Original Research

Family Background and Genius II: Nobel Laureates in Science

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Objective: In a previous study of literary creative achievement, we presented evidence refuting the still-influential statistical studies of Frances Galton on the inheritance of genius and also described a family background constellation of creativity. This study aims to assess empirically the hereditary transmission hypothesis with respect to creative achievement in the natural sciences.

Methods: Family background data were collected on 435 of all 488 Nobel laureates in chemistry, physics, and medicine and physiology, from 1901 through 2003. These were compared with a matching group of 548 eminent nonscientists for incidence of occupational inheritance (that is, same parent–offspring occupations) and with 560 high-IQ nonprizewinners for predominant type of occupation.

Results: The incidence of one or both parents having the same occupation was only 2% for science Nobel laureates but 20% for eminent nonscientists ($P < 0.001$). The predominant family background constellation (63%) for science Nobel laureates consisted of the same-sex parent either having a performance-equivalent occupation involving applied science, technology, or a natural-world focus and skills ($P < 0.001$, compared with the matching group) or having an unrelated occupation with unfulfilled scientific interests and wishes for creative expression.

Conclusions: Nobel laureates in the natural sciences do not manifest direct inheritance of creativity from their parents; instead, congruent-sex parents are predominantly in applied or performance-equivalent occupations, with unfulfilled creative and scientific wishes. Early developmental influences on motivation involving identification and competition with the congruent-sex parent are suggested.

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Clinical Implications

- The finding that there is no evidence for direct inheritance of scientific creativity or genius, along with other types of creativity or genius, applies to healthy processes and therapeutic facilitation of creativity, psychiatric treatment of creative persons, and genetic counselling.
- Factors related directly to creativity, such as exceptionally intense motivation, should be differentiated from aberrant factors and psychopathology.
- In the childhood development of creative persons, intergenerational competition as well as adoption of parental implicit and explicit creative goals may be accepted and fostered.

Limitations

- The findings are based on resemblance criteria, that is, similarities between parent and offspring behaviour, of behavioural genetics rather than on a gene-transmission approach.
- The main finding is based on test and control group evaluations, but the supplementary finding is based on assessment with a comparison group.
- Data regarding the grandparents and other probands of the Nobel laureates, control subjects, or the comparison group are not assessed.

Key Words: *creativity, genius, heredity, motivation, genetic counselling, occupational inheritance, Nobel laureates in science, creativity and mental illness, treatment of creative patients*

The Nobel Foundation's recent Centennial Exhibition, "Cultures of Creativity," (see http://nobelprize.org/nobel/nobelmuseum/exhibition/) focused on the importance of individual creativity in scientific progress. Although the corpus of scientific knowledge develops from a large population effort involving investigation and validation by the entire scientific enterprise, particular individuals provide special impetus through important theories and discoveries. These creative achievements by scientists from the fields of physics, chemistry, and medicine and physiology have, in the 20th and 21st centuries, been recognized by the Nobel Prize award. Although the term genius is nowadays often applied to a broad range of persons and capacities, there is strong professional consensus that recipients of the prize, especially in science, meet the strict criteria for the designation (1,2). According to Webster, these criteria are "extraordinary . . . intellectual power especially as manifested in unusual capacity for creative activity of any kind" (3).

That the unusual capacity designated as genius is born, not made—that it is inherited capacity—is a long-held tenet. As we pointed out in our previous study (4), contemporary researchers continue to cite Francis Galton's work on hereditary genius as proof for this contention, despite the lack of any definitive support for his results. In studies of what is today called "occupational inheritance"(that is, the child follows the same occupation as one or the other parent [5]), Galton attempted to show that high proportions of eminent persons had distinguished parents in the same occupation as well as having a large number of eminent relatives (6). Subsequent studies of connections between eminence and inheritance, based on ethnic, temporal, cultural, and IQ distributions by Cattell (7), Cox (8), Clarke (9), Terman (10), Bramwell (11), and Simonton (12), have yielded variable results.

In our previous investigation, we presented evidence refuting Galton's findings with respect to creative literary achievement and genius (4). Assessing outstanding literary prizewinners, including Nobel laureates in literature, we found that less than 1% had parents in the same occupation. When we compared the outstanding literary prizewinner group with an independently selected and matching group of eminent persons in a wide variety of fields, occupational inheritance was significantly absent. Instead, we identified a specific familial constellation comprising parental applied or performance-equivalent occupations and lifelong unfulfilled wishes for creative achievement.

We pointed out previously that Galton's findings were very likely unduly influenced by the British practice of primogeniture and by his inclusion of persons who were simply well respected (for example, jurists and military commanders) in the genius category. However, his studies were the foundation for the science of behavioural genetics, and Galton was the earliest psychologist to use statistical methodologies. As Kendler has recently pointed out, the behavioural genetics findings of genetic epidemiology have been the guideposts for more specific laboratory approaches to gene finding and molecular genetics (13). Moreover, Galton's exploration of genius did appropriately include a large group of eminent scientists, and he also carried out surveys of his scientific contemporaries (6,14). Consideration of the familial background of scientists with outstanding creative achievements is necessary for a full assessment of occupational inheritance and genius. Studies of the parental occupations of eminent scientists since Galton have indicated only that they were largely in the broad professional category; distributions in other occupational categories or types were not documented or calculated (8,15).

In the present study, the assessment has been extended to the familial background of persons recognized for creative achievement in the natural sciences. I first compared available occupational inheritance data on all Nobel laureates in the natural sciences with similar data from a matching, eminent nonscientific control group (16,17). Using these results, as well as previous findings from our assessment of outstanding literary prizewinners and other creativity research (4,18–21) indicating a specific background pattern, I further assessed specific types of parental occupation patterns in the science Nobel laureate group. These were compared with the independently defined group of high-IQ persons studied by Terman (10). I also determined the incidence of Nobel laureate parents' unfulfilled wishes for scientific achievement.

Abbreviations used in this article

CH	Nobel laureate in chemistry
ENS	eminent nonscientists
M&P	Nobel laureate in medicine and physiology
NLS	Nobel laureates in the natural sciences
PH	Nobel laureate in physics

Assessment I

I ascertained the presence or absence of equivalent parental occupations among all NLS from the inception of the award to the present. The factor of eminence was controlled through comparison with an empirically defined matching ENS group. The general incidence of all types of occupational inheritance, as last assessed by the US Bureau of Census, is that 21% of all men follow the same occupation as their fathers (22).

Table 1 Distribution of occupational types in the NLS and ENS groups

	Father		Mother	
	NLS	ENS	NLS	ENS
Occupation type	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Professional	217 (50)	215 (39)	53 (66)	43 (47)
Commercial	129 (30)	160 (29)	14 (18)	20 (22)
Industrial	63 (15)	112 (20)	12 (15)	27 (29)
Public service	26 (6)	61 (11)	1 (1)	2 (2)
Total	435	548	80	92

Table 2 Parents in same occupations as offspring in nobel and eminent nonscientist groups

	NLS (*n* = 435) *n* (%)	ENS (*n* = 548) *n* (%)
Fathers	9 (2)	93 (17)
Mothers	2 (< 1)	16 (3)
Both parents	2 (< 1)	10 (2)
Totals	11 (2)	109 (20)

Method

Available background occupational data from the years 1901 through 2003 were collected from biographical sources regarding Nobel laureates in physics (PH), chemistry (CH), and medicine and physiology (M&P). The group comprised 435 subjects: 153 PH, 123 CH, and 159 M&P. Overlapping data for those who were prizewinners twice were excluded (Marie Curie separately in chemistry and physics, John Bardeen twice in physics, and Frederic Sanger twice in chemistry). In the group, 427 (98%) were men, and 8 (2%) were women. Ethnic and geographic backgrounds were broad, with the largest distribution from Europe (including the British Commonwealth) and the US; others came from Latin America, the Middle East, Africa, and Asia. Offspring data, which would not apply to all members of the subject group, were not collected.

Similar data were collected from a control group of 548 ENS from a similar time period, empirically and independently identified in Goertzel and Goertzel's biographical studies of eminence (16,17). All were recognized as highly accomplished in the fields of politics, social reform, religion, the military, business, arts, music, education, scholarship, law, entertainment, communication, and sports. (Among this group were Jomo Kenyatta, Ho Chi Minh, J Edgar Hoover, Greta Garbo, Hubert Humphrey, Charles Lindbergh, Emma Goldman, Louis Renault, Lytton Strachey, Frank Sinatra, Joe Namath, Paul Tillich, Bob Dylan, Henry Kissinger, Pierre Trudeau, Aly Khan, Pope Paul, and General George Patten.) World distribution of countries of origin of the ENS group closely matched the NLS group, with a slightly higher Asiatic representation among the ENS. Sex distribution was not comparable; 445 (81%) were men, and 103 (19%) were women.

Results

To assess for clustering of NLS parents in a distinct type of occupational category and to determine whether the NLS and ENS groups were comparable with respect to types of occupations, I calculated the distributions for both groups according to the following US Bureau of Census–defined occupational categories: professional, commercial, industrial, and public service (Table 1). Distributions of fathers' occupations showed no distinct clusterings. In both groups, occupational categories were arrayed in the same rank order, that is, predominately professional, followed by commercial, industrial, and public service. A much larger proportion of mothers' occupations were in the professional category for the NLS group, and a slightly higher proportion of the ENS group had mothers with industrial-type occupations. These data are inconclusive because mothers' occupations, except for the broad nonspecific designation of "homemaker," were only reported for less than one-fifth of subjects in both groups.

With respect to specific occupations, I calculated the distribution of subjects having the same occupation or occupational

Table 3 Applied and performance occupations (practice, materials, and nature)

- Agriculture
- Animal breeding
- Chemical and dye manufacture and processing
- Climatology
- Dentistry
- Electrician
- Engineering (structural, chemical, mechanical, civil, and communications)
- Forestry
- Geology
- Horticulture
- Land survey
- Machine design
- Machinist
- Medical supply
- Mining
- Pharmacist and pharmaceuticals
- Practising physician
- Veterinary medicine

activity as one or both parents for both the assessment NLS and the control ENS group. In the entire NLS group, only 11 subjects had parents who were either physicists, chemists, biologists, or medical or inventive scientists (Table 2). There is little or no association between parent and offspring occupations among the NLS group, compared with those in the ENS group ($\chi^2 = 68.21$, df 1; $P < 0.001$).

Assessment II

The results of Assessment I clearly show an absence of occupational inheritance among Nobel laureates in the natural sciences. In our previous study of outstanding literary prizewinners, and in research on creative persons in art, literature, and science (4,18–21), we found a different type of familial linkage in outstanding creative achievers—a clear pattern of parental occupations in the applied or performance equivalent of the offspring's field of creative achievement. This was especially true for parents of the same sex as the offspring. For example, the father of playwright Eugene O'Neill was an actor, and Pablo Picasso's father was an art teacher. For the NLS group, I hypothesized that there would be a similar parental occupational pattern consisting of science-related types of applied or performance fields. For example, Albert Einstein (NLS-PH), Carlo Rubbia (NLS-PH), and David Lee (NLS-PH) had fathers who were electrical engineers; Owen Chamberlin's (NLS-PH) father was a practising radiologist; Dorothy Crawford Hodgkin's (NLS-CH) mother was a field archeologist and botanist; and Charles Huggin's (NLS-M&P) father was a pharmacist. This hypothesis was separately assessed.

Method

For the NLS group, I calculated the presence or absence of a parent with an applied or performance-equivalent occupation. I defined applied or performance-equivalent occupations related to creative scientific achievement as those involving predominant use of one or more of 3 key factors: 1) practical applications of scientific knowledge, 2) technical use or production of materials involved in scientific pursuits, and 3) work with the natural world. These parental occupations found in the NLS group are shown in alphabetical order in Table 3. To establish whether the specific cluster of applied or performance parental occupations was connected with scientific creative achievement, the incidences of these occupations were calculated for both the NLS and the related independently and empirically defined group of 560 high-IQ subjects longitudinally studied by Terman (10). Intelligence, as measured by high IQ, has been determined to be not directly correlated with (that is, independent of) creativity (23–27). Chronologies for the Terman comparison group and NLS parents were similar: members of the former group were born and had worked during the same timespan as most of the NLS parents. Although all the Terman subjects had achieved exceptionally high IQ scores, none had received Nobel awards during their lifetime.

Results

In the NLS-CH group, 53% had one or both parents in an applied or performance-equivalent occupation; in the NLS-PH group, 51%; in the NLS-M&P group, 52%. Overall, 52% of the NLS group had one or both parents in an applied or performance-equivalent occupation. Whether the NLS was male or female, the parent with the applied or performance-equivalent occupation was predominately (83%) of the same sex. There was no significant association between these occupations and any of the following 4 ethnographic groupings: US; Anglo and (or) British Commonwealth, including Ireland, Australia, and New Zealand; European; others ($\chi^2 = 0.27$, df 3; $P = 1.00$).

Table 4 shows the numbers of subjects with parents in applied or performance-equivalent occupations in the NLS and Terman high-IQ groups. For the Terman high-IQ group, the percentage is 17%. Applied or performance-equivalent occupations are significantly associated with the NLS group ($\chi^2 = 132.38$, df 1; $P < 0.001$). For each type of NLS (CH, PH, and M&P), there were no significant category differences.

Table 4 Applied or performance-equivalent occupations in NLS and high-IQ groups

Group	Performance	Total *n*
NLS-CH	65	123
NLS-PH	78	153
NLS-M&P	82	159
All NLS	225	435
Terman high-IQ	97	560

Table 5 Unfulfilled wishes with applied and performance-equivalent and remote nonscience-related occupations

Unfulfilled wishes	Chemistry	Physics	Medicine and physiology	Total
With applied and performance-equivalent occupation	14 (22%) *n* = 65	22 (28%) *n* = 78	20 (24%) *n* = 82	56 (25%) *n* = 225
With remote occupation	11 (19%) *n* = 58	20 (27%) *n* = 75	19 (24%) *n* = 77	50 (24%) *n* = 210
Total remote and performance	25 (20%) *n* = 123	42 (27%) *n* = 153	39 (25%) *n* = 159	106 (24%) *n* = 435

Assessment III

Parental applied or performance-equivalent occupations, rather than the same occupations (as shown in Assessment I) characterize the NLS group. The difference between the NLS and Terman high-IQ groups points to a specific link between this family background factor and creativity (rather than intelligence). Findings in our previous study of literary prize-winners, as well as in interview (35 NLS subjects)and biographical research (18–21), suggest that the development of creativity is facilitated by this parental occupation pattern, together with another factor—parents' unfulfilled scientific and creative wishes and tendencies. For NLS, these are lifelong tendencies and wishes for scientific careers or creative achievement in natural science activities. A family background constellation comprises both the occupation and the wish or tendency factors operating in the parent having the same sex as the child, whether in a remote nonscience-related or an applied or performance-equivalent occupation. This is manifested by the same-sex parent's strong interests in science, scientific investigation, and invention, as well as by early attempts to follow a scientific career. In addition, the parent having the opposite sex to the child, whether in a remote or applied or performance-equivalent occupation, usually implicitly or explicitly shares or appreciates the interests of the other parent or has also had unfulfilled wishes for creative achievement. The influence of such unfulfilled wishes during a creative person's development may not be obvious or overt but may be even more motivating than the effects of parental applied or performance-equivalent occupations.

Method

Reports indicating parental unfulfilled wishes were collected from all available published sources and from confidential NLS systematic research interviews, which I conducted (20,28). For example, the physician father of biophysicist Maurice Wilkins (NLS-M&P) had a lifelong interest in basic research but reportedly had little opportunity to do it. Similarly, during a research interview, microbiologist Werner Arber (NLS-M&P) first asserted that there was no scientific background in his family—that his father was a dirt farmer. Then, he remembered that his farmer father strove constantly to invent materials and improvements in agricultural products and practices (21). Physicist Richard Feynman's (NL-PH) small-businessman father was an early medical school dropout; he frequently spoke to his son of his frustrated ambition to be a research scientist and, from an early age, actively taught him principles of pattern recognition (29). Such wishes and tendencies emerged frequently throughout systematic research interviews (as in the case of Werner Arber) and are likely underreported in published biographies.

Results

Unfulfilled scientific and creative wishes and tendencies were calculated separately for parents in remote, nonscience-related occupations and for those in applied or performance-equivalent ones. Table 5 shows the incidence for each type of NLS parental occupation. Similar proportions

of parents with both types of occupations were reported with unfulfilled creative and scientific wishes. A nonoverlapping percentage of family-background influences on creativity combines all NLS parents in an applied or performance-equivalent occupation with only the nonscientific, remote-occupation parents expressing unfulfilled creative and scientific wishes. Percentages are as follows: CH = 76 (62%), PH = 98 (64%), M&P = 101 (64%), and overall NLS = 275 (63%). Differences between the types of NLS awards were not significant.

Of all parents with unfulfilled wishes, in both applied or performance-equivalent and remote occupations, 73% were of the same sex as the individual NLS. However, the incidence of such wishes in parents of the opposite sex is unclear, either because of underreporting or because of spillover effects between the parents. Among parents in remote occupations with unfulfilled wishes, there was no concentration in any particular category or type of occupation. Their distribution among categories of occupations was similar to that found for the entire NLS group as reported in Table 1: 46% professional, 38% commerical, 14% industrial, and 2% public service.

Discussion

These findings of minimal occupational inheritance among Nobel laureates in the natural sciences, together with similar findings in our previous study of literary prizewinners (including Nobel laureates in literature), broadly contradict Galton's thesis of direct hereditary transmission of eminent genius. Moreover, because the subjects of this study are derived from a wide cultural and ethnic range as well as from the extended time period of the 20th and 21st centuries, the findings refute other inferences about connections between heredity and eminence that use temporal and national distributions (7,8).

Data collected in this study for parental occupations should be considered quite comprehensive, derived as they are from a large proportion of all Nobel laureates in the physical sciences, from the inception of the award to the present (that is, 435 of 488 prizewinners in total) as well as from an extensive number of 20th-century nonscientist eminent persons (selected according to the Goertzel and Goertzel selection criterion of at least 2 major biographies). Also, the high-IQ comparison group consisted of Terman's reported full sample of longitudinally followed successful persons who were not Nobel laureates. With respect to information regarding lifelong unfulfilled creative and scientific wishes, tendencies, or goals, face-to-face research interviews such as that with Werner Arber indicate such data are very likely unrecognized and underreported in published biographical sources. This is illustrated in detail by the following verbatim recorded interview revelation. After stating that he had no scientist models in his family, Arber responded to the interview question, "Were there any other influences?" by stating:

> Well, he [my father] himself constructed a machine to make 3 sizes of potatoes—very small ones, medium, and large ones, to be sorted separately [and other inventions, too] . . . . So, in that sense I think there was something innovative there, not just accepting what . . . [one] learns from . . . [one's] own father but let's make something different. When I was still a very small kid, he did help me in that way (21).

Taken together with the previously found proportion (36%) of lifelong unfulfilled creative wishes and goals among parents in the outstanding literary prizewinner group, this factor seems to be a distinct tendency in the family background of creative achievers.

The constellation of parental applied and performance-equivalent occupations with the tendency toward unfulfilled creative and scientific wishes could point to patterns of recessive inheritance, dominant transmission with environmental suppression, or partial gene expression. Parental skills similar to those of scientifically creative offspring may be involved in applied or performance-equivalent occupations (for example technical or mathematical proficiency), and parents' unfulfilled wishes may indicate unrealized scientific creative potential. Other gene interactions—such as possibly transmitted factors of temperament or abstract thinking capacity—may be necessary for scientific creativity. The investigations of both Nobel laureates in science and outstanding literary prizewinners, like all previous studies on the topic, including Galton's (6,14), are based on resemblance criteria similarities between parent and offspring behaviour. Studies of grandparents and other probands, as well as direct assessments of gene transmission, are desirable.

Intellectual capacity, usually characterized as very high intelligence, may well be shown to be a genetically determined factor in scientific achievement. This has not yet been proven, partly because intelligence is no longer thought to be a single capacity and fully adequate measurement instruments have not been devised. Study estimates have consistently predicted that all the NLS subjects assessed here would have very high scores on traditional IQ tests (1,2). An indication that this factor alone is not sufficient for creative scientific achievement is the absence of outstanding scientific prizes among the high-IQ population followed over a long period by Terman and associates, a finding differentiating that group from the NLS group (30,31). Given the complex nature of the scientific enterprise, however, some special types of intellectual capacity must accompany creative ones. Such capacity probably

interacts either with other genetically determined capacities or with environmental influences, or with both.

Particular environmental influences operating together with genetic factors are suggested by the findings of similar types of family constellations in this and our previous study of literary prizewinners. Parents in applied or performance-equivalent occupations and parents with unfulfilled wishes have very likely provided both opportunities for creative achievement and developmental influences on creative motivation. With respect to opportunities, many of the parents, whether or not they possessed large financial or social resources, were probably especially disposed to give their offspring educational advantages and, when appropriate, work or academic connections. In their autobiographical writings, the NLS group particularly have frequently cited parental devotion to education as a crucially important factor in their backgrounds.

As for developmental influences, dual factors of identification and competition operating together may be presumed to exert considerable effect on individual motivation for creative achievement. Strong motivation, evidenced by a lifetime in constant pursuit of creativity and innovation, characterizes creative achievers in all fields (8,19,24,32). For most of the NLS group, the interests and science-related skills of their parents in applied or performance-equivalent occupations were conveyed over long periods of time. The developing creative scientist apparently identified with the goals and wishes of the congruent-sex parent, as well as the shared explicit or implicit scientific, creative, or achievement interests of the opposite-sex one. An occupational field was chosen on the basis of its similarity (as well as familiarity) to that of the congruent-sex parent, and creative success was a living out of that parent's wishes. With parents in nonscience-related, remote occupations, unfulfilled creative or scientific wishes alone may have provided a basis for identification. As in the Arber example, the prospective scientist may not have been immediately aware of such a motivating factor; however, it seemed to be a significant impetus in his life's work.

The preponderance of parents in applied or performance-equivalent, science-related occupations suggests that, together with identification, there was intergenerational competition and a desire to supersede. The offspring all pursued the more distinguished and socially acceptable path of scientific discovery and creativity. Gratifying an achievement-valuing opposite-sex parent with scientific and creative interests may have been a factor. In research interviews with Nobel scientists, several identified an opposite-sex parent's important pride in their scientific accomplishment. When the dual motivating factors of identification and competition begin to operate early, they instill intense, lifelong drives for creative scientific achievement.

As we suggested with respect to literary prizewinners, the developmental influence of dual identification and competition is consistent with research findings pertaining to the affective and cognitive structure of processes leading to creative achievement. This structure consists of concomitantly breaking away (competition) and continuing a connection (identification) with the past, which is involved in creative homospatial (33–35) and articulation (36) processes. The significant effect of both processes on literary creativity and on important mathematical and scientific discoveries by Poincaré, Hadamard, Benedictus, Watts, and also by Kekulé, has been described (18,37).

Conclusions

This study's findings regarding family background factors contribute to the recognition and treatment of persons with special capacities, to genetic counselling of such patients and their families (as well as to counselling those overly ambitious ones with lesser capacities), and to understanding the interactions between genetic and environmental factors in development. Creative achievement in science as well as in literature (and presumably in other fields) is associated with a family background constellation involving the work and aspirations of the congruent-sex parent as well as the creative orientation of the opposite-sex parent. This constellation, which may involve genetic transmission, very likely instills strong motivation for creative achievement. In genetic counselling of creative patients and their relatives, direct inheritance of creativity should not be stressed. Such counselling should include descriptions both of these investigations' findings and of the different types of parental influence. It should recognize the importance of psychological nurturance along with intellectual capacity for facilitating creative scientific success.

With respect to psychiatric treatment, it is important to be aware of factors specifically related to creativity rather than psychopathology. While there is no proven connection between creativity and psychopathology (38–40), creative persons and those with special capacities often knowledgeably seek therapy for work blocks and a range of psychiatric disorders. Strong creative motivation in patients, identification and competition with parents, and the creative aspirations of parents should be differentiated from aberrant processes and influences.

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References

1. Simonton DK. Scientific genius: a psychology of science. Cambridge (MA): Cambridge University Press; 1988.
2. Feist GJ, Gorman ME. The psychology of science: review and integration of a nascent discipline. Review of General Psychology 1998;2:3– 47.
3. Webster's third new international dictionary. Springfield (MA): Merriam-Webster Inc; 1986.
4. Rothenberg A, Wyshak G. Family background and genius. Can J Psychiatry 2004;49:185–91.
5. Pomer MI. Intergenerational mobility in the United States. Gainesville (FL): University Press of Florida; 1981.
6. Galton F. Hereditary genius: an inquiry into its laws and consequences. London (UK): Macmillan; 1869.
7. Cattell J McK. A statistical study of eminent men. Popular Science Monthly 1903;42:359–77.
8. Cox C. The early mental traits of three hundred geniuses. Stanford (CA): Stanford University; 1926.
9. Clarke EL. American men of letters. New York (NY): Columbia University; 1916.
10. Terman L. Mental and physical traits of a thousand gifted children. Genetic studies of genius. Volume 1. Stanford (CA): Stanford University Press; 1925.
11. Bramwell BS. Galton's "hereditary genius" and the three following generations since 1869. Eugenics Review 1948;39:146–53.
12. Simonton DK. Biographical determinants of achieved eminence. J Pers Soc Psychol 1976;33:218–26.
13. Kendler KS. Psychiatric genetics: a methodological critique. Am J Psychiatry 2005;162:3–11.
14. Galton F. English men of science. London (UK): Macmillan; 1874.
15. Roe A. The making of a scientist. New York (NY): Dodd, Mead; 1952.
16. Goertzel V, Goertzel MG. Cradles of eminence. Boston (MA): Little, Brown & Co; 1962.
17. Goertzel V, Goertzel MG. Three hundered eminent personalities. San Francisco (CA): Jossey-Bass; 1978.
18. Rothenberg A. The emerging goddess: the creative process in art, science and other fields. Chicago (IL): University of Chicago Press; 1979.
19. Rothenberg A. Creativity and madness: new findings and old stereotypes. Baltimore (MD): Johns Hopkins University Press; 1990.
20. Rothenberg A. Studies in the creative process: an empirical investigation. In: Masling JM, Bornstein RR, editors. Empirical perspectives on object relations theory. Washington (DC): American Psychological Association Press; 1994. p 195–245.
21. Rothenberg A. Family background and literary creativity. Directions in Psychiatry 2002;22:273–8.
22. US Bureau of the Census. Lifetime occupational mobility of adult males, March 1962. Current Population Reports, Series P-23, No 11 (May 12). Washington (DC): US Government Printing Office; 1964.
23. Wallach MA, Kogan N. A proof to distinguish between creativity and intelligence. Megamot 1965;13:289–94.
24. Simonton DK. Genius, creativity, and leadership. Cambridge (MA): Harvard University Press; 1984.
25. Haensley P, Reynolds CR. Creativity and intelligence. In: Glover JA, Ronning RR, Reynolds CR, editors. Handbook of creativity. New York (NY): Plenum Press;1989. p 111–34.
26. Gardner H, Kornhaber ML, Wake WK. Intelligence: multiple perspectives. New York (NY): Harcourt Brace & Co; 1996.
27. Sternberg RJ, Lubart TE.The role of intelligence in creativity. In: Runco MA, editor. Critical creative processes. Cresskill (NJ): Hampton Press; 2003. p 153–87.
28. Rothenberg A. The janusian process in scientific creativity. Creativity Research Journal 1996;9:207–32.
29. Gribbin JR. Richard Feynman: a life in science. New York (NY): Dutton; 1997.
30. Terman LM. Scientists and non-scientists in a group of 800 gifted men. Psychol Monographs 1954;68:44.
31. Shurkin JN. Terman's kids: the ground breaking study of how the gifted grow up. Boston (MA): Little, Brown; 1992.
32. Amabile T. Creativity in context. Boulder (CO): Westview; 1996.
33. Rothenberg A. Creativity and the homospatial process: experimental studies. Psychiatr Clin North Am 1988;11:443–59.
34. Rothenberg A, Sobel RS. Adaptation and cognition. An experimental study of creative thinking. J Nerv Ment Dis 1980;168:370–4.
35. Rothenberg A, Sobel RS. Adaptation and cognition II. Experimental study of homospatial thinking in artistic creativity. J Nerv Ment Dis 1981;169:417–23.
36. Rothenberg A. Articulation. In: Runco MA, Pritzker SR, editors. Encyclopedia of creativity. San Diego (CA): Academic Press; 1999. p 121–5.
37. Rothenberg A. Creative and cognitive processes in Kekulé's discovery of the structure of the benzene molecule. Am J Psychology 1995;103:419–38.
38. Waddell C. Creativity and mental illness: Is there a link? Can J Psychiatry 1998;43:166–72.
39. Rothenberg A. Creativity and psychopathology. Bulletin of Psychology and the Arts 2000;1:54–8.
40. Rothenberg A. Bipolar illness, creativity, and treatment. Psychiatr Q 2001;72:131–48.

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Résumé : Les antécédents familiaux et le génie II : les lauréats du prix Nobel en science

Objectif : Dans une étude précédente sur les réalisations de création littéraire, nous avons présenté des preuves réfutant les études statistiques toujours influentes de Frances Galton sur l'hérédité du génie, et avons aussi décrit une constellation d'antécédents familiaux de la créativité. Cette étude vise à évaluer empiriquement l'hypothèse de la transmission héréditaire, en ce qui concerne la réalisation créatrice en sciences naturelles.

Méthodes : Des données d'antécédents familiaux ont été recueillies auprès de 435 sur 488 lauréats du Nobel en chimie, physique, médecine et physiologie, de 1901 à 2003. Ceux-ci ont été comparés avec un groupe jumelé de 548 non-scientifiques éminents pour l'incidence de l'hérédité professionnelle (c'est-à-dire, le même emploi parent-descendant) et avec 560 sujets non-lauréats, au QI élevé, pour un type d'emploi prédominant.

Résultats : L'incidence d'un ou des deux parents ayant le même emploi n'était que de 2 % pour les lauréats du Nobel en science, mais de 20 % des non-scientifiques éminents ($P < 0{,}001$). La constellation prédominante d'antécédents familiaux (63 %) pour les lauréats du Nobel en science consistait dans un parent du même sexe ayant soit un emploi de performance équivalente portant sur les sciences appliquées, la technologie ou le monde naturel ($P < 0{,}001$, comparé avec le groupe jumelé), soit un emploi non relié et des désirs non comblés d'expression créatrice.

Conclusions : Les lauréats du Nobel en sciences naturelles ne manifestent pas d'hérédité directe de la créativité de leurs parents; plutôt, les parents de même sexe sont principalement dans des emplois appliqués ou de performance équivalents, avec des désirs créateurs non comblés. Les influences développementales précoces sur la motivation, faisant appel à l'identification et à la concurrence avec le parent de même sexe sont suggérées.