Scientific Creativity: An Individual Differences Perspective

Commentary by J. Philippe Rushton

An evolutionary approach to creativity may properly be considered to have begun with Darwin's cousin, Francis Galton. Galton's (1869) seminal work *Hereditary Genius* was concerned with the heritability, distribution, and measurement of individual differences in "zeal and industry", as well as intelligence, and appeared six years before *Descent of Man* (Darwin, 1871). It provided early evidence that individual differences in intelligence are substantially heritable, and was the first to advocate the use of twins to illustrate this. However, Galton was not exclusively hereditarian; he also carried out surveys to assess the other influences that made for genius, and reported that high-minded mothers and first born ordinal position were important predictors.

In recent years, explaining great originality in terms of individual differences has been de-emphasized in favor of theories involving social structure. A striking feature of high creativity, however, is its statistical rarity, which poses a problem for purely sociocultural explanations (Simonton, 1986c). Of course, individual and social hypotheses are no longer viewed as incompatible. As F&L discuss, genetic and environmental sources of variance are best understood as complementary analyses.

I will here re-emphasize the importance of individual differences and review the role of personality dispositions in creativity. I shall focus primarily on the research creativity of university professors, a topic that has become of high interest to me (Jackson & Rushton, 1986).

While scientific creativity is a difficult concept to operationalize, one approach is to assess the impact of an individual's work (Rushton, 1984). It becomes clear that a small minority accounts for a disproportionate impact. Consider the citation and publication counts reported in Table 1, which are based on 4,070 faculty members in the top 100 psychology departments in the U.S., Canada, and the U.K. (Endler, Roediger & Rushton, 1978). It can be seen that 52 per cent did not publish in 1975 in any of the journals reviewed by the *Social Sciences Citation Index*. Similarly, the great majority had relatively few citations.

Such large variations of individual productivity are commonplace in the sciences (Shockley, 1957), and one can identify various factors that contribute to the distribution skew. Empirically, the distributions are "ageist", "sexist", and "elitist". F&L suggest (and see also Horner, Rushton & Vernon, 1986) that productivity increases up to around 40 years of age and then gradually diminishes. Similarly, women are not only underrepresented in science but, per capita, produce less than their male counterparts (Cole, 1981). Finally, those individuals who receive doctorates from and/or are appointed to high prestige universities are more productive than those at less reputable institutions (Gaston, 1978).

With respect to personality traits, one "classic" study was Terman's (1955) longitudinal investigation of genius. He reported data on 800 men who were divided into scientists and nonscientists based on their college majors. As measured by ratings made at ages 11 and 30 (for which there was substantial stability across time), scientists differed from nonscientists in showing high general intellectual curiosity at an early age and in being low in sociability. Terman concludes that "the bulk of scientific research is carried on by devotees of science for whom research is their life and social relations are comparatively unimportant" (p. 7). Cited is the work

Table 1. Frequencies and cumulative percentage frequencies for the distribution of citations of and publications by faculty members at the top 100 British, Canadian, and American graduate departments of psychology (after Endler, Rushton, & Roediger, 1978).

	CITATIONS		PUBLICATIONS	
Number of citations or publications	Frequency	Cumulative percentage frequency	Frequency	Cumulative percentage frequency
> 100	134	100	—	—
26-99	556	97	—	—
21-25	164	83	1	100
16-20	223	79	1	99
11-15	338	74	1	99
10	97	65	3	99
9	82	63	4	99
8	102	61	12	99
7	105	58	18	99
6	125	56	37	99
5	187	53	54	98
4	187	48	147	97
3	207	44	259	93
2	302	38	468	87
1	365	31	971	75
0	896	22	2,094	52
Total	4,070		4,070	

Note. From the 1975 *Social Sciences Citation Index.*

of Roe (1953), whose sample of scientists is described as tending "to be shy, lonely, slow in social development, and indifferent to close personal relationships, group activities or politics" (p. 7). Terman noted that such traits were not necessarily defects, for emotional breakdowns were no more common than among nonscientists. Instead, he suggested that they constituted a normal departure from the average that was decidedly favorable for the professional development of a scientist.

Cattell has reported that a reliable profile of the prototypic scientist emerges from both the qualitative study of biographical material and from quantitative psychometric studies of leading researchers (Cattell, 1962, 1965; Drevdahl & Cattell, 1958). Successful scientists were reported to be: reserved and introverted, intelligent, emotionally stable, dominant, serious-minded, expedient, venturesome, sensitive, radical thinking, self-sufficient, and having a strong and exacting self-concept. The feature on which they differed most from normal was reserved-introverted. Elaborating on this dimension, Cattell describes scientists as being skeptical, internally preoccupied, precise, critical, exacting, and reliable.

Numerous other studies on this issue have been carried out. Barron (1962) found creative people generaly to be cognitively complex, more differentiated in personality structure, independent and nonconformist, self-assertive and dominant, and to be low in suppression of impulses and thoughts. Chambers (1964) compared eminent researchers with those less eminent but matched on other relevant variables, and found the former to be more dominant, self-sufficient, and motivated toward intellectual success. McClelland (1962) found successful scientists to be calculating risk-takers in the same way as business entrepreneurs; the risk-taking, however, involved dealing with physical rather than social situations, for he too found scientists to be avoidant of interpersonal relationships. McClelland also believed that the source of the need for scientific achievement was a strong aggressive drive "which is normally kept carefully in check and diverted into taking nature apart" (1962, p. 192).

More recently, studies of academic psychologists have found that measures of achievement motivation correlate with both number of publications and number of citations by others (Helmreich *et al.*, 1978, 1980). This was particularly true of those measures concerned with a preference for challenging tasks and enjoyment of working hard, but not concerned with liking of interpersonal competition and the desire to better others. Type A behavior (aggressive, incessantly struggling, time oriented, hostile when frustrated) has also been associated with superior scientific work as indexed by the number of times that one's work was cited by others (Matthews *et al.*, 1980).

In my own research with Harry Murray and Sam Paunonen, the personality profiles of effective researchers were contrasted with those of effective teachers. Two separate studies were conducted, one based on a sample of psychology professors from the University of Western Ontario, and the second on a mail survey of psychologists at nine other Canadian universities (Rushton, Murray & Paunonen, 1983). In both, factor analyses were carried out on 29 personality traits, with research and teaching effectiveness composites (which intercorrelated zero) targeted as separate orthogonal factors. The results of the two studies were congruent, with one cluster of traits associated with being an effective researcher while a quite different set characterized the effective teacher (Figure 1). The only variables loading positively on both dimensions were intelligence and leadership, while meekness suggested being poor on both.

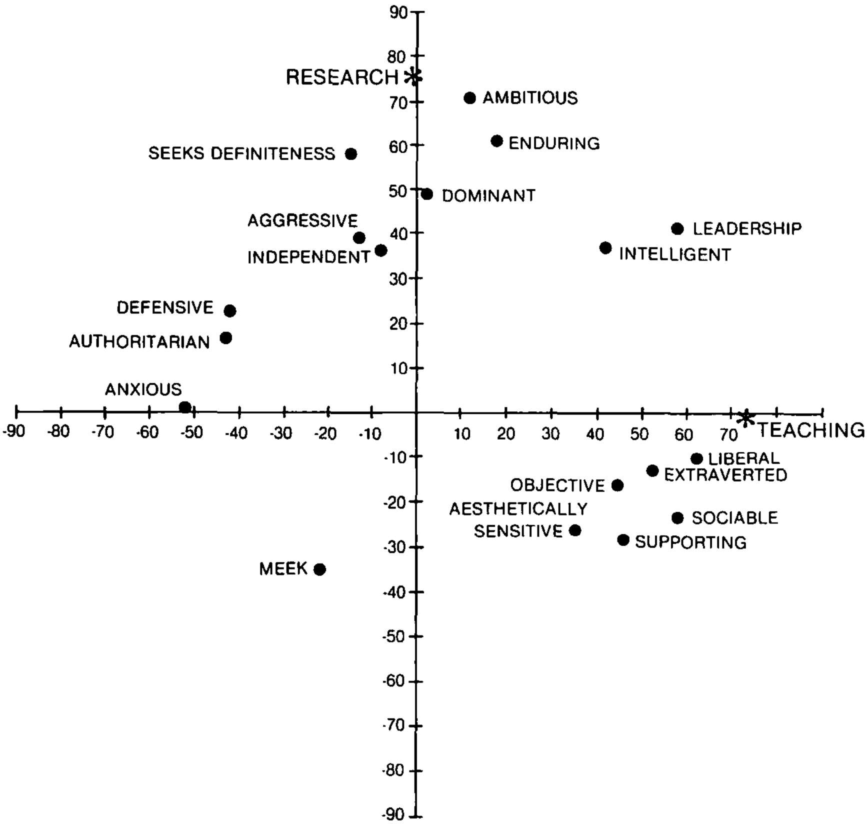

Figure 1. Plot of mean factor pattern coefficients of personality traits on dimensions of research productivity and teaching effectiveness, averaged across Study 1 and 2. Only those traits with absolute values of greater than .30 on either factor in both studies are shown. (After Rushton, Murray & Paunonen, 1983.)

In summary, the impression that emerges of the successful research scientist is that of a person less sociable than average, serious, intelligent, aggressive, dominant, achievement oriented, and independent, as well as cognitively complex, with a radical imagination and a well-articulated self-concept. In short, the creative person is both "introverted and bold" (Drevdahl & Cattell, 1958). Variations can, of course, be expected. For example, as Cattell (1962) noted, such scientists as Leibnitz were fully at home in the social free-for-all of court circles as in the laboratory.

As shown in Table 1, the distribution of scientific productivity is positively skewed. Walberg *et al.* (1984) point out that such distributions are typical when underlying causes have combined multiplicatively rather than additively. (Additive causes typically produce normal distributions). In economics, multiplicative theories of production are currently dominant, and Walberg *et al.* extend the reasoning to education; that is, learning is a multiplicative, diminishing-returns function of student ability, time, motivation, and amount or quality of instruction. (This perspective also explains the absence of learning, because any zero score in the equation is expected to result in zero output). They also apply the analysis to production in science, showing that the influences of early publication, job placement, external recognition, etc. may cumulate multiplicatively to produce highly skewed productivity. From our standpoint here, multiplicative causation may also occur with personality characteristics. Assuming independence of traits, a scientist who is at the 90th percentile on endurance, ambition, intelligence, and introversion, for example, would be one in ten thousand on the combination of attributes. Such probability pyramiding may help account for the small proportion of outstanding scientists.

It is interesting to inquire how personality affects creative productivity. Traits such as the need to achieve excellence, or the capacity to override difficulties, exert influence in a relatively straightforward manner. As P.L. van den Berghe (personal communication, April 19, 1985) pointed out, the traits associated with high productivity in Figure 1 almost parody the "alpha male" concept, and are those that would imply successful achievement in almost any occupation. Other characteristics, e.g., introversion, need for autonomy, and a differentiated self-concept, require a deeper analysis. One possibility is that such traits bear on F&L's suggestion, based on a quite different literature, that "mechanisms serving to insulate (or dissociate) cognitive state from the physical environment may actually facilitate creativity." Some traits may thus have the effect of distancing the individual from immediate circumstances, thereby fostering the imaginative shoots of the fertile brain.

Following Galton, therefore, and given that (1) personality traits do differentiate the creative scientist, and that (2) approximately 50 per cent of the phenotypic variance in personality is associated with genetic variance (Rushton, Russell & Wells, 1985), is it not time that the individual difference perspective was given more attention? For example, F&L link the creative process to life history phenomena. This was of particular interest to me since I have recently reviewed data suggesting that a constellation of individual differences in human life history characteristics co-occur and are related to brain size, intelligence, timing of sexual events, and some of the personality characteristics discussed in this commentary (Rushton, 1985). It would seem that, as F&L discuss, the study of the creative process belongs in a much broader evolutionary context than has been considered to date. Within this context, the sorts of data presented in this commentary must also be taken into account if a full understanding is to be achieved.

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