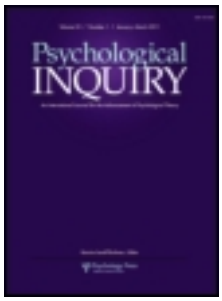

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TARGET ARTICLE

Creativity and Personality: Suggestions for a Theory

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An attempt is made in this article to relate creativity to personality in a much more definitive way than has been done previously and to use the known correlates of personality to suggest a theory of creativity that would explain many of the phenomena associated with this concept. A causal chain is suggested reaching from DNA to creative achievement, based largely on experimental findings not usually considered in relation to creativity (e.g., latent inhibition). Inevitably, the model is highly speculative, but it is testable and hence may prove useful in not only accounting for many observations and experimental results but also in suggesting new experiments and observations.

Many theories in psychology (and not only in psychology!) are fuzzy; precise quantitative theories are largely lacking. What I am doing here is multiplying the offense by linking several fuzzy theories (some more fuzzy than others) to try to throw some light on a fundamental problem in science and art and possibly other fields as well—namely, the nature of creativity and its relation to intelligence, personality, and genius. The fuzzy nature of the concept of creativity is well illustrated by Glover, Ronning and Reynolds (1989), who argued that this whole field of study "had come to be a large-scale example of a 'degenerating' research program" (p. xi), using Lakatos's (1978) expression to characterize a theoretical system that failed to provide new insights and findings and that was reduced to explaining away failures and defaults. Certainly, the early excitement about "divergent thinking" has given way to deep-seated misgivings about the measurement of "creativity" (R. T. Brown, 1989). Here I try to bring together several findings and theories to suggest a testable model of creativity. I also try, somewhat speculatively, to look at possible and plausible biological causes of creativity in an attempt to span the gap between DNA and achievement. I hope that the existence of such a model may stimulate the experimental study of the various conceptions involved and of their interrelations.

It may be useful to state briefly now the theoretical model developed in more detail later. Following Campbell (1960), Furneaux (1961), and Simonton (1988), I argue that intelligence is essentially characterized as a search process in order to discover *noegenetic* solutions, to use Spearman's (1923, 1927) term, bringing together different ideas from memory to produce new answers to problems. I disagree with these authors in not regarding this search process as blind or random, as they do; there is strong evidence that search processes of this kind are always guided by explicit or implicit ideas of relevance. Differences in intelligence are explained in terms of the speed of the search mechanism, and this in turn by individual differences in the probability of errors occurring in the processing of information across the cortex.

I then argue that there are individual differences in the definition of *relevance.* Some people are overinclusive in their thinking, having a rather wide conception of relevance (Payne, 1960; Payne & Hewlett, 1960), whereas others have a narrow or a more conventional conception. I argue that unusualness of responses to a word association test can be used as a measure of this hypothetical quality. I suggest that this cognitive style lies at the basis of creativity, providing the individual whose thought processes are overinclusive with a larger sample of ideas for the search process, thus making possible the production of unusual, novel, and creative ideas.

I also suggest that the personality type of the individual with overinclusive thought processes is likely to have affinities with schizophrenia or generally psychotic disorders but to fall short of actual psychiatric disease—in other words, a person high on psychoticism (P) but not really psychotic. I attempt to support this suggestion by citing evidence to the effect that there is a relation between insanity and genius, that genuinely

creative people are high on P, and that the choice of unique responses on the word association test is a good measure of psychosis, of psychoticism, and of creativity.

Last, I argue that this theory explains (a) the observed differences between creativity as a personality trait (originality) and creativity as demonstrated by scientific or artistic achievement and (b) the difference between creativity and intelligence. I do not suggest that the theory developed here solves the riddle of creativity in any final sense, but it does make testable predictions, it unifies many findings, and it may lead to improvements and discoveries that will serve to make the theory more quantitative and more precise in the definition of the parts that go into it. Individual aspects of the theory are not original for the most part, but the way the parts are integrated into a whole does perhaps deserve to be considered somewhat novel.

Inclusion of intelligence (IQ) in this discussion may require some explanation. Genius is the highest form of creativity, almost by definition, and it has been shown that high IQ is a necessary (Cox, 1926) but not sufficient (Terman, 1925; Terman & Oden, 1959) condition. The 300 geniuses studied by Cox (1926) had a mean (corrected) IQ of 165; high IQ seems to be "necessary" for the emergence of genius. But Terman's (1925; Terman & Oden, 1959) large group of high–IQ children failed to produce a single genius or even a near-genius; clearly, high IQ is not a sufficient condition for the emergence of genius. I return to this point later.

Granted that intelligence is important in a consideration of creativity, it is necessary to have some model of cognitive functioning into which creativity can be introduced; only in this way can we characterize the differential nature of intelligence and creativity. Hence, the next section deals with a general theory of intelligence.

A Theory of Intelligence

This section is relatively short because I refer for the most part to a theoretical conception well-known to many readers—namely, the theory Campbell (1960) called the *chance-configuration theory.* According to this theory, which Simonton (1988) recently adopted and extended, the acquisition of new knowledge and the solution of novel problems require some means of producing variation, and this variation, to be truly effective, must be fully "blind." Campbell (1974) defined *blindness* in terms of variations being correlated to the environmental conditions—including the specific problem—under which the variations are generated. As for the generality of these variations, Simonton (1988) preferred the adjective *chance.*

These heterogeneous variations are subjected to a consistent selection process to retain only those that exhibit selective fit (i.e., those offering viable solutions to the problem at hand). Last, the variations that are selected must be preserved; that is, there must be a proper retention mechanism so that a successful variation can represent a permanent contribution to adaptive fitness. Thus, this manipulation of mental elements by a process of blind chance, issuing in a selection for problem-solving fitness, leads to configuration formation (i.e. stable permutations hanging together in a stable arrangement or patterned whole of interrelated parts). This very brief description fails to do justice to the extended discussion given by the authors of this theory, but it must suffice here.

A similar theory was developed independently and around the same time by Furneaux (1961). Furneaux postulated that the brain structure of any individual P includes a set of $_PN$ neural elements that participate in problem-solving activities. The solution of a particular problem h of difficulty D involves bringing into association a particular set $D^N h$ of these elements, interconnected in some precise order. When problem h is first presented, single elements are first selected, at random, from the total pool $_PN$ and are examined to see whether any one of them, alone, constitutes the required solution. A device is postulated that carries out this examination—it must bring together the neural representation of the perceptual material embodying the problem, the rules according to which the problem has to be solved, and the particular organization of elements whose validity as a solution has to be examined. It must give rise to some sort of signal that, in the case of an acceptable organization, will terminate the search process and will initiate the translation of the accepted neural organization into the activity that specifies the solution in behavioral terms. Alternatively, if the organization under examination proves to be unacceptable, a signal must result that will lead to the continuation of the search process. Furneaux called this hypothetical device the *comparator.*

Furneaux (1961) also said that, if $D \neq 1$, the comparator will reject each of the $_PN$ trial solutions involving only a single element, and the search will then start for a pair of elements, which, when correctly interconnected, might constitute a valid solution. If $D = r$, then the comparator will reject in turn all the organizations involving from 1 to $(r - 1)$ elements. Speed of mental processing (i.e., time to solution) is an essential element of the theory, and Furneaux postulated that there will be a time

$$T \sum_{r-1}^{1} E$$

sec within which a solution cannot occur, where T = the time required for completing a single elementary operation within the search process and

$$\sum_{r-1}^{1} E$$

is the number of elementary operations involved in the search process up to the level of complexity ($r - 1$). Similarly, after a time

$$T \sum_{r}^{1} E$$

sec, all possible organizations embodying r elements will have been examined, so that correct solutions to problems of difficulty r will always arise within the period defined by the two limiting times

$$T \sum_{r-1}^{1} E$$

and

$$T \sum_{r}^{1} E$$

Extensions of the theory, possible objections, and empirical proof are dealt with in the original chapter (Furneaux, 1961). Critical discussions are found in H. J. Eysenck (1982, 1985, 1986, 1987, 1988), and an experimental test of the theory is found in Frearson, H. J. Eysenck, and Barrett (1990).

The similarities between the two theories are obvious. Both postulate a random/chance search process, leading to an organization/configuration that satisfies a comparator/selector. The major difference is that Furneaux dealt with intelligence, Campbell and Simonton with creativity. I discuss the difference between the two concepts in more detail later, but note that Spearman (1923, 1927) defined *intelligence* in terms of his noegenetic laws—that is, as creating something new, which is of course also a definition of *creativity.* Spearman seemingly equated intelligence and creativity, but he also stimulated the work of Hargreaves (1927), who was among the first to use tests of divergent ability and who found them to be highly correlated with measures of *g*, even though these "fluency" tests defined a separate factor. These early measures of "fluency," and the history of their development, were discussed in detail by H. J. Eysenck (1970b). These early studies of what was later called "divergent thinking" (Guilford, 1967, 1981a, 1981b) are sadly neglected in recent writings on "creativity and intelligence" (e.g., Haensly & Reynolds, 1989). Spearman (1923, 1927) suggested that creativity might be a personality characteristic rather than a cognitive characteristic; H. J. Eysenck (1983) gave some evidence to support this notion, which is discussed more fully later.

D. M. Johnson (1955) provided much evidence to show that virtually all the persons who made major creative advances in science and technology in historic times have possessed very great general problem-solving powers, but that of course does not answer the question; high intelligence may be a necessary but not sufficient trait in the production of creative results, as already argued here.

Newell, Shaw, and Simon (1962) also argued against the existence of a division along cognitive lines between intelligence and creativity, and clearly the matter deserves fuller discussion. It is interesting to note that these authors also postulated a search process involving trial-and-error processes as bulking very large in highly creative problem-solving; as Newell et al. wrote, "at the upper end of the range of problem difficulty there is likely to be a positive correlation between creativity and the use of trial-and-error generators" (p. 73).

Intuitively, the notion of chance/random/trial-and-error search does not dovetail well with our experience of reasoning and problem solving; what is characteristic of the process is the adoption of heuristics and strategies (Newell et al., 1962). As Newell et al. wrote:

> We have seen that the success of a problem-solver who is confronted with a complex task rests primarily on his ability to select—correctly—a very small part of the total problem-solving maze for exploration. The processes that carry out this selection we call "heuristics." (p. 96)

Heuristics and the strategies built thereupon are found in both human and computer problem-solvers and, while retaining elements of random search, use heuristic search techniques such as "recoding" (G. A. Miller, 1956) to simplify the choice and availability of elements from which a solution can be built.

A good guide to the many different search algorithms that exist can be found in the literature on artificial intelligence (AI; R. Smith, 1990). The following may be mentioned:

1. *A* algorithm,* a form of heuristic search that attempts to determine the cheapest path from the initial state to the goal.
2. *Alpha–beta "pruning,"* in which nodes not needed to evaluate the possible moves of the top cards are pruned.

3. *Bandwidth search,* a search strategy in an ordered state–space search.

4. *Beam search,* a scheme used in speech understanding systems.

5. *Best-first search,* in which the move considered next is the most promising in the entire search tree generated so far.

6. *Bidirectional search,* a state–space search that proceeds both backward and forward.

7. *Breadth-first search,* a strategy applicable to a hierarchy of rules or objects, contrasted with ...

8. *Depth-first search,* a search strategy within a hierarchy of rules or objects in which one rule or object at the highest level is examined first.

9. *Full-width search,* in which all legal moves from a position are examined; this may lead to alpha pruning.

10. *Generate-and-test,* a problem-solving technique that uses a generator to produce possible solutions and an evaluator to test whether solutions are acceptable.

11. *Heuristic paths algorithm,* a generalization of the graph traverser algorithm, giving an ordered state–space search with an evaluation function.

12. *Hierarchical search,* an attempt to reduce the problem of combinatorial explosion, which threatens all problem solvers attempting to use heuristic search in a sufficiently complex problem domain.

13. *Length-first search,* in which a complete plan for reaching a goal is formed at each node before moving on to any lower level node.

14. *Negmax,* a technique for searching game trees.

15. *Ordered search,* a heuristic search that always selects the most promising node as the next node to expand.

16. *Uniform-cost search,* a type of breadth-first algorithm in which a non-negative cost is associated with every operator. These algorithms are not always clearly differentiated; thus, uniform-cost search is reduced to breadth-first search if all operators have equal cost.

17. *State–space search,* a generic term for several formalisms already enumerated.

Closest to the random/chance/blind combination model is:

18. *Blind search,* an algorithm that treats the search space syntactically, as contrasted with heuristic models, which use information about the nature and structure of the problem domain in order to limit the search. The search for a solution in state–space search is carried out by making explicit just enough of the state–space graph to contain a solution path. A search is called *blind* if the order in which potential solution paths are considered is arbitrary and uses no domain-specific information to judge where the solution is likely to be. This type of blind search seems to be what Campbell and Furneaux have suggested, but the evidence does not lend much support to what would seem a completely unstructured mind working on a random basis.

Newell et al. (1962) gave an example of the combinatorial explosion involved in blind search. It concerns the Moore and Anderson (1954) study of the problem-solving behavior of subjects who were given a small set (one to four) of logic expressions as premises and were asked to derive another expression from these, using 12 specified rules of transformation. Assuming (and this is an oversimplification) that each rule of transformation operates on one premise and that each such rule is applicable to any premise, this particular tree branches in 12 directions at each choice point. A blind trial-and-error search for the derivation would require the construction of, on average, 18,000,000 sequences!

Another example is choosing a move in chess. On average, a chess player has a choice among 20 to 30 alternatives; these can be evaluated by considering the opponent's possible replies, one's replies to the opponent's replies, and so on. The tree of move sequences is tremendously large; considering just 5 move sequences for each player, with an average of 25 legal continuations at each stage, the set of such moves has more than 10^{14} (100 million million) members. No wonder simple power-crunching computer chess players never did well and were outclassed by machines using heuristic processes, strategies, and memory recall—just like humans!

Granted some form of heuristic search, we are faced with a combinatorial explosion less severe than that involved in blind search, but serious enough. In most cases, the domain of possible combinations is so large that the time required to find the (optimum) solution increases exponentially and exceeds the capacity of the computer system, or the human mind. "Exhaustive search is rarely feasible for non-trivial problems" (Smith, 1990, p. 56). Examining all sequences of n moves, for example, would require operating in search space in which the number of nodes would grow exponentially with n. This is what is meant by the term *combinatorial explosion,* and it eliminates many of the algorithms considered here, blind search in particular.

Considerations of time and the combinatorial explosion make any chance search process extremely unlikely. But, in addition, we do have a certain amount of firm experimental support for the view that human searching mechanisms adopt a very different mode. This evidence comes from research into linguistics and memory. Consider linguistics first. There is considerable evidence from word-association–type experiments that verbal mechanisms are strongly constrained; see Bell (1948), Bonfield (1953), Cramer (1968), Garskof and Houston (1963), Laffal and Feldman (1962), Underwood and Schulz (1960), and, in particular, Osgood, Suci, and Tannenbaum (1957). That language

and associative mechanisms are heavily structured and mediate search processes of a highly predictable kind does not agree with any theory of blind search. For any given verbal problem, this structure immediately suggests sequences of nodes and arcs (to use the language of AI) on the search tree or in the search space. Each tree is constructed before a search takes place and includes all states that are theoretically possible. Different problem domains have different search spaces, which may be large or even infinite. It is possible to measure the search space by estimating the number of nodes it encompasses. Given a typical noegenetic verbal problem—Optimal : Mumpsimus = Best : ?—we do not indulge in a blind search, leading to a combinatorial explosion, but deduce the correct solution using the proper heuristic.

Best researched of all search processes is probably that involved in memory retrieval (recall or recognition), which also plays an important part in intelligence testing and problem solving (Richardson-Klavehn & Bjork, 1988). The generate-recognize model (R. Brown & McNeill, 1966; G. V. Jones, 1978; Norman, 1970; Watkins & Gardiner, 1979) is one example; the spreading-activation theory is another (Collins & Loftus, 1975; Collins & Quillian, 1970; Quillian, 1967); Ratcliff's "resonance" theory is a third (Ratcliff, 1978); and the "CHARM" model (Nilsson & Gardiner, 1991) is a fourth. It is not the point of this article to judge the explanatory value of these models or to choose one of them; I cite them to illustrate the point that empirical studies of search mechanisms arrive at a picture that disagrees profoundly with any notion of "random" search or "blind chance."

As Theios (1973) pointed out:

> In serial human information processing tasks, the short-term stores become completely filled up with representations of the occurring stimuli and responses, and ... to the extent that there is any structure in the sequence of physical stimuli and required responses, that structure will be mirrored in (or at least affect) the structure and organization of the serially searched, short-term stores. (p. 44)

Clearly this organization must determine the nature of the search process, which cannot be blind given the degree of organization in the short-term stores.

In H. J. Eysenck's (1985, 1986, 1987) theory of intelligence, speed of information processing is a crucial ingredient and is itself a consequence of (comparatively) error-free cortical processing. What, in such a scheme, would be the role of creativity? Any meaningful mental search process that has some empirical support requires qualification of the search domain in terms of relevance. Given a particular problem, we search our memory store only in terms of the requirement of that problem. Given the problem—1 3 6 10 15 21 ?—we do not draw upon our knowledge of the causes of the Peleponesian War or upon the quantum mechanics "graviton" theory of gravitation; we confine ourselves to a heuristic search for numerical solutions fitting the progression indicated by the problem. *Any problem defines its solution horizon, limiting its search to a given, circumscribed area.* Although Campbell, Simonton, and Furneaux do not formally state such a limitation on their concepts of random or blind search, it does not seem likely that they would disagree and insist on a truly blind/random search involving the whole of our knowledge background. However, they fail to introduce the important concept of relevance, which clearly needs explicit treatment—particularly as it is a vital component of creativity.

As a preliminary statement, we may consider the usual associationistic approach to creativity (Spearman, 1931), according to which a creative idea results from the novel combination of two or more ideas that have been isolated from their usual association. S. A. Mednick (1962; S. A. Mednick & M. T. Mednick, 1964) has defined the creative process as "the forming of associative elements into new combinations which either meet specified requirements or are in some way useful. The more mutually remote the elements of the new combinations, the more creative the process or solution" (S. A. Mednick, 1962, p. 221). Creativity thus becomes a function of people's "associative hierarchy," which can be defined as generalization gradients of differing degrees of steepness, with associations to words, percepts, or problems ranging from common to unique. Individuals with steep gradients are likely to give common associations at high strength but few or no uncommon associations; persons with less steep or even with flat gradients are more likely to make uncommon or unique responses.

An alternative model to that of gradients might be one of horizons, which may be close or wide. Figure 1 shows a single word and three levels of associative commonality. (The data are taken from Russell & Jenkins, 1954.) Thus, a very narrow horizon of responses to the word *foot* would contain the word *shoe(s),* which occurred 232 times. A somewhat wider horizon would contain the words *hand* (198), *toe* (191), and *leg* (118). A third level of associative commonality would contain words like *soldier* (26), *ankle* (13), and *sore* (9), and the widest horizon level would contain singles (i.e., responses occurring only once). Each person could then be graded according to his or her association horizon. Of course, we are dealing with a continuum rather than with categorical differences, but the analogy with an event horizon is still useful.

We may use this concept to formally categorize our notion of relevance. Relevance is differentially defined

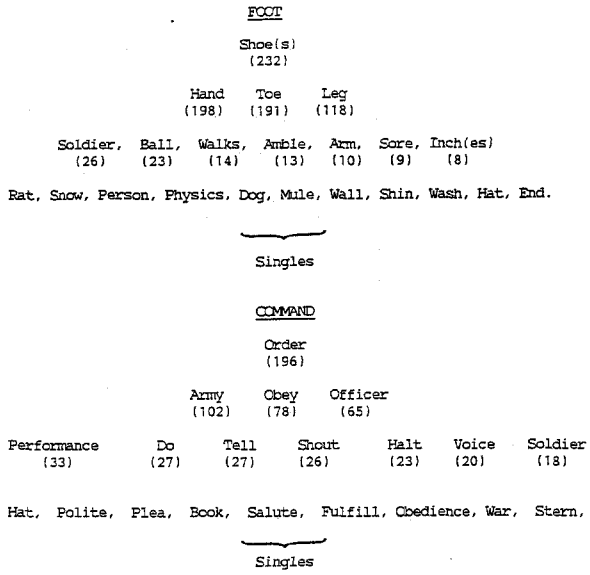

Figure 1. *Associative horizon of two words, foot and command. Four sets are given in each case, with relative frequencies of occurrence, illustrating four horizons.*

for each person, under each set of circumstances, in terms of his or her event horizon. A person with a wide horizon will consider some words, concepts, memories, or whatever to be relevant, but a person with a narrow horizon might consider the same items irrelevant, and the relative position of that person's horizon may be measured in terms of the commonness or remoteness of his or her associations. A creative person will have a wide horizon, an uncreative person a narrow one. The horizon will determine the search process, in the sense that no one will go outside his or her horizon because what is outside is not considered relevant—hence, the analogy with what in physics is known as the *event horizon* or the *Schwartzschild horizon* surrounding a *black hole;* nothing inside the horizon (not even light) can escape to the outside. The event horizon delimits the existence of the black hole and in some way defines it, just as the asssociative horizon delimits the extent of an individual's conception of relevance.

As aready mentioned, my argument is based on the view that intelligence (IQ) is a necessary but not sufficient cause of creative achievement. Cox (1926) showed that 300 geniuses (defined in terms of their lasting fame) had (estimated) IQs that averaged around 160 when disattenuated. This conclusion applied equally to the members of 10 different professions into which Cox ordered her subjects (estimated raw IQs in parentheses): statesmen (142); philosophers (156); scientists (152); writer-essayists, historians, scholars (148); religious leaders (145); writer-poets, novelists, dramatists (149); artists (135); soldiers (125); musicians (140); and revolutionary statesmen (144). Without taking individual or average scores too seriously in any quantitative sense, Cox's work leaves little doubt that, on the whole, these 300 geniuses excelled the average by some 3 to 4 *SD*s, with none being below average.

This proof that high IQ is a necessary condition for creative achievement is followed by proof that high IQ is not sufficient for high creative achievement. Terman and Oden (1959) followed up Terman's (1925) original group of children with IQs of 140+ and found plenty of talent but little sign of genius. (The Nobel Prize–winning physicist William Shockley might be classed as a genius, but he narrowly failed Terman's cutting point of 140!) These fundamental findings define our problem: What variables interact with IQ to produce high creative achievement?

Creativity and Its Measurement

The major problem with the theoretical analysis and measurement of creativity has always been that the term *creativity* has been used in two quite different senses. On the one hand, creativity is conceived as a trait characteristic of a person; Mozart, or Picasso, or Einstein, or Hannibal is considered a creative person (i.e., possessing in high measure a dispositional trait that others, less famous, may possess in lesser measure). This trait is supposed to be normally distributed, like intelligence, with a mean value characteristic of the "average" person.

Measurement of creativity as a trait began with the London school's concept of "fluency" (Hargreaves, 1927) and led to the concept of "divergent thinking" (Glover et al., 1989). These tests have face validity, and, as we shall see, they also show evidence of empirical validity. In addition, there is some evidence of stability in the concept of a measured trait of creativity (Magnusson & Bachteman, 1977), which of course is an important and necessary property of a meaningful and useful trait concept.

On the other hand, we may define *creativity* in terms of a finished product; such products may be extremely varied and include the *Principia Mathematica* (Newton), the *Mona Lisa* (Leonardo da Vinci), *Hamlet* (Shakespeare), the Battle of Cannae (Hannibal), the *Nibelungen* (Wagner), and so forth. The great problem of psychological research into creativity lies in discovering the relation between these two conceptions of creativity as a universal, normally distributed trait and creativity as unique achievement, distributed more like a Poissonian curve.

In order to avoid using the term *creativity* in two different senses, it might be useful to use the term *originality* instead of *creativity as a trait.* Obviously, it is possible to be original (i.e., to present unusual solutions, associations, etc.) without being creative in the

achivement sense. Creativity implies that the original responses are relevant, and the production of creative objects requires a lengthy process of constructive work, defense against critics, and so forth. Originality by itself is not enough to be considered creativity; much more is required. A psychotic person's responses are original (in the sense of unusual), but they are hardly ever creative.

The evidence for creativity as achievement being very abnormally distributed comes from the highest realm of artistic or scientific achievement but also from lesser but still notable successes. Concentrating on scientific achievement, where judgments are perhaps more objective than in art, it is well known that a small proportion of active scientists is responsible for the major number of creative works. Thus, Dennis (1955) found that the top 10% most productive contributors in a variety of scientific disciplines were responsible for about half the total works published, whereas the bottom 50% were least productive and contributed only about 15% of the total output (Bloom, 1963; Davis, 1987; Shockley, 1957). In psychology, for instance, the most prolific author can claim more contributions than can 80 colleagues in the lower half of the distribution (Dennis, 1954). These data in fact underestimate the difference because they include only those who have made at least one contribution, thus leaving out of consideration all those never making any contribution at all!

Lotka (1926) and Price (1963) have attempted to formulate quantitative laws to encapsulate these and similar findings. There is agreement on the general shape of the distribution—monotonically decreasing at a decelerating rate. According to Lotka, the number of scientists publishing n papers is roughly proportional to $1 / n^2$, where the proportionality constant varies with the discipline. Supposing the constant to be 10,000, then the number of scientists producing n contributions would be $10^4 / n^2$. That gives us 10,000 scientists with just 1 publication, 2,500 with 2, 1,111 with 3, and 100 with 10. Only 1 scientist would contribute as many as 100 papers. According to Price's law, if K represents the total number of contributors to a given field, then K will be the predicted number of contributors who will generate half of all contributions. The larger the discipline, the more elitist the outcome (Zhao & Jiang, 1985), although the law may cease to hold at extreme values of K.

These laws do not apply only to scientific productions; they have far wider applicability. Dennis (1955) found similar distributions in the publication of secular music and in the books represented in the Library of Congress. Simonton (Simonton, 1984, 1987) demonstrated its applicability to classical music; as he pointed out, about 250 composers account for all the music heard in the modern repertoire, but only 16 are responsible for creating half the pieces heard ($16 = \sqrt{250}$). Whether Price's law can be derived from Lotka's law is immaterial (Allison, Price, Griffiths, Moravscik, & Stewart, 1976); there is general agreement on the major outlines of the function.

The distribution of creativity as a trait (originality), which is approximately normal (Hovecar & Bachelor, 1989; Michael & Wright, 1989; Woodman & Schoenfeldt, 1989), is very different from the distribution of achievement, which is approximately J-shaped. This suggests a theory that may indicate their proper relation. Figure 2 suggests this relation. I argue that creative achievement in any sphere depends on many different factors: (a) cognitive abilities—for example, 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. I argue this point presently. Let us consider for a moment the variables listed. They are not claimed to be a complete set but are merely indicative of the many different variables that have been suggested in the past (Glover et al., 1989).

Environmental variables constitute an obvious set of conditions that are necessary in order to allow creativity to bloom. Lack of education, political unrest, low level of culture, poverty, and the like may not kill creativity altogether, but they will certainly make its appearance more difficult. Newton, Hokusai, Einstein, Confucius, Shakespeare, and Wagner would not have made their scientific, artistic, or philosophical contributions had they been living in a Hottentot kraal, an Eskimo igloo, or an Apache wigwam. Intelligence, acquired knowledge, special skills, and talents are essential ingredients

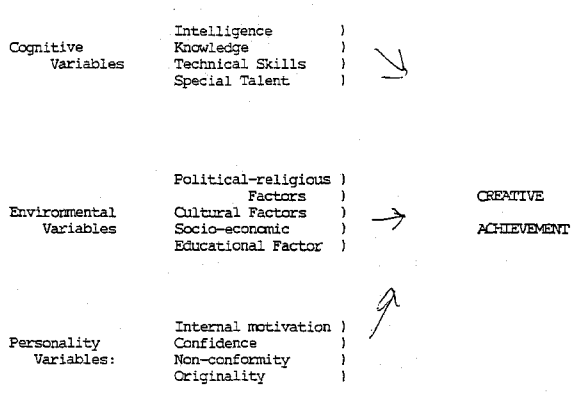

Figure 2. *Factors interacting synergistically to produce creative achievement.*

for any creative achivement. Personality traits such as those listed have usually been found associated with creative individuals (Barron, 1969, Crutchfield, 1962; Glover et al., 1989). I postulate that originality is one of the essential ingredients of creativity (as achievement), but I conceive it as a necessary, not a sufficient, cause.

The relation between the trait and the achievement in the case of creativity is not dissimilar to that between intelligence and income (Burt, 1943). Here too we have a normal (or nearly normal; Burt, 1963) distribution of the trait—but a J–shaped distribution of the achievement (in terms of income, in this case). Pareto (1897) suggested a "universal law" for the distribution of earnings—a law that closely resembles the Lotka and Price laws,

$$N = \frac{C}{X^a}$$

where N is the number of persons whose income exceeds X units, and C is a constant; the exponent a measures the inequality of the incomes and cannot vary much from 1.5. Here too, intelligence seems to be a necessary but not sufficient cause of wealth; indeed, it may not be necessary in some cases (successful sportsmen, popular musicians, royalty, prostitutes, TV personalities, etc.), but, over all, it does play an important role (H. J. Eysenck, 1979).

Intelligence combines with motivation (desire to get rich), special talents, socioeconomic backgrounds, lack of scruples, and so forth to produce wealth. Burt (1943) argued that the interaction of these factors is most likely to be multiplicative, and he gave examples of how several normally distributed factors can combine multiplicatively to produce a J–shaped effect curve. Let us take only two factors—each distributed into five classes (allotted marks of 0, 1, 2, 3, and 4, respectively) with distributions obeying the binomial law (i.e., with frequencies proportional to 1, 4, 6, 4, and 1). If we now combine the factors by multiplying them and redistribute the final marks into five classes as before, we arrive at frequencies of 49.6 for a score of 0 to 1, 36.0 for a score of 1 to 2, 10.9 for a score of 2 to 3, 3.1 for a score of 3 to 4, and 0.4 for a score of 4 to 5! Now 50% have a score of 0 to 1, and the others are strung out along a J–shaped curve similar to the Lotka–Price distribution.

If a synergistic model is anywhere near correct, and much in the literature supports the various parts of it (Glover et al., 1989), then we can see why the actual correlation between originality and achievement creativity may not be very large; many people with trait creativity are likely to fall by the wayside without any great achievement because there are adverse circumstances, because they lack ability, or because they possess personality traits not conducive to great achievement—in fact, the "mute inglorious Miltons" or the "village Hampdens" of Grey's *Elegy*. Thus, the low correlation between the two concepts of creativity should not cause us to abandon attempts to measure trait creativity (originality); it is important as a vital constituent of achievement creativity and may be useful in many other ways. It may, for instance, serve as a measure of the degree to which a given educational system attempts (and succeeds) to further creativity—assuming that genetic factors, although present, do not account for more than some proportion of trait creativity (Vernon, 1989).

How can we tell whether our attempts to measure originality have actually been successful in the task of measuring something similar to the hypothesized trait that enables the genius to make a creative achievement (H. J. Eysenck, in press)? The answer must lie in the correlates of creativity. If creative people who have achieved something important have certain characteristics, such as independence; openness to feelings and emotions; self-awareness; self-acceptance; dominance; and being poised, spontaneous, self-confident, aggressive, and self-centered (Cattell & Butcher, 1968; MacKinnon, 1962a, 1962b, 1965; Roe, 1952, 1953), then it might be expected that highly original people might show the same traits. If they did, that would indicate similarity of underlying personality structure—and hence validity for the trait measures. Indeed, it might indicate a pleiotropic relation between creativity and personality; only aggressive, self-confident, dominant individuals can successfully show creative talents in a world full of envious mediocrities. I develop this argument in more detail later on. For the moment, it must suffice to state that the high correlation of a certain personality type with both originality and achievement creativity suggests considerable validity for the former type of measurement.

If we can measure creativity-originality, can we also measure a style of problem solution that has become closely associated with creativity in philosophical discourse and in historical writings on genius—namely, intuitive thinking (Wild, 1938)? Westcott and Ranzoni (1963) defined *intuition* as a process of "reaching a conclusion on the basis of little information which is normally reached on the basis of significantly more information" (p. 595). Bouthilet (1948) and Westcott (1961, 1964) have actually attempted to transform this definition into a measurement paradigm. The principle is simple. The subject is confronted with a problem that can be solved only with the help of several clues. These can be obtained seriatim from the experimenter, and the intuitive person is defined in terms of attempting the solution on the basis of only a small number of clues, as contrasted with the more rigid sort of person who

demands a large number of clues. This process results in a fourfold typology—the intuitive versus rigid typology subdivided in terms of solutions that are correct or incorrect.

It turned out that the measurement of intuition along these lines was possible—acceptable reliabilities being obtained on repeated applications of the paradigm. There was little correlation with indices of intelligence but considerable correlation with personality—intuitive persons, particularly successful intuitive persons, appearing unconventional and comfortable in their unconventionality. They are deeply involved in what they are doing and are not afraid of themselves, their experiences, or their world; they accept challenges readily and eagerly. They can live with doubt and uncertainty, even enjoying risks and seeking out instabilities in the world. They are willing to commit themselves to causes and are able to become wrapped up in them. The causes and concerns that capture their imagination appear to be seemingly abstract issues—either at the level of academic intellectual problems or problems of human values. They are willing and able to create—to commit themselves to paper, to be criticized, to express themselves—and they take chances both willingly and eagerly. They assess themelves much the way an observer might assess them: as alert, independent, foresighted, confident, and spontaneous (Westcott & Ranzoni, 1963).

In contrast, the subjects solving the problems on the basis of a large number of clues (rigid persons) tend to be less impulsive than the intuitive or "insight" persons. The rigid persons are cautious, conservative, and compliant. They are well socialized and acknowledge little change in their lives and almost no profound influences on their lives. They see themselves mostly in terms of social virtues—cautious, kind, modest, and confident. According to Westcott and Ranzoni (1963), "Within a firmly conservative and conventional framework, they have the best of both worlds—the social and the intellectual" (p. 612). These contrasting personality types correspond well with the creative–noncreative personality types, as we shall see.

Creativity and Psychoticism

Creativity has from the earliest times been thought to be related to psychosis or "madness" (Hyslop, 1925, Lange-Eichbaum, 1931; Lombroso, 1895; Nisbet, 1900), with some writers (Ellis, 1926; Juda, 1949) actually bringing forward some evidence from controlled studies to supplement these mostly anecdotal accounts (Hasenfus & Magaro, 1976). Other writers have found evidence of high creativity in close relatives or descendents of psychotic parents; this evidence was surveyed by H. J. Eysenck (1983), who suggested that it was not psychosis (i.e., a psychopathological state) that was related to creativity genius, but psychoticism (i.e., a dispositional trait underlying susceptibility to the development of psychotic symptoms; H. J. Eysenck & S. B. G. Eysenck, 1976). H. J. Eysenck (1983) postulated that high scores on measures of the trait psychoticism (P) were positively correlated with creativity, both as a trait and in terms of achievement.

Richards's (1981) survey lends support to this view. Richards found elevated levels of psychopathology among recognized creators compared to the general population as well as familial (and perhaps genetic) problems of creativity–psychopathology association.

It may be useful to digress and explain a little further what precisely is meant by *psychoticism.* It is postulated (and found) that certain traits frequently found in psychotics and their relatives are correlated to form a continuum ranging from psychotic through average to highly socialized, conventional, and altruistic.

The traits in question are shown in Figure 3, and the continuum in question in Figure 4; in Figure 4, the curved line P_A indicates the probability that an individual on any given part of the abscissa will develop a psychotic illness. The further to the right, the greater the probability. This theory, and the empirical evidence supporting it, was described in great detail in H. J. Eysenck (1992), and I will not go into it again here.

A rather similar connection to that here postulated was already included in Bleuler's (1978) description of the "schizoid personality"—a concept in some ways similar to psychoticism and first used by Bleuler around 1911. Of course, Bleuler's (1978) description of schizoid personality was based on careful observation rather than on formal correlational study:

> He is taciturn or has little regard for the effect on others of what he says. Sometimes he appears tense and becomes irritated by senseless provocation. He appears as insincere and indirect in communication. His behavior is aloof and devoid of human warmth; yet he does

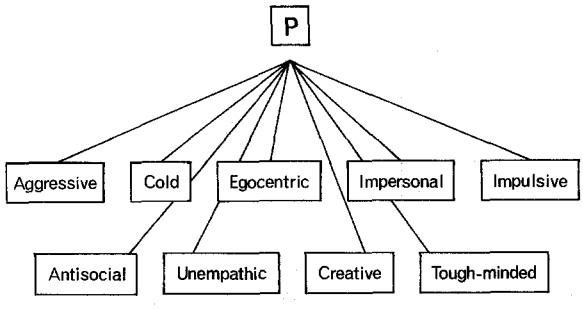

Figure 3. *Traits that correlate together to produce psychoticism (P). From H. J. Eysenck and M. W. Eysenck (1985).*

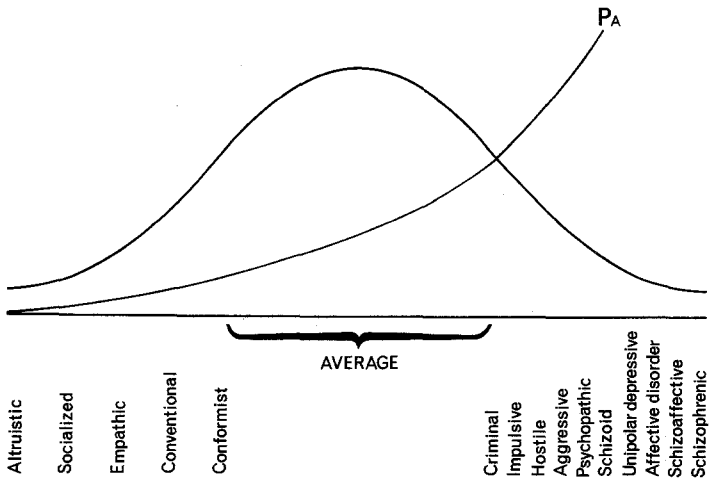

Figure 4. *Psychoticism continuum (abscissa), with P_A curve suggesting increasing probability of showing actual psychosis. From H. J. Eysenck (1992).*

> have a rich inner life. In this sense he is introverted. ... Ambivalent moods are more pronounced in the schizoid than in others, just as he distorts the meanings of, and introduces excessive doubts into, his own concepts. But on the other hand, the schizoid is also capable of pursuing his own thoughts and of following his own interests and drives, without giving enough consideration to other people and to the actual realities of life. He is autistic. The better side of this autism reveals a sturdiness of character, and inflexibility of purpose, an independence *and a predisposition to creativity* [italics added]. The worse side of it becomes manifest in a lack of consideration for others, unsociability, a world-alien attitude, stubbornness, egocentricity, and occasionally even cruelty. (p. 146)

Claridge (1985) added the following explanatory remarks:

> Assessing his own patients according to these traits Manfred Bleuler concluded that at least half had shown some degree of schizoid tendency before their psychotic breakdown. Similar characteristics were also very noticeable, he says, in their siblings and in their offspring. Like most other writers on the topic, Bleuler is quick to point out that a range of personality types can be observed among schizophrenics and their relatives. But he leaves us in no doubt that the most important reference point for trying to gain insight into the schizophrenic personality is schizoidness, or schizoidia as it was later called; with its undertones of disharmony, self-contradiction, and ambivalence of feeling. So important for Bleuler is this notion of disharmony of personality traits that he bases his views about the inheritance of schizophrenic disposition on it. He rejects the idea that there is a specific genetic defect in schizophrenia, arguing instead that the underlying hereditary tendency is the apperance in some people of characteristics which, taken individually, are perfectly healthy but which, occurring in certain disharmonious combinations, are potentially maladaptive. (p. 137)

It is certainly a frequent finding in studies of genuinely creative people (achievement criterion) that they show evidence of what is often called *psychopathology*. Thus, Barron (1969), comparing creative groups (writers, mathematicians, architects) with representative (average, noncreative) groups, wrote:

> The creative groups consistently emerge as having *more* psychopathology than do more representative members of the same profession. The *average* creative writer, in fact, is in the upper 15 per cent of the general population on *all* measures of psychopathology furnished by this test (the MMPI [Minnesota Multiphasic Personality Inventory]). (p. 72)

Thus, creative writers have average MMPI scores of 63 (for Hypochondriasis), 65 (for Depression, 68 (for Hysteria), 65 (for Psychopathic Deviate), 61 (for Paranoia), 64 (for Psychasthenia), 67 (for Schizophrenia), and 61 (for Hypomania)—as compared with a score of 50 for the general population.

Andreasen (1987) looked at the rate of mental illness in 30 creative writers, 30 matched control subjects, and the first-degree relatives of both groups. The writers had a substantially higher rate of mental illness, predominantly affective disorder, with a tendency toward the bipolar type. There was also a higher prevalence of affective disorder and creativity in the writers' first-degree relatives, suggesting that these traits run together in families and could be genetically mediated. Writers and controls had IQs in the superior range, with the writers only excelling on the Wechsler Adult Intelligence Scale (WAIS) Vocabulary subtest, confirming the view that intelligence and creativity are independent variables after a threshold value of about 120 has been achieved.

A series of studies by Richards and her colleagues has also given some support to this thesis. Having constructed a "peak creativity" index based on raters'

assessments (the Lifetime Creativity Scales; Richards, Kinney, Benet, & Merzel, 1988), Richards, Kinney, Lunde, Benet, and Merzel (1988) tested 17 manic depressives, 16 cyclothymes, and 11 normal first-degree relatives and compared their creativity scores with those of 33 controls with no personal or family history of major affective disorder, cyclothymia, or schizophrenia. Oddly enough, only 15 controls were normal, and 11 "carried another diagnosis" (Richards, Kinney, Benet, & Merzel, 1988, p. 281); the nature of this diagnosis is coyly hidden, and it is not made clear why "non-normal" subjects were included in the control group. All this makes the results difficult to interpret. However, it appears that creativity was related to normality—manic depressive psychosis in a curvilinear manner; normals and manic depressives having low scores; and cyclothymes and normal first-degree biological relatives of cyclothymes and manic depressives having the highest scores. Significance levels are not impressive, but the ordering of creativity scores is certainly in line with our theory.

In his sample of architects, MacKinnon (1962b) found creativity to correlate .22 with MMPI Psychopathic Deviate and .19 with MMPI Schizophrenia. As MacKinnon pointed out:

> The meanings of these correlations for such an effective reality-correlating sample as our 124 architects, are not those which would apply in psychopathological groups. In the present context they are indicative of greater unusualness of thought processes and mental content and less inhibition and freer expression of impulse and imagery. (p. 34)

This may be so, but, comparing creative with noncreative architects, MacKinnon (1962b) found the creative lower than the noncreative on sense of well-being, responsibility, socialization, self-control, good impression, communality, achievement via conformance, and sociability (as shown by the California Psychological Inventory [CPI]; Gough, 1957).

Barron (1969) found that his creative writers and architects showed superior ego-strength (score of 58 for writers, 61 for architects on the MMPI)—a pattern that, as he pointed out, is quite unusual; the Ego-Strength scale usually correlates negatively with the psychopathological scales (between –.50 and –.60). A similar pattern was found for the CPI scores, linking psychopathology in creative subjects with personal effectiveness. Barron contrasted psychosis and the "divine madness" of the artist by writing that the artist is not, as psychosis is, something subtracted from normality; rather, it is something added. "Genuine psychosis is stifling and imprisoning, the divine madness is a liberation from 'the consensus'" (p. 73). All this may be true, but it does not furnish us with a criterion of "genuine psychosis" as contrasted with "divine madness"—other than the creative achievement—but of course that is what we have to explain!

I have argued (H. J. Eysenck, 1952a; H. J. Eysenck & S. B. G. Eysenck, 1976) that we must carefully distinguish between psychosis and psychoticism, which is a trait, normally distributed, predisposing people with high P scores to psychosis (already explained here). The objection made by MacKinnon and Barron to an identification of psychosis and creativity does not apply to an identification of creativity with psychoticism; psychosis as a clinical state adds something to a high degree of psychoticism, which transforms it into a proper mental illness irreconcilable with genuine creativity.

A great deal has been written about psychoticism as a major dimension of personality (Claridge, 1981, 1983; H. J. Eysenck, 1952a, 1952b; H. J. Eysenck & S. B. G. Eysenck, 1968, 1975, 1976; M. Zuckerman, 1989) and about the question of its genetic determination (Eaves & H. J. Eysenck, 1977; Eaves, H. J. Eysenck, & Martin, 1989; H. J. Eysenck, 1972a; Heath, Eaves, & Martin, 1989; Heath, Jardine, Eaves, & Martin, 1988, 1989), leaving no doubt about the (partial) genetic determination of P. The notion of a general factor of psychoticism would seem to contradict the usual Kraepelinian assumption of two quite separate major psychotic disorders, schizophrenia and manic depressive disorder. As Crow (1986) showed, the evidence from clinical and genetic studies is not in agreement with this view but rather favors a variant of the Guislain (1833)–Neumann (1859)–Griesinger (1861) theory of the *Einheitspsychose*—that is, a continuum of psychosis extending from pure affective disorder to schizophrenia. Crow quoted a great deal of empirical evidence to support this view but exaggerated the unity of psychotic states; there is considerable evidence also for separate types of psychosis, genetically determined (H. J. Eysenck, 1992).

On the genetic side, H. J. Eysenck (1972a) argued that psychoticism has a polygenic inheritance, to which may be added specific genes or gene clusters predisposing a person to any of the many different forms of psychosis—paranoia, hebephrenia, depression, and so forth. According to this hypothesis, psychosis retains its hold on the population, in spite of its dysgenic potential, because the genes making for psychoticism include some that make for inclusive fitness (creativity, dominance). Thus, our theory does not claim that psychosis as such produces creativity or that great artists and scientists are psychotic; such statements, frequently made in the past, are clearly untrue (Kretschmer, 1929; Lange-Eichbaum, 1956; Turck, 1901); what may be happening is that high P is necessary for high creativity and that high-P people may sometimes de-

velop psychosis or at least suffer psychotic episodes during which their creative talents lie fallow. Many historical examples are available to support such a theory (Prentky, 1980, Richards, 1981).

Of course, the concept of psychoticism (H. J. Eysenck, 1952a, 1952b) and the various forms of the P scale are not the only examples of a theory of some sort of dispositional dimension underlying psychosis or, more particularly, schizophrenia; the ancient concept of schizoid personality is suggestive of this notion. Meehl (1990) contributed a lengthy historical introduction and critique dealing extensively with his own contributions dating from 1962 but unfortunately leaving out the many German and British contributions. Bentall, Claridge, and Slade (1989) referred to 14 published scales of schizotypal traits; factor analysis disclosed three major factors. On the first, P had a loading of .72, and other high loadings were found for the Magical Ideation Scale, the Hypomanic Personality Scale, the Hallucination Scale, and Claridge's Schizotypal and Borderline Personality scales. The second factor had its highest loading on N (neuroticism); the third factor had its highest loading on E (extraversion) and social anhedonia. Thus, even in this highly selected group of tests, the P–E–N trinity emerges—suggesting that, in addition to a general factor of P, we have E and N determining the special ways in which P expresses itself, possibly leading to different diagnoses (H. J. Eysenck, 1970a). L. J. Chapman, J. P. Chapman, and E. V. Miller (1982) also cited correlations for eight measures of "proneness to psychosis"—but without factor analysis.

The literature is large and varied and cannot be discussed in detail; Meehl's (1990) discussion runs to almost 100 pages and leaves out many of the most important studies. It may be useful to indicate the most important generalizations I think follow from a consideration of all the material published. The P scale emerges as the most general measure of the concept of psychoticism. It is not really subject to charges like being overloaded with paranoid items (Teasdale, Seagraves, & Zacune, 1971). Friedman, Wakefield, Boblitt, and Surman (1976) explicitly investigated the charge and concluded that the scale "is probably not overloaded with paranoid content" (p. 1309). Similarly, although the P scale includes items relating to borderline personality, Snyder, Pitts, and Pokorny (1986) found that "borderline psychopathology was closer to the schizophrenic spectrum than had been anticipated" (p. 51). These and other criticisms are still *sub judice,* but the empirical evidence does not support them.

The second major finding is that many of the schizotypal scales have a very high neuroticism content, which makes them contra-indicated for use in research; scales should be independent as far as possible in order to avoid redundancy, and, if so-called schizotypal or schizoid scales measure largely N, then they simply duplicate another personality factor and do not add much to the specific measurement of psychoticism. It is a major part of the theory of psychoticism that it is almost wholly unrelated to N, and that, after this orthogonality is lost, the scales in question measure a mixture of factors rather than one.

Last, the theory of creativity here explained, linking it with P, cannot properly be tested with scales largely measuring N, or E, in addition to P. What is required is a measure that concentrates on the essential features of psychoticism and excludes other dimensions of personality that are not theoretically related to creativity.

It has often been suggested that P may measure psychopathy, rather than proneness to psychosis, because psychopaths and criminals tend to have P scores even higher than those of psychotics (H. J. Eysenck & Gudjonsson, 1989). The theory does indeed put antisocial, criminal, and psychopathic behavior high on the P scale, but the lower P scores of psychotics, as compared with those of these other groups, must be viewed in perspective.

Psychotics are usually tested when under the influence of very powerful drugs that are supposed to change their abnormal behavior and cognition in the direction of normality. They are tested under conditions of segregation in an environment that is often perceived as limiting, inhibiting, and hostile. The psychosis may seriously limit the patient's ability to answer questions meaningfully and truthfully (see H. J. Eysenck, 1992). These and other reasons make the questionnaire answers of psychotic patients of doubtful validity. Last but not least, diagnosis of psychotic as opposed to neurotic disorders is chaotic; the work of the US–UK Diagnostic Unit showed that identical patients were several times as likely to be labelled *schizophrenic* in the United States as in the United Kingdom (Cooper, Kendell, Gurland, Sharpe, & Copeland, 1972)! Where psychosis is so ill-defined, it is difficult to know what to expect, although there is a clear relation between P and severity of psychosis (Verma & H. J. Eysenck, 1973).

Another criticism that has been made of the concept of psychoticism is that the notion of a dimension contradicts the categorical diagnostic model derived from medicine. I have tried to reduce this theoretical argument to a testable form by developing the method of criterion analysis (H. J. Eysenck, 1950); results have favored the dimensional theory over the categorical system of classification (H. J. Eysenck, 1952a, 1952b, 1970a). This may not be the final answer to the question, but the data certainly do not contradict our underlying hypothesis (H. J. Eysenck, 1992).

Given the hypothesis that P, as a measure of predisposition to the development of psychotic illness, is causally related to creativity, how can one test this hypothesis? There are several directions such tests can take. I enumerate these and the available evidence for each. First in line is evidence of creativity in persons not themselves psychotic but closely related to psychotics and hence genetically likely to be high on psychoticism. Several genetic studies have indeed supported such a view. Heston (1966) studied offspring of schizophrenic mothers raised by foster parents; Heston found that, although about half showed psychosocial disability, the remaining half were notably successful adults, possessing artistic talents and demonstrating imaginative adaptations to life to a degree not found in the control group. In Iceland, Karlsson (1968, 1970) found, among relatives of schizophrenics, a high incidence of individuals of great creative achievement. McNeil (1971) studied the occurrence of mental illness in highly creative adopted children and their biological parents and discovered that the mental illness rates in the adoptees and in their biological parents were positively and significantly related to the creativity level of the adoptees.

These findings clearly support our main theory, as well as prior hypotheses (e.g., those of Hammer & Zubin, 1968; Jarvik & Chadwick, 1973) to the effect that there is a common genetic basis for great potential in creativity and for psychopathological deviation. These studies also make it clear that actual psychosis works in ways that are inimical to creativity and achievement; it appears to be psychoticism in the absence of psychosis that is the vital element in translating the trait of creativity (originality) from potential into actual achievement. This is the trait behind Dryden's often quoted verse: "Great wits are sure to madness near alli'd and thin partitions do their bounds divide." It is these "thin partitions" that divide high P from psychosis.

A second line of investigation would suggest a significant correlation between P and creativity as measured by current creativity (trait) tests, such as the Torrance (1974) and Wallach and Kogan (1965) tests. Several such studies have been reviewed elsewhere (H. J. Eysenck & S. B. G. Eysenck, 1976); here, we may concentrate on what is perhaps the most impressive study done so far—namely, Woody and Claridge (1977).

Woody and Claridge's (1977) subjects were 100 Oxford University undergraduate and graduate students. The students constituted a wide sampling of the various fields of specialization at the university. The writers chose students as their subjects based on evidence that creativity is significantly related to IQ up to about 120 but becomes independent of IQ above 120 (Canter, 1973; Haensly & Reynolds, 1989). The tests they used were the Eysenck Personality Questionnaire (EPQ; H. J. Eysenck & S. B. G. Eysenck, 1975) and the Wallach–Kogan Creativity Tests (Wallach & Kogan, 1965), somewhat modified and making up five different tasks (instances, pattern meanings, uses, similarities, and line meanings). Each task was evaluated in terms of two related variables—number of unique responses produced by the subject (originality) and total number of responses produced by the subject (fluency).

For P with "number of responses" scores, the Pearson product–moment correlation coefficients between psychoticism and creativity scores are .32 for instances, .37 for pattern meanings, .45 for uses, .36 for similarities, and .38 for line meanings; for P with "uniqueness" scores, the coefficients are .61, .64, .66, .68, and .65, respectively. It can be seen that all the correlations are positive and significant and that those with the uniqueness scores—which are, of course, more relevant than those with the "number of responses" scores—are all between .6 and .7. These values are exceptionally high for correlations between (a) what is supposed to be a cognitive measure and (b) a test of a personality trait—particularly when general intelligence has effectively been partialed out from the correlations through selection of subjects. Effectively, there were no significant correlations between E and N, on the one hand, and creativity on the other. However, it is interesting to note that the L score of the personality questionnaire, which is up to a point a measure of social conformity, showed, throughout negative correlations with creativity scores, 7 of 10 being statistically significant. L is known to correlate negatively with P (H. J. Eysenck & S. B. G. Eysenck, 1976).

A partial replication of the Woody and Claridge (1977) study was carried out by Stayte (1977), who used the Wallach and Kogan (1965) tests and the EPQ score as a measure of psychoticism. According to Stayte, "All the correlations are positive, and a fair proportion are significant or near significant" (p. 49). Stayte also used two other psychoticism measures, which, however, correlated poorly with P. Only the "total uniqueness" global score on the creativity tests correlated positively with all three psychoticism tests. Rawlings (1985) also provided some replication of the Woody and Claridge (1977) finding—with correlations between P and creativity centering on .20.

Studies not using the P scale have come up with creative person traits not dissimilar to those characteristic of the person scoring high on P. Getzels and Jackson (1962) found that divergers were unconventional and independent of judgment (see also Torrance, 1962). Hudson (1966, 1968) also noted convergers' conformity and divergers' rebelliousness and failure to "fit in."

Of the studies reviewed so far, it might be said in criticism that they deal with psychological tests of creativity and originality in normal and not very distinguished people and that what is normally understood by originality and creativity demands something more than that. The objection is reasonable, although it should not be taken to weaken the remarkable success achieved by Woody and Claridge's (1977) empirical testing of the hypothesis linking P and creativity.

We must now turn to the third line of research suggested by our theory—namely, the correlation of P with creative achievement of a high order. The only study of what most lay people would consider genuine creativity was reported by K. O. Götz and K. Götz (1979a, 1979b), whose work significantly extends that of other investigators who tried to link creativity in the arts with personality (e.g., Barron, 1972; Csikszentmihalyi & Getzels, 1973; Drevdahl, 1956; H. J. Eysenck, 1972b; H. J. Eysenck & Castle, 1970). Some of these studies are difficult to interpret, but we may note that H. J. Eysenck (1972b) and H. J. Eysenck and Castle (1970) found that art students were significantly more introverted and neurotic than non-art students. K. O. Götz and K. Götz (1973) pointed out in criticism that art students in general may not be particularly creative but that, when a group of highly gifted art students was compared with a group of less gifted and ungifted subjects, the highly gifted students also had low scores on extraversion and high scores on neuroticism. It may be noted that neuroticism would seem to be related positively to creative work in the arts and negatively to creative work in the sciences; the reason might be the emotional involvement in art and the explicit rejection of emotion in science. The point would be that neuroticism is not related to creativity per se but to the direction of creativity. Introversion is characteristic of high creative achievement in art and science—but probably by way of concentrating the mind on the tasks in hand and preventing the dissipation of energy on social and sexual matters unrelated to work (Glover et al., 1989).

K. O. Götz and K. Götz (1979a, 1979b) administered the EPQ to 337 professional artists living in West Germany; 147 men and 110 women returned the questionnaire. Mean age was 47 years. One outstanding result of this work was that male artists were significantly more introverted and significantly more neurotic than non-artists; for female artists, there was no difference on either dimension. As K. O. Götz and K. Götz suggested, it is perhaps true that, in our Western world, mainly women with average or higher scores on extraversion have the courage to become artists, whereas the more introverted and possibly more artistically gifted women do not dare enter the precarious career of the artist.

We must now turn to scores on psychoticism. Here the results are very clear—male artists have much higher P scores than male non-artists, and female artists have much higher P scores than female non-artists. As K. O. Götz and K. Götz (1979a) pointed out:

> These results suggest that certainly many artists may be more tough-minded than non-artists. Some traits mentioned by [H. J.] Eysenck [and M. W.] Eysenck [(1985)] may also be typical for artists, as for instance they are often solitary, troublesome and aggressive, and they like odd and unusual things. (p. 332)

K. O. Götz and K. Götz's (1979a, 1979b) work thus offers important support for the results of Woody and Claridge (1977) and the other authors already cited in that this more recent work uses actual artistic achievement as a criterion for the measurement of creativity and originality. In doing so, K. O. Götz and K. Götz gave credibility to the validity of divergent-thinking tests as measures of creativity and originality, and the fact that significant correlations have been found between psychoticism and creativity and originality both in artistic and non-artistic populations studied by other investigators very much strengthens the hypothetical link between the personality trait and the behavioral pattern. Thus, we may be justified in concluding that originality and creativity are the outcome of certain traits rather than cognitive variables or abilities. This is an important conclusion that is somewhat in contrast with assumptions usually made in this field.

P. Rushton (1990) provided another direct test of P–creativity (achievement) correlation. With 52 university professors, publication and citation counts correlated .26 with rated psychoticism. Among 69 university professors, enjoyment of research correlated .43 with self-rated psychoticism. Also, among 194 university students, the Wallach–Kogan test of divergent thinking correlated .17 with EPQ–P. The correlations are low but in the right direction.

The K. O. Götz and K. Götz (1979a, 1979b) study is the only one that actually used the Psychoticism scale, but other studies have implicated creative person traits that are clearly part of the P syndrome. Thus work of the Institute for Personality Assessment and Research (IPAR) at Berkeley, under the direction of MacKinnon (1962a, 1962b), was concerned with creativity in architects, writers, and mathematicians. As described by MacKinnon (1962a, 1962b) and Barron (1969), creative people showed traits of individualism and independence, lack of social conformity, unconventionality, and lack of suggestibility (Crutchfield, 1962); they were also below par in sociability and self-control. Responses on tests like word association were odd and unusual, almost like those of schizophrenics.

Most important, the creative architects studied by the IPAR group consistently showed greater psychopathology on the MMPI Depression, Hypochondriasis, Hysteria, Psychopathy, and Paranoia scales than did the controls. Lytton (1971) concluded that "it is difficult ... to deny that there is more than a chance association between psychiatric difficulties and creative powers" (p. 63). As already mentioned, however, this psychopathology is countered by greater ego-strength, as also shown on the MMPI scales.

The position of introversion and neuroticism in the creativity field needs a little further discussion. Introversion seems to be implicated both for artists and scientists (Cattell & Drevdahl, 1955; K. O. Götz & K. Götz, 1979a, 1979b; Roe, 1951, 1952), although perhaps more for scientists than for artists (Hudson, 1966). Neuroticism, however, is clearly more associated with the arts than the sciences (Wankowski, 1973). It is unfortunate that most empirical studies have used interviewing techniques and tests that do not always enable the reader to make clear distinctions among P, E, and N; the use of standard tests like the EPQ would seem to make strict comparisons between studies possible, in a way that the random use of different inventories does not. Nevertheless, the major trends are unmistakable.

Here, I will not pursue in detail other arguments linking P and creativity because they are less relevant to the problem of measurement, and they allow for alternative explanations. Thus, male gender is positively correlated with P (H. J. Eysenck & S. B. G. Eysenck, 1976) and with creativity (achievement). To illustrate the latter, there are no women among Roe's (1951, 1952, 1953) eminent scientists; very few in American Men of Science, or the Royal Society, or a list of the leading mathematicians (Bell, 1965); and none would be found among the 100 best-known sculptors, painters, or dramatists. Simonton (1991) found no women in a list of the 120 most famous composers, from the Renaissance to the 20th century, and hardly any women among his scientists. It is only among poets and novelists that a small proportion of women would be found in the top class. Over (1980, 1982) and J. P. Rushton (1989) have published figures for productivity for men and women in departments of psychology and also for number of citations—showing very marked and, in fact, increasing disparity. This proportionality (P to maleness as creativity to maleness) might be used to argue for the relation between P and creativity, but there may be other, more cultural arguments to explain these phenomena. However, it would not be correct to argue that being married and having children are the responsible factors in the gender differentiation. Cole and H. C. Zuckerman (1987) found that "women publish less than men, but marriage and family obligations do not generally account for the gender difference. Married women with children publish as much as their single female colleagues" (p. 119).

It is also interesting to note that schizoid monozygotic co-twins of schizophrenics showed character disorders when male, neurotic symptoms when female (Cadoret, 1973). Thus, the aggressive, antisocial characteristics of the character-disordered type may be the variable making for success in science or in the arts—rather than creativity by itself. Clearly, the causal arrow points in several directions, making interpretation difficult.

Age is another variable that shows a correlation with both P and creativity; P scores decline with age (H. J. Eysenck, 1987), and so does creativity (Simonton, 1984). Such a correlation can be predicted on the basis that high P underlies creativity; as P declines with age, so does creativity. Of course, this relation should be more firmly established by longitudinal studies; there are obvious difficulties and dangers involved in cross-sectional investigations.

A final and rather mysterious relation between schizophrenia and eminence is found in the "season of birth" field. Huntington (1938) and Kaulins (1979) found that eminent people (defined as being listed in the *Encyclopaedia Brittanica)* showed a strong tendency to be born in the months between the winter solstice and the spring equinox; at the peak, in February, 36 eminent persons were born per day as compared with 27 at the trough! (The study encompassed more than 11,000 people, and the trend is significant beyond doubt, whatever the reasons.) The explanation does not lie in IQ; if anything, the opposite trend applies to IQ data, although it is much weaker (Pintner & Forlano, 1943). The same trend as for eminence is observed with respect to psychosis (E. H. Hare, 1987); psychotics also show a strong tendency to be born in February! It is not clear why either eminent people, presumably high on creativity, or schizophrenics should be conceived with very much greater frequency in May and June, as compared with ordinary people. Until this question is answered, the observed close correlation between eminence and schizophrenia remains a puzzle.

The association of genius-creativity with P may also serve to explain what would otherwise be somewhat confusing—namely, the proclivity of genius to fraud and deceit (Broad & Wade, 1982). The range of famous scientists who "betrayed the truth" (to use the title of Broad & Wade's book) is immense, ranging from Ptolemy to Newton, from Mendel to Millikan. How can honest, upright citizens descend to such conduct, which would be criminal if indulged in by an accountant or tax inspector? We have already noted the close genetic link between psychoticism and psychopathy; psychopathic behavior of this kind is not unexpected in high-P individuals, such as creative people in the scientific

field. The prevalence of fraud in modern science—documented by Broad and Wade, particularly among the most creative—should therefore come as no surprise. (Of course, we cannot argue the reverse. It is not true that the more a scientist cheats, the more creative he will be!)

Of course, it should not be assumed that this personality trait of P, even when found in conjunction with high N and low E, can by itself produce original work of consequence. A certain reasonably high amount of intelligence and/or artistic or scientific ability is obviously required in order to enable a person possessing high creativity and originality to produce anything worthwhile. It is obviously important to separate the successful use of personality traits such as those mediating creativity and the unsuccessful use degenerating into mere oddity and possibly psychotic deterioration. For the future study of gifted children, it seems desirable that personality tests such as the Junior EPQ (H. J. Eysenck & S. B. G. Eysenck, 1975) should be included in order to measure the influence that personality traits have on the manifestations of creativity and originality. Creativity and originality are such important aspects of human endeavor that a better understanding of their relations to both temperament and cognition seems vital, and no doubt future research will clarify these relations even further.

For the moment, we should bear in mind these results in looking at the education of original and creative children. The findings discussed in this article suggest that such children will be particularly difficult to deal with because they will be troublesome, unusual, difficult to reach, and behaving in possibly odd ways that may not appeal to the teacher or their peers; their very originality may upset the even running of the classroom and may produce difficulties for the teacher trained to insist on standard responses. Getzels and Jackson (1962) noted that their creative children were not particularly popular with teachers. This is perhaps not to be wondered at in view of what has already been said here. Possibly more important than special methods of educating original and creative children would be special ways of educating their teachers in the appreciation of the value of originality and creativity and in the ways creative children are likely to behave (or misbehave!). Essentially, such children tend to go their own way, and, in a culture geared to uniformity, this is a pattern not easily accommodated in school. All the more important, then, that teachers should make allowances and should learn to value the independence shown by such children.

K. O. Götz and K. Götz (1979b) made an interesting comparison between professional artists and successful artists. They found that, when ratings were made on the artistic success of their subjects, the more successful subjects—in terms of one-person shows in galleries and museums; participation in important exhibitions; works in museums and important collections; articles and reproductions in books and art reviews; existence of catalogues of their own work—had much higher P scores than the less successful subjects ($p < .001$). K. O. Götz and K. Götz (1979b) attributed this worldly success in part to the personality traits associated with P: "Persons who score high on Psychoticism and who are impersonal, egocentric, and self-contained seem to be exceptionally well positioned to look after themselves in our type of society. This may also be true for the majority of successful artists" (p. 922). Of eight very successful artists, five had very high scores on P. Those with relatively low scores were quite old, and success had come only after a very long period of neglect. (Note that P declines with age; H. J. Eysenck, 1987.) K. O. Götz and K. Götz (1979b) also found that P–type behavior can be successful in some people who, although having "no highly personal artistic conception," (p. 923), by "manufacturing the ideas of others; they may be successful because they are assertive and well positioned to look after themselves" (p. 923).

K. O. Götz and K. Götz's (1979a, 1979b) conclusion may be summarized by saying that P contributes both to the creativity of artists and to worldly success. This suggests a pleiotropic genetic mechanism at work; creativity contributes only to inclusive fitness when linked with certain personality traits that enable the creative person to impose his or her creative conceptions on society. Clearly, this is no more than a suggestion for future research; not enough data are at hand to establish the hypothesis with any confidence. The degree of psychopathy, paranoia, and dominance shown by persons scoring high on P is, of course, characteristic of many famous scientists and artists (Newton, Wagner, Galileo), although such traits are by no means universal (Kepler, Faraday, Maxwell).

The resistance to creative novelty is not confined to the arts; if anything, it is even more apparent in science (Barker, 1961). In documenting this theme, Barker (1961) referred to many well-authenticated examples. Planck's (1949) famous remark (cited in Barker, 1961) is typical of the situation: "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it" (p. 598). Such obtuseness on the part of the establishment clearly implies that creativity is not enough; the creative scientist needs a personality sufficiently combative, resilient, self-reliant, dominant, aggressive, and perhaps self-centered and bloody-minded to make his or her ideas triumph over orthodoxy (H. J. Eysenck, 1990). There are many martyrs in this battle—

Galileo being the most obvious example; Semmelweiss (Slaughter, 1950) is another; Lobachevsky a third (Bell, 1965).

I have listed three major lines of inquiry for determining the likelihood that the P–creativity theory might have a right to be considered seriously; of course, these are additional to the many demonstrations that traits associated with P are also often associated with creative achievers. I have already quoted sufficient findings to substantiate such a relation. A much more detailed review was given by Prentky (1980), who also came to the conclusion that creative achievement is linked with psychopathology, although not with actual psychosis (see also Richards, 1981). Thus, this line of argument may be our fourth empirical support for the theory linking P with creativity. A fifth line of support is exceptionally important and is considered in the next section; it deals with the identification of cognitive styles leading to creative behavior, with psychoticism and psychosis (particuarly schizophrenia). Thus, we have five different ways of supporting the P–creativity model:

1. Persons genetically related to psychotics are unusually creative.
2. P is related to tested creativity (originality).
3. P is related to creative achievement.
4. Creative persons often suffer psychopathology.
5. Identical cognitive styles are characteristic of psychotics, high P scorers, and creative achievers.

Any one of these lines of inquiry would be sufficient to strengthen the model; in combination, they may serve to make it acceptable.

A Theory of Creativity

The best proof of a fairly general theory in a "fuzzy" field is the creation of a model that makes testable predictions. The particular model suggested here derives directly from Figure 4. The argument relating to testable derivations from the model is as follows: Let us postulate that trait T is co-linear with the abscissa X; if X = P, then T should correlate with P in a normal population. It should also correlate with P in a schizophrenic-psychotic population. Last, it should differentiate between normal and psychotic subjects. This is part of the method of criterion analysis (H. J. Eysenck, 1950). To illustrate the method, let us take a few tests that have been shown to differentiate between normals and psychotics (usually schizophrenics). The intention is to demonstrate a method that enables us to determine whether a personality inventory scale (P) assumed to measure psychoticism does in fact do so. We then go on to apply the same method to originality-creativity and demonstrate that it is related both to P and to psychosis in the same way as to the other psychosis markers to be discussed.

As an example, consider HLA B27, a subsystem of the human leukocyte antigen system, which is found more frequently in schizophrenics than in normal, nonpsychotic subjects (Gattaz, Ewald, & Beckman, 1980; McGuffin, 1979). In a comparison of schizophrenic patients with (n = 11) and without (n = 29) HLA B27, Gattaz (1981) showed that those with the antigen had significantly higher P scores ($p < .02$). In another study (Gattaz, Seitz, & Beckman, 1985), 17 B27 positive and 16 B27 negative nonpsychotic subjects showed a difference on P scores in the expected direction ($p < .01$). This example shows the expected effects of an association between P and T in normal and psychotic groups and might serve to illustrate the method.

Many other studies have given similar results supporting the view that P = psychoticism. These studies are concerned with the prevalence of hallucinations (Launay & Slade, 1981; Slade, 1976), eye tracking (Bosch, 1984; Iacono & Lykken, 1979; Iacono, Peloquin, Lumry, Valentine, & Tuason, 1982; Lipton, Levy, Holzman, & Levin, 1983; Siever et al., 1982; Simons & Katkin, 1985; Yasamy, 1987), hemispheric differences (Flor-Henry & Gruzelier, 1983; Jutai, 1988), dichotic shadowing (Broks, 1984; R. D. Hare & McPherson, 1984; Rawlings & Borge, 1987; Rawlings & Claridge, 1984), attention deficit (Goldstein, 1965; Hinton & Craske, 1976; Malmo, Shagass, & A. A. Smith, 1951), masking deficit (Badcock, G. A. Smith, & Rawlings, 1988; Braff, 1981; Braff & Saccuzzo, 1981; Mannuzza, Spring, Gottlieb, & Kietzman, 1980; Merritt & Balogh, 1984; S. Miller, Saccuzzo, & Braff, 1979; Saccuzzo & Schubert, 1981; Nuechterlein & Dawson, 1984), low platelet MAO (Buchsbaum, Coursey, & Murphy, 1976; Checkley, 1980; Klinteberg, Schalling, Edman, Oreland, & Aesberg, 1987; Schalling, Edman, & Aesberg, 1987), serotonin levels (Schalling et al., 1987; M. Zuckerman, 1991), and negative priming (Beech, Baylis, Smithson, & Claridge, 1989; Beech & Claridge, 1987; Beech, Powell, McWilliam, & Claridge, 1989; Claridge & Chappa, 1973; Claridge, Robinson, & Birchall, 1985; Frith, 1979; Tipper, 1985; Tipper & Baylis, 1987; Tipper & Cranston, 1985). A detailed analysis of all this work is given elsewhere (H. J. Eysenck, 1992).

Of particular importance, for theoretical reasons, is the final concept to be discussed here—namely, "latent inhibition," a close relation of negative priming (Weiner, 1990). Passive pre-exposure to a stimulus reduces the ability of the stimulus to enter into new associations when that opportunity is offered in the same context as the initial pre-exposure (Pearce & Hall, 1980). This

phenomenon, originally studied in animals, has now also been widely investigated in human subjects, both adults and children (Lubow, 1989). Lack of latent inhibition would promote attentional deficits, such as occur in schizophrenics, and it has been shown that schizophrenics not under medication, or at an early stage of medication, do indeed show less latent inhibition than controls (Baruch, Hemsley, & Gray, 1988). It was found that medication, as expected, reversed this trend.

When the same procedure was tried on normal subjects, using the Claridge Schizotypy Scale and the Eysenck Psychoticism measure as psychosis-prone scales, these were negatively correlated with latent inhibition, supporting the hypothesis. Lubow, Ingberg-Sachs, Zalstein, and Gewirtz (in press) replicated the Baruch et al. (1988) study, showing that latent inhibition was weaker in high–P than in low–P subjects. Here, also, predictions of proportionality are successfully verified.

Of course, much more could be said about the theories involved in these studies, the experimental difficulties of taking into account drug administration in chronic schizophrenics, or, indeed, the theoretical prediction of changes in experimental behavior to be expected when acute psychosis becomes chronic (Gray, Feldon, Rawlins, Hemsley, & A. D. Smith, 1991). Many of the questions find at least a tentative answer in the Gray et al. article, which attempted the construction of a neuropsychological model of schizophrenia (or perhaps psychosis?). This model includes animal studies, amphetamine effects on psychotic-like behavior, and several other topics indirectly relevant to our purpose, but not sufficiently so to deserve detailed comment here.

We may summarize the findings of this section so far by stating that the methodology of proportional effect has been surprisingly successful in showing that schizophrenic–normal differences are reproduced when comparing high–P and low–P subjects both in normal and (less frequently) psychotic groups. Although not universally successful, the great majority of comparisons have shown the expected effects, and it would seem difficult to account for these findings on grounds other than the admission of a continuum ranging from the normal to the psychotic, with gradings within both the normal and the psychotic portions. Many details remain to be sorted out, and many other hypotheses remain to be tested, but the outline is becoming clear.

These are only some examples from a large literature to illustrate the analogical method of hypothesis testing here used. Let us now consider its adoption to test specific causal theories of schizophrenia. If theory *T* predicts that schizophrenics, or psychotics in general, will show behavior *B*, as compared with normals, it follows that high–P subjects will also show behavior *B* when compared with low–P subjects. Now extend this analogical reasoning to creativity. If a special measure of creativity *(C)* is the behavior under consideration, then both schizophrenics (as compared with normals) and high–P subjects (as compared with low–P subjects) should show it. But, in addition, highly creative (achievement criterion) subjects should show *C* more than less creative subjects. Thus, on our hypothetical test of creativity-originality, psychosis : normality = P+ : P– = creative persons : noncreative persons. Thus, we now have a triple proportionality, all of whose relations must be verified in order to satisfy our criterion. What is the theory, and what is the test used?

What the main characteristic of schizophrenic thinking is has been hotly debated, but divergent theories often give similar predictions, suggesting that different labels may refer to similar underlying reality. We may begin with the concept of "overinclusive thinking," originally formulated by Cameron (1938, 1947; Cameron & Magaret, 1951) and reviewed and extended by Payne (1960, 1973; Payne & Hewlett, 1960). Overinclusive thinking is a conceptual disorder in which the boundaries of concepts become overextensive. Associated ideas, or even distantly related ideas, become incorporated into the concepts of schizophrenics, making them broad, vague, and imprecise. A second aspect of overinclusive thinking is the "interpretation" of irrational themes. Completely irrelevant, often personal ideas intrude themselves and become mixed up with the problem-solving process. Related to this conception is Cromwell's (1968) "defective filter" hypothesis—that is, the failure of schizophrenics to "filter out" irrelevant stimuli. Payne and Hewlett (1960) provided much empirical support for theories of this kind. (See also Hemsley, 1976.)

The notion of a defective filter was an early application of the information-processing paradigm in schizophrenic research, following Broadbent's (1958) model. Later work along several lines was reviewed by Hemsley (1982), who also pointed out the weaknesses of this approach as customarily applied to schizophrenic thinking. Hemsley (1987, 1991) himself has published a rather different theory, drawing on the work of Frith (1979, 1987), Posner (1982), and Schneider and Shiffrin (1977). Hemsley postulated that a weakening of the influence of stored memories of regularities of previous input on current perception is basic to the schizophrenic condition (see also Patterson, 1987) and leads to a lessening in the abilities of schizophrenics to use "top-down" strategies in processing information (i.e., to interpret incoming stimuli with reference to a model composed of stored information of past experience and knowledge). Schizophrenics thus have to rely on "bottom-up" processing, wherein fragments of in-

formation from the stimulus are pieced together without reference to an expected model (Hemsley, 1987).

In some ways, these models are but adaptations of Bleuler's (1978) original hypothesis that the primary problem in schizophrenics is a disturbance of the associative process—that is, a disturbance of the cognitive organizing mechanisms that allow associations or connections between ideas, enabling the organization of single thoughts and the exclusion of irrelevant thoughts. All the models mentioned would suggest that one deduction from the theories involved would be a widening of the associative horizon. This indeed appears to be an almost universal accompaniment of schizophrenia (and affective disorders frequently associated with schizophrenics; Sheldrick, Jablensky, Sartorius, & Shepherd, 1977). In recent years, attempts have been made to use clinical neuropathology findings to account for cognitive impairment in schizophrenics (Levin, Yurgelun-Todd, & Craft, 1989), but I do not follow up on this line of argument here.

Payne (1973) catalogued research on the tendency to produce unusual responses, a clear consequence of this hypothetical horizon-widening. Among the most widely researched tests has been the Word Association Test (WAT; Cramer, 1968; Kent & Rosanoff, 1910; Pavy, 1968; Rapaport, Gill, & Schafer, 1968). Using their 100-item test, Kent and Rosanoff (1910) tested 1,000 "normal" subjects and 247 psychotics (of whom 108 were diagnosed dementia praecox, 32 manic depressive, 33 paranoid, and 32 general paresis, with a few other diagnoses). Individual responses formed 6.8% of the associations of the normal subjects but 26.8% of the associations of the psychotics. (Neurotics gave 10.3% of individual responses and so were much more like the normal subjects than the psychotics.) Similar findings have been reported almost universally. De (1953) used an all-male population of 60 normals, 96 psychotics, and 75 neurotics; he split each group into two subgroups and counted popular responses. For normals, scores were 97 and 50; for neurotics, 56 and 46; for psychotics, 42 and 40 ($p < .001$). S. B. G. Eysenck (1955) used 123 controls, 55 neurotics, and 55 psychotics and found that psychotics (a) more frequently had fewer than 10% "popular" responses and (b) gave fewer responses agreeing with the majority ($p < .01$). There were many additional differences among the three groups: The psychotics repeated the stimulus word more frequently, gave multiple responses more frequently, perseverated the same response more frequently, gave synonyms more frequently, and gave "cause–effect" responses more frequently; in every case, the neurotics were much more like the normals than the psychotics.

Many other studies have replicated these findings (L. J. Chapman, 1958; Downing, Ebert, & Shubrooks, 1963; Faibish, 1961; R. C. Johnson, Weiss, & Zelhart, 1964; Lehman & Dorken, 1953; Lester, 1960; Moran, 1953; Schwartz, 1978, 1982; Seth & Beloff, 1959; Shakow & Jellinek, 1965; Soumer, Dewar, & Osmond, 1960; Tendler, 1933, 1945; Wynne, 1964); this must be one of the best-established facts in psychology, although causal models differ with respect to an explanation. These results assume particular importance when it is realized that common, primary, or usual responses occur with intra-individual regularity; in other words, measurement is highly reliable (Pack & Pons, 1985).

If our hypothesis of an underlying continuum of psychoticism is correct, we would expect biological relatives of schizophrenics—although not themselves psychotic—also to show unusual responses in word association tests. Several studies have shown this to be so (Ciarlo, Lidz, & Ricci, 1967; Griffith, S. Mednick, Schulsinger, & Diderichsen, 1980; S. A. Mednick & Schulsinger, 1968; Zahn, 1968). As Ward, McConaghy, and Catts (1991) pointed out, this suggests that the altered associative process reflected by normal WAT responses may be linked to a constitutional vulnerability factor, rather than to schizophrenia as such. This is important evidence suggesting that psychoticism rather than psychosis is linked with the greater associative horizon. McConaghy and Clancy (1968) used the term *allusive thinking* to describe this familially transmitted conceptual style; they used "loose" sortings on an object sorting test (OST) created by Lovibond (1954) as a measure of this allusive thinking and found that parents of "thought disordered" schizophrenics showed greater "loosening" on the test, as did the parents of university students with high OST scores.

Similar results have also been reported by E. N. Miller and L. J. Chapman (1983) using the L. J. Chapman and J. P. Chapman (1980) scales as measures of schizotypal behavior. Using a continuous word association test, E. N. Miller and L. J. Chapman found that subjects with high scores in Perceptual Aberration/Magical Ideation gave a larger number of idiosyncratic responses. It is also relevant that Griffith et al. (1980) reported more deviant associations in the children of schizophrenic parents.

Andreasen and Powers (1974) showed that highly creative writers are "overinclusive" as shown by their scores on the Goldstein–Sheerer Object Sorting Test. Andreasen and Powers's data suggested that the conceptual style of writers may resemble mania rather than schizophrenia and that, if overinclusiveness is an index of thought disorder, manics may have a more florid thought disorder than schizophrenics.

Along similar lines, Armstrong and McConaghy (1973) examined measures of word association in university students based on the hypothesis that the "halo"

of words considered to be related in meaning to a particular stimulus word would be broader in allusive than in non-allusive thinkers—including more words and hence words more distant in meaning from that of the stimulus word. (Armstrong & McConaghy used the term *halo* in much the same way I have used the term *horizon.)* Armstrong and McConaghy did indeed find significant correlations between their Word Halo Test (WHT), testing the selection of words considered by the subject to be nearly the same in meaning as nominated stimulus words, a Word Sorting Test (WST) requiring the subject to group together words similar in meaning, and the OST. Several PhD theses quoted by Ward et al. (1991) reported the expected correlations between these tests, on a variety of samples, and also the predicted correlation with the WAT, using less common responses as the score.

In addition, earlier studies related patterns of unusual word association performance with psychosis proneness (Allen, L. J. Chapman, & J. P. Chapman, 1987; E. N. Miller & L. J. Chapman, 1983) and the Eysenck Psychoticism Scale (summary by Ward et al., 1991). Using this early work as a base, these authors then went on to administer to 93 students the OST, total number of words chosen on the WHT (WHT–WC), mean commonality on the WHT (WHT–COM), commonness of responses on the WAT (WAT–COM), proportion of distance responses on the WAT (WAT–PD12), the EPQ–P, the Perceptual Aberration Scale (PAS; L. J. Chapman, J. P. Chapman, & Raulin, 1978), the Physical Anhedonia Scale (ANH; L. J. Chapman, J. P. Chapman, & Raulin, 1976), and the WAIS, as a measure of intelligence.

The psychometric vulnerability measures showed positive but low intercorrelations for men and women—except for the ANH, which failed to correlate with the OST, the PAS, and the EPQ–P. All four scales showed slight negative correlations with IQ. The word usage tests (WAT, WHT) correlated as expected with the EPQ–P, the OST, and the PAS but not with the ANH, which clearly does not belong with the other vulnerability scales (as also shown in factor analyses already mentioned). Ward et al.'s (1991) results for P replicated two earlier (unpublished) studies giving evidence of a "distant response tendency associated with high EPQ–P scores" (p. 478), although, as with most results in the Ward et al. study, correlations were higher for men than women.

Upmanyu and Kaur (1986) also tested this hypothesis, albeit unintentionally; their aim was not related to our theory, but their results are nevertheless highly relevant. Upmanyu and Kaur tested 140 female university students at Gurn Kanak Dev University, Amritsar, using the Kent–Rosanoff WAT (Kent & Rosanoff, 1910), the EPQ (H. J. Eysenck & S. B. G. Eysenck, 1975), an IQ test, and the Cattell–Scheier Anxiety Scale Questionnaire. Six emotionality indicators were scored on the WAT:

1. Unique response (UR): Following W. Brown (1965) and Kuntz (1974), any response made by 1% or fewer of the subjects.
2. Long reaction time (LRT): RTs longer than 2.6 sec.
3. Repetition of stimulus word before responding (RSBR).
4. Reproduction failure—Forgetting (F_g): subject indicates he or she is unable to recall his or her initial response.
5. Reproduction failure—Misremembering (M): subject recalls previous response incorrectly.
6. Response repetition (RR): subject responds with word already used as response to previous stimulus. The WAT was given twice, with instruction to give the same response again on the second presentation of the given stimulus.

A factor analysis of the intercorrelations between the five WAT variables and the personality variables showed that the Psychoticism scale correlated at the $p < .01$ level with UR ($r = .32$) and RR ($r = .26$); the correlation with M was almost significant ($r = .15$). Correlations of E and N with the WAT scores were all quite insignificant, as were those with L and IQ. A factor analysis of the combined WAT and personality test scores resulted in a factor loading prominently on P (.58), M (.56), UR (.70), and RR (.66). The results clearly demonstrate the hypothesized relation between P and indicators of unusual verbal reactions. Compared with single indicators, combinations of indicators showed even higher correlations with P—the correlation of P with M–UR being .40 and with RR–UR being .45; combinations not including UR were universally insignificant, suggesting that UR was the most important feature of the WAT as far as association with personality was concerned.

A small group of schizophrenics and neurotics was also tested; the schizophrenics were clearly differentiated from normals and neurotics on UR, M, and RR and even better on the M–UR and RR–UR combinations. Clearly, P differences in normal subjects mirror differences between schizophrenics on the one hand and normals and neurotics on the other.

The data cited would seem to establish that both schizophrenics and high–P subjects are characterized by wide associative horizons; is it also true that creativity (achievement) shows similar correlations? MacKinnon (1962a) administered a word association test to his sample of architects and scored their responses for unusualness of mental associations, taking as his measure "associations given by no more than 1%

to 10% of the population" (p. 491). The score for the most creative group of architects was 204; the score for the least creative group was 114; the score for an intermediate group was 128. For the total sample, his measure of unusualness of mental associations correlated .50 with rated creativity. This is a truly astonishing correlation, given the obvious lack of complete reliability and validity of the ratings and the fact that the WAT score would have a reliability of only around .70.

Correcting for attentuation on any reasonable estimate of reliabilities would give us an estimate of the "true" relation of between .65 and .70. That means that almost 50% of the variance of creativity (achievement) can be predicted on the basis of a simple word association test—surely a remarkable finding! It certainly completes our proportionality argument and suggests that we may regard this fourth proof of our general theory linking creativity and P as supported by the available evidence.

Gough (1976) reported on a similar study done with 80 engineering students and 45 industrial reward scientists. The subjects were rated for creativity and were given two word association tests—one general and one using a scientific-word list. Both lists correlated with creativity, but the scientific-word list gave higher correlations. This is an intriguing finding that ought to be followed up on in future research.

Clearly, there appears to be a paradox in the prevalence of high–psychoticism-schizotypy traits among highly creative individuals and high–trait-creativity (original) individuals; this does support the view that high trait-creativity bears some relation to high achievement-creativity, but this clearly cannot be the whole story. MacKinnon (1965) was well aware of the problem. Having noted that his creative architects were "more complicated and more psychologically disturbed" (p. 279) than his less creative architects, he asked, "That being the case, what is it that gives them a greater capacity to handle the psychic turbulence which they experience?" (p. 279). MacKinnon referred, in terms of the tests used, to the "integrative power of the person as a whole" (p. 279), as shown in the MMPI Ego-Strength scale developed by Barron (1953) and the IPAR Self-Assertiveness scale; MacKinnon also mentioned concepts such as "positive will" (Rank, 1945). Other potential traits mentioned by MacKinnon (1962a) are dominant; self-confident; aggressive; self-assured; independent and high on autonomy; and strong motivation to achieve (p. 490). Rutter (1985) drew attention to the existence of "protective factors and resistance to psychiatric disorder" (p. 598) and discussed in detail the conditions favoring the emergence of such protective factors; historiometric studies of such factors in the development of genius and creativity would be most welcome.

There is considerable evidence for the existence and indeed prominence of such positive protective factors as MacKinnon (1965) found in his creative architects and as Cox (1926) found in her outstanding geniuses in the course of her "Genetic Studies of Genius—The Early Mental Traits of Three Hundred Geniuses." Although Cox's IQ estimates of these geniuses are much better known, suggesting a disattenuated mean IQ around 165, she also presented personality ratings of her subjects based on the early factorial studies of Webb (1915). One hundred cases were rated on 67 character traits by two raters independently, giving an average reliability of .53. Marks were awarded on a 7-point Likert scale, although of course Likert had not yet given his name to such a scale! What were the most characteristic traits of these youthful geniuses? Cox summed up her findings:

> We may conclude that the following traits and trait elements appearing in childhood and youth are diagnostic of future achievement: an unusual degree of *persistence—tendency not to be changeable, tenacity of purpose,* and *perseverance in the face of obstacles*—combined with *intellective* energy—*mental work bestowed on special interests, profoundness of apprehension,* and *originality of ideas*—and the vigorous *ambition* expressed by the possession to the highest degree of *desire to excel.* (p. 180)

These findings agree well with MacKinnon's, given the somewhat different nomenclature, and centers on the concept of "will" used by Webb in his original study to characterize noncognitive factors discovered in what was the first multifactorial analysis ever carried out—long antedating Thurstone. Schopenhauer would have approved of these findings, which support his conception of the "Welt als Wille und Vorstellung"!

In more modern language, we have conceptions like hardiness, coping style, autonomy, and so forth to represent these forces, which work against the negative ones inherent in the concept of psychoticism; clearly, the truly creative person is poised on the knife edge between two antagonistic sets of forces, the opposition of which may be responsible for the creative tension driving his or her work. This is an area that could well deserve more study than it has received.

The Causal Chain From DNA to Creativity

In the preceding sections, I have shown (or at least have attempted to show) that (a) creativity understood as a trait can be measured, (b) creativity is closely connected with personality (psychoticism), and (c) creativity interacts synergistically with intelligence, envi-

ronmental, cognitive, and personality variables to produce creative achievement. Given that psychoticism is strongly determined by genetic factors (Eaves et al., 1989) and that it is difficult to understand creative geniuses in other than largely genetic terms (Vernon, 1989), it is natural to ask what are the intermediaries between DNA on the one hand and creative behavior on the other. No confident answer can be given, of course; the question has seldom been asked, and it is unlikely that the answer here suggested will prove more than a platform for suggesting experiments to explore the field.

Nevertheless, the literature on psychosis–psychoticism, reviewed very briefly in the "A Theory of Creativity" section, does include hints that may add up to a theory that is at least suggestive, even though it may be regarded as highly speculative. There has been a resurgence of interest in the cognitive deficits in schizophrenics (Hemsley, 1991), and, as these link up closely with similar deficits in high–P normals, as compared with low–P normals, they may suggest links with creativity that should not go unnoticed. The particular cognitive features that link psychoticism with creativity are overinclusiveness, lack of latent inhibition, failure of the Kamin blocking effect (S. H. Jones, Gray, & Hemsley, 1992), inefficient negative priming, and the like. How can this link be conceptualized?

The link would appear to be selectivity in human information processing. Models of normal cognitive functioning agree on the proposition that perception is dependent on the interaction between the presented stimulus and stored memories of regularities in previous input. These memories result in expectancies (response biases) and serve to reduce information load. Several theoretical models consider schizophrenics' disturbances of perception and cognition; Hemsley (1991) listed seven. What seems to be basic to all these models (and to the facts that led to their acceptance) is the observation that a weakening of the influence of stored memories of regularities of previous input on current perception is basic to the schizophrenic condition (Hemsley, 1991, p. 113). Hemsley (1991) presented a good deal of recent evidence in support of this formulation.

In a similar vein, Anscombe (1987) argued that both internally and externally generated perceptions are not placed in a context of background knowledge. Altogether, there is much agreement on the proposition "that the schizophrenic condition is characterized by a reduction in the influence of the regularities of past experiences on current perception" (Hemsley, 1991, p. 115). In the schizophrenic literature, this fundamental notion is usually applied to delusional beliefs, thought disorders, hallucinations, and the like; these are extreme consequences that nevertheless might be considered "creative." But here we would be more concerned with their possible influence on originality generally. Regularities of past experience are invaluable in creating a pattern to which new experiences, problems, and perplexing difficulties can be referred in the hope of bringing order into the booming, buzzing confusion of unordered existence. But, insofar as they impose such a pattern, they inhibit novel, original, creative ideas not included in these past regularities from emerging. Reliance on regularities of past experiences constrain our word associations to customary channels; *table* has always been found conjoined to *chair* in our experience, and, insofar as we are relying on these regularities of past experience to guide our thought processes, we will be inhibited from replying with *fish* or some other unique response.

Clearly, there is a continuum from rigidity (i.e., close uniformity for those experiential regularities that are very similar to different members of any social group) to extreme looseness or overinclusiveness. Many authors have postulated a concept of inhibition to account for the limitation of associative connections and for the adherence to the dictates of experience, learning, and habit; this inhibition leads to a reduction in load on a limited capacity system. As Hemsley (1991) pointed out, "cognitive abnormalities in schizophrenia might then be seen as related to a weakening of inhibitory processes crucial to conscious attention" (p. 113). Such a failure of inhibition has also been used to explain the performance of schizophrenics (and high–P normal subjects) on tasks involving latent inhibition, negative priming, and Kamin blocking. Lubow (1989), in particular, has been active in developing more explicit theories for latent inhibition, but these theories can obviously be extended beyond this one type of paradigm.

The particular theory advocated by Lubow (1989) can be generalized because it uses attention as a hypothetical construct with the characteristics of a Pavlovian response and, of course, because cognitive deficits related to attention have concerned most modern theorists of psychotic behavior. Lubow's conditional attention theory of latent inhibition is too complex to be discussed here in detail; it is a particularly good example of an inhibition theory used by him to throw light on schizophrenic behavior. Lubow's studies suggest that amphetamine decreases inhibition and haliperidol increases inhibition. They also suggest that the crucial factor is the dopaminergic action of amphetamine, as contrasted with the activity of a dopaminergic antagonist, such as haloperidol; of course, this links this concept of latent inhibition with more general theories of psychosis involving dopamine; it is well known that antipsychotic drugs block dopamine receptors and suppress some types of schizophrenic symptoms. There is

also evidence of serotonin involvement; Lubow showed that 5-HIAA depletion abolishes latent inhibition. Hippocampal involvement in latent inhibition, too, follows what is known about its involvement in schizophrenia (Gray et al., 1991). Thus, there is an obvious similarity between one well-studied example of cognitive inhibition and schizophrenia, suggesting that the argument here advanced may not be entirely lacking in plausibility—particularly when we look at the enzyme and neurotransmitter results with psychoticism, reported in the previous section.

In a recent critical summary of the evidence on the biological background of latent inhibition, Weiner (1990) gave evidence relevant to the position taken by Lubow. Weiner concluded that the neural substrates of LI include the mesolimbic-dopaminergic system, the mesolimbic serotonergic system, and the hippocampus and suggested (a) that the hippocampus inhibits the switching mechanism of the nucleus accumbens via the subiculum-accumbens pathway and (b) that this action of the hippocampus is modulated by the mesolimbic-serotonergic system via its interaction with the hippocampus system, the mesolimbic-dopaminergic system, or both. In any case, there is a close correspondence with theories of schizophrenic behavior.

Note also that amphetamine—and cocaine, which, like amphetamine, is a powerful stimulant because it potentiates the release of catecholamines (NE and DA) and slows their re-uptake—has powerful effects on some form of creativity; it certainly potentiates vivid and original percepts that are often sought after by artistically inclined persons engaged in visual or auditory art production. Obviously, these remarks do not constitute a proper theory of creativity, although they may suggest testable deductions that in time may lead to the elaboration of a proper theory. But perhaps we may suggest, very tentatively, a causal chain linking all the different aspects of our theory into a testable whole, as shown in Figure 5.

Martindale (1989, 1991) put forward a somewhat different theory that nevertheless agrees in many particulars with the one outlined here. Beginning with theories like Kris's (1952) on the ability of creative people to alternate between primary-process and secondary-process modes of thought and Mendelsohn's (1976) contention that differences in focus of attention are the causes of differences in creativity, Martindale (1989) argued that defocused attention is a property of primary-process cognition. He used a neural-network model to illustrate the phenomena I have subsumed under the label of *overinclusiveness* and went on to use the concept of cortical arousal to explain creativity, making use of Hull's (1943) "behavioral law," which states that increases in drive (arousal) make the dominant response to a stimulus even more dominant, because P = D × H (i.e., performance is the product of drive and habit). Thus, high drive-arousal makes performance more stereotyped, and low drive-arousal makes creative and original behavior more likely. Indeed, virtually anything that increases arousal seems to impair performance on tests of creativity. This has been shown to be true of stress (Dentler & Mackler, 1964), the mere presence of other people (H. C. Lindgren & F. Lindgren, 1965), noise (Martindale & Greenough, 1973), extremes of temperature (Lombroso, 1895), and even reward (Amabile, 1983). This seems true in spite of the fact that creative people may be habitually somewhat more anxious than noncreative people and may have slightly higher levels of basic arousal on physiological measures (Martindale, 1992). Martindale has suggested that creative people may be more variable in their levels of arousal than are uncreative people—that is, creative people show more extreme fluctuation.

An alternative hypothesis would be that, although high on arousal, creative people practice withdrawal in order to escape overstimulation. There is much evidence for oversensitivity in creative people (e.g., Martindale & Armstrong, 1974; Nardi & Martindale, 1981). On all these points, creative people behave exactly like introverts (H. J. Eysenck, 1967; H. J. Eysenck & M. W. Eysenck, 1985), showing both high arousal and withdrawal in order to lower their level of arousal.

Martindale (1992) himself appeared to accept this as the more likely interpretation when he wrote:

> Although creative people do not seem in general to have low levels of arousal, their over-sensitivity may drive them to withdraw or to restrict sensory input. This in turn would put them in the low-arousal state necessary for creative inspiration.

The findings also agree well with the widespread finding that creativity is found more frequently in intro-

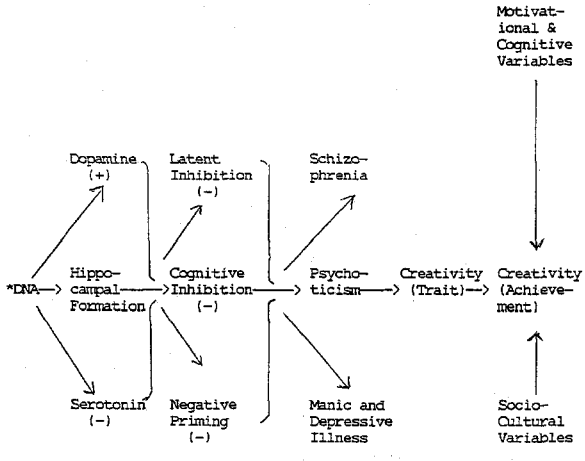

Figure 5. *Hypothetical causal chain from DNA to creativity. *Genetic determinants.*

verts, showing precisely this combination of high arousability and withdrawal. Martindale (1992) also linked creativity with lack of cortical inhibition:

> Primary process cognition can be connected with a relative lack of cortical inhibition. The disinhibition of creative people seems not to be confined to cognition but is a general trait. This is to be expected if creativity is related to low levels of cortical arousal.

The result, Martindale wrote, is "a general lack of both cognitive and behavioral inhibition." But this is not characteristic of introverts, who are more law-abiding and conforming than extraverts (H. J. Eysenck & Gudjonsson, 1989). There is clearly a paradox in Martindale's theory, or perhaps even an anomaly.

The arousal theory of creativity can be reconciled with Lubow's inhibition theory when we realize the implications of the work of Claridge (1972) and Venables (1963)—namely, that schizophrenia and psychoticism imply a chaotic interaction between the person and his or her environment, "manifest in *swings of physiological arousal,* fluctuating attention, disordered mood, distorted perceptions of reality, and patterns of thought and language that disrupt social communication" (Venables, 1980, p. 113). In other words, psychoticism is characterized by just the presence of both high and low arousal described by Martindale, and the inhibitory mechanism he has postulated can be found in the phenomena of latent inhibition, discussed previously. Essentially, I would suggest that Martindale's theory is self-contradictory as it stands but agrees well with the one offered here when we realize the importance of swings of arousal from high to low and back, which is so characteristic of psychotic behavior and its underlying physiological processes.

All the stages discussed in Figure 5, and all their interconnections, obviously need and deserve much closer investigation than they have received hitherto. Clearly, there is much guesswork involved in putting together this framework for future theorizing. Yet, even in its present form, the diagram does bring together a large amount of information that, for the most part, has not been linked in any way. It is agreed that there is a long and thorny way from DNA, through neurotransmitters and enzymes, to concepts of cognitive inhibition, psychoticism, and creativity. That there are some such connections I have no doubt; that they resemble those indicated is much more doubtful. All that can be demanded of a theory at such an early stage of investigation is that its various parts be testable and that the theory brings together, without obvious contradiction, most of the known facts. The decision as to the relative success of the theory in doing both these things must of course be left to the reader. I would plead in extenuation that the reason for the rather pessimistic tune with which Glover et al. (1989) open their *Handbook of Creativity*—they felt that this had become a large-scale example of a "degenerating" research program—may have been the lack of any fundamental theory bringing together the many and varied aspects of the field. That this should have been so was almost inevitable in a science that has not yet learned Cronbach's (1957) precept about "the two disciplines of scientific psychology"—namely, that both the experimental and the correlational, the field of generalized behavior and the field of individual differences, must ultimately fail if they remain in isolation and that they can only accomplish their objective if they cooperate. This theory is one attempt to put such cooperation into effect.

Even so, many components of creative achievement have been omitted, such as cultural factors, socioeconomic factors, many cognitive factors, and also many personality factors other than psychoticism. Of course, the reason is that many other writers have dealt with these aspects, and these aspects do not bear directly on the causal chain here developed. But, any complete theory would of course have to include them and, in due course, will undoubtedly do so. The study of creativity clearly needs more creativity in its devotees—more than is required in most other fields in psychology!

One possibility that may deserve closer study is the attempt to integrate the study of creativity with AI (i.e., computer processing). Boden (1990) argued in favor of the proposition that computers can be "creative" in some meaningful sense of the term and gave several impressive examples in the fields of drawing, mathematics, music, and science. There are certain interesting similarities between the fields of psychology and computers; the notion of association becomes a "semantic net" (p. 94), the associationist theory becomes a "connectionist" one (p. 118), and I have already discussed the use of "heuristics" in both fields. "Combinatorial explosion" sets limits to "blind research" for persons and computers alike.

The search algorithms listed by R. Smith (1990) link up with the concept of "relevance," which I have stressed, and may be used to clarify it further. Unfortunately, AI experts seldom listen to psychologists, and vice versa; what could be a useful example of cross-disciplinary fertilization has developed instead into a formation of "schools" unfortunately so characteristic of psychology. A proper degree of cooperation might be of considerable advantage to both sides, accelerating the advent of a general theory of creativity.

Summary and Conclusions

In this essay, I have tried to deal with the extremely "fuzzy" concept of creativity in an attempt to consider

the validity of creativity tests and to suggest a theory of creativity and the relation of creativity to mental abnormality. To know whether a test measures what it is supposed to measure (validity), we must have a theoretical model in mind into which test results can be fitted; the most obvious solution of measuring the test against an agreed criterion is obviously futile because, by definition, there is no such criterion, or else it would constitute an acceptable test itself!

In the case of creativity, such a model must be complex, even more so than in the case of intelligence, because creativity is much more circumscribed in its manifestations than is intelligence. Hence, this essay has dealt more with the construction of the model than with measurement directly; if the model is satisfactory, it can be used to judge the validity of any measurements suggested.

The model here developed distinguishes clearly between (a) creativity, or originality, as a dispositional trait or cognitive style, measurable by means of psychometric tests, normally distributed in the population, and general in its application and (b) creativity defined by exceptional achievement, assessed in terms of scientific or artistic work produced, with a J-shaped distribution in the population, and highly specific in its application. Creativity as a trait (originality) is assumed to be a necessary but not sufficient condition for creative achievement; cognitive abilities like intelligence, socio-cultural-economic conditions, and personality factors like persistence and motivation are also required and interact multiplicatively with creativity as a trait to produce the J-shaped curve of productivity (Price-Lotka law). It follows from these assumptions that trait creativity and achievement creativity would not necessarily intercorrelate highly—the latter being determined by many different factors in addition to creativity as a trait.

What lies at the back of the trait of creativity? I have suggested that a fundamental role in creativity is played by a trait of personality, psychoticism, that is characterized by a large associative horizon ("overinclusiveness") resembling that found in psychotic patients, particularly schizophrenics. I have shown that the behavior (including the cognitive behavior) of high–P normal people resembles that of psychotic patients in many ways and that both groups are characterized by wide associative horizons. I have also shown that creativity (achievement) is correlated quite strongly with measures of wide associative horizons, so that we have a triple proportionality among psychoticism, creativity, and schizophrenia. This does not mean that psychosis is directly related to genius, as it has often been put; psychosis, in addition to being characterized by a wide associative horizon, includes many elements that are completely destructive of creative achievement—and lacks many of the elements necessary for it. The distinction between psychoticism as a dispositional variable and psychosis as a disease state is similar to that between creativity as a dispositional state and creative achievement.

Both psychoticism and schizophrenia are strongly determined by genetic factors (Eaves et al., 1989; Fulker, 1973; Gottesman & Shields, 1972; McGuffin & Murray, 1991; Shields, Heston, & Gottesman, 1975) in the form of polygenic inheritance, with additional genes determining the form of psychotic symptoms (H. J. Eysenck, 1972a). This genetic determination of a fundamental basis for creativity may also include the key to a profound puzzle in the phenotypic study of creativity—namely, the association of a cognitive variable (creativity) with behavioral variables (impulsivity), psychopathy, aggressiveness, egocentricity, and so forth. A solution has been suggested in the form of pleiotropy. As a general rule in genetics, a single gene affects more than just a single phenotype, and pleiotropy is the name given to the multiple effects of a gene or group of genes (Plomin, De Fries, & McClean, 1990). As explained in a previous section, social and scientific opposition to creative endeavor is so strong that only strong personalities are likely to survive; this may be the evolutionary way this association has grown. I have not stressed the importance of the behavioral traits associated with P, many of which are antisocial—and, indeed, psychopathic behavior is associated with high P scores and is part of the schizoid pattern—but no account of really high achievement can neglect the many normally undesirable qualities shown in the behavior of many geniuses. Simple survival of the creative person may demand personality characteristics more like those of the street-fighter than those of the ivory-tower academic!

As a final link in the causal chain from DNA to creativity, I have suggested the intermediary action of the hippocampal formation, neurotransmitters, and enzymes in producing variations in psychoticism and schizophrenia—leading to and involved with cognitive inhibition and other forms of inhibition linked with psychosis–psychoticism (latent inhibition, negative priming, Kamin blocking) and leading to overinclusiveness and other cognitive features linked with creativity. This part of the theory is the most speculative, although it does not lack factual support.

If the model proves acceptable, we may conclude that the methods of measurement used for trait creativity are valid and reliable; this is an important conclusion. By themselves, the measurement methods are certainly not sufficient to predict outstanding achievement; this restriction is a necessary consequence of the theoretical distinction made between trait and achievement. Nevertheless, such methods are of both scientific

and practical interest; they are in a position to tell us something about cognitive styles, and they may be useful in giving us information about the effects of our teaching practices and social policies on creativity. The *Handbook of Creativity* (Glover et al., 1989) was published to argue the case that creativity research was a "degenerating" research program; my conclusion would be a little more optimistic. We now know much more about creativity—including many of the problems that require answers!—than did our predecessors, and, if we follow the hypothetico-deductive method a little further, we are likely to add considerably to that information.

Note

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References

Allen, J. J., Chapman, L. J., & Chapman, J. P. (1987). Cognitive slippage and depression in hypothetically psychosis-prone college students. *Journal of Nervous and Mental Diseases, 175,* 347–353.

Allison, P. D., Price, D., Griffiths, B. C., Moravscik, M. J., & Stewart, J. A. (1976). Lotka's law: A problem in its interpretation and application. *Social Studies of Science, 6,* 269–276.

Amabile, T. M. (1983). *The social psychology of creativity.* New York: Springer-Verlag.

Andreasen, N. C. (1987). Creativity and mental illness: Prevalence rates in writers and their first-degree relatives. *American Journal of Psychiatry, 144,* 1288–1292.

Andreasen, N. J. C., & Powers, P. S. (1974). Overinclusive thinking in mania and schizophrenia. *British Journal of Psychiatry, 125,* 452–456.

Anscombe, R. (1987). The disorder of consciousness in schizophrenia. *Schizophrenia Bulletin, 11,* 241–260.

Armstrong, M. S., & McConaghy, N. (1973). Allusive thinking, the word halo and verbosity. *Psychological Medicine, 7,* 439–445.

Badcock, J. C., Smith, G. A., & Rawlings, D. (1988). Temporal processing and psychosis proneness. *Personality and Individual Differences, 9,* 709–719.

Barker, B. (1961). Resistance by scientists to scientific discovery. *Science, 134,* 596–602.

Barron, F. (1953). An Ego-Strength scale which predicts response to psychotherapy. *Journal of Consulting Psychology, 5,* 327–333.

Barron, F. (1969). *Creative person and creative process.* New York: Holt, Rinehart & Winston.

Barron, F. (1972). *Artists in the making.* New York: Seminar.

Baruch, I., Hemsley, D. R., & Gray, J. (1988). Latent inhibition and "psychotic proneness" in normal subjects. *Personality and Individual Differences, 9,* 777–783.

Beech, A., Baylis, G. C., Smithson, P., & Claridge, G. (1989). Individual differences in schizotypy as reflected in measures of cognitive inhibition. *British Journal of Clinical Psychology, 28,* 117–129.

Beech, A., & Claridge, G. (1987). Individual differences in negative priming. *British Journal of Psychology, 78,* 349–356.

Beech, A., Powell, T., McWilliam, J., & Claridge, G. (1989). Evidence of reduced "cognitive inhibition" in schizophrenics. *British Journal of Clinical Psychology, 28,* 109–116.

Bell, E. T. (1948). *Projective techniques.* New York: Longmans, Green.

Bell, E. T. (1965). *Men of mathematics.* London: Scientific Book Club.

Bentall, R. P., Claridge, G. S., & Slade, P. D. (1989). The multidimensional nature of schizotypal traits: A factor analytic study with normal subjects. *British Journal of Clinical Psychology, 28,* 303–375.

Bleuler, M. (1978). *The schizophrenic disorders.* New Haven, CT: Yale University Press.

Bloom, B. S. (1963). Report on creativity research by the Examiner's Office of the University of Chicago. In C. W. Taylor & F. Barron (Eds.), *Scientific creativity* (pp. 251–264). New York: Wiley.

Boden, M. (1990). *The creative mind: Myths and mechanisms.* London: Weidenfeld & Nicolson.

Bonfield, W. A. (1953). The occurrence of clustering in the recall of randomly arranged associates. *Journal of General Psychology, 49,* 229–240.

Bosch, R. van den. (1984). Eye-tracking impairment: Attentional and psychometric correlates in psychiatric patients. *Journal of Psychiatric Research, 18,* 277–286.

Bouthilet, L. (1948). *The measurement of intuitive thinking.* Unpublished PhD thesis, University of Chicago, Chicago.

Braff, D. L. (1981). Impaired speed of information processing in non-medicated schizotypal patients. *Schizophrenia Bulletin, 7,* 499–508.

Braff, D. L., & Saccuzzo, D. P. (1981). Information processing dysfunction in schizophrenia: A two-factor deficit theory. *American Journal of Psychiatry, 138,* 1051–1056.

Broad, W., & Wade, N. (1982). *Betrayers of the truth: Fraud and deceit in science.* Oxford, England: Oxford University Press.

Broadbent, D., (1958). *Perception and communication.* London: Pergamon.

Broks, P. (1984). Schizotypy and hemisphere function: II. Performance asymmetry on a verbal divided visual-field task. *Personality and Individual Differences, 5,* 649–656.

Brown, R. T. (1989). Creativity: What are we to measure? In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 3–32). New York: Plenum.

Brown, R., & McNeill, D. (1966). The "tip-of-the-tongue" phenomenon. *Journal of Verbal Learning and Verbal Behavior, 5,* 325–337.

Brown, W. (1965). Emotional indicators in word association. *British Journal of Psychology, 56,* 401–412.

Buchsbaum, Coursey, R. D., & Murphy, P. L. (1976). The biochemical high-risk paradigm: Behavioral and familial correlates and low platelet monoamine oxidase activity. *Science, 194,* 339–341.

Burt, C. (1943). Ability and income. *British Journal of Educational Psychology, 13,* 83–98.

Burt, C. (1963). Is intelligence distributed normally? *British Journal of Statistical Psychology, 16,* 175–190.

Cadoret, R. J. (1973). Toward a definition of the schizoid state: Evidence from studies of twins and their families. *British Journal of Psychiatry, 122,* 679–685.

Cameron, N. (1938). Reasoning, repression and communication in schizophrenics. *Psychological Monograph, 50,* 1–33.

Cameron, N. (1947). *The psychology of behavior disorders.* Boston: Houghton Mifflin.

Cameron, N., & Magaret, A. (1951). *Behavior pathology.* Boston: Houghton Mifflin.

Campbell, D. T. (1960). Blind variation and selective retention in creative thought as in other knowledge processes. *Psychological Review, 67,* 380–400.

Campbell, D. T. (1974). Unjustified variation and selective retention in scientific discovery. In F. J. Ayala & T. Dobzhansky (Eds.), *Studies in the philosophy of biology* (pp. 131–169). London: Macmillan.

Canter, S. (1973). Some aspects of cognitive function in twins. In G. Claridge, S. Canter, & W. I. Hume (Eds.), *Personality differ-*

ences and biological variation: A study of twins (pp. 79–91). Oxford, England: Pergamon.

Cattell, R. B., & Butcher, H. J. (1968). *The prediction of achievement and creativity.* New York: Bobbs-Merrill.

Cattell, R. B., & Drevdahl, J. E. (1955). A comparison of the personality profile (16 P.F.) of eminent researchers with that of eminent teachers and administrators, and of the general population. *British Journal of Psychology, 46,* 248–261.

Chapman, L. J. (1958). Intrusion of associative responses into schizophrenic conceptual performance. *Journal of Abnormal and Social Psychology, 53,* 374–391.

Chapman, L. J., & Chapman, J. P. (1980). Scales for rating psychotic and psychotic-like experiences as continua. *Schizophrenia Bulletin, 6,* 476–489.

Chapman, L. J., Chapman, J. P., & Miller, E. V. (1982). The reliabilities and intercorrelations of eight measures of proneness to psychosis. *Journal of Counselling and Clinical Psychology, 50,* 187–195.

Chapman, L. J., Chapman, J. P., & Raulin, M. L. (1976). Scales for physical and social anhedonia. *Journal of Abnormal Psychology, 85,* 374–382.

Chapman, L. J., Chapman, J. P., & Raulin, M. L. (1978). Body image aberration in schizophrenics. *Journal of Abnormal Psychology, 87,* 399–407.

Checkley, S. A. (1980). Neuroendocrine tests of monoamine function in man: A review of basic theory and its application to the study of depressive illness. *Psychological Medicine, 10,* 35–53.

Ciarlo, D. P., Lidz, T., & Ricci, J. (1967). Word meaning in parents of schizophrenics. *Archives of General Psychiatry, 17,* 470–477.

Claridge, G. S. (1972). The schizophrenias as nervous types. *British Journal of Psychiatry, 121,* 1–17.

Claridge, G. (1981). Psychoticism. In R. Lynn (Ed.), *Dimensions of personality* (pp. 79–109). London: Pergamon.

Claridge, G. (1983). The Eysenck Psychoticism Scale. In J. V. Butcher & C. D. Spielberger (Eds.), *Advances in personality assessment* (Vol. 2, pp. 71–114). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Claridge, G. (1985). *Origins of mental illness.* Oxford, England: Blackwell.

Claridge, G. S., & Chappa, H. J. (1973). Psychoticism: A study of its biological basis in normal subjects. *British Journal of Social and Clinical Psychology, 12,* 175–187.

Claridge, G. S., Robinson, D. L., & Birchall, P. M. A. (1985). Psychophysiological evidence of "psychoticism" in schizophrenics' relatives. *Personality and Individual Differences, 6,* 1–10.

Cole, J. R., & Zuckerman, H. C. (1987). Marriage, motherhood and research performance in science. *Scientific American, 225,* 119–125.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of romantic processing. *Psychological Review, 82,* 407–428.

Collins, A. M., & Quillian, M. R. (1970). Facilitating retrieval from semantic memory: The effect of repeating part of an inference. *Acta Psychologica, 33,* 304–314.

Cooper, J. E., Kendell, R. E., Gurland, B. J., Sharpe, L., & Copeland, J. D. M. (1972). *Psychiatric diagnosis in New York and London.* London: Oxford University Press.

Cox, C. (1926). *The early mental traits of three hundred geniuses.* Stanford, CA: Stanford University Press.

Cramer, P. (1968). *Word association.* New York: Academic.

Cromwell, R. L. (1968). Stimulus redundancy and schizophrenia. *Journal of Nervous and Mental Diseases, 146,* 360–375.

Cronbach, L. J. (1957). The two disciplines of scientific psychology. *American Psychologist, 12,* 671–684.

Crow, T. J. (1986). The continuum of psychosis and its implication for the structure of the gene. *British Journal of Psychiatry, 149,* 419–429.

Crutchfield, R. S. (1962). Conformity and creative thinking. In H. E. Gruber, G. Terrell, & M. Wertheimer (Eds.), *Contemporary approaches to creative thinking* (pp. 114–128). New York: Atherton.

Csikszentmihalyi, M., & Getzels, J. W. (1973). The personality of young artists: An empirical and theoretical exploration. *British Journal of Psychology, 64,* 91–104.

Davis, R. A. (1987). Creativity in neurological publications. *Neurosurgery, 20,* 652–663.

De, B. (1953). *A study of the validity of the word association technique for the differentiation of normal and abnormal persons.* Unpublished PhD thesis.

Dennis, W. (1954). Productivity among American psychologists. *American Psychologist, 9,* 191–194.

Dennis, W. (1955). Variations in productivity among creative workers. *Scientific Monthly, 80,* 277–278.

Dentler, R. A., & Mackler, B. (1964). Originality: Some social and personal determinants. *Behavioural Science, 9,* 1–7.

Downing, R. V., Ebert, J. N., & Shubrooks, S. J. (1963). Effects of three types of verbal distractors on thinking in acute schizophrenia. *Perceptual and Motor Skills, 17,* 881–882.

Drevdahl, J. E. (1956). Factors of importance for creativity. *Journal of Clinical Psychology, 12,* 21–26.

Eaves, L. J., & Eysenck, H. J. (1977). A genotype–environmental model for psychoticism. *Advances in Behavior Research and Therapy, 1,* 5–26.

Eaves, L., Eysenck, H. J., & Martin, N. (1989). *Genes, culture and personality: An empirical approach.* New York: Plenum.

Ellis, H. (1926). *A study of British genius.* New York: Houghton Mifflin.

Eysenck, H. J. (1950). Criterion analysis: An application of the hypothetico-deductive method to factor analysis. *Psychological Review, 57,* 38–53.

Eysenck, H. J. (1952a). Schizothymia-cyclothymia as a dimension of personality: II. Experimental. *Journal of Personality, 20,* 345–384.

Eysenck, H. J. (1952b). *The scientific study of personality.* London: Routledge & Kegan Paul.

Eysenck, H. J. (1967). *The biological basis of personality.* Springfield, IL: Thomas.

Eysenck, H. J. (1970a). A dimensional system of psychodiagnostics. In A. R. Mahrer (Ed.), *New approaches to personality classification* (pp. 169–208). New York: Columbia University Press.

Eysenck, H. J. (1970b). *The structure of human personality* (3rd ed.). London: Methuen.

Eysenck, H. J. (1972a). An experimental and genetic model of schizophrenia. In A. R. Kaplan (Ed.), *Genetic factors in "schizophrenia"* (pp. 504–515). Springfield, IL: Thomas.

Eysenck, H. J. (1972b). Personal preferences, aesthetic sensitivity and personality in trained and untrained subjects. *Journal of Personality, 40,* 544–557.

Eysenck, H. J. (1979). *The structure and measurement of intelligence.* New York: Springer.

Eysenck, H. J. (Ed.). (1982). *A model for intelligence.* New York: Springer.

Eysenck, H. J. (1983). The roots of creativity: Cognitive ability or personality trait? *Roeper Review, 5,* 10–12.

Eysenck, H. J. (1985). The theory of intelligence and the psychophysiology of cognition. In R. J. Sternberg (Ed.), *Advances in research on intelligence* (Vol. 3, pp. 1–34). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Eysenck, H. J. (1986). Speed of information processing, reaction time, and the theory of intelligence. In P. A. Vernon (Ed.), *Speed of information processing and intelligence* (pp. 21–57). Norwood, NJ: Ablex.

Eysenck, H. J. (1987). Personality and aging: An exploratory analysis. *Journal of Social Behavioral Personality, 3,* 11–12.

Eysenck, H. J. (1988). The biological basis of intelligence. In S. H. Irvine & J. W. Berry (Eds.), *Human abilities in a cultural context* (pp. 87–104). New York: Cambridge University Press.

Eysenck, H. J. (1990). *Rebel with a cause.* London: Allen.

Eysenck, H. J. (1992). The definition and measurement of psychoticism. *Personality and Individual Differences, 13,* 757–785.

Eysenck, H. J. (in press). *The measurement of creativity.*

Eysenck, H. J., & Castle, M. (1970). Training in art as a factor in the determination of preference judgments for polygons. *British Journal of Psychology, 61,* 65–81.

Eysenck, H. J., & Eysenck, M. W. (1985). *Personality and individual differences: A natural science approach.* New York: Plenum.

Eysenck, H. J., & Eysenck, S. B. G. (1968). A factorial study of psychoticism as a dimension of personality. *Multivariate Behavioral Research, 4,* 15–32.

Eysenck, H. J., & Eysenck, S. B. G. (1975). *Manual of the Eysenck Personality Questionnaire.* London: Hodder & Stoughton.

Eysenck, H. J., & Eysenck, S. B. G. (1976). *Psychoticism as a dimension of personality.* London: University of London Press.

Eysenck, H. J., & Gudjonsson, G. (1989). *The causes and cures of criminality.* New York: Plenum.

Eysenck, S. B. G. (1955). *A dimensional analysis of mental abnormality.* Unpublished PhD thesis, University of London, London.

Faibish, G. M. (1961). Schizophrenic responses to words of multiple meaning. *Journal of Personality, 29,* 414–427.

Flor-Henry, P., & Gruzelier, J. (Eds.). (1983). *Laterality and psychopathology.* New York: Elsevier.

Frearson, W., Eysenck, H. J., & Barrett, P. T. (1990). The Furneaux model of human problem-solving: Its relationship to reaction time and intelligence. *Personality and Individual Differences, 11,* 239–257.

Friedman, A. F., Wakefield, J. A., Boblitt, W. E., & Surman, G. (1976). Validity of Psychoticism scale of the Eysenck Personality Questionnaire. *Psychological Reports, 39,* 1309–1310.

Frith, C. D. (1979). Consciousness, information processing and schizophrenia. *British Journal of Psychiatry, 134,* 225–235.

Frith, C. D. (1987). The positive and negative symptoms of schizophrenia reflect impairments in the perception and inhibition of action. *Psychological Medicine, 17,* 631–648.

Fulker, D. W. (1973). A biometrical genetic approach to intelligence and schizophrenia. *Social Biology, 20,* 266–275.

Furneaux, D. (1961). Intellectual abilities and problem-solving behaviour. In H. J. Eysenck (Ed.), *Handbook of abnormal psychology* (1st ed., pp. 167–192). London: Pitmans.

Garskof, B. E., & Houston, J. P. (1963). Measurement of verbal relatedness: An idiographic approach. *Psychological Review, 70,* 277–288.

Gattaz, W. F. (1981). HLA-B27 as a possible genetic worker of psychoticism. *Personality and Individual Differences, 2,* 57–60.

Gattaz, W. F., Ewald, R. V., & Beckman, H. (1980). The HLA system and schizophrenia. *Archiv fur Psychiatric und Nervenkrankheite, 228,* 205–211.

Gattaz, W. F., Seitz, M., & Beckmann, H. (1985). A possible association between HLA-B27 and vulnerability to schizophrenia. *Personality and Individual Differences, 6,* 283–285.

Getzels, J. W., & Jackson, P. W. (1962). *Creativity and intelligence: Exploration with gifted students.* New York: Wiley.

Glover, J. A., Ronning, R. R., & Reynolds, C. R. (Eds.). (1989). *Handbook of creativity.* New York: Plenum.

Goldstein, I. B. (1965). The relationship of muscle tension and autonomic activity to psychiatric disorders. *Psychosomatic Medicine, 27,* 39–52.

Gottesman, I. I., & Shields, J. (1972). A polygenic theory of schizophrenia. *International Journal of Mental Health, 1,* 107–115.

Götz, K. O., & Götz, K. (1973). Introversion, extraversion and neuroticism in gifted and ungifted art students. *Perceptual and Motor Skills, 36,* 675–678.

Götz, K. O., & Götz, K. (1979a). Personality characteristics of professional artists. *Perceptual and Motor Skills, 49,* 327–334.

Götz, K. O., & Götz, K. (1979b). Personality characteristics of successful artists. *Perceptual and Motor Skills, 49,* 919–924.

Gough, H. G. (1957). *California Psychological Inventory manual.* Palo Alto, CA: Consulting Psychologists Press.

Gough, H. G. (1976). Studying creativity by means of the Word Association Tests. *Journal of Applied Psychology, 61,* 348–353.

Gray, J., Feldon, J., Rawlins, J. P., Hemsley, D. R., & Smith, A. D. (1991). The neuropsychology of schizophrenia. *Behavioral and Brain Sciences, 14,* 1–84.

Griesinger, W. (1861). *Die Pathologie und Therapie der Psychischen Krankheiten* [The pathology and treatment of psychological sicknesses]. Stuttgart: Krabbe.

Griffith, J. J., Mednick, S., Schulsinger, F., & Diderichsen, B. (1980). Verbal associative disturbances in children at high risk for schizophrenia. *Journal of Abnormal Psychology, 89,* 125–131.

Guilford, J. P. (1967). *The nature of human intelligence.* New York: McGraw-Hill.

Guilford, J. P. (1981a). Higher-order structure of intellect model abilities. *Multivariate Behavioral Research, 16,* 421–435.

Guilford, J. P. (1981b). Some changes in the structure of intellect model. *Educational and Psychological Measurement, 48,* 1–4.

Guislain, J. (1833). *Traite des Phrenopathies.* Brussels: Etablisement Encyclographique.

Haensly, P., & Reynolds, C. R. (1989). Creativity and intelligence. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 111–132). New York: Plenum.

Hammer, M., & Zubin, J. (1968). Evolution, culture and psychopathology. *Journal of General Psychology, 78,* 154–175.

Hare, E. H. (1987). Epidemiology of schizophrenia and affective psychosis. *British Medical Bulletin, 43,* 514–530.

Hare, R. D., & McPherson, L. M. (1984). Psychopathy and perceptual asymmetry during verbal dichotic listening. *Journal of Abnormal Psychology, 93,* 141–149.

Hargreaves, H. L. (1927). The "faculty" of imagination. *British Journal of Psychology* (Monograph Suppl. 10).

Hasenfus, N., & Magaro, P. (1976). Creativity of schizophrenia: An equality of empirical constructs. *British Journal of Psychiatry, 129,* 346–349.

Heath, A. C., Eaves, L. J., & Martin, N. G. (1989). The genetic structure of personality: III. Multivariate genetic item analysis of the EPQ scales. *Personality and Individual Differences, 10,* 877–888.

Heath, A. C., Jardine, R., Eaves, L. J., & Martin, N. G. (1988). The genetic structure of personality: I. Phenotypic factor structure of the EPQ in one Australian sample. *Personality and Individual Differences, 9,* 59–67.

Heath, A. C., Jardine, R., Eaves, L. J., & Martin, N. G. (1989). The genetic structure of personality: II. Genetic item analysis of the EPQ. *Personality and Individual Differences, 10,* 615–624.

Hemsley, D. R. (1976). Attention and information processing in schizophrenia. *British Journal of Social and Clinical Psychology, 19,* 199–209.

Hemsley, D. R. (1982). Cognitive impairment in schizophrenia. In A. Burton (Ed.), *The pathology and psychology of cognition* (pp. 169–203). London: Methuen.

Hemsley, D. R. (1987). An experimental psychological model for schizophrenia. In R. Hafner, W. F. Gattaz, & W. Janzarik (Eds.), *Search for the causes of schizophrenia* (pp. 179–188). Heidelberg: Springer-Verlag.

Hemsley, D. R. (1991). What have cognitive defects to do with schizophrenia? In G. Huber (Ed.), *Idiopathische Psychosen* (pp. 289–294). Stuttgart: Schattover.

Heston, I. I. (1966). Psychiatric disorders in foster home reared children of schizophrenic mothers. *British Journal of Psychiatry, 112,* 819–825.

Hinton, J., & Craske, B. (1976). A relationship between Eysenck's P scale and change in muscle action potentials with attention to perceptual tasks. *British Journal of Psychology, 67,* 461–466.

Hovecar, D., & Bachelor, P. (1989). A taxonomy and critique of measurements used in the study of creativity. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 53–75). New York: Plenum.

Hudson, I. (1966). *Contrary imaginations.* London: Methuen.

Hudson, I. (1968). *Frames of mind: Ability, perception and self-perception in the arts and sciences.* London: Methuen.

Hull, C. L. (1943). *Principles of behavior.* New York: Appleton–Century–Crofts.

Huntington, E. (1938). *Season of birth: Its relation to human abilities.* New York: Wiley.

Hyslop, T. B. (1925). *The Great Abnormals.* New York: Doran.

Iacono, W. G., & Lykken, D. T. (1979). Eye tracking and psychopathology: New procedures applied to a sample of normal monozygotic twins. *Archives of General Psychiatry, 30,* 1361–1369.

Iacono, W. G., Peloquin, L. J., Lumry, A., Valentine, B. H., & Tuason, V. B. (1982). Eye tracking in patients with unipolar and bipolar affective disorder in remission. *Journal of Abnormal Psychology, 91,* 35–44.

Jarvik, I. F., & Chadwick, S. B. (1973). Schizophrenia and survival. In M. Hammer, K. Salzingerand, & S. Sulton (Ed.), *Psychopathology* (pp. 343–362). New York: Wiley.

Johnson, D. M. (1955). *The psychology of thought and judgment.* New York: Harper.

Johnson, R. C., Weiss, R. L., & Zelhart, P. F. (1964). Similarities and differences between normal and psychotic subjects in response to verbal stimuli. *Journal of Abnormal and Social Psychology, 68,* 221–326.

Jones, G. V. (1978). Recognition failure and dual mechanisms in scale. *Psychological Review, 85,* 464–469.

Jones, S. H., Gray, J. A., & Hemsley, D. R. (1992). The Kamin blocking effect, incidental learning and schizotypy (a re-analysis). *Personality and Individual Differences, 13,* 57–60.

Juda, A. (1949). The relationship between highest mental capacity and psychic abnormalities. *American Journal of Psychiatry, 106,* 296–307.

Jutai, J. W. (1988). Spatial attention in hypothetically psychosis-prone college students. *Psychiatry Research, 27,* 207–215.

Karlsson, J. I. (1968). Genealogic studies of schizophrenia. In D. Rosenthal & S. Kety (Eds.), *The transmission of schizophrenia* (pp. 184–198). Oxford, England: Pergamon.

Karlsson, J. I. (1970). Genetic association of giftedness and creativity with schizophrenia. *Heredity, 66,* 177–182.

Kaulins, A. (1979). Cycles in the birth of eminent humans. *Cycles, 30,* 9–15.

Kent, A. J., & Rosanoff, A. J. (Eds.). (1910). A study of association in insanity [Whole issues]. *American Journal of Insanity, 67*(1 & 2).

Klinteberg, B., Schalling, D., Edman, G., Oreland, L., & Aesberg, M. (1987). Personality correlates of platelet monoamine oxidase (MAO) activity in female and male subjects. *Neuropsychobiology, 18,* 89–96.

Kretschmer, E. (1929). *Geniale Meuschen.* Berlin: J. Springer.

Kris, E. (1952). *Psychoanalytic explorations in art.* New York: International University Press.

Kuntz, D. (1974). Response faults on word association as a function of associative difficulty and of affective connotations of the words. *Journal of Consulting and Clinical Psychology, 42,* 231–235.

Laffal, J., & Feldman, S. (1962). The structure of single word and continuous associations. *Journal of Verbal Learning and Verbal Behavior, 1,* 54–61.

Lakatos, I. (1978). *Philosophical papers: Vol. 1. The methodology of scientific research programmes.* Cambridge, England: Cambridge University Press.

Lange-Eichbaum, W. (1931). *The problem of genius.* London: Kegan Paul.

Lange-Eichbaum, W. (1956). *Genie, Irrsin und Ruhm.* Munich: Reinhardt Verlag.

Launay, G., & Slade, P. (1981). The measurement of hallucinatory predisposition in male and female prisoners. *Personality and Individual Differences, 2,* 221–234.

Lehman, H., & Dorken, H. (1953). The clinical application of the Verdum Prospective Battery. *Canadian Journal of Psychology, 7,* 69–80.

Lester, J. R. (1960). Production of associative sequences in schizophrenia and chronic brain syndrome. *Journal of Abnormal and Social Psychology, 60,* 225–233.

Levin, S., Yurgelun-Todd, D., & Craft, L. S. (1989). Contributions of clinical neuropsychology to schizophrenia. *Journal of Abnormal Psychology, 98,* 341–356.

Lindgren, H. C., & Lindgren, F. (1965). Brainstorming and orneriness as facilitators of creativity. *Psychological Reports, 16,* 577–583.

Lipton, R. B., Levy, D. L., Holzman, P. S., & Levin, S. (1983). Eye movement dysfunction in psychiatric patients: A review. *Schizophrenia Bulletin, 9,* 13–32.

Lombroso, C. (1895). *The man of genius.* London: Walter Scott.

Lotka, A. J. (1926). The frequency distribution of scientific productivity. *Journal of the Washington Academy of Sciences, 16,* 317–323.

Lovibond, S. N. (1954). The Object Sorting Test and conceptual thinking in schizophrenia. *Australian Journal of Psychology, 6,* 52–70.

Lubow, R. E. (1989). *Latent inhibition and conditioned attention theory.* New York: Cambridge University Press.

Lubow, R. E., Ingberg-Sachs, Y., Zalstein, N., & Gewirtz, J. (in press). Latent inhibition in low and high "psychotic-prone" normal subjects. *Personality and Individual Differences.*

Lytton, H. (1971). *Creativity and education.* London: Routledge & Kegan Paul.

MacKinnon, D. W. (1962a). The nature and nurture of creative talent. *American Psychologist, 17,* 484–495.

MacKinnon, D. W. (1962b). The personality correlates of creativity. A study of American architects. In G. S. Nielsen (Ed.), *Proceedings of the XIV International Congress of Applied Psychology* (Vol. 2, pp. 11–39). Copenhagen: Munksgaard.

MacKinnon, D. W. (1965). Personality and the realization of creative potential. *American Psychologist, 20,* 273–281.

Magnusson, D., & Bachteman, G. (1977). *Longitudinal stability of person characteristics: Intelligence and creativity* (Department of Psychology Rep. No. 511). Stockholm: University Press.

Malmo, R., Shagass, C., & Smith, A. A. (1951). Responsiveness in chronic schizophrenia. *Journal of Personality, 19,* 359–375.

Mannuzza, S., Spring, B., Gottlieb, M. D., & Kietzman, M. L. (1980). Visual detection threshold differences between psychiatric patients and normal controls. *Bulletin of the Psychonomic Society, 15,* 69–72.

Martindale, C. (1989). Personality, situation, and creativity. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 211–232). New York: Plenum.

Martindale, C. (1991). *Cognitive psychology: A neural-network approach.* Pacific Grove, CA: Brooks/Cole.

Martindale, C. (1992). *How can we measure a society's creativity?* Paper presented at the Achievement Project Symposium, Ashford, England.

Martindale, C., & Armstrong, J. (1974). The relationship of creativity to cortical activation and its operant control. *Journal of Genetic Psychology, 124,* 311–320.

Martindale, C., & Greenough, J. (1973). The differential effect of increased arousal on creative and intellectual performance. *Journal of Genetic Psychology, 123,* 329–335.

McConaghy, N., & Clancy, M. (1908). Familial relationships of allusive thinking in university students and their parents. *British Journal of Psychiatry, 114,* 1079–1087.

McGuffin, P. (1979). Is schizophrenia an HLA-associated disease? *Psychological Medicine, 9,* 721–728.

McGuffin, P., & Murray, R. (1991). *The new genetics of mental illness.* London: Butterworth–Heinemann.

McNeil, T. F. (1971). Rebirth and postbirth influence on the relationship between creative ability and recorded mental illness. *Journal of Personality, 39,* 391–406.

Mednick, S. A. (1962). The associative basis of the creative process. *Psychological Review, 69,* 220–232.

Mednick, S. A., & Mednick, M. T. (1964). An associative interpretation of the creative process. In L. W. Taylor (Ed.), *Widening horizons in creativity* (pp. 54–68). New York: Wiley.

Mednick, S. A., & Schulsinger, F. (1968). Some premorbid characteristics related to breakdown in disorder with schizophrenic mothers. *Journal of Psychiatric Research, 6*(Suppl. 1), 267–291.

Meehl, P. E. (1990). Toward an integrated theory of schizotaxia, schizotypy, and schizophrenia. *Journal of Personality Disorder, 4,* 1–99.

Mendelsohn, G. A. (1976). Associative and attentional processes in creative performance. *Journal of Personality, 44,* 341–369.

Merritt, R. D., & Balogh, D. W. (1984). The use of a backward masking paradigm to assess information-processing deficits among schizophrenics: A re-evaluation of Steranko and Woods. *Journal of Nervous and Mental Disease, 172,* 216–224.

Michael, W. B., & Wright, C. P. (1989). Psychometric issues in the assessment of creativity. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 33–52). New York: Plenum.

Miller, E. N., & Chapman, L. J. (1983). Continued word association in hypothetically psychosis-prone college students. *Journal of Abnormal Psychology, 92,* 468–478.

Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity for processing information. *Psychological Review, 63,* 81–97.

Miller, S., Saccuzzo, D. P., & Braff, D. (1979). Information processing deficits in remitted schizophrenia. *Journal of Abnormal Psychology, 88,* 446–449.

Moore, O. K., & Anderson, S. (1954). Search behavior and problem-solving. *American Sociological Review, 19,* 702–714.

Moran, L. J. (1953). Vocabulary knowledge and usage among normal and schizophrenic subjects. *Psychological Monograph, 67*(20, Whole No. 370).

Nardi, K., & Martindale, C. (1981). *Creativity and preference for tones varying in dissonance and intensity.* Paper presented at the meeting of the Eastern Psychological Association, New York.

Neumann, H. (1859). *Lehrbuch der Psychiatrie* [Textbook of psychiatry]. Erlangen, Germany: Enke.

Newell, A., Shaw, J. C., & Simon, H. A. (1962). The process of creative thinking. In H. E. Gruber, G. Terrell, & M. Wertheimer (Eds.), *Contemporary approaches to creative thinking* (pp. 633–719). New York: Atherton.

Nilsson, L., & Gardiner, J. M. (1991). Memory theory and the boundary conditions of the Tulwing–Wiseman law. In W. E. Hockley & S. Lewandowsky (Eds.), *Relating theory and data: Essays on human memory in honor of Bennet B. Murdock* (pp. 245–268). Hillsdale, NJ: Lawrence Erlbaum Associates, Inc.

Nisbet, J. F. (1900). *The insanity of genius.* London: Grant Richards.

Norman, D. A. (1970). *Memory and attention.* New York: Wiley.

Nuechterlein, K. H., & Dawson, M. E. (1984). Information processing and attentional functioning in the developmental course of schizophrenic disorders. *Schizophrenic Bulletin, 10,* 160–203.

Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning.* Urbana: University of Illinois Press.

Over, R. (1980). Research productivity and impact of men and women in departments of psychology in the United Kingdom. *Bulletin of the British Psychological Society, 33,* 385–386.

Over, R. (1982). Rsearch productivity and impact of male and female psychologists. *American Psychologist, 37,* 24–31.

Pack, D., & Pons, L. (1985). Correlation between two indices of commonality and of repetition in free word-association responses. *Psychological Reports, 56,* 931–938.

Pareto, V. (1897). *Cours d'economie politique.* Paris: Armand.

Patterson, T. (1987). Studies towards the subcortical pathogenesis of schizophrenia. *Schizophrenia Bulletin, 13,* 555–576.

Pavy, D. (1968). Verbal behavior in schizophrenia: Review or recall studies. *Psychological Bulletin, 70,* 164–178.

Payne, R. W. (1960). Cognitive abnormalities. In H. J. Eysenck (Ed.), *Handbook of abnormal psychology* (1st ed.). London: Pitman.

Payne, R. W. (1973). Cognitive abnormalities. In H. J. Eysenck (Ed.), *Handbook of abnormal psychology* (2nd ed.). London: Pitman.

Payne, R. W., & Hewlett, J. H. G. (1960). Thought disorder in psychotic patients. In H. J. Eysenck (Ed.), *Experiments in personality* (Vol. 2, pp. 3–104). London: Routledge & Kegan Paul.

Pearce, J. M., & Hall, G. (1980). A model of Pavlovian learning: Variations in the effectiveness of conditional but not of unconditional stimuli. *Psychological Review, 87,* 532–552.

Pintner, R., & Forlano, G. (1943). Season of birth and mental differences. *Psychological Bulletin, 40,* 25–35.

Plomin, R., De Fries, J. C., & McClean, G. E. (1990). *Behavioral genetics.* New York: Freeman.

Posner, M. I. (1982). Cumulative development of attentional theory. *American Psychologist, 37,* 168–179.

Prentky, R. A. (1980). *Creativity and psychopathology.* New York: Praeger.

Price, D. (1963). *Little science, big science.* New York: Columbia University Press.

Quillian, M. R. (1967). Word concepts: A theory and simulation of some basic semantic capabilities. *Behavioral Science, 12,* 410–430.

Rank, O. (1945). *Will therapy add truth and reality?* New York: Knopf.

Rapaport, D., Gill, M., & Schafer, R. (1968). *Diagnostic psychological testing.* Chicago: Yearbook.

Ratcliff, R. (1978). A theory of memory retrieval. *Psychological Review, 85,* 59–103.

Rawlings, D. (1985). Psychoticism, creativity and dichotic shadowing. *Personality and Individual Differences, 6,* 737–742.

Rawlings, D., & Borge, A. (1987). Personality and hemisphere function: Two experiments using the dichotic shadowing technique. *Personality and Individual Differences, 8,* 483–488.

Rawlings, D., & Claridge, G. (1984). Schizotypy and hemisphere function: III. Performance asymmetries on task of letter recognition and local–global processing. *Personality and Individual Differences, 5,* 657–663.

Richards, R. L. (1981). Relationship between creativity and psychopathology: An evolution and interpretation of the evidence. *Genetic Psychological Monograph, 103,* 261–324.

Richards, R., Kinney, D. K., Benet, M., & Merzel, A. (1988). Assessing everyday creativity: Characteristics of the Lifetime Creativity Scales and validation with three large samples. *Journal of Personality and Social Psychology, 54,* 476–485.

Richards, R. L., Kinney, D. E., Lunde, I., Benet, M., & Merzel, A. (1988). Creativity in manic-depressives, cyclothymes, their normal relatives, and control subjects. *Journal of Abnormal Psychology, 97,* 281–289.

Richardson-Klavehn, A., & Bjork, R. A. (1988). Measures of memory [Whole issue]. *Annual Review of Psychology, 39,* 475–743.

Roe, A. (1951). A psychological study of physical scientists. *Genetic Psychology, 43,* 121–239.

Roe, A. (1952). *The making of a scientist.* New York: Dodd, Mead.

Roe, A. (1953). A psychological study of eminent psychologists and anthropologists, and a comparison with biological and physical scientists. *Psychological Monographs: General and Applied, 67*(Whole No. 352).

Rushton, J. P. (1989). A two-year scientometric revisit of British psychology departments. *The Psychologist, 2,* 64–68.

Rushton, P. (1990). Creativity, intelligence, and psychoticism. *Personality and Individual Differences, 12,* 1291–1298.

Russell, W. A., & Jenkins, J. (1954). *The complete Minnesota norms for responses to 100 words from the Kent–Rosanoff Word Association Test* (Tech. Rep. No. 11). Minneapolis: University of Minnesota.

Rutter, M. (1985). Resilience in the face of adversity: Protective factors and resistance to psychiatric disorders. *British Journal of Psychiatry, 147,* 598–611.

Saccuzzo, D. P., & Schubert, D. L. (1981). Backward masking as a

measure of slow processing in schizophrenic spectrum disorders. *Journal of Abnormal Psychology, 90,* 305–312.

Schalling, D., Edman, G., & Aesberg, M. (1987). Impulsive cognitive style and inability to tolerate boredom: Psychobiological studies of temperamental vulnerability. In M. Zuckerman (Ed.), *Biological bases of sensation seeking, impulsivity and anxiety* (pp. 123–145).

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search and attention. *Psychological Review, 84,* 1–66.

Schwartz, S. (1978). Do schizophrenics give rare word associations? *Schizophrenia Bulletin, 4,* 248–250.

Schwartz, S. (1982). Is there a schizophrenic language? *Brain and Behavioral Science, 5,* 579–626.

Seth, G., & Beloff, H. (1959). Language impairment in a group of schizophrenics. *British Journal of Medical Psychology, 32,* 288–293.

Shakow, D., & Jellinek, E. M. (1965). Composite index of the Kent–Rosanoff free association test. *Journal of Abnormal Psychology, 30,* 403–404.

Sheldrick, C., Jablensky, A., Sartorius, N., & Shepherd, M. (1977). Schizophrenia succeeded by affective illness: Catamnestic study and statistical enquiry. *Psychological Medicine, 7,* 619–627.

Shields, J., Heston, L. L., & Gottesman, I. I. (1975). Schizophrenia and the schizoid: The problem for genetic analysis. In R. R. Fieve, D. Rosenthal, & H. Brill (Eds.), *Genetic research in psychiatry* (pp. 176–197). Baltimore: Johns Hopkins University Press.

Shockley, W. (1957). On the statistics of individual variation of productivity in research laboratories. *Proceedings of the Institute of Radio Engineers, 45,* 279–290.

Siever, L. J., Haier, R. J., Coursey, R. D., Sostek, A. J., Murphy, D. C., Holzman, P. S., & Buchsbaum, M. S. (1982). Smooth pursuit tracking impairment: Relation to other "markers" of schizophrenia and psychologic correlates. *Archives of General Psychiatry, 39,* 1001–1005.

Simons, R. F., & Katkin, W. (1985). Smooth pursuit eye movements in subjects reporting physical anhedonia and perceptual aberrations. *Psychiatry Research, 14,* 275–289.

Simonton, D. K. (1984). *Genius, creativity, and leadership.* Cambridge, MA: Harvard University Press.

Simonton, D. K. (1987). Creativity, leadership, and chance. In R. J. Sternberg (Ed.), *The nature of creativity* (pp. 74–95). Cambridge, England: Cambridge University Press.

Simonton, D. K. (1988). *Scientific genius.* Cambridge, England: Cambridge University Press.

Simonton, D. K. (1991). Emergence and realization of genius: The lives and works of 120 classical composers. *Journal of Personality and Social Psychology, 61,* 829–840.

Slade, P. D. (1976). An investigation of psychological factors involved in the predisposition to auditory hallucinations. *Psychological Medicine, 6,* 123–132.

Slaughter, F. G. (1950). *Immortal Magyar: Semmelweis, conqueror of childbed fever.* New York: Henry Schuman.

Smith, R. (1990). *Collins dictionary of artificial intelligence.* London: Collins.

Snyder, S., Pitts, W. M., & Pokorny, A. D. (1986). Borderline personality traits in psychiatric in-patients. *Psychological Reports, 58,* 51–60.

Soumer, R., Dewar, R., & Osmond, H. (1960). Is there a schizophrenic language? *Archives of General Psychiatry, 3,* 665–673.

Spearman, C. (1923). *The nature of "intelligence" and the principles of cognition.* London: Macmillan.

Spearman, C. (1927). *The abilities of man.* London: Macmillan.

Spearman, C. (1931). *Creative mind.* New York: Appleton.

Stayte, S. (1977). *Incidental learning, creativity and schizophrenia.* Unpublished doctoral dissertation, Institute of Psychiatry, London.

Teasdale, J. D., Seagraves, R. T., & Zacune, J. (1971). "Psychoticism" in drug users. *British Journal of Social and Clinical Psychology, 10,* 160–171.

Tendler, A. C. (1933). Associative tendencies in psychoneurotics. *Psychological Clinic, 22,* 108–116.

Tendler, A. C. (1945). Significant features of disturbance in free association. *Journal of Psychology, 20,* 65–89.

Terman, L. M. (1925). *Mental and physical traits of a class of gifted children.* Stanford, CA: Stanford University Press.

Terman, L. M., & Oden, M. (1959). *The gifted child of mid-life.* Stanford, CA: Stanford University Press.

Theios, J. (1973). Reaction time measurements in the study of memory process: Theory and data. In G. H. Bower (Ed.). *The psychology of learning and motivation* (Vol. 7, pp. 43–85). New York: Academic.

Tipper, S. P. (1985). The negative priming effect: Inhibitory priming by ignored objects. *Quarterly Journal of Experimental Psychology, 37a,* 571–590.

Tipper, S. P., & Baylis, G. C. (1987). Individual differences in selective attention and priming. *Personality and Individual Differences, 8,* 667–675.

Tipper, S. P., & Cranston, M. (1985). Selective attention and priming: Inhibitory and facilitatory effects of ignored primes. *Quarterly Journal of Experimental Psychology, 37a,* 591–611.

Torrance, E. P. (1962). *Guiding creative talent.* Englewood Cliffs, NJ: Prentice-Hall.

Torrance, E. P. (1974). *Torrance Tests of Creative Thinking: Norms—Technical manual.* Lexington, MA: Ginn.

Turck, H. (1901). *Der Geniale Mensch.* Berlin: Dummler.

Underwood, B. J., & Schulz, R. W. (1960). *Meaningfulness and verbal learning.* Chicago: Hippinot.

Upmanyu, V. V., & Kaur, K. (1986). Diagnostic utility of word association emotional indicators. *Psychological Studies, 32,* 71–78.

Venables, P. (1963). The relationship between level of skin potential and fusion of paired light flashes in schizophrenics and normal subjects. *Journal of Psychiatric Research, 1,* 279–287.

Venables, P. (1980). Primary dysfunction and cortical lateralization in schizophrenia. In M. Kruckow, D. Lebusann, & J. Angst (Eds.), *Functional states of the brain: Their determinants* (pp. 115–128). Amsterdam: Elsevier.

Verma, R. M., & Eysenck, H. J. (1973). Severity and type of psychotic illness as a function of personality. *British Journal of Psychiatry, 122,* 573–585.

Vernon, P. E. (1989). The nature–nurture problem in creativity. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 93–110). New York: Plenum.

Wallach, M. A., & Kogan, N. (1965). *Modes of thinking in young children.* New York: Holt, Rinehart & Winston.

Wankowski, J. A. (1973). *Temperament, motivation and academic achievement.* Birmingham: University of Birmingham, Educational Survey and Counselling Unit.

Ward, P. B., McConaghy, N., & Catts, S. P. (1991). Word association and measures of psychosis-proneness in university students. *Personality and Individual Differences, 12,* 473–480.

Watkins, M. J., & Gardiner, J. M. (1979). An appreciation of generate–recognize theory of recall. *Journal of Verbal Learning and Verbal Behavior, 18,* 687–704.

Webb, E. (1915). Character and intelligence. *British Journal of Psychology* (Monograph Suppl. 1, No. III).

Weiner, I. (1990). Neural substrates of latent inhibition: The switching model. *Psychological Bulletin, 108,* 442–461.

Westcott, M. (1961). On the measurement of intuitive leaps. *Psychological Reports, 9,* 267–274.

Westcott, M. R. (1964). Empirical studies of intuition. In C. W. Taylor (Ed.), *Widening horizons in creativity* (pp. 34–53). New York: Wiley.

Westcott, M., & Ranzoni, J. (1963). Correlates of intuitive thinking.

Psychological Reports, 12, 595–613.
Wild, K. (1938). *Intuition.* New York: Macmillan.
Woodman, R. W., & Schoenfeldt, L. F. (1989). Individual differences in creativity. In J. A. Glover, R. R. Ronning, & C. R. Reynolds (Eds.), *Handbook of creativity* (pp. 77–91). New York: Plenum.
Woody, E., & Claridge, G. (1977). Psychoticism and thinking. *British Journal of Social and Clinical Psychology, 16,* 241–248.
Wynne, R. D. (1964). Are normal word association norms suitable for schizophrenics? *Psychological Reports, 14,* 121–122.
Yasamy, M. T. (1987). Schizoaffective disorder: A dimensional approach. *Acta Psychiatrica Scandinavica, 76,* 609–618.
Zahn, T. P. (1968). Word association in adoptive and biological parents of schizophrenics. *Archives of General Psychiatry, 19,* 501–503.
Zhao, H., & Jiang, G. (1985). Shifting to world's scientific center and scientists' social ages. *Scientometrics, 8,* 59–80.
Zuckerman, M. (1989). Personality in the third dimension: A psychobiological approach. *Personality and Individual Differences, 10,* 391–418.
Zuckerman, M. (1991). *Psychobiology of personality.* Cambridge, England: Cambridge University Press.