. J. Eysenck's P scale (EPQ: P, H. J. Eysenck & Eysenck, 1975; EPQ: P-R, S. B. G. Eysenck et al., 1985) was envisioned as a general personality trait that determines proneness to psychosis. However, studies have showen that high P scorers do not experience higher rates of psychosis (J. P. Chapman, Chapman, & Kwapil, 1994) and that the scores of individuals with schizophrenia cannot be differentiated from those of university art students (S. B. G. Eysenck et al.). Modern conceptions of the personality traits underlying psychopathology take a dimensional approach (Mason, Claridge, & Jackson, 1995). The P scale is found to generally correspond to an asocial or impulsive nonconformity dimension (Bentall, Claridge, & Slade, 1989; L. J. Chapman, Chapman, & Miller, 1982; Green & Williams, 1999), rather than to a representative measure of proneness to psychopathology.

27. The distinction between schizophrenic and bipolar psychopathologies may be artificial.

28. *Schizotypy* is the one of the terms preferred for describing proneness to psychosis (Claridge, 1997).

29. Effectively, H. J. Eysenck presented a two-level theory. The superfactor P is hypothesized as containing two subordinate-level factors: (a) confidence or dominance and (b) disordered thinking. Both of these factors are postulated to contribute to trait creativity and relate to the dimensional view of schizotypy.

30. McCrae's (1987) interactional account of personality variables and creativity is highly useful but does not take into account whether domain specificity influences the ways in which creativity is expressed.

31. The criticisms of Merten and Fischer's (1999) study also apply here.

32. However, Hattie (1977) suggested that the conditions of testing do not affect the expression of creativity.

33. DT tests are referred to here as if they were comparable. In practice, DT tests can differ greatly (e.g., figural vs. verbal).

34. Individual precocity in mathematics during childhood may indicate that such an individual be considered a scientist, but the same individual may ultimately either make a creative contribution to the arts or, more likely, make none at all. Yet, were psychologists to study this individual, they would undoubtedly consider him or her an example of a mathematical creator. It is clear that the study of creativity in children cannot be truly valid without reference to adult achievement.

35. However, in part, the explorative open-minded approach of high O scorers predisposes them to see a DT test as the perfect opportunity to explore an idea or a proposition. This, in turn, has an effect on fluency scores and therefore a greater chance of statistical infrequency of response.

36. The criteria used depend on the sample studied. For example, it is unhelpful to examine professional awards data in assessing the creativity of preschool children.

AUTHOR NOTES

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APPENDIX
Selected Definitions of Creativity

Author(s)	Definition
	New and useful
M. A. Boden	"Creativity is the ability to come up with ideas or artefacts that are new, surprising, and valuable. 'Ideas' here include concepts, poems, musical compositions, scientific theories, cookery recipes, choreography, jokes—and so on. 'Artefacts' include paintings, sculptures, steam engines, vacuum cleaners, pottery, origami, penny whistles—and many other things you can name" (2004, p. 1).
M. D. Mumford	"Over the course of the last decade, however, we seem to have reached a general agreement that creativity involves the production of novel, useful products" (2003a, p. 110).
R. J. Sternberg and T. I. Lubart	"Creativity is the ability to produce work that is both novel (i.e., original, unexpected) and appropriate (i.e., useful, adaptive concerning task constraints)" (1999, p. 3).
D. K. Simonton	"Psychologists have reached the conclusion that creativity must entail the following two separate components. First a creative idea or product must be original. . . . However, to provide a meaningful criterion, originality must be defined with respect to a particular sociocultural group. What may be original with respect to one culture may be old news to the members of some other culture. . . . Second, the original idea or product must prove adaptive in some sense. The exact nature of this criterion depends on the type of creativity being displayed" (1999, pp. 5–6).
G. J. Feist	"Creative thought or behaviour must be both novel-original and useful-adaptive" (1998, p. 290).
M. Csikszentmihalyi	"Creativity is any act, idea, or product that changes an existing domain, or that transforms an existing domain into a new one. . . . What counts is whether the novelty he or she produces is accepted for inclusion in the domain" (1996, p. 28).
R. Ochse	"Creativity involves bringing something into being that is original (new, unusual, novel, unexpected) and also valuable (useful, good, adaptive, appropriate)" (1990, p. 2).
F. X. Barron	"If a response is to be called original, it must be to some extent adaptive to reality" (1955, p. 553).

(appendix continues)

APPENDIX (continued)

Author(s)	Definition
	Product oriented
T. M. Amabile	"Creativity can be regarded as the quality of products or responses judged to be creative by appropriate observers, and it can also be regarded as the process by which something so judged is produced" (1983, p. 31).
C. R. Rogers	"There must be something observable, some product of creation. Though my fantasies may be extremely novel, they cannot be usefully defined as creative unless they eventuate in some observable product. . . . These products must be novel constructions. . . . The creativity has the stamp of the individual upon its product, but the product is not the individual, nor his materials, but partakes of the relationship between the two" (1954, p. 252). "The action of the child inventing a new game with his playmates, Einstein formulating a theory of relativity, a housewife devising a new sauce for the meat, a young author writing his first novel; all of these are, in terms of our definition, creative, and there is no attempt to set them in some order of more or less creative" (1954, p. 251).
	Part of a process
M. A. Runco	"Creativity is a useful and effective response to evolutionary changes. In addition to what may be its most obvious function, namely as part of the problem-solving process" (2004, p. 658).
G. J. Feist and F. X. Barron	"Creativity is a specific capacity to not only solve problems but to solve them originally and adaptively" (2003, p. 63).
R. A. Finke, T. B. Ward, and S. M. Smith	"We conceive of creativity not as a single unitary process but as a product of many types and of mental processes, each of which helps to set the stage for creative insight and discovery. In particular, we distinguish between processes used in the generation of cognitive structures and those used to explore the creative implications of those structures" (1992, p. 2).

(appendix continues)

APPENDIX (continued)

Author(s)	Definition
S. A. Mednick	"We may proceed to define the creative thinking process as the forming of associative elements into new combinations which either meet specified requirements or are in some way useful" (1962, p. 221).
	Componential conceptions of creativity
M. Csikszentmihalyi	"Creativity can be observed only in the interrelations of a system made up of three main parts. The first of these is the domain, which consists of a set of symbolic rules and procedures. . . . The second component of creativity is the field, which includes all the individuals who act as gatekeepers to the domain. It is their job to decide whether a new idea or product should be included in the domain. . . . Finally, the third component of the creative system is the individual person" (1996, pp. 27–28).
H. J. Eysenck	"I argue that creative achievement in any sphere depends on many different factors: (a) cognitive abilities (e.g., intelligence, acquired knowledge, technical skills, and special talents [e.g., musical, verbal, numerical]); (b) environmental variables—such as political-religious, cultural, socioeconomic, and educational factors; and (c) personality traits—such as internal motivation, confidence, nonconformity, and originality. All or most of these, in greater or lesser degree, are needed to produce a truly creative achievement, and many of these variables are likely to act in a multiplicative (synergistic) rather than additive manner" (1993, p. 153).
M. D. Mumford and S. B. Gustafson	"Creativity appears to be best conceptualised as a syndrome involving a number of elements: (a) the processes underlying the individual's capacity to generate new ideas or understandings, (b) the characteristics of the individual facilitating process operation, (c) the characteristics of the individual facilitating the translation of those ideas into action, (d) the attributes of the situation conditioning the individuals' willingness to engage in creative behaviour, and (e) the attributes of the situation influencing evaluation of the individual's productive efforts" (1988, p. 28).

(appendix continues)

APPENDIX (continued)

Author(s)	Definition
E. P. Torrance	"I defined creativity as a process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on; identifying the difficulty; searching for solutions, making guesses, or formulating hypotheses and possibly modifying and retesting them; and finally communicating the results" (1966, pp. 73–74).
J. P. Guilford	"In its narrow sense, creativity refers to the abilities that are most characteristic of creative people. Creative abilities determine whether the individual has the power to exhibit creative behaviour to a noteworthy degree. Whether or not the individual who has the requisite abilities will actually produce results of a creative nature will depend upon his motivational and temperamental traits" (1950, p. 444).

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