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A PORTRAIT OF THE ARTIST AND THE SCIENTIST AS YOUNG MEN--I.
BIOGRAPHICAL CHARACTERISTICS OF AWARD WINNERS IN THE TWO
CULTURES.

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THE PURPOSE OF THIS RESEARCH WAS TO IDENTIFY THE BIOGRAPHICAL CHARACTERISTICS WHICH DISTINGUISH POTENTIALLY CREATIVE SCIENTISTS AND ARTISTS IN THEIR ADOLESCENCE FROM EACH OTHER AND FROM THEIR FELLOW STUDENTS. FROM A SAMPLE OF 442 BRIGHT MALE STUDENTS TAKING A NEW PHYSICS COURSE IN 72 CLASSROOMS IN 17 STATES SCATTERED THROUGHOUT THE COUNTRY, THREE GROUPS WERE IDENTIFIED--(1) 33 WHO HAD WON COMPETITIVE AWARDS OR SOME OTHER FORM OF RECOGNITION IN SCIENCE, (2) 49 WHO HAD WON AWARDS IN THE ARTS, AND (3) 360 WHO HAD WON NO AWARDS. RESPONSES OF THE GROUPS TO 300 BIOGRAPHICAL QUESTIONS (ON THE BIOGRAPHICAL INVENTORY TEST, WHICH MEASURES CREATIVE POTENTIAL) WERE COMPARED AND TESTED FOR STATISTICAL SIGNIFICANCE. CONCLUSIONS STEMMING FROM THE RESEARCH ARE--(1) THE POTENTIAL SCIENTISTS AND ARTISTS ARE SIMILAR TO ONE ANOTHER AND DIFFERENT FROM OTHER STUDENTS IN INTERESTS AND WORK HABITS, SOCIAL RELATIONSHIPS, REACTIONS TO SCHOOL, LIFE AMBITIONS, PLANS, AND VALUES, AND (2) BIOGRAPHICAL CHARACTERISTICS EXIST WHICH MAKE THEM DIFFERENT FROM ONE ANOTHER. LIMITATIONS TO THE RESEARCH INVOLVE--(1) SAMPLING, (2) THE NATURE OF THE QUESTIONNAIRE DATA, (3) THE STABILITY OF CREATIVITY OVER TIME, AND (4) THE POSSIBILITY OF A CURVILINEAR RELATION BETWEEN THE CRITERION OF CREATIVITY AND BIOGRAPHICAL VARIABLES. (RD)

DRAFT
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A Portrait of the Artist and the Scientist as Young Men:

I. Biographical Characteristics of Award Winners
in the Two Cultures

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C.P. Snow, a man who has experienced the "two cultures" intensively through his scientific training and his literary avocation, has written eloquently of the growing alienation of artists and humanists from the science and technocracy of our times.⁴ Educators from both cultures have become increasingly concerned about their divergence from one another and from mass culture. A striking example from the sciences is modern physics. Perhaps no other intellectual discipline has more potently shaped modern society. In the world of ideas, through the notions of empiricism, operationalism, materialism, mechanism, and indeterminacy, physics has enormously influenced the other natural sciences, the social sciences, and, indeed, mathematics, theology, and the arts. In the world of practical affairs, from the steam engine to the laser, applied physics has brought forth many of the wonders of our scientific age. Yet the percentage enrollments in high school physics have steadily declined for the past decade. Alarmed by this trend, Harvard Project Physics, the curriculum group sponsoring the present study, is attempting to develop a variety of educational media to enable students to understand and appreciate physical ideas even though they may not intend to devote their careers to science. Toward this end, the research reported here is addressed to the problem of identifying the biographical characteristics which distinguish potentially creative scientists.

tists and artists in adolescence from/ each other and from their fellow students. Answers to the problem are interesting in their own right and they may also lead to practical implications: the early identification and nurturance of boys and girls with both kinds of creative potential, the improvisation of experiences associated with creativity for all students, and the inclusion of factors appealing specifically to potential scientists and artists and others in new curricula.

Much of the research on adolescent creativity employs as its starting point the frequency of unique, remote associative responses to verbal and visual stimuli. Boys and girls who produce large numbers of these responses identified as "creative," and the research proceeds by examining their distinctive traits. In contrast, the approach here is to equate "creativity" with the winning of awards, prizes, or other social recognition. In line with purposes brought out above, three groups of high school students are contrasted: 1) those achieving distinction in science, 2) in the arts--writing, music, visual and performing arts (a broader group than Snow had in mind, namely, the literary intelligentsia), and 3) the larger group of students who have won no recognition for either kind of creativity.

Procedure, Sampling, and Instrument

About 2100 students in 72 classrooms in 17 states in the East, South, Midwest, and Far West participated in the preliminary evaluation of Harvard Project Physics in the academic year 1966-67. A number of tests (totaling to 83 separate scores and subscores) were administered at the beginning, middle, and end of the academic year. A system of randomized data collection was employed which tends to minimize testing time and to maximize the number of tests that can be given.⁸ In addition, about 40 percent of the total sample took the Biographical Inventory. Taylor and Ellison⁵ developed the 300 items on this instrument to measure creative potential. The general nature of the items will be brought out in the results. Parent forms of the instrument correlated substantially (.4 to .6) with assessments of creativity such as peer and supervisor ratings in samples of research scientists. Our purposes in using the BI is 1) to determine whether or not a "humanistic" course in physics penalizes students with scientific potential, 2) to use individual items to identify sub-groups of students and find out how they respond to the course, and 3) to carry out basic educational research such as that reported here.

Two selective factors have operated on the sampling procedure. One is that the teachers were selected from a pool of volunteers in order to be represent-

ative of national regions locale (urban, rural, sub-urban), and control (public, sectarian, independent). A study of these teachers revealed that they are intellectually superior to non-volunteers and score similarly to scientists on personality measures.⁹ Secondly, the sample is comprised of physics students a rather select group. The mean Henmon-Nelson IQ of the total group is 115 placing the median students at the 84th national percentile. Tabulation of BI items showed that half the fathers of the students graduated from high school; 17 percent attended college; 12 percent graduated; and 7 percent did graduate work. Eighty-seven percent of the students are in college preparatory programs; 43 percent plan to attend college; and another third plan to obtain graduate degrees. Thus any results should be interpreted with these two biasing factors in mind: volunteer teachers, bright physics students.

The group took the BI with the understanding that their responses would not be used in determining grades and that no individual results would be reported. After the answer sheets were checked for out-of-range responses and incomplete answer sheets, the item responses were punched into IBM cards, verified, and subjected to a series of cross-checks and statistical analyses. A group was identified which had agreed to item alternatives stating that they

have a strong interest in science and that they spend a great deal of time working on scientific projects or papers which have won public recognition, prizes, or awards. An artistic group was identified using a slightly more stringent standard (to equalize the number of scientists and artists) - the social recognition for music, writing, and visual and performing arts must have been gained in competition. Students who had won awards in both areas were excluded from the analysis, and the three remaining groups - scientists, artists, and others - were compared in a series of cross

tabulations against the 300 HI items. A preliminary analysis shown in Table 1 revealed that girls comprise proportionately more of the artist group and boys are over-represented in the science group. Also, cross-tabulations against individual items often went in different directions for the two sexes. Consequently, with two exceptions, girls were excluded from the analysis of the present study.

In the sample of boys were 54 artists (10 in the performing arts, 23 in music, 5 writers, and 15 in visual arts), 38 scientists and 360 others though the numbers vary slightly because not all the students answered every item and not every student was classified on certain variables. The significance tests were appropriately adjusted for the number of cases. Chi-square tests of no association between group membership and the distribution of responses to the 300 items revealed 22 items significant at the .10 level, 23 at .05, 29 at .01 and 24 beyond .001. Thus there are many more items which differentiate significantly

Table 1
 Percentages of Boys and Girls
 in Three Groups

| Sex | Group | | | Total | Number |
|--------|------------|--------|---------|-------|--------|
| | Scientists | Others | Artists | | |
| Girl | 23 | 39 | 49 | 39 | 289 |
| Boy | 77 | 61 | 51 | 61 | 443 |
| Total | 6 | 81 | 13 | 100 | |
| Number | 43 | 592 | 97 | | 732 |

between the groups that would be expected by chance. The detailed statistical cross tabulations are presently available from the writer. The paragraphs following summarize the response distributions of the three groups for the 76 items with significance levels at or beyond the .05 level.

Interests and Work Habits

As one might expect, the interests of the Ss were stronger and arose earlier than Os in mechanical and scientific objects: electrical appliances, radio, chemistry sets, electromagnets, telescopes, and models of machinery and vehicles. The Ss had also more frequently worked on the solutions to mathematical problems outside of school and at their own initiative. Similarly, the As had earlier, stronger interests in the arts: music, visual art, and dance. Moreover, they had received more musical training, play more instruments, and spend more time writing stories and poems. What is less expected perhaps is that the Os expressed least interest in both the scientific and artistic activities.

In reading, the Ss indicated much less enjoyment of mystery stories, novels, biographies, and autobiographies than the other two groups. Both Ss and As enjoy professional and technical books more than the Os and are also more apt to visit libraries for non-

school reading. Lastly, both creative groups, when asked how many books their families had at home, more often checked "several bookcases" or "a large library."

The As and Ss were similar to one another and sharply different from Os on two questions related to work habits. The creative groups indicated much more frequently that they have difficulty putting work aside once they have started and that when working on a paper or project, they do it over and over until it is as good as they can make it. However, on another question "How would you rate yourself in following through with something in spite of difficulties and distractions?" the Ss tended to be sharply above, and the As sharply below, the Os. Also, the Ss and, to a lesser extent, As more often reported "much fine detail" in work rather than "little" presently interests them most. Both creative groups more often indicated that they "rarely have spare time to relax and not do much of anything" and that they go to bed before rather than after 11:00 at night.

Social Relations

When asked to compare themselves with their classmates, both the scientists and artists indicated more often than the others that they make friends more easily. Both creative groups belong to more clubs and societies. Also Ss and As, in contrast to Os, were more

self-confident and felt more forceful as opposed to cooperative. But here the similarity of Ss and As ends. When asked to remember occasions when they changed schools, the Ss and Os had more difficulty in making new friends. In answer to the question "How easy have people found it to talk to you about their personal problems?" the As more frequently indicated "easy" and the Ss, "difficult," both compared with Os.

There are also differences between the Ss and As in more emotionally-laden social relations. In dating patterns, the As were more apt to date one girl at a time; the Ss, to date different girls or not date at all. In all three dating patterns the Os were between the Ss and As in frequency. When asked about their roles in playing practical jokes on someone, a third of the Ss, a fifth of the Os, and 15 percent of the As said they would lead the others. On the other hand more of the Ss than Os and fewer of the As were attracted to the alternative stating that "(practical joking) is not right and I do not participate." The Ss and As responded similarly on the other two alternatives: they indicated more often than the Os that they "sit back and enjoy watching others" and less often played the role of accomplice. When asked to think of humiliating experiences in retrospect, the Ss were more likely than Os to say

they were not bothered at all; As were most likely to worry about it.

The other items on social relations have to do with introversion-extroversion. Ss and, to a lesser extent, As more often than Os find books more interesting than people. But As, more often than the other two groups, indicated that they had "taken an interest in other people's hobbies, interests, and problems and had done something for them." While the S group as a whole indicated less desire to be alone with their thoughts and interests than the other groups, they were also more likely on this item to spread their responses to the extreme alternatives "very frequently" and "very rarely."

Reactions to School

Most of the Ss and the As reactions to school were similar and contrasted sharply with the responses of the Os. Both groups claimed to apply themselves more to school work and to spend more time in serious study outside of school as well. This is notwithstanding the fact that they both had changed schools more often. The Ss and, to a lesser extent, the As indicated that they like to study and do their school work much faster than their classmates. Greater proportions of the S and A groups had been members of a school debating team; and more of the students in these groups indicated that they would not object, or would even like, to give a speech before a large group of their classmates. The As indicated more often than

the Os that they spend a great deal of time participating in organized school activities such as plays, band, and student government; however, the Ss were less involved in these activities than Os.

With respect to specific school subjects, there are more differences between the creative groups. The two sharpest differences are in music and mathematics. Compared with the Os, the Ss expressed more interest in mathematics and less in music. Just the opposite was true for the As. As and, to a lesser extent, Ss had achieved success in art, painting, and sculpture classes. Ss and, to a lesser extent, As had achieved more success in science classes.

Knowledge of the school presently attended by the students in the sample permitted two additional analyses--the cross-classification of creativity against locale and against region. Locale was broken into three categories: urban, suburban, and rural. The results of this analysis are shown in Table 2. Many more Ss than would be expected by chance were attending schools in urban and rural areas. Correspondingly fewer Ss attended schools in the suburbs. There are also slight tendencies for greater percentages of As to attend schools in rural areas and fewer in the suburbs. Incidentally, the same trends were present for As and Ss in the sample of girls. Combining the sexes for an additional analysis raised the Chi-Square probability from .04 to .02.

Table 2

Percentages of Boys Attending
Schools in Three Locales

| Locale | Group | | | Total | Number |
|----------|------------|--------|---------|-------|--------|
| | Scientists | Others | Artists | | |
| Urban | 58 | 41 | 43 | 42 | 186 |
| Suburban | 9 | 36 | 31 | 34 | 148 |
| Rural | 33 | 23 | 26 | 24 | 108 |
| Total | 7 | 81 | 11 | 100 | |
| Number | 33 | 360 | 49 | | 442 |

Chi -square = 10.152 with 4 degrees of freedom; p=.04

The schools were also broken into three regions corresponding roughly to the three great megalopolitan cultures seriously predicted for the year 2000 and frivolously termed; "Sansan" from San Diego to Santa Barbara (or even San Francisco), "Chipitts" stretching from Chicago to Pittsburgh and north to Canada, and "Boswash," the northeastern seaboard.³ Presumably Sansan will be the home of the "Bar-B Q" culture and "wholesome degeneracy" and will include large and self-conscious groups--the alienated New Left, hip, and bohemian. Chipitts "recently the

site of successful architectural and urban-renewal programs, will probably still have traces of both the "Bible belt" and Carl Sandberg's raw and lusty vitality" notwithstanding Picasso monuments. Boswash will be "cosmopolitan--the home of New York liberals, Boston bankers, tired or creative intellectuals in publishing entertainment and the arts, and political Washington."³

The statistical test for association between region, on one hand, / artistic and scientific creativity, on the other, just missed our customary level of significance ($p=.07$) for boys alone. However, exactly the same trends were found in the sample of girls. Therefore for this variable, the data on the girls ($n=219$) was brought into analysis and retested for significance. The level turned out to be highly significant ($p=.004$), and the results are shown in Table 3. Boswash contain-

Table 3

Percentages of Boys and Girls Attending Schools in Three Megalopolitan Regions

| Region | Group | | | Total | Number |
|----------|------------|--------|---------|-------|--------|
| | Scientists | Others | Artists | | |
| Sansan | 26 | 30 | 31 | 30 | 196 |
| Chipitts | 34 | 44 | 59 | 45 | 298 |
| Boswash | 40 | 27 | 11 | 25 | 167 |
| Total | 6 | 81 | 13 | 100 | |
| Number | 38 | 538 | 85 | | 661 |

Chi-square = 15.612 with 4 degrees of freedom; $p=.004$.

ed many more Ss than expected by chance while Sansan and particularly Chipitts contained fewer. The As were sharply over-represented in Chipitts and under-represented in Boswash. Sansan contained about as many As as would be expected.

Creativity and Intelligence

The cross-classification of dichotomized measures of creativity and intelligence produces a four-fold table. Previous research on adolescents has been fruitful in developing typologies of distinctive traits of boys and girls in the four cells. For example, Getzels and Jackson² described the differences between highly creative-less intelligent and the less creative-highly intelligent. Wallach and Kogan¹¹ also investigated these groups as well as the highly creative-highly intelligent and the less creative-less intelligent. Here, of course the analysis is reversed: given a group of "creative" students, i.e., competitive award winners in science and the arts, what are their distinctive self-perceptions and attitudes on questionnaire items having to do with creativity and intelligence?

To anticipate the results, one can invoke the common sense doctor's adage: "To find out what's wrong with the patient (or in this case, if a student is creative), ask him." Both Ss and As in con-

trast to Os indicated above average creativity and imagination, greater opportunity to express themselves in creative activity, higher interest in doing things in different, original ways, and more curiosity about mechanical things and intellectual topics. Moreover, in contrast to Os, As and, to a lesser extent, Ss reported attaching greater personal importance to being creative and imaginative, more self-satisfaction in thinking of new ways to express an idea, and the suggestion of a greater number of projects to neighborhood friends during childhood.

With respect to intelligence, both creative groups rated themselves brighter than their classmates. In comparing themselves to friends, the Ss and, to a lesser extent, the As felt they could more often understand things before they are fully explained. The Ss differed sharply from the As and the Os on the other two items: Ss much more often agreed that it is extremely important to be intelligent and that they themselves are intelligent and well read rather than self-confident and aggressive.

Life Ambitions, Plans, and Values

While greater percentages of both creative groups agreed with the self-description "ambitious and determined to make something of myself," the Ss aspired to more education. Ninety-four percent of the Ss, seven

ty-five percent of the O's, and 72 percent of the As expect at least to graduate from college. Moreover, 61 percent of the Ss, a third of the Os, and one-half of the As expect to obtain a graduate degree. On the other hand, 56 percent of the Ss, 50 percent of the Os, and 60 percent of the As expect salaries of \$12,000 or more ten years after graduation from school.

The Ss indicated more often than the As and Os that they had made a definite decision about their future occupation. Respectively, 93, 81, and 79 percent of the Ss, Os, and As had definite or tentative plans for their future occupations. In contrast to Os, As and, to a lesser extent, Ss tended to be more confident in their occupational choices rather than agreeing with the alternative "I have little or no idea because few things interest me." Aside from occupational plans which are more settled in both these groups, the Ss and As differed greatly in their general procedures for planning. The Ss more often than As and Os "make careful detailed plans." The As more than the other groups "make few plans, let nature take its course."

When asked to check the most important alternative of the five listed, the Ss more frequently chose ideas and money rather than people, things, or "don't know." The As more frequently selected money and "don't know" while the Os more frequently chose people, things, and "don't know." In another list, the characteris-

tics you would most like to have or develop in life," the Ss more often than the other groups chose "skillful user of practical knowledge (such as a doctor), creativity (such as an artist or inventor)," or "intellectual (such as a philosopher)." The Ss tended not to select "wealth and power (such as a successful businessman)" and "well-liked and personable (such as a politician)." Compared with the other groups, the As more often chose "creativity" and the Os preferred "wealth and power" or "well-liked and personable." When asked what they would like best in a job, the Ss more often chose interest, security, and responsibility and less often chose salary and opportunities for advancement. Os were most attracted by opportunities for advancement and, to a slightly lesser extent, interest and salary. As more often chose salary and responsibility despite the fact that on another item they indicated that they would like to have minimal responsibility in a job.

Non-Significant Differences

Having examined the statistically significant differences among Ss, As, and Os, it may be of interest to note some of the reported biographical characteristics for which no differences were found, particularly those which have been important in prior speculative and empirical work.⁵ No significant ($p > .05$)

differences among the three groups were found on: birth order, twinship, number of siblings, size of school attended the longest, mother's and father's ages at birth, amount of parent educations, number of employees supervised by father, prospective financial support for college by parents, number of illnesses and hospitalizations, athletic ability, affiliations of school attended longest (public, private, parochial, military or trade), physical growth rate, magazines and newspapers read, time spent on making things, collecting, chess, photography, informal discussions, camping, and reading fiction, number of, and hours worked on, part-time jobs, whether or not the mother works, number of professional and social organizations belonged to by parents, amount of family travel, sources and spending of money, number of school positions held--social club officer, cheerleader, class officer, editor, and member of student council--where seated in class, percentage of students exceeded in grades, nervousness about tests, number of hours in school study per week, desire to work with others and extent of supervision preferred, social ability, extent of social contact with girls, desire for popularity, memory, capacity for school success, self-control to work on future rewards, propensity to suggest "wild" ideas, interest in what makes people "tick," importance of independence, regard for hard work as a factor in success, regularity

and scheduling of hours, willingness to accept new or apparently foolish solutions to problems, general nervousness, argumentativeness, optimism, personal appearance, rate of progress through school, opinion of school grading standards, propensity for group leadership, conservative versus liberal attitudes toward life, tolerance of ambiguity and frustration, and age.

Methodological Reservations

Before summarizing and interpreting the results, four points of uncertainty/^{in the research design} should be brought out: sampling the nature of the questionnaire data, the stability of creativity over time, and the possibility of curvilinear relationships between the criterion creativity, and biographical variables. Despite the fact that schools were scattered throughout the country (the East and central parts of the South excepted), the sample is definitely not random and probably not representative of the nation. Moreover, neither the teachers nor the students typical. We have shown in a previous study that the teachers, being volunteers to teach the new course, have a greater knowledge of their field and personality profiles resemble those of creative scientists. Moreover, physics students in general are more intellectual. In the present sample, for example, the mean Henmon-Nelson IQ is

115, placing the group at the 84th percentile nationally; 43 percent expect to graduate from college, while another third of the group plan to earn graduate degrees. Hence the pool of the future intelligentsia is probably over-represented in the sample. For this reason, the strength of the associations in the present research are probably attenuated somewhat by the sample homogeneity. A replication planned for the following year on a national random sample is likely to produce even higher statistical significance levels.

Questionnaire data are always suspect. Nevertheless, several factors may make this reservation less crucial. The students were informed that their responses would be confidential and not used for grading, and that the results may benefit students in the future. Moreover, the answer blanks with more than five wild responses (e.g., checking the fifth alternative when only four alternatives were provided) were excluded from the analysis. Lastly, the results presented here appear to have a logical internal consistency.

The last two points are more subtle, and psychology has provided no definite answers to them. The first is the nature of the relationship between adolescent and adult creativity. A host of studies has shown that eminent persons exhibit creativity while in adolescence and in early childhood. Moreover,

Bloom's massive review of longitudinal studies of the stability of human characteristics¹ shows that measures taken in childhood predict adult characteristics. For example, half the variance of adult measured intelligence and intellectuality is predictable by age four.

The second problem is the possibility of curvilinearity between creativity and other variables. For example, adolescents with moderate to high capacity for creativity in science and the arts may be "wholesome," "well-rounded," and "adjusted to school" while those with the very highest creative potential as well as "deviants" and those who have little capacity are "withdrawn," "insecure," or "slow." In practically every creative endeavor, examples of these types can be cited. Both instability and curvilinearity may have affected the results of this study.

Summary and Interpretations

From a national sample of 442 boys taking a new course, three groups were identified: 33 who had won competitive awards in science, 49 winning prizes in music, writing, visual and performing arts and 360 who had won no prizes in either area. The responses of the groups to 300 biographical questions were compared and tested for statistical significance. Chi-square tests revealed significant differences ($p < .05$) on 76 items. The bulk of these items showed the Sci-

entists and Artists to be similar to one another and different from the Others. These findings will be summarized and interpreted first before discussing the items revealing divergent tendencies between Ss and As.

In social relations both creative groups tended more often than Os to describe themselves as outgoing, self-confident, forceful rather than cooperative, and as joiners of clubs. Yet they were also more likely to find books more interesting than people. Both groups had earlier and stronger interests in mechanical and scientific objects as well as the arts; they more often enjoyed professional-technical books, visit libraries for non-school reading, and have greater numbers of books at home. They are more interested in work with fine detail, more persistent in carrying things through, and have less time to relax. They like school more, apply themselves to it more, and spend more time studying; they also do their work faster than their classmates. Fewer creative students attended suburban schools.

The creative group feels more creative, imaginative, curious, expressive, and tended to make more original suggestions to childhood playmates and to feel that it is important to be creative. In contrast to some previous formulations and empirical work, they have no greater propensity to suggest "wild ideas"

although they did express interest in expressing ideas in new, original ways. They indicated that they are brighter than their friends and quicker to understand. Larger proportions of the creative groups expect to earn graduate degrees and higher salaries after graduation. They also attached greater importance to money and thought responsibility is a relatively desirable job attribute. However, in choosing the best characteristic to develop in life, they selected "creativity" more often and "wealth and power" less often. In short, creative As and Ss are more outgoing, interested in a variety of things, studious, curious and attentive to detail, interested in, and self-confident of, their own creativity and intelligence and ambitious for their own education, salary and most important, creativity.

The characteristics of the creative groups are highly valued and rewarded in contemporary culture. It is difficult to reconcile these wholesome, socially mobile propensities with biographical characteristics of persons of the very highest eminence (those having greatest ultimate impact on culture) who have been withdrawn, indifferent to social rewards, and willing to undergo persecution and make supreme sacrifices for their convictions. One goes out on a limb to cite these persons, but to me, Galileo, Newton, Gauss, Darwin, and Freud come

to mind in science, Dante, da Vinci, Michelangelo, Dostoevski, and Van Gogh in the arts. Socrates is the classic case in philosophy, and there are prime examples in religion: Buddha, Moses, Mohammed, Jesus, Paul, Luther, and perhaps Gandhi. I can only offer a "curvilinear hypothesis": conformity and striving for social success leads to penultimate creativity.

Artistic vs. Scientific Creativity

Let us now consider the biographical characteristics which distinguish As and Ss. In contrast to the As, the Ss indicated that people have more difficulty in talking to them about personal problems and that they had more difficulty making friends after changing schools. The Ss more often do not date or date different girls rather than dating one at a time. They were less bothered by humiliating experiences and take less interest in other people's interests while less interested in books about people but generally more bookish and more interested, as one would expect, in science and mechanics rather than the arts, music, and writing. The Ss are also more interested in finely detailed work and are more apt to bring work to completion in the face of difficulty and distraction. The Ss are less involved in organ-

ized school activities and more inclined academically to mathematics and science rather than music and the arts. There were slight tendencies for the As to value and express more confidence in their own creativity while the Ss felt this way about intelligence. The Ss have higher educational aspirations, are more definitely decided about their future occupation, and tend to make carefully detailed plans rather than letting nature take its course. Lastly, in contrast to the As, the Ss tended to favor "security" as the best characteristic of a job.

The outstanding differences can be further abstracted: in contrast to As, Ss are preoccupied with things and ideas rather than people and feelings, avoid intense emotional closeness to others, persist in the face of difficulty, are attracted to academic work and detail, and are less willing to let nature take its course. Obviously mastery is crucial in the arts, and the subconscious plays an important role in science. Nevertheless the differences found here imply that communicated inner feeling is the essential of art, the pursuit of Beauty, while the single-minded, conceptual grappling of external realities is the sine qua non of science, the pursuit of Truth (or, in modern times, probable truth).

Regional Differences

Proportionately more Ss attended schools in Boswash,³ fewer in Chipitts and Sansan. While Sansan contained about as many As as would be expected, Chipitts was sharply over-represented in artistic talent while Boswash was sharply deficit. These findings may stem from a sampling fluke although none is evident to me. They may also result from differing standards of awards for science and arts in the three regions and locales. Hopefully, these uncertainties will be resolved in a replication on a random, national replication planned for the coming academic year. Nevertheless, the associations are strong and intriguing enough to speculate about. There are several possible explanations. The "Protestant Ethic" particularly Puritanism which Max Weber associated with the rise of modern capitalism, rationalism, and science¹⁰ started, and may still be more pervasive, in the Northeast. While the scientific productivity rate of Puritan descendants has steadily declined (corrected for population percentages) from the extremely high rates of yesteryear,¹² their scientific elan may yet pervade Eastern education and social institutions. There may also be heavier concentrations of ethnic groups of highly productive scientists (Jews, Dutch, Germans

Scandinavians, Scots, and English, in order and corrected)¹² in the East.

The Northeast has maintained a leading tradition of leadership in higher education. Two of the three consistently top producers and employers of scientists and particularly eminent scientists (Harvard, Columbia, and Chicago) are located in the East.⁵ Moreover, the "Eastern Establishment" has more than its share of what one wit has called the "Academic Mafia," those universities and other institutions which have justified their greater access to federal and foundation funds by high productivity in scientific research.

Previous studies on institutional and regional productiveness of eminent scientists have shown a decline in New England from the first place at the turn of the century to fourth place (following in order Far West, Middle West, and Middle Atlantic states and exceeding the South only) by mid century.⁵ If one can generalize from these limited data, Boswash is resurgent in science. Whether this conclusion is valid and whether it is attributable to the growth of the electronic and other highly technical industries in the East, the emergence of the Kennedy dynasty or other factors are largely matters of opinion until further data on national samples are analyzed.

The regional distribution of the As is unexpected. Why Chipitts is over-productive and Boswash is under-productive is most puzzling when one immediately thinks of New York as the literary and cultural capital. Moreover, the more limited research on regional productiveness of artists and writers shows the pre-eminence of New England followed closely by the Middle Atlantic states.⁵ Again, one must raise the possibility that competition and standards of rewards may vary among the three regions. Midwestern award winners may be big frogs in small ponds. Still, for one who has spent his youth in the Midwest, the Louis Sullivan-Frank Lloyd Wright Chicago school and contemporary architecture come to mind as well as thriving concert orchestras in Midwestern cities, the Sunday afternoon band concerts in small towns, the muckraker novels, Hemingway and other self-exiles to Paris and New York. One wonders if grass roots, Midwestern enthusiasm nurture budding artists more than the competitive austerity of, say, New York.

Lastly, the findings summarized above are for the sample of boys only; the analysis of the differences between "I" boys and girls deserves mention. While boys constitute 61 percent of the total sample, they comprise more than three-fourths

of the Ss but less than half of the As. Thus for this sample of high school physics students, more boys than would be expected by chance are scientifically creative while more girls are artistically creative.

These results are consistent with a recent attempt to reconcile, on the one hand, girls' higher grades in school even in subjects in which boys score higher on standardized achievement tests, and, on the other hand, the girls' lack of career productiveness especially in science.⁷ While acknowledging homemaking as an impediment to a woman's scientific career, the paper reviews a number of related studies of sex differences and presents original data on 58 measures taken on about 2100 boys and girls in high school physics classes. Four distinguishing patterns of significant difference were found, and the girls scored higher on all four: verbal aptitude (but not quantitative and spatial abilities), social values and interpersonal needs, cautiousness, and aesthetic values. These factors may lead to greater academic success in high school but appear to be antithetical to career eminence in science. These qualities of femininity are also more consonant with the characteristics which distinguish artists from scientists as brought out above.

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