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Creativity as a Product of Intelligence and Personality

Hans J. Eysenck

Creativity has always been a problem in the well-tended garden of cognitive ability, and though its empirical study has flourished, a recent handbook (Glover, Ronning, & Reynolds, 1989) has characterized it as "a large-scale example of a 'degenerating' research program" (p. xi). The reasons for such a disparaging estimate are not hard to find: Research in this area has been largely descriptive, full of anecdotal evidence, and without close links with the two disciplines of scientific psychology (Cronbach, 1957)—the experimental and the psychometric. Admittedly there have been many attempts to measure creativity along psychometric lines (Runco, 1991), but these have not been linked theoretically or experimentally with the large body of the psychological literature, and thus they have remained resolutely isolated.

I have tried to support a theory of creativity that attempts to bridge this gap (Eysenck, 1993). I shall try here to continue this process, demonstrating links with experimental constructs (e.g., latent inhibition and negative priming) that may give a solid foundation to observations of "differential associative hierarchies" (Mednick, 1962). This attempt to construct a nomological network in order to provide proper construct validity for the measurement of creativity is an assertion of my belief in the correctness of Lewin's famous saying: "There is nothing as practical as a good theory." It is, of course, a moot point whether the theory here developed deserves to be called good; at least it is testable, and hence it fulfills the minimum requirement of a scientific theory in a field that has notoriously been lacking in such theories.

THE NATURE AND DEFINITION OF CREATIVITY

It is well known that there are two major definitions of the term *creativity*, and these are quite different in many ways. *Trait creativity* is conceived as a latent trait underlying creative behavior, normally distributed in the population, and a necessary but not sufficient cause of creative productivity. *Achievement creativity* is defined in terms of novel and socially useful/acceptable products; it is the *product* of trait creativity, intelligence, and many other components, as suggested in Figure 1. It is distributed as a J-curve, like many socially nonconformist behaviors (Allport, 1934). This type of distribution is characteristic of behaviors that are determined by several causal agents acting synergistically (i.e., their effects are multiplicative rather than additive; Eysenck, 1993).

Trait creativity has been measured in several ways (Runco, 1991), but most usually and characteristically in terms of tests of fluency (i.e., the number

Hans J. Eysenck • Institute of Psychiatry, University of London, London SE5 8AF, England.

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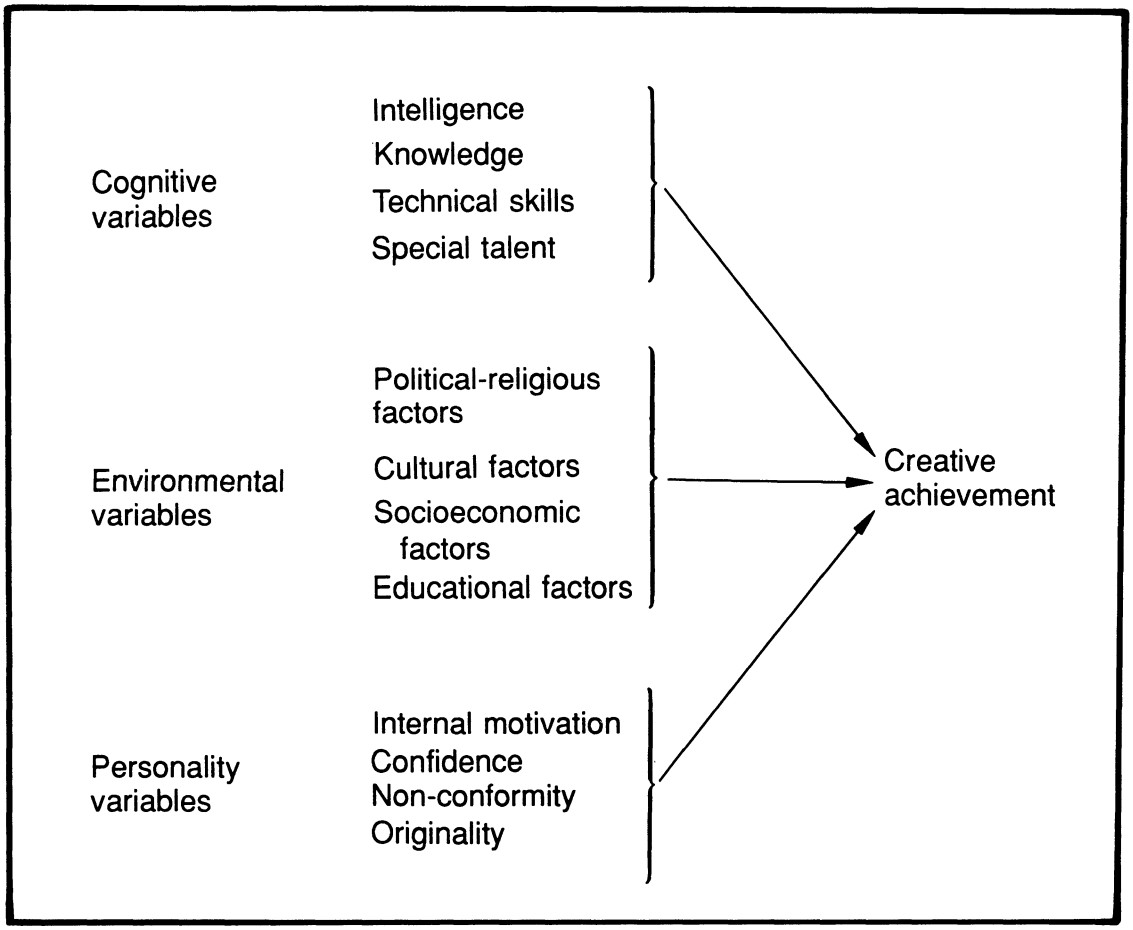

Figure 1. Relation between creative achievement and originality (trait creativity). From Eysenck (1993).

and/or originality of items produced in response to a problem having multiple solutions); an alternative and more recent name is *divergent* (as opposed to *convergent*) problem solution (Guilford, 1950). The foundations for work along this line were laid by Hargreaves (1927) in his studies of "the faculty of imagination," suggested and supervised by Spearman. Hargreaves found that a number of tests calling for a large number of imaginative responses tended to correlate together, with an average intercorrelation of .3. These correlations fulfilled the demands of the tetrad criterion (matrix rank = 1), and were shown not to be identical with intelligence ("*g*"). The tests included were number of things seen in an inkblot, number of words written, number of different completions to an incomplete picture, and so forth; other early workers in this field followed Hargreave's lead (Eysenck, 1970).

These early findings are mentioned because there is little if any mention of this early work by Glover et al. (1989), although they laid down the major laws according to which creativity may be conceptualized: (a) Creativity correlates with intelligence overall, but (b) is also something independent of intelligence. Also, (c) creativity is correlated with personality; the trait usually mentioned is extraversion. Traits correlated with fluency on the Fells Child Behavior Scales were curiosity, gregariousness, originality, aggressiveness, competitiveness, and cheerfulness, together with an absence of social apprehensiveness and patience (Benassy & Chauffard, 1947; Gewirtz, 1948). Later studies of "divergent ability" added the important point that intelligence only correlated with creativity measures up to IQ values of approximately 120; when this value was reached or exceeded, no correla-

tions were found. We may interpret this to mean that a certain amount of intelligence is needed to lay a foundation in knowledge that enables trait creativity to make a genuine contribution—to understand the fundamentals of the problem, interpret the rules, and give solutions that are socially acceptable. Most of the work done on trait creativity has accordingly been done with bright children and adults.

CREATIVITY AND PERSONALITY

There is a large body of evidence linking creativity and genius with psychopathology (Lange-Eichbaum, 1931; Lombroso, 1901; Prentky, 1980); though others have emphasized a link with psychological health (Kessel, 1989; Kubie, 1958; Maslow, 1976; Rogers, 1961). A good summary of the debate is provided by Ochse (1991) and Richards (1981). The evidence, both historical and from more recent empirical studies, demonstrates quite clearly that (a) there is a definite link between creativity/genius and psychopathology, but (b) actual psychosis is negatively related to these traits, and (c) certain favorable personality traits (e.g., ego strength) are usually found positively correlated with creativity and/or genius.

A few examples will illustrate the kind of evidence that links psychological abnormality with creativity and genius. Karlsson (1970), on the basis of biographical material, claimed to have found the rate of psychosis to be 30% for great novelists, 35% for great poets, 35% for great painters, 25% for great mathematicians, and 40% for great philosophers; these values are well above those for ordinary people (roughly 2%). Similarly, Andreasen (1987), in a controlled study of 30 eminent writers, 30 matched control subjects, and first-degree relatives of both groups, found that no fewer than 80% of the writers had experienced an episode of affective disorder, whereas only 30% of the controls had done so. In addition, "the families of writers were riddled with both creativity and mental illness, while in the families of the control subjects much of the illness and creativity seems to be randomly scattered" (p. 1290). Ochse (1991) cites an unpublished study in which 38% of 47 eminent British writers had been treated for manic-depressive illness or recurrent depression, whereas 50% of the poets in the sample had received psychiatric treatment. In addition to these studies, it has been found quite generally that when highly creative subjects are given personality questionnaires, their answers (e.g., on the MMPI) have been similar to those of neurotic or psychotic individuals, although usually at a lower level (e.g., see Barron, 1968; Cattell, 1971; Goetz & Goetz, 1979a,b; McKinnon, 1965; Mohan & Tiwana, 1987; Roe, 1953).

Yet the presence of psychopathology does not make the appearance of positive personality characteristics impossible. Dellas and Gaier (1970), who evaluated more than two dozen studies, conclude that "evidence points up a common pattern of personality traits among creative persons, and also that these personality factors may have some bearing on creativity in the abstract, regardless of field" (p. 65). They found major 13 traits to be associated with creativity: independence in attitude and social behavior; dominance, introversion, openness to stimuli, wide interests, self-acceptance, intuitiveness, flexibility, social presence and praise, an asocial attitude, concern for social norms, radicalism, and rejection of external constraints.

Similarly, Welsh (1975), on the basis of his own work, gives a list of the personality characteristics (including both socially positive and negative items) of creative and noncreative students not having any overt psychopathology. Creative students were unstable, irresponsible, disorderly, rebellious, uncontrolled, self-seeking, tactless, intemperate, rejecting of rules, uncooperative, impulsive, and careless—surely all negative traits socially, and positively indicative of psychopathology. But they were also original, adventurous, liberal, refined, tolerant, candid, subtle, spontaneous, interesting, flexible, and artistic—all rather positive variables. Perhaps one side of the coin implies the other; it is impossible to possess all of a number of contradictory virtues.

McKinnon (1962, 1965, 1978), whose group's very large-scale research into creativity extended over many years and included external criteria of achievement as well as internal ratings, repeatedly draws attention to the high scores of his creative subjects on some MMPI scales related to psychosis (e.g., Schizophrenia, Depression, Psychopathic Deviate, Paranoia): "On the eight scales which measure the strength of these descriptions in the person, our creative subjects earn scores which, on the average, are some 5 to 10 points above the general population's average score of 50" (MacKinnon, 1962, p. 488). A difference of 10 points is equal to a whole standard deviation and is certainly not negligible, particularly when it is remembered that his sample (successful architects) came from a socioeconomic and educational group whose mean scores on these scales is usually well below 50

(Dahlstrom, Lachar & Dahlstrom, 1986; Friedman, Webb, & Lewak, 1989). MacKinnon adds that "in the self-reports and in the MMPI profiles of many of our creative subjects, one can find rather clear evidence of psychopathology, but also evidence of adequate control mechanisms, as the success with which they live their productive and creative lives testifies" (p. 488). Ego strength in particular has been found to be above average in these highly creative people, although in the general population ego strength correlates −.50 to −.60 with the MMPI psychopathological variables. Possibly it is the creative tension set up by these contradictory personality traits that is responsible for the outstanding success of MacKinnon's subjects.

CREATIVITY/GENIUS AND PSYCHOTICISM

I have suggested that a possible answer to the obvious paradox of genius and psychopathology may be found in the concept of psychoticism, conceived as a latent trait underlying a variety of functional psychotic disorders (schizophrenia, manic-depressive illness, schizoaffective illness, unipolar depression), as well as schizoid, psychopathic and other borderline or "spectrum" disorders (Eysenck, 1952; Eysenck & S. Eysenck, 1976). I have recently summarized the large body of empirical and experimental work that has gone into establishing the concept as a useful complement to neuroticism (N) and extraversion (E) among the major dimensions of personality. Figure 2 illustrates the nature of psychoticism (P). The abscissa runs from low-P characteristics (altruism, socialization, empathy, conformity) to the high-P characteristics (impulsivity, hostility, aggression) and through criminality and schizoid personality to the various functional psychoses (Eysenck, 1992a). P_A in the figure indicates the probability of an individual developing an actual psychosis, given his or her score on the abscissa.

There is good evidence to show that (a) different psychotic illnesses are not categorically differentiated from each other, but are closely connected and run into each other; (b) genetic relations fail to show *specific* heritability for assumed specific illnesses; and (c) diagnoses change over time from one illness to another. These and many other types of evidence make it impossible to accept the ancient Kraepelinian division, although it is equally impossible to return to the even more ancient concept of the "Einheitspsychose" as apparently advocated by Crow (1986, 1990). It seems safe to accept that a general trait of psychoticism (proneness to psychosis) underlies nonneurotic psychopathology, but that there are also specific genes or groups of genes related to specific symptomatologies. Psychoticism is a dispositional trait making it more likely for a P^+ person to develop psychotic illness under stress (the diathesis-stress model), but P is not to be identified with psychosis.

Some of the individual traits that correlate together to produce the higher-order concept of P are shown in Figure 3. Clearly they are not the only ones; others (e.g., Machiavellianism) have been identified (Allsop, Eysenck, & Eysenck, 1991), as well as such components of the "big five" system as agreeableness (negative) and conscientiousness (negative; Eysenck, 1991, 1992b).

The construct of psychoticism is based on the factor analytic study of questionnaire responses, but a special technique has been used to make the identification of the dimension with psychotic-proneness more objective. Consider a test, *T*, which on theoretical grounds is predicted to differentiate significantly between a group of psychotics and a group of nonpsychotic, normal people. If P is colinear with psychotic-proneness, then we would predict that P+ normals would be distinguished from P− normals in their *T* scores in the same way that psychotics are distinguished from normals. Similarly, P+ psychotics should be distinguished from P− psychotics along similar lines.

Experiments of this kind have been reported extensively in the literature, mostly with positive results (Eysenck, 1992a). Several classes of variables have been so studied. One class dealt with biological variables (H2A B27, MAO, serotonin) of various kinds. A second dealt with laboratory behavior (eye tracking, dichotic listening, sensitivity levels). A third was concerned with learning-conditioning variables (latent inhibition, negative priming). Yet another group dealt with physiological variables (EMG, autonomic-perceptual inversion). Finally, a fifth group was concerned with psychological variables (hallucinatory activity, word association, creativity). For obvious reasons, it is the role of creativity in this list that will mostly concern us.

We have already seen that psychopathology is directly related with creativity-genius; it is required to show that P is also thus related, both with trait creativity and with achievement creativity. I will discuss the former first.

Some of the early studies linking psychoticism

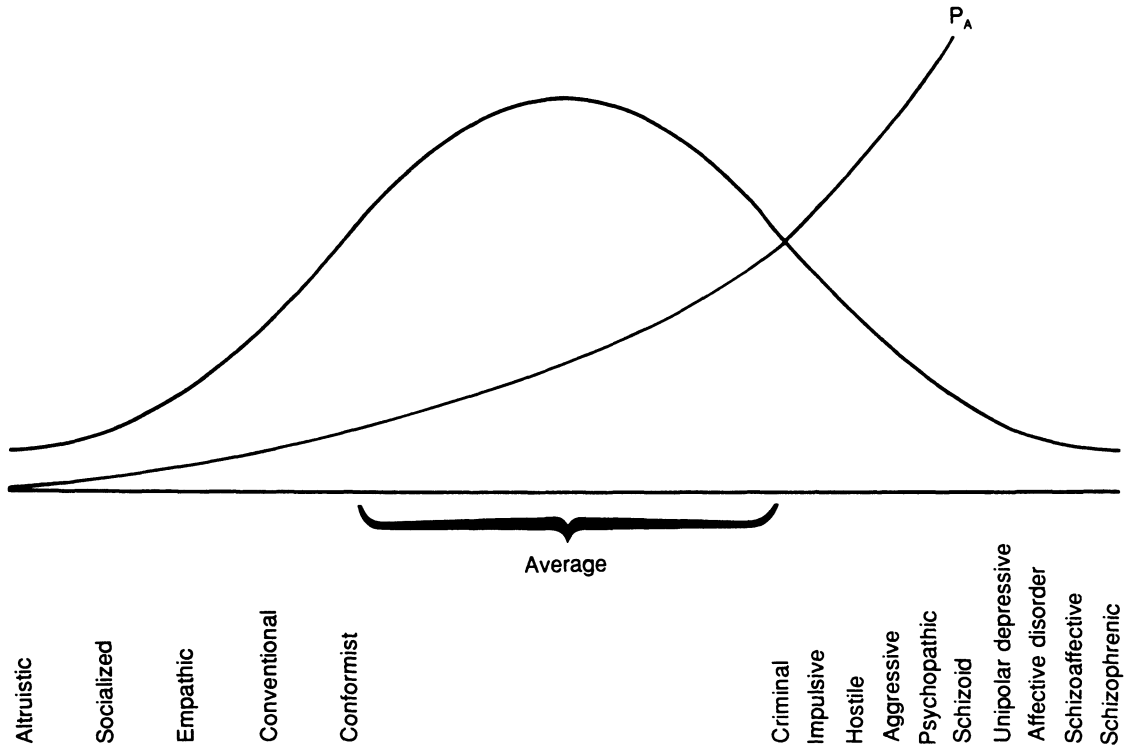

Figure 2. Psychoticism as a personality variable. P_A indicates probability of psychopathology at various levels of P. From Eysenck (1992a).

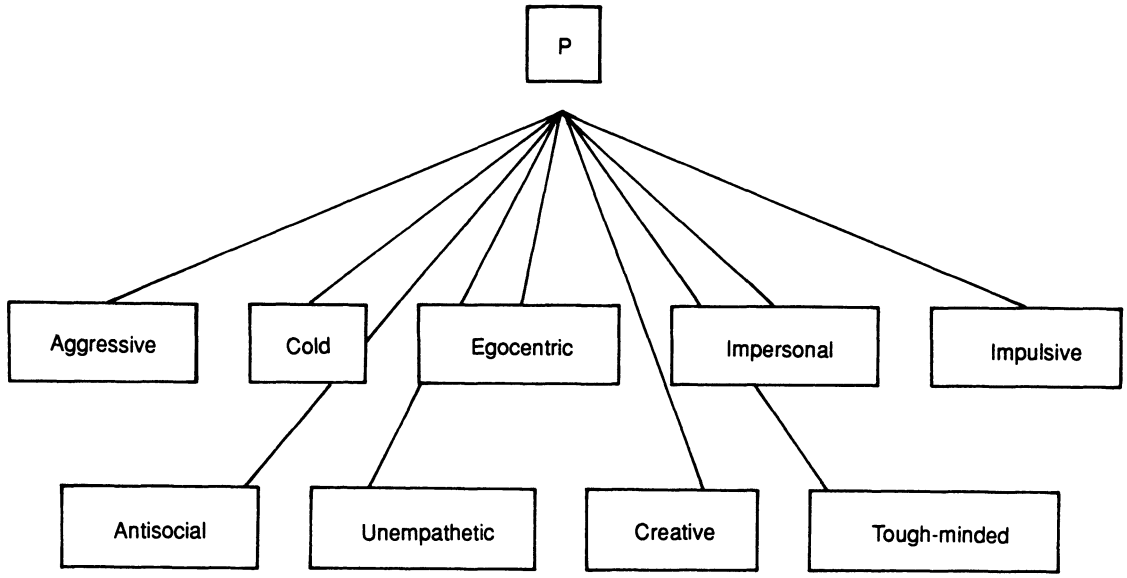

Figure 3. Number of primary traits combining to identify psychoticism (P). From Eysenck and M. Eysenck (1989).

and creativity have been discussed elsewhere (Eysenck & S. Eysenck, 1976). Farmer (1974) found two factors, fluency and originality, in a factor analysis of correlations between divergent-thinking tests. P had a small loading of .24 on fluency, but a very high one on originality (r = .74). Kidner (1978; see Eysenck & S. Eysenck, 1976, pp. 186–187) used IQ and divergent-thinking tests, creating an "index of creativity" by subtracting the standardized sum of the IQ tests from that of the creativity tests; this correlated .31 with P and .21 with E (extraversion). In another experiment Kidner replicated the correlation of P with creativity and also found P to be correlated with over-inclusiveness of thinking and slowness in categorization; these aspects of schizophrenic thinking are discussed in later sections.

Much more important and impressive is a study by Woody and Claridge (1977), which was designed especially to test the hypothesis of a strong relationship between creativity and psychoticism. The tests used were the Eysenck Personality Questionnaire (Eysenck & S. Eysenck, 1975), the Wallach-Kogan (Wallach & Kogan, 1965) creativity tests, and the Nufferno Speed Test as a measure of intelligence (Furneaux, 1960). The subjects were 100 Oxford University students, sampled widely from the various fields of specialization; the mean age of the group was 20 years (SD = 2 years).

Consider first the correlation of P with the 5 tasks constituting the creativity test—instances, pattern meanings, uses, similarities, and line meanings. For each of these divergent tests, there are two scores, one for numbers of suggestions (fluency) and the other for consequences (originality); correlations with P were .32, .37, .45, .36, and .38 for number score and .61, .64, .66, .68, and .65 for uniqueness. Overall the correlations with extraversion and neuroticism were quite insignificant, but those for the Lie scale (L) were significant and in the −.20 region. (For groups such as this, L probably measures social conformity rather than lying, and it correlates negatively with P.) It is worth noting that the 10 indices of creativity were all highly intercorrelated, with correlations ranging from .37 to .83; thus it appeared that the tests were tapping a unitary factor. Correlations between the creativity and personality variables, on the one hand, and intelligence, on the other, were insignificant.

Using all ten tests of creativity predicted P at a high level (multiple R = .84). Although replications no doubt would give a lower value for R, using the same prediction formula, the fact that R is higher than the reliability of P does suggest an astonishingly close relationship between the two variables and thus supports the original theory.

Of course, these results refer only to creativity as a trait; they say nothing about creativity in terms of achievement. This problem has been tackled by Goetz and Goetz (1979a,b), two internationally known German painters who were successful, because of their inside position, in getting 147 male and 110 female artists of renown to return completed forms of the EPQ. Painters and sculptors were included in this sample; the mean age was 47 years, with a range of 29 to 78 years. 300 male and 300 female controls with a similar age range (mean 41 years, range 21 to 79 years) were also tested. Testing was done individually or in small groups.

Male but not female artists were more introverted (perhaps women need more dominance and surgency to compete!) and more neurotic than respective controls. Most important from our point of view, male artists had higher P scores than male controls (6.53 vs. 5.79), and female artists had higher P scores than female controls (6.18 vs. 4.32); the standard deviations were around 3.00. Both differences were highly significant and are in the predicted direction. Note the exceptionally high P score of the female artists; this is expected on the basis of the double-threshold hypothesis (Eysenck & Gudjonsson, 1988) and is similar to findings concerning P scores for male and female criminals. For L, there is no difference for males, but a large one for females (negative; $p < .001$). It should be noted that comparisons between artists and controls as stated may appear less significant than they really are, because P declines with age (Eysenck, 1987) and the artists were significantly older (by 6 years).

In a second study (Goetz & Goetz, 1979b), 60 well-known artists were divided by experts into 37 more and 23 less successful ones. The more successful ones had significantly higher P scores. Some artists who were successful had low P scores, but these tended to be in the high age group, where P scores tend to drop. Altogether, being a successful artist correlates well with P, and P distinguishes artists from nonartists. This is very much in line with our theory. These studies are thus complementary in linking P with both definitions of creativity.

What is the position with respect to psychosis? Hebeison (1960), Kidner (1978), and Soueif and Farar (1971) have found significantly *depressed* performance of schizophrenics on tests of creative thinking. As I have argued, creativity demands a combination of

high P and high ego strength; there is considerable evidence for the necessity of combining these two apparently antithetical properties. Rawlings (1985) has suggested a theoretical resolution to this problem, using an experiment involving dichotic listening. As he points out, the problem is similar to that of reaction time, where P correlates with quick reactions, whereas psychotics are generally slow. Psychosis adds a new element to high psychoticism, eliminating individuals with high ego strength (who would not succumb to actual psychotic illness) and influencing performance in a negative direction. Psychosis should never be identified with psychoticism; the former is an illness, the latter a predisposition.

It may be more illuminating to consider persons within the psychotic Erbkreis, but who are not themselves psychotic. This can be done by looking at relatives of psychotics to see if they show unusual amounts of creativity (Eysenck, 1983). Heston (1966) studied offspring of schizophrenic mothers raised by foster parents and found that although about half showed psychosocial disability, the remaining half were certainly successful adults, pursuing artistic talents and demonstrating imaginative adaptations to life to a degree not found in the control group. In Iceland, Karlsson (1970) found that among relatives of schizophrenics there was 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, discovering 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. Such findings give powerful support to a link between psychoticism and creativity.

CREATIVITY AS A MENTAL PROCESS

What has been said so far suggests that psychotics, high P scorers in normal populations, and creative people generally share certain mental processes or cognitive styles, and any theory of creativity must be able to identify the nature of these styles. Measurement always implies a theory and a model, however primitive, and the only model to lend itself to scientific testing—and to have received such testing—is the one that views creativity as an associative process (Mednick, 1962). According to Mednick, the creative thinking process may be defined 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 combination, the more creative the process or solution" (p. 221). Mednick postulated an "associative hierarchy" (i.e., a way in which people produce associations to words or problems) in which creative people have a shallow gradient, extending much further than the steep gradients of less creative people.

Mednick was concerned with the steepness of the associative gradient, or what I would call the extent of the associative horizon (Eysenck, 1993). But that has to be set in a more inclusive associative framework, such as that provided by the Campbell (1960) and Simonton (1984) and the Furneaux (1960) and Eysenck (1953) models. Both postulate something like a chance-configuration theory, according to which random variations in associate formation occur in response to a perceived problem, with certain successful combinations being selected for retention. I have suggested that both formulations make the unlikely assumption that the production of associates is truly random (Eysenck, 1993); this is inherently unlikely and contradicted by a wealth of experimental studies. I have postulated instead that associations are restricted to a class that may be considered relevant, although it is also postulated that the criterion of relevance varies from person to person, with creative people having a less stringent criterion. This, in turn, gives rise to the less steep association gradient (or wider association horizon) of the creative person.

How does creativity fit into this model, which is here only sketched in most inadequately? The answer may lie in considering the nature of psychotic (mainly schizophrenic) thinking. If the theory is correct, or at least along the right lines, then there should be some connection between what characterizes such thinking and creative cognition. It may be useful to start with a well-established theory, namely, Cameron's notion of overinclusion (Cameron, 1947; Cameron & Magaret, 1950, 1951). Cameron believes that schizophrenics' concepts are overgeneralized. Schizophrenics are unable to maintain the normal conceptual boundaries, and thus they incorporate into their concepts elements—some of them personal—that are merely associated with the concept but not an essential part of it. Cameron (1939) used the term *overinclusion* to describe this abnormality; he reported that in solving problems on the Vygotsky test and a sentence completion test, schizophrenics "included such a variety of categories at one time, that the specific problems became too extensive and too complex for a solution to be reached"

(Cameron, p. 267). A fair number of experiments have been carried out to investigate this theory (for reviews, see Payne, 1960; Payne & Hewlett, 1960; Payne, Matussek, & George, 1959). The results obtained have consistently supported the theory (e.g., Epstein, 1953; Moran, 1953; see also Chapman, 1956; Chapman & Taylor, 1957).

Payne et al. (1959) have suggested that it is possible to reformulate Cameron's theory of overinclusion in a slightly more general way so that a number of predictions follow from it. Concept formation can be regarded as largely the result of discrimination learning. When a child first hears a word in a certain context, the word is associated with the entire situation (stimulus compound). As the word is heard again and again, only certain aspects of the stimulus compound are reinforced. Gradually the extraneous elements cease to evoke the response (the word), having become inhibited through lack of reinforcement. This inhibition is in some sense an active process, as it suppresses a response that was formerly evoked by the stimulus. Overinclusive thinking may be the result of a disorder (failure) of the process whereby inhibition is built up to circumscribe and define the learned response (the word or concept). In short, such thinking could be an extreme degree of stimulus generalization.

The same theory can be expressed in different terms. All purposeful behavior depends for its success on the fact that some stimuli are attended to and some other stimuli are ignored. It is a well-known fact that when concentrating on one task, normal people are quite unaware of most stimuli irrelevant to the task. It is as if some filter mechanism cuts out or inhibits the irrelevant stimuli, both internal and external, to allow the most efficient processing of incoming information. Overinclusive thinking might be only one aspect of a general breakdown of this filter mechanism.

A similar concept to overinclusion is that of allusive thinking, which is characteristic of many schizophrenics on object-sorting tests. McConaghy and Clancy (1968) demonstrated that this type of thinking exists widely in less exaggerated forms in the normal population, shows similar familiar transmission in schizophrenics and nonschizophrenics, and is akin to creative thinking. Dykes and McGhie (1976) actually demonstrated that highly creative normals score as highly on the Lovibond object-sorting test as do schizophrenics. In their study, less creative normals tended to produce conventional, unoriginal sortings, whereas the highly creative normals and the schizophrenics tended to give an equal proportion of unusual sortings. "This supports strongly [the hypothesis] that a common thinking style may lead to a controlled usefulness in normals and an uncontrollable impairment in schizophrenics" (Woody & Claridge, 1977).

The notion of overinclusion and allusive thinking as being characteristic of normal as well as schizophrenic thinking ultimately derives from Rapaport's (1945) suggestion that at least two quite different types of formal thought disorder contributed to the disturbances of thinking found in schizophrenics, neither of which was in fact specific to schizophrenia. One of these defects, demonstrated clearly in object-sorting tests, consisted in a tendency to function more at a concrete than an abstract level (Vygotsky, 1934). The other consisted of a loosening of the concept span, in that schizophrenics included objects in various groups of the test to which those objects did not strictly belong. This "looseness" of thinking is what others have called overinclusive or allusive thinking, and it occurs in normal people as well as in schizophrenics. Looseness of thinking, as measured by sorting tests, correlates well with clinical assessments of that behavior (Lovibond, 1954). Looseness thus may be suggested to be a normal type of thinking related to psychoticism and fundamental to creativity; concrete thinking is characteristic rather of psychosis and has no link with creativity, but rather precludes it.

An interesting study that demonstrates the dependence of creativity (as shown by fluency and unusualness of word associations) on psychosis, as well as the relevance of bipolar disorders, was done by Shaw, Mann, and Stokes (1986), who found that lithium decreases both the number of productions and the idiosyncracy of production. Thus the link with creativity may be via psychotic depression rather than schizophrenia.

Whatever may be the most appropriate name for the thinking characteristics that link schizophrenics and highly creative normals (overinclusiveness, allusive thinking, etc.), there clearly is a marked similarity. Furthermore, this view supports the notion of schizophrenia as a genetic morphism (Huxley, Mayr, Hoffer, & Osmond, 1964) whose frequency results from a balance between selectively favorable and unfavorable properties. The term *overinclusion* has long since been replaced, and new theories and experiments developed to include what are essentially similar ideas and conceptions: I have discussed these in some detail elsewhere (Eysenck, 1993).

Our theory would thus demand that some good and appropriate measure of overinclusion should

(a) be commonly found in schizophrenics and/or in other psychotic patients, (b) correlate with measures of psychoticism in normal people, and (c) correlate with creativity. The obvious choice for such a test must be one of word association, because it has been known for a long time that unusual associations are highly characteristic of schizophrenic patients; I have reviewed the literature elsewhere (Eysenck, 1993). Does the giving of unusual word associations correlate with creative performance? An excellent test of this hypothesis comes from the work of MacKinnon (1962, 1965), who has described the study in detail.

MacKinnon (1962) starts his account with a reference to a study by Bingham (1953), who tested the poet Amy Lowell with (among other tests) the word association test and found that "she gave a higher proportion of unique responses than those of anyone outside a mental institution" (p. 11). With groups of creative, somewhat creative, and noncreative architects (n = 124), MacKinnon found the same. The unusualness of responses correlated .50 with the rated creativity of the architects: Group 1 (the most creative) scored 204, group 2 scored 128, and group 3 (the least creative) scored 114. The postulated association between creativity and overinclusion, at least as measured by this test, was thus clearly demonstrated.

Gough (1976) has reported on a similar study done with 60 engineering students and 45 industrial research scientists. The subjects were rated for creativity and given two word association tests: one a general test, and the other using a scientific word list. Both correlated with creativity, but the scientific word list gave rather higher correlations. This is an intriguing finding that ought to be followed by in future research.

Similar results have also been reported by Miller and Chapman (1983) using the Chapman and Chapman (1980) scales as measures of schizotypal behavior. Using a continuous word association test, Miller and Chapman found that subjects with high scores in perceptual aberration/magical ideation gave a larger number of idiosyncratic responses. It is also relevant with Griffiths, Mednick, Schulsinger, and Diderichsen (1980) reported more deviant associations in the children of schizophrenic parents.

Finally, we come to the predicted association between unusual word associations and psychoticism. In the most relevant study (Upmanyu & Kaur, 1986), 140 university students were tested on the Kent- Rosanoff Word Association Test (WAT) and the Eysenck Personality Questionnaire (Eysenck & S. Eysenck, 1975). Unique responses correlated .32 with P; E, N, and L failed to show any correlation, as did intelligence. The reliability of the WAT was .72, and that of the P scale was .68; correcting for attentuation gives us a correlation between P and unique responses of .46. Ward, McConaghy, and Catts (1991) reported similar results; this requirement of our theory seems to be fulfilled.

THE CAUSES OF OVERINCLUSIVENESS

Negative Priming

What has been said so far is merely a brief summary of what has been discussed at much greater length in earlier presentations (Eysenck, 1983, 1993). It has been suggested that creativity is closely related to psychoticism, and that underlying both is a cognitive style loosely identified as overinclusiveness (i.e., a tendency to have a flat associative gradient, which allows the individual a wider interpretation of relevance as far as responses to stimuli are concerned). This overinclusiveness may be attributed to a failure of inhibition characteristic of psychotics, high P scorers, creative people, and geniuses. Clearly, though, there must be further characteristics of the cognitive apparatus that makes the difference between a psychotic patient and a genius; presumably these include high intelligence (and the other variables associated with creative achievement listed in Figure 1) and an ability to reject responses that are too far removed from the stimulus to make a genuine contribution to solving the problem under consideration.

In this section and the next, I shall discuss two candidates for the role of inhibitor of remote associations: negative priming and latent inhibition. Both fulfill this role to an extent indicated by a great deal of experimental work; both have been shown to be linked with schizophrenia (by their absence, or at least weakness); and both have been shown to be equally related to psychoticism. Both sections are theoretical in nature; there has not been any direct study of these variables in creative as opposed to noncreative people, as far as I know. The theory underlying negative priming and latent inhibition, however, presents a possible answer to our problem, as well as an experimental paradigm that can be used to test the theory presented here. It is hoped that this may encourage readers to carry out the necessary experiments to disprove or support the theory.

Among experimental paradigms used to investigate the stages and selectivity of processing information, the concept of cognitive inhibition is only one of many that have recently been applied to the assessment of possible creative dysfunction in mental health (Power, 1991). Incoming information has to be narrowed down and irrelevant information selectively excluded, a process that is postulated to occur through a balancing of facilitatory processing of task-relevant stimuli and the inhibition of task-irrelevant ones. Schizophrenia is postulated to be characterized by a breakdown of this balance, in that the failure of inhibitory processes produces over inclusiveness (Beech, Powell, McWilliam & Claridge, 1989; Bullen & Hemsley, 1986; Frith, 1979). This line of argument originated with Treisman (1964), who suggested that selecting certain specific stimuli for analysis might involve the exclusion or alternation of others. Keele and Neill (1978) produced a similar argument for the activation of memory traces; activated memory inappropriate to the task in hand had to be actively inhibited. An experimental paradigm for such cognitive inhibition is that of *negative priming*.

Negative priming may be defined in terms of the experimental paradigm in which a distractor object that had previously been ignored is subsequently represented as the target object to be named, classified, or otherwise dealt with. These processes take longer than if there had been no prior presentation; because the subject has associated the prime with negative salience, it is more difficult (i.e., takes longer) to make it salient when required. A typical defining experiment is the Stroop color-naming task, in which a color word (e.g., *red*) is presented, written in ink of a different color (e.g., green); the task is to disregard the word and state the color of the ink. If now the next word in the above example is printed in red ink, the response of normal subjects is significantly slowed; the previously ignored word *red* has acquired negative salience, which inhibits cognition associated with it. Hence the term *negative priming*, as the irrelevant stimulus word acts as a negative prime for later recognition and meaning by inhibiting reaction.

Frith (1979) suggested that schizophrenia is associated with a weakening of the inhibitory selection mechanisms that are active in the early phases of information processing, giving rise to some of the positive symptoms of schizophrenia, including hallucinations, delusions, and formal thought disorders such as overinclusiveness. Cognitive inhibition is vital for normal thought processes to occur; its absence (lack of negative priming) would therefore characterize—and be causally related to—the vagaries and excesses of schizophrenic thinking. Beech, Powell, et al. (1989) used a negative priming task to differentiate a group of schizophrenics from a matched group of mixed diagnosis psychiatric patients; as predicted, the schizophrenics shared reduced inhibition. We would expect that high-P (or schizotypal) normal subjects would show a similar lack of cognitive inhibition, and this has been shown to be so (Beech, Baylis, Smithson, & Claridge, 1989b; Beech & Claridge, 1987; Beech, McManus, Baylis, Tipper, & Agar, 1991). High schizotypes not only showed failure of negative priming but even *positive* primary effects; in other words, the supposedly negative prime had facilitatory rather than inhibitory effects for this group.

Curiously enough, the failure of negative priming was less noticeable in the schizophrenic subjects studied in these experiments than in the (normal) high schizotypes. This may be explained in terms of the medication effects shown by the schizophrenics. As Beech, Powell, McWilliam, and Claridge (1990) have shown, a small dose of chlorpromazine in normal subjects significantly increased the negative priming effect, as compared to placebo.

The nature and definition of the negative priming effect are fairly clear, but the actual processes involved are still a matter of debate. Neill (1977) has put forward the view that priming effects occur as a result of active inhibition of the irrelevant stimulus, making possible an efficient response to the target stimulus. The need to undo the inhibition produces a response cost on the subsequent trial, measured in terms of increased reaction time. In an alternative theory, Tipper (1985) has suggested that what is inhibited is the access of the activated structure to the mechanisms required for an overt response, an effect that decouples the representations from the construct of action. For the purpose of this section, we need not prefer one theory over the other.

In general terms, what makes the negative priming paradigm applicable to our problem? It is based on the view that both facilitatory and inhibitory processes are involved in selectivity determining attention to relevant information input, relevance being decided by prior experience. Marked individual differences exist in the degree of cognitive inhibition, measured by negative priming, with schizophrenics/schizotypes failing to show such inhibition and consequently becoming overinclusive. In other words, the flat associative gradient characteristic of creative people may be

the result of lack of cognitive inhibition, as measured by negative priming. At present this is clearly only an hypothesis, there being no direct evidence on the assumed relation between creativity and negative priming. The fact that high P scorers have been shown to be creative and also to have low negative priming scores, however, is at least indirect evidence to firm up the general theory.

Latent Inhibition

The theories of Tipper (1985) and Neill (1977), mentioned in the previous section as explaining negative priming effects, are clearly cognitive theories. Yet these phenomena may also be explained along the lines of classical conditioning theory. As far as I know this line of argument has not previously been followed, but the theory and phenomena of latent inhibition bear a remarkable similarity to negative priming. (Lubow, 1989, in a book on latent inhibition, does not mention negative priming.)

Latent inhibition (LI) is defined by an experimental paradigm that requires, as a minimum, a two-stage procedure. The first stage involves stimulus preexposure (i.e., the to-be-CS is exhibited without being followed by any UCS); this leads theoretically to the CS acquiring a negative salience (i.e., it signals a lack of consequences, and thus acquires inhibitory properties). The second stage is one of *acquisition*: The CS is now followed by an UCS, and it acquires the property of initiating the UC response. Latent inhibition is shown by increasing difficulties of acquiring this property, as compared with lack of preexposure. As with negative priming, there is a masking task during preexposure to the CS. For instance, the masking task might be the auditory presentation of a series of syllable pairs, whereas the CS would be a white noise randomly superimposed on the syllable reproduction. The LI group would be exposed to this combined recording, with the control group was exposed only to the syllable pairs without the white noise. In the test phase the white noise is reinforced, and subjects are given scores according to how soon they discover the rule linking CS with reinforcement. LI would be indicated by the group with preexposure to the white noise discovering the rule later than the control group. There are more complex, three-stage procedures, but these complications are not crucial to our argument (Lubow, 1989).

Is it possible to classify negative priming as a variant of latent inhibition? There are obviously close similarities. Conditioning of performance is preceded by the exhibition of the to-be-CS (or action stimulus) under conditions that endow it with negative salience; the subject either is instructed to disregard it (negative priming) or learns independently that the to-be CS does not signal anything specific. Hence in both cases the sign-significate (S-S) link is counterindicated, and the establishment of such a link is made more difficult.

Applying the nomenclature of conditioning to the negative priming paradigm is permissible in the recent climate of S-S theorizing and inclusion of cognitive elements in the conditioning process (Gray, 1975; Macintosh, 1974, 1983). The cognitive elements in latent inhibition theory are emphasized by Lubow (1989) in terms of his conditioned attention theory. According to this theory, nonreinforced preexposure to a stimulus retards subsequent conditioning to that stimulus, because during such preexposure the subject learns not to attend to it. The theory is based on the use of attention as a hypothetical construct with the properties of a Pavlovian response, and on the specification of reinforcement conditions that modify attention.

The same theory may be used to explain negative priming effects. Nonreinforced preexposure in this case is the not-to-be-reacted-to part of the red-green Stroop combination, which retards subsequent conditioning to that stimulus because during preexposure the subject learns not to attend to it. The general view of the importance of changes in attention to stimuli, which underlies this theory, goes back to Lashley (1929) and Krechewsky (1932), and may be traced through Lawrence (1949) to MacIntosh (1975), Frey and Sears (1978), and Pearce and Hall (1980). Granted the similarities, we would expect (a) less latent inhibition in schizophrenics, and (b) less latent inhibition in high P scores. The evidence supports both deductions.

Baruch, Hemsley, and Gray (1988) found an abolition of latent inhibition in acute schizophrenics, but not in chronic schizophrenics or normals. Lubow, Weiner, Schlossberg & Baruch (1987) also failed to find such abolition in chronic cases, presumably because such patients are on a dopaminergic antagonist, neuroleptic drug regime that would normalize attentional processes (e.g., Braff & Saccuzzo, 1982; Oltmans, Otayon & Neale, 1978). There is a large body of evidence to show that LI can be attentuated or abolished in rats by dopamine agonists (e.g., amphetamines) and can also be increased with dopamine antagonists (e.g., haloperidol, chlorpromazine; see discussion by Lubow, Ingberg-Sacks, Zalstein-Orda,

& Gewirtz, 1992). In this respect, then, latent inhibition closely resembles negative priming.

Regarding their high-versus-low psychoticism group, Baruch et al. (1988) found the expected negative correlation between LI and P: the greater the proneness to psychosis, the less latent inhibition. Similar results have been reported by Lubow et al. (1992) using two different experimental procedures; again, high-P subjects showed an attentuated latent inhibition effect compared with subjects with low P scores. Both auditory and visual stimulus preexposure resulted in slower acquisition of new associations as compared with a lack of preexposure to the test stimulus, but to a much lesser extent in high-P than in normal and low-P subjects. Lubow et al. (1992) argue that "the idea that schizophrenics fail to filter out irrelevant stimuli is congruent with the phenomenology of schizophrenics, and with a considerable variety of data on the differential effects of distractors on the behavior of schizophrenics and normals. Frith (1979) cogently and succinctly described this type of result as reflecting an inability to limit the contents of consciousness." (p. 570).

This, of course, is precisely what is characteristic of the mechanism needed to explain the overinclusiveness of schizophrenics and high P scorers. The failure of negative priming and/or latent inhibition to limit associationist spreading (flat associationist gradient) would appear to account for the prominent symptoms of psychotic cognition and the major feature of creativity. Accordingly, this may be the missing link between psychopathology and genius. Of course, as already explained, a flat associative gradient produced by an absence of cognitive inhibition is not enough by itself to produce creative achievement; other components, such as those listed in Figure 1, are needed. Among these, the ability to weed out unsuitable and unusuable associations must be the distinguishing mark between the word salad of the schizophrenic and the utterances of the poet.

Latent inhibition and negative priming have a biological basis, of course, and this seems firmly related to dopamine levels. As reported, dopamine agonists (e.g., amphetamines) attenuate or abolish LI, while dopamine antagonists (e.g., haloperidol, chlorpromazine) increase LI, just as they affect psychotic behavior. As Lubow et al. (1992) say, "these data are in accord with the premise that schizophrenia has a major attentional deficit component . . . and that the disorder is mediated by a dopamine system dysfunction. While other neurotransmitter involvements in schizophrenia have been proposed . . . the dopamine hypothesis remains a leading component in understanding schizophrenia (Gray, Feldman, Rawlins, Hemsley & Smith, 1991) (p. 503).

The suggested relevance of LI to creativity is, of course, similar to that suggested for negative priming. Cognitive inhibition characteristic of most people is lessened or removed in creative individuals, and hence the associationist gradient is flattened, criteria for relevance are reduced, and "overinclusiveness" appears. Again, it should be emphasized that there is no *direct* evidence in favor of the theory; it is based essentially on the strong association between creativity and psychoticism, the finding that psychoticism (like schizophrenia) is characterized by low degrees of LI and negative priming, and that LI and negative priming account for the lack of cognitive inhibition apparent in schizophrenia and high P scorers. Direct evidence is needed before the theory can be accepted as a true, rather than merely possible, account of the observed relation between personality and creativity.

CREATIVITY, AROUSAL, AND PERSONALITY

An additional psychological variable that has been connected both with creativity and personality is *cortical arousal*. Theoretically this link between creativity and (lack of) arousal dates back to Hull (1943), who postulated a "behavioral law" according to which increases in drive (arousal) make the dominant response to a stimulus even more dominant (i.e., increase the steepness of the associative gradient). Anxiety, acting as a drive, has a similar effect (Eysenck, 1973). Easterbrook (1959) similarly put forward the hypothesis that arousal causes attentional narrowing, again suggesting an increase in the steepness of the associative gradient. Martindale (1981, 1989) has rephrased this general law, stating that in the information network more nodes will be activated and to a more equal degree in a state of low as compared with high arousal.

Martindale (1981) has provided some empirical evidence that defocused attention, flat associative hierarchies, and "primary process thought" are indeed associated with states of low cortical activation. This law would imply that anything that increases arousal impairs performance on tests of creativity. Positive evidence for such a deduction from the general principle has been found for stress (Dentler & Mackler, 1964), the simple presence of other people (Lindgren

& Lindgren, 1965), noise (Martindale & Greenough, 1973), extremes of temperature (Lombroso, 1901), and even reward (extrinsic motivation; Amabile, 1983a).

There is an apparent contradiction here: It would not be true to say that generally creative people are in a state of low arousal. Maddi and Andrews (1966) found that creative people are more anxious than uncreative people; they also tend to show slightly higher levels of resting (basal) arousal on physiological measures. Similarly, creative people like scientists tend to be introverted (Eysenck, 1973) as do artists (Goetz & Goetz, 1979a,b). Introversion, of course, is linked with *high* levels of arousal (Eysenck & M. Eysenck, 1989; Strelau & Eysenck, 1987); Goetz and Goetz (1979a,b) also found successful artists to be high on neuroticism. Clearly there is a paradox here.

Martindale has suggested the solution: As compared with less creative people, those who are more creative do show low levels of cortical arousal while performing creative tasks (Martindale & Hines, 1975). Martindale and Hasenfus (1978) found that low levels of arousal were found precisely where they were expected to occur—during creative inspiration, rather than during the elaboration stage. Martindale goes on to suggest that creative people may be more *variable* in their level of arousal, and thus they show more extreme fluctuations. This is a psychophysiological restatement of Kris's (1952) contention that creative people are more variable on the primary process–secondary process continuum. Although there is no direct evidence for this hypothesis, Gooding and Jamison (1990) have shown that highly creative people tend to fluctuate between states of excessive energy and excessive apathy, abulia, and depression; this variance is perhaps the effect of high P (manic-depressive abnormality).

Quite generally, people tend to influence their level of arousal by choosing activities that raise or lower arousal to approach optimum levels. Hence introverts seek solitude, and extraverts look for company (Wilson, 1990). Though anecdotal, the evidence of supreme acts of intuition/creativity on the part of scientific geniuses suggests that very frequently these acts occur in states of low arousal—dreamy pre-sleep, sitting on a train or bus, or during a vacation. High arousal accompanied the elaboration stage (when creative people attempt to prove their intuitive insights, search the literature, argue with skeptics, etc.).

Although the evidence is less strong than in the case of introversion, it seems clear that P is related to low arousal or arousability (Zuckerman, 1991); the physiological mediators are again dopamine and monoamine oxydase (MAO). There has been less study of the low arousal-P connection than of the low arousal-E connection. In particular, the possibility of rapid change from high to low arousal, suggested by Martindale, has not been investigated in relation to personality, although Pavlov's notion of excitation-inhibition equilibrium may be relevant. Here, as in so many other aspects of this theory, future research must come to the aid of Martindale's view and support it (or not, as the case may be). That there is a connection between arousal and creativity is very likely; whether this connection is similar to that suggested by Martindale remains to be seen. He has certainly made an important beginning in the direction of testing it.

I may add one further point here. The concept of arousal has many similarities with the concept of drive in the Hullian sense, and an attempt has been made to see if schizophrenics are characterized by low drive, as has often been suggested in explanation of their frequently poor performance on various tasks. I have reported an experiment to test this hypothesis (Eysenck, 1961), using as a measure of drive the amount of reminiscence on a pursuit-rotor task. (Eysenck and Frith, 1977, have summarized the evidence that reminiscence can be used as a good measure of drive.) The results showed no evidence of low drive in schizophrenics, but did show that they had a low rate of dissipation of inhibition. If this is true of (normal) high P scorers, too, then we may have to consider slow dissipation of inhibition as a possible causal factor for creativity. Another, more appealing explanation of the observed retarded appearance of reminiscence in schizophrenics and manic-depressives may be a slow process of consolidation of the memory trace (Eysenck & Frith, 1977). This might lead to a comparative failure in psychotics (and possibly high-P subjects) to form firm memory structures, which might in turn impede the use of flat associationist gradients. Unfortunately, little work has been done in this field, so this possibility must remain a suggestion.

SUMMARY AND CONCLUSIONS

Creativity clearly is a complex concept, defined at two very different levels as a personality trait or creative style and as an achievement-oriented behavior. Because of the multiple determination of creative behavior by synergistically acting causes of which trait creativity is only one, we would not expect (and

do not find) high correlations between trait and achievement creativity (Eysenck, 1993). This does not lessen the importance of or lower our interest in trait creativity; although the latter does not carry all the burden of creative achievement, it is one indispensable condition for such achievement.

Creativity is best conceived in terms of an associative paradigm—namely, in terms of being the product of a flat associative gradient that allows remote associations to influence cognitive processes of problem-solving. Flat associative gradients in general lead to overinclusiveness, which is a characteristic feature of schizophrenia and functional psychoses generally (Eysenck, 1992a); this may explain the close connection between creativity and psychoticism. The latter concept differs from psychosis by not being pathological and hence enabling people to use remote associations in a constructive way, whereas psychotics are overwhelmed by overinclusive thoughts and cannot cope with them in a critical manner.

If we do conceptualize creativity as being closely linked with personality through the cognitive style just specified, we have the added opportunity of being able to explain the reasons for a flat associative gradient in terms of reasonably well understood processes like negative priming, latent inhibition, and low arousal—processes that have been theoretically and empirically linked with both psychoticism and psychosis. Such a link with experimental psychology and learning theory is essential if we are ever to go beyond a purely descriptive effort and attempt a causal analysis of creativity and genius. This emphasis on personality-related mechanisms has always been prominent in theories about creativity and genius, linking "great wits" and "madness," as in Dryden's famous poem. Modern thinking insists more on the "thin partitions" that "their bounds divide": the distinction between psychoticism as a dispositional trait and psychosis as an active illness, where the characteristics pertaining to the illness overwhelm the positive features of the disposition (Eysenck, 1993).

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