Emergence and Realization of Genius: The Lives and Works of 120 Classical Composers

Article *in* Journal of Personality and Social Psychology · November 1991

DOI: 10.1037/0022-3514.61.5.829

1 author:

Dean Keith Simonton
University of California, Davis
375 PUBLICATIONS **9,963** CITATIONS

SEE PROFILE

Journal of Personality and Social Psychology
1991, Vol. 61, No. 5, 829-840

0022-3514/91/$3.00

Emergence and Realization of Genius: The Lives and Works of 120 Classical Composers

Dean Keith Simonton
University of California, Davis

Building on a model of individual differences in career development, new predictions are proposed regarding the preparatory phase of a creative life. After data on an elite sample of 120 classical composers from the Renaissance to the 20th century were collected, productivity variables were defined in terms of both themes and works, and the "hits" in each category were identified according to actual popularity. The theory successfully provided a foundation for understanding the positive, negative, and null relationships among eminence, lifetime output, maximum annual output, and the ages of first lessons, first composition, first hit, best hit, last hit, maximum annual output, and death. On the basis of the results, further questions are raised regarding the early childhood roots of adulthood creativity.

Anyone familiar with the lives of the notable contributors to a given discipline probably has been impressed with the tremendous variation that can be observed in the course of their respective careers. Some are child prodigies, and others late bloomers; some peak early and others late; some seem over the hill at a disreputably youthful age, whereas others seem to save their magnum opus for the swan song of their life and career; and, of course, where some shine as mass producers, manufacturing creations at a breakneck pace, others may don the guise of perfectionists and leave posterity with a select handful of well-polished masterworks. Over and above these divergent career trajectories are manifest discrepancies in ultimate outcomes: Some luminaries emerge as the truly illustrious, as the starred entries on the lists of all appreciators and experts, whereas others assume the more diminutive status of also-rans —still worthy of note but seldom mentioned in the same breath as those who secured a position in the upper ranks. The question addressed in this article is how all of these facets of a creative life interrelate: Are there distinctive patterns governing how creative work emerges in a creator's life that inform one about his or her likely place in the ultimate hierarchy of cultural esteem? In concrete terms, does a William Shakespeare likely exhibit a different career structure than, say, a Thomas Kyd?

A recent study of "career landmarks" in science and technology made an initial attempt to comprehend the connections between individual differences and longitudinal changes in behavioral creativity (Simonton, 1991a). A theoretical framework was developed from an earlier model that explains how creative productivity varies over the life span (Simonton, 1984a, 1988b). According to this longitudinal model, substantial individual differences exist on a latent variable called the initial "creative potential," which is defined as the total amount of contributions an individual is capable of producing in an unrestricted life span. Orthogonal to this variation is cross-sectional variation in the age at which a career begins, which is taken as the age when the creative process starts. Once a career commences, the initial creative potential is translated into actual products through a two-step process of ideation and elaboration. The expected rates of ideation and elaboration are contingent on the domain in which creativity takes place; some fields, such as mathematics and poetry, have fast information-processing rates, whereas other fields, such as philosophy and history, have much slower rates, the differences ensuing from the contrasts in the nature of the concepts that must be manipulated to generate and develop new ideas (Simonton, 1991a). These interdisciplinary contrasts in processing speed then have repercussions for the most probable location of the career optimum for a given professional age along with the most common slope of the post-peak decline. Some fields exhibit early peaks, others late, and some fields feature dramatic descents where others harbor creativity well into old age. All of the parameters just mentioned—creative potential, career onset, and the ideation and elaboration rates for a chosen discipline—lead to specific predictions about how output per annum varies as a function of age. But what is of interest now are the individual differences in career course that still can be anticipated even when one confines attention to creators working within the same domain of cultural activity. To appreciate the possibilities, inspect Figure 1.

All of the curves depict productivity (p) as a function of career age (t), with the latter variable assigned crude equivalents in terms of chronological age. Each of the four curves shown is identical in broad shape, with the consequence that the expected peaks in output all appear at the same professional age—approximately two decades into the career. But the two graphs in the upper half represent creators who began their careers at age 20, whereas the two graphs on the lower half

I thank the following research assistants for making this investigation possible: Naomi Braun, Steve Castellón, Hillary Cox, Michelle Ferreira, Cara Kennedy, and Bettina Murphy. The comments of three anonymous reviewers helped me substantially improve the quality of the article.

Correspondence concerning this article should be addressed to Dean Keith Simonton, Department of Psychology, University of California, Davis, California 95616-8686.

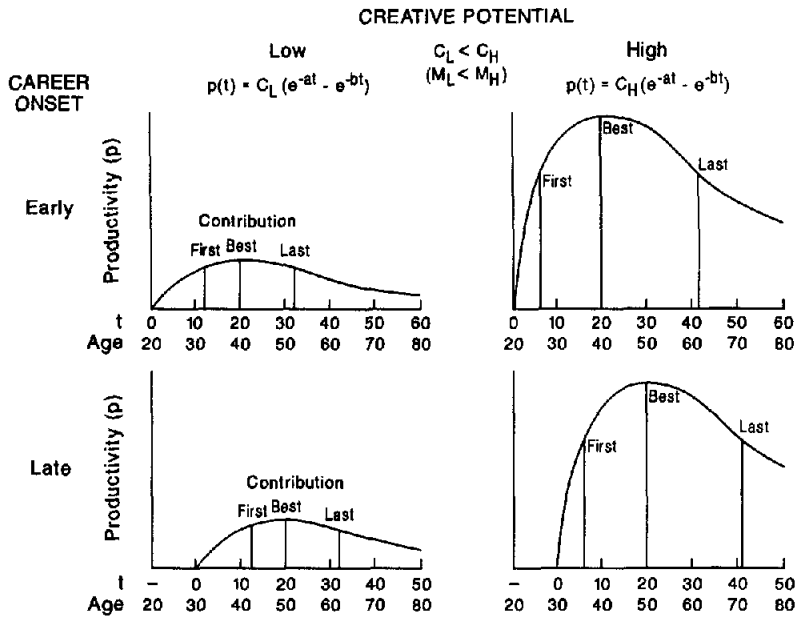

Figure 1. Four alternative trajectories for the relation between annual productivity and career age. (Because all careers are presumed to operate within the same creative discipline, the rates of ideation [a] and elaboration [b] are held constant, but cross-sectional variation is permitted between two orthogonal latent variables, initial creative potential [high = M_H vs. low = M_L] and career onset [early, where career age t = 0 at 20 years, or late, where $t = 0$ at 30 years]. All curves are based on the general equation for annual productivity, $p[t] = C[e^{-at} - e^{-bt}]$, where $C = abM/[b - a]$ and e is the exponential constant. For fixed a and b, M, which defines the initial creative potential, is directly proportional to C, which determines the height of, and hence the area under, the productivity curve. From "Career Landmarks in Science: Individual Differences and Interdisciplinary Contrasts" by D. K. Simonton, *Developmental Psychology*, 1991, 27, p. 121. Copyright © 1991 by the American Psychological Association.)

represent those who waited until age 30 before launching their careers. Moreover, comparing the graphs in the orthogonal direction, the two graphs on the left-hand side typify people with low creative potential, whereas the two on the right-hand side typify those with high creative potential. No matter which of the four graphs one views, the total lifetime output for any given individual is given by the area under the curve from career onset (at $t = 0$) to the person's death.

The curves in Figure 1 can be converted into some predictions about individual differences in the placement of three career landmarks. These three critical events are the ages at which a creator produces his or her first important contribution, best contribution, and last significant contribution—events that illuminate the dawn, high noon, and sunset of the strictly creative phase of any achiever's life work. Given this definition, assume that the "constant-probability-of-success" model applies to the connection between quality and quantity of output throughout a creative career (Simonton, 1988a).[1] That is, suppose that the odds of producing a notable creation is a probabilistic consequence of the total number of products offered, and hence the quality ratio, or proportion of hits to all shots, does not change systematically with age (for evidence, see Over, 1989; Simonton, 1977a, 1985). On the basis of this principle, the placement of the three career landmarks should be quite evident. First, the faster works are produced at the beginning of a career, the sooner a hit is likely to emerge; therefore, those individuals with the higher creative potential, as shown on the right-hand side of Figure 1, will be disposed to get a hit at a younger career age than those with the lower creative potential, as shown on the left-hand side of the same figure. Second, those periods of the career in which creators are most prolific should tend, on the average, to be those in which their most successful creations appear, and accordingly, the landmark of the best work has the highest likelihood of emerging when the productivity curve reaches its peak. This career optimum for quantity and quality, as should be clear from examination of Figure 1, depends on career age but not creative potential. Third, by the same argument used for the first career landmark, a higher creative potential is associated with greater over-

[1] Both the longitudinal model concerning the age function for creative productivity and the constant-probability-of-success model regarding the relation between quality and quantity of output across and within careers have been subsumed under a more comprehensive theory (Simonton, 1988b). Also, many of the same derivations can be pulled out of an alternative supposition that the age curves represent separate creative ideas and that a certain number of such ideas must accumulate to produce the "least publishable unit" (Simonton, 1991a). Nonetheless, this rival specification, unlike that derived from the constant-probability-of-success model, would have difficulty explicating the results for the thematic measures, because themes already define the smallest possible building block in musical creativity.

all output rates, and consequently the last contribution should be offered later in the career. Thus, the placement of the three career landmarks is determined by individual differences in both age at career onset and initial creative potential.

Elsewhere this twofold determination of the three landmarks has been shown to support several unique predictions regarding how the ages at first, best, and last contributions must be correlated across individual careers (Simonton, 1991a). These include the expectations that (a) lifetime productivity should correlate negatively with the age of first contribution but positively with the age of last contribution, (b) lifetime productivity should correlate precisely zero with age of best contribution, (c) age of the best contribution should correlate positively with the ages of first and last contributions, and (d) the first-order partial correlation between the ages of first and last contributions should be negative once the age of the best contribution is statistically controlled. These predictions, along with two derivations concerning interdisciplinary contrasts in the career placement of the landmarks, were then confirmed on a sample of 2,026 scientists and inventors, with due provision for such contaminating factors as life span (Simonton, 1991a). In addition, tests were made of subsidiary hypotheses that specified how lifetime productivity and the three career landmarks relate to subsequent eminence in scientific and technological history. For example, it was shown that differential fame is uncorrelated with the age of best work (see also Raskin, 1936; Zusne, 1976). Furthermore, even though eminence correlates negatively with the age of first contribution and positively with the age at last contribution, these correlations vanish once one controls for individual differences in lifetime output. Even if this inquiry made a first step toward delineating individual differences in creative careers, some deficiencies can also be noted.

To begin with, some predictions implied by the theoretical model were not tested because the appropriate variables could not be measured. Returning to Figure 1, it should be manifest that, in line with the constant-probability-of-success principle, the age at maximum output should correspond closely with the age at best work. As a consequence, correlations that are predicted for the middle career landmark should hold in equal force for the point of peak output. In particular, because the age at maximum output is a function of the age at career onset but not of creative potential, this event should correlate positively with both age at first contribution and age at last contribution as well as the age at best contribution; however, the age at maximum output should correlate zero with either lifetime productivity or final eminence. On the other hand, the maximum annual output observed at this career optimum is held to be contingent not on career age but rather on creative potential, implying that this variable should correlate postively with, and have the same correlates as, lifetime productivity. Specifically, individual differences in the peak productivity rate should correlate negatively with the age at first contribution, positively with the age at last contribution, and zero with both the age at best contribution and the age at maximum contribution. To test these predictions, one must possess data sufficiently ample that serious floor effects can be avoided in the tabulations, a goal unattainable for the sample of scientists and inventors (Simonton, 1991a).

Another problem stems from the restriction to contributions in science and technology. Not only must one raise the issue of the generalizability of the career patterns to other disciplines, especially in the arts, but one must also wonder whether certain artifacts may have intruded on the operational definitions of the central variables. Career landmarks in scientific and technological careers were identified according to the judgments of historians who compiled the chronologies, encyclopedias, and biographical dictionaries. Although some of these historians were also scientists in their own right, many were not, which might invite doubts about whether their assessments, however scholarly, genuinely correspond to what practicing scientists may have seen as the most influential contributions. Even those historians who can claim scientific training may not be the best judges, because, as Kuhn (1970) has argued, disciplinary histories tend to be revisionist in that older ideas are often recast in terms of modern paradigms (see also Brannigan, 1981). Therefore, it would enhance one's confidence in the findings if the same career structures appeared when the assessments of creative accomplishment depend on criteria more directly linked with the real-world appreciation of creative products.

Finally, although the examination of scientific careers strove to be truly life span developmental in scope, extending from birth to death, in fact the investigation fell short. Creativity, whether in a lesser-known figure or in the most exemplary genius, never springs forth like Athena from the head of Zeus. On the contrary, an ample period of preparation must precede the career onset during which a creator-to-be acquires the requisite skills, knowledge, and expertise. This requirement is implicit in the theory just presented given that creative potential presumably must have been established during childhood and early adolescence. And numerous investigations carried out since Galton's (1874) study of scientific genius have pointed to a respectable inventory of developmental antecedents of eventual achievement (Simonton, 1987). Of this vast collection, the interest here is in the smaller subset, which fulfills two requirements: (a) The age location of the event or condition must operate so that individual differences in its onset have subsequent consequences for the career course, and (b) the developmental cause itself should be domain specific so that it contributes directly to the mastery of the distinctive expertise demanded for effective work in a given discipline. The first prerequisite follows from the desire to help fill in the hiatus between the year of birth and the year of first contribution, a gap that averages just shy of 30 years for renowned scientists (Simonton, 1991a). The second specification recognizes the tendency in current research to emphasize the domain-specific nature of imaginative skills (e.g., Gardner, 1985). After years of designing tests that purport to gauge generic creativity, most investigators now agree that accomplishments of any social value demand thorough preparation in the particulars of a given discipline (see Wallach, 1985).

Two developmental variables seem to meet these specifications and at the same time lend themselves to reasonably easy measurement. The first is the age at which a person begins training specific to the discipline of later adulthood achievement. A provocative study reported in Hayes (1989, pp. 293–299) suggests the impact of this factor. Operating under the assumption common to information-processing models that creativity depends on having an ample "problem space"—which Simon (1986) estimates at some 50,000 chunks of disci-

pline-relevant data—Hayes sought to estimate the time lapse between the onset of intensive musical training and the first enduring work as gauged by the availability of recordings. The prediction was that the interval of apprenticeship would be of the order of a decade, an expectation resulting from studies of experts like chess masters (e.g., Simon & Chase, 1973). After collecting data on 76 classical composers for both variables, Hayes showed that such a preparatory period was indeed ubiquitous, even for a composer as precocious as Mozart. A straightforward implication of this work is that the age at first lessons should be positively correlated with the age of the first career landmark. If studies are begun later, an individual must wait longer before the wherewithal is present for conceiving a masterpiece. Hayes presented some statistics in support of this linkage.

Although closely related to the age at first lessons, the second variable is more directly linked to the theoretical model discussed earlier: the age that productivity begins, regardless of quality. Inspecting once more the four career types in Figure 1, it is patent that the time lapse between career onset at $t = 0$ and the completion of the first lasting contribution varies across individuals according to creative potential. The higher the initial potential, the faster the increase in the productivity rate, and therefore the sooner the creator finally gets a hit. Consequently, one must necessarily predict that variables that might serve, according to theory, as proxy indicators of creative potential—namely lifetime output, maximum annual output rate, and (most approximately) posthumous eminence—will display negative correlations with the temporal separation between these two developmental events, one in the preparatory period and the other in the period of creative accomplishment. An intriguing side question, about which one can derive no specific predictions, is whether the preparatory interval that Hayes (1989) measured will display a parallel inverse relation to creative potential. On the other hand, the actual age at which a person attempts the first product should correlate positively with the age at first success, because both variables should be intimately related to age at career onset, a latent variable that, like creative potential, can only be known by its consequences for career outcomes.

In light of these reservations, in the present inquiry I attempt to replicate and extend the model developed on scientists by analyzing the careers of a more select group of classical composers. Because extensive listings of works are available for those composers who produced pieces in the standard repertoire, variables can be defined that had to be omitted in the earlier investigation. Moreover, because the identification of career landmarks and other career variables can be made contingent on the judgments of those who attend concerts and buy recordings, these measures cannot have the same sources of "method variance" as assessments dependent on the opinions of experts. Compositions will be investigated that have established a place in the "hearts and minds" of a broad audience. Also, the biographical information available on the more distinguished classical composers is of impressive quality and richness (Simonton, 1977a), allowing access to the preparatory phase of the creative career—the life before the work. One reason for this wealth of information is that musical creators are probably more prone to have been child prodigies, or at least to have displayed some precocity (Feldman, 1986), a condition that is likely to attract attention from parents and teachers, and thus provide objective documentation of early development (Simonton, 1976). In fact, Hayes (1989) has already shown that the age that musical study is first initiated can be assessed on a large sample of composers, and in comparison with that variable, measuring the age when serious composition began should be almost routine. Finally, because 696 classical composers have already been analyzed in terms of a structural equation model (Simonton, 1977b), and a subset of 477 scrutinized according to their thematic output (Simonton, 1980), there is some foundation in past research on which to build, including a couple of measurements that can be advantageously exploited for different purposes here.

Method

Sample

Granting the need to examine composers for whom the data would be of uniformly high quality, a restrictive sampling procedure was implemented. First, only those composers were selected who had entries in both of two independent reference works: (a) the two-volume dictionary of musical themes collected by Barlow and Morgenstern (1948, 1976) and (b) the chronology of musical works compiled by Gilder and Port (1978). Second, the composers had to be deceased at the time the most current reference work was published. Third, of the composers remaining, only those were included whose most often-performed creations could be assigned reasonably accurate dates. Just 120 composers satisfied all three criteria, yielding a select sample that is nonetheless highly representative of the entire domain. For example, according to a survey described in Moles (1958/1966), members of this sample account for 89% of all music heard in the classical repertoire. The earliest composer was Palestrina, born in 1524, the most recent Britten, who died in 1976. Over a dozen nationalities are represented, but there are no women in the sample (cf. Simonton, 1977b, 1991a).

Career Success and Course

To assess the composers on posthumous reputation, a measure of their differential eminence was incorporated from a previous inquiry (Simonton, 1977b). This six-item composite encompasses objective assessments of performance frequencies (Moles, 1958/1966, pp. 28–39), rankings founded on a survey of members of the American Musicological Society (Farnsworth, 1969, p. 228), subjective judgments of musicologists (Illing, 1963, pp. 133–175; Scholes, 1955; Slonimsky, 1956), and attention received in a general reference work (*Encyclopaedia Britannica,* 1974). A recent covariance-structure analysis indicated that these alternative measures of fame are adequately described by a single, transhistorically stable factor on which all items exhibit factor loadings in the upper .60s to upper .80s (Simonton, 1991b).

The remaining measures are defined in two sets according to the unit of composition. Unlike the science investigation, which took its basic unit to be the single discovery or invention (Simonton, 1991a), here the units are taken to be either the individual theme or the entire work. Examination of both classes of operational definitions ensures that all conclusions drawn are robust across contrasting ways of conceiving productivity.

Themes. By a "theme" is meant the melody, motive, or subject that constitutes a building block of any musical composition. Barlow and Morgenstern (1948, 1976) listed a total of 12,966 themes that are attributable to the composers examined here, and of these fully 12,819 could be assigned dates. However, according to the results of an earlier as-

sessment (Simonton, 1980), the number of themes that can be said to have a secure place in the classical repertoire must be slightly reduced to 12,312, which nonetheless retains 95% of the original selection. Because these themes come from compositions having proven aesthetic merit, they can be referred to as "hits" in the following variable definitions:

1. *Age at first hit* was the composer's chronological age at the time his first successful theme was composed. As a reliability check, the correlation between this variable and the age at the first theme of any merit was calculated as well; the coefficient was essentially unity.

2. *Age at best hit* was the composer's chronological age at the time his most popular theme was created. Differential popularity was based on an earlier 32-point scale that consolidated the evaluations contained in music appreciation texts, record-buying guides, record anthologies, concert guides, collections of popular excerpts, thematic dictionaries, and so forth (Simonton, 1980). The best hit is almost invariably one of the "war-horses" that dominate the concert or opera season and the record catalogues, such as Beethoven's Fifth Symphony.

3. *Age at last hit* was the composer's chronological age at the time that the last popular theme was completed. Again as a data quality check, the age at last hit was correlated with the age at which the last theme was composed, its aesthetic impact notwithstanding—and that coefficient was also almost exactly unity. Because Barlow and Morgenstern (1948, 1976) confined their thematic dictionary to pieces listeners are most likely to have heard, the hits used here to define the onset and termination of a creative career are virtually identical to all potential themes that might have been so used.

4. *Age at maximum output* was defined using all dated themes in the dictionary to avoid floor effects (see Simonton, 1991a). This was simply the chronological age at which the most total themes were composed. Occasionally, two such ages qualified, in which case the years immediately before and after the competing ages were examined, and that age adopted that had the highest output in the 3-year interval centered on that age.

5. *Maximum annual output* was the count of the total number of themes, hits and otherwise, that were created in the year designated as that of maximum output. The occasional existence of ties obviously causes this indicator no chagrin.

6. *Lifetime output* was the total count of thematic hits for each composer. Although one might think that a count of hits is not identical to a count of total products, research suggests that the two are highly correlated (Simonton, 1984b, chap. 5). Theoretically, in fact, the constant-probability-of-success model applies to cross-sectional variation in quantity and quality just as much as longitudinal fluctuations, mandating a strong association between hits and total attempts. In any event, as might be expected from the highly selective pool of themes, this measure correlates very highly not only with the total number of dated themes ($r = .997$) but also with the total stock of themes whether dated or not ($r = .996$).

Tabulating themes involves implicitly giving more weight to larger compositions than to smaller works; an art song will contain fewer melodies than an opera. Yet, in some respects the most proper unit of creativity can be considered to be the whole composition, such as a completed work earning an opus number. Although a large work may contain more thematic material, there is evidence from computer content analyses that such content may be more superficial than that filling smaller forms, somewhat compensating for the discrepancy in quantity (Simonton, 1980, 1986). Hence arises the desirability of the next set of measures.

Works. The same six creativity measures were defined using works rather than themes as the unit of analysis, where a "work" represents a piece played as a whole. Selection began with the 4,252 compositions listed in the chronologies published by Gilder and Port (1978), and then the hits were determined by the extensive ratings in a discography by Halsey (1976). The latter evaluated 4,101 recorded classical compositions on two 5-point scales, one concerning "aesthetic significance" (from "masterpiece" down to "flawed or insubstantial") and the other regarding "listener accessibility" (from "work commands attention; an immediate connection is made" down to "austere, esoteric, or too arbitrary for most listeners"; see Halsey, 1976, pp. 43–44). The six resulting measures were specifically defined as follows:

1. *Age at first hit* was the chronological age at which the composer produced the first work rated by Halsey (1976). Because Halsey restricted his assessments to pieces that had secured a place in the standard repertoire, this age occurred almost 9 years later than the age at which the first work listed in Gilder and Port (1978) was composed, a contrast in keeping with the Hayes (1989) hypothesis that creative preparation requires about a decade. Even so, the correlation between the age at first hit and the age at first composition catalogued is .63 ($p < .001$), indicating a respectable correspondence. It is still evident from inspecting the lists that Gilder and Port were far more inclusive in their compilation, listing many compositions too obscure to command a place in Halsey's discography.

2. *Age at best hit* was the chronological age at which the composer created the work that Halsey (1976) assigned the highest rating on aesthetic significance. When more than one composition received the highest designation—which happened often for the most illustrious composers in the sample—that work was selected that also had the highest score on listener accessibility. In a few rare cases, more than one composition might have received the highest rating on both assessments, in which case that piece was chosen as the best that was the longest according to Halsey's determination of the typical duration of performance.

3. *Age at last hit* was the age at which the composer created the last work worthy of rating by Halsey (1976). As in the case of age at first hit, the final work to appear in Halsey was by no means the same as the final work to appear in Gilder and Port (1978), the latter placing the last piece almost 10 years later, again owing to a lack of discrimination concerning the pieces actually enjoyed by devotees of classical music. Still, the placement of the last hit correlated .60 ($p < .001$) with the placement of the last work independent of merit.

4. *Age at maximum output* was gauged by using all the compositions dated in Gilder and Port (1978) and then identifying the chronological age in which the most compositions emerged. When more than 1 year qualified, the immediately adjacent years were again scrutinized, the age of maximum output then falling in the year on which the peak 3-year period was centered. Total output, rather than mere hits, was examined for the same reason as for themes—to avoid serious floor effects that would lower discriminatory power.

5. *Maximum annual output* was the count of the total number of works, hits and esoterica alike, that were composed in the year found to be that of highest productivity.

6. *Lifetime output* was the count of total hits. Of the works listed in Gilder and Port (1978) on behalf of the 120 composers, just 1,478, or only about 35%, earned some rating in Halsey (1976) and thereby attained status as a hit. Nevertheless, the correlation between the lifetime tabulation of total works and total hits is .88, indicating that quality does indeed correspond closely to quantity.

Although the definition of the works measures was deliberately designed to be as independent as possible from the definition of the themes measures, some correspondence would be expected if creative productivity is to have any generic meaning whatsoever. Therefore, it is worth pointing out that some concordances exist between the objective popularity measure used to define the thematic hits and the subjective ratings used to define the compositional hits. Although the functional relationships are sometimes complicated by curvilinear functions (Simonton, 1986), across 1,919 compositions the zero-order linear correlations are .33 ($p < .001$) between popularity and significance and .24

($p < .001$) between popularity and accessibility (significance and accessibility themselves only correlate .07; Simonton, 1989b). Thus, the isolation of the hits in the two sets of measures should not be utterly discrepant. On the other hand, because works most often consist of multiple themes, measures of maximum annual output and lifetime output should differ for themes and works. In particular, both the means and the standard deviations of the two thematic counts should be larger than the statistics for the two compositional counts. One consequence of this contrast is that, other factors held constant, thematic productivity should correlate more strongly with other variables than should compositional productivity, owing to the truncated variance of the works measures. This generally proves to be the case.

Biographical Context

One variable was implicit in the definition of several of the preceding career measures, namely *birth year*. The age at which a particular type of hit appears is the difference between the year of composition and the year of birth. The latter also can serve as an important control variable should there exist any linear trends in two or more variables from the Renaissance to the current century (Simonton, 1990). For example, it has been shown previously that judgments of composers display a "classicist bias" in which older contributors are rated more highly than later contributors (Simonton, 1977b). A second biographical measure is just as easily defined, the *age at death*, or life span, which is the difference between the year of death and the year of birth. This variable places manifest constraints on the duration of a creative career, especially on the appearance of the last work (see Simonton, 1991a). Furthermore, inclusion of this variable allows a truly life span developmental survey of the composers' lives and works from birth to death.

The next two measures are far more difficult and subjective, and consequently it was deemed advisable to enlist the services of research assistants. Five undergraduates were given lists of the composers and then instructed to determine two key events in the acquisition of musical expertise: the *age at first lessons* and the *age at first composition*. Music lessons could include training on an instrument as well as instruction in counterpoint, harmony, and general composition, and could be received from parents or relatives, private teachers, or conservatories of music. Composition included work in any form and did not necessarily have to be published or performed, thereby counting the "juvenilia" that fill up the archives without necessarily gracing the concert halls. In addition, the raters were kept ignorant of both the composers' scores on the objective variables and the central hypotheses of this study (although they were told that the inquiry concerned the origins of musical talents). All raters were given ideas about what reference works to consult (e.g., Blom, 1966; Sadie, 1980; Sainsbury, 1966; Scholes, 1955; Slonimsky, 1958) but were otherwise given no detailed direction on how to make the assessments. In particular, because sometimes quantification had to be predicated on qualitative statements (e.g., so-and-so began lessons in his early teens), the raters were left to use their own judgments on how to perform the desired translation. Nonetheless, the judges were offered the option of leaving an assessment blank if they thought a judgment impossible, but they were not encouraged to do so if they could provide a ballpark estimate. Fortunately, despite this latitude, all 120 composers received at least one estimate on both variables. Finally, it should be noted that the five raters worked independently, a desideratum facilitated by the fact that all but two did their assessments in different quarters of the academic year, and the two who gathered data in the same quarter did so at different times.

Despite the problems faced by all judges, including diffidence over whether any consensus could issue from their guesswork, considerable agreement was nonetheless observed. For age at first lessons, the correlations among the five ratings ranged from .31 to .88; for age at first composition, the correlations ranged from .34 to .77. These coefficients are based on pairwise deletion of missing values, where the number of cases ranged from 48 to 118. Because the raters disagreed on which composers had missing values, and because one rater would sometimes arrive at an aberrant estimate of a particular composer by evidently overlooking some crucial datum, the final composite score for each measure was taken to be the median of the scores available on a given composer. The correlations between these final medians and the separate ratings varied between .50 and .94 for age at first lessons and between .59 and .94 for age at first composition, which seem like reasonable correspondences given the difficulty of these subjective ratings. The correlation between these two early developmental measures is .59 ($p < .001$), suggesting that they are strongly correlated. Even so, there was discriminant validity in the sense that the correlations of each final score with the separate ratings of the other measure were noticeably smaller than the correlations of each final score with the separate ratings of the same measure (viz., .41–.64 for lessons and .42–.60 for composition).

Age at first lessons and age at first composition were then combined with age at first hit to devise two final biographical measures. *Musical preparation* was defined as the age at first hit minus the age at first lesson, whereas *compositional preparation* was defined as the age at first hit minus the age at first composition. These two differences can be calculated for both themes and works, yielding four indicators altogether; the two musical preparation measures correlate .52 and the two compositional preparation measures .55, showing some agreement between themes and works.

Results

Although most of the statistical relationships to be examined subsequently can be predicted on the basis of past research and strong theory, two-tailed significance levels will still be used for all tests.[2]

Statistics and Correlations

Table 1 gives the basic descriptive statistics for the six measures regarding themes and works. According to the thematic measures, the typical famous composer obtains his first hit at age 26, best hit at age 40, and last hit around 52, with the age of maximum output close to that for the best hit, where the peak productivity attains 20 themes per year, in contrast to a total lifetime output averaging approximately 103 themes (cf. Simonton, 1977b). The picture for the works measures is much the

[2] This statement itself might be viewed as merely approximate insofar as some of the variables are described by skewed distributions. In line with past research, eminence, lifetime productivity, and maximum annual output are all skewed right, exhibiting the typical elitist distribution (Simonton, 1984b, chap. 5). Still, the substantive conclusions are unchanged even if one resorts to log-transformed versions of these same variables—in fact, if anything, the strength of the confirmation is mainly improved. The reason for this robustness is that the correlations between raw and log-transformed scores are rather high anyway, between .76 and .94 with a median of .86, correspondences in keeping with the fact that the Pearson product–moment correlation coefficient is usually swayed more by the ordinal placements than by the interval separations of scores. In any case, it can be argued on theoretical grounds that the raw and not the log-transformed measures are the natural units of creative behavior (Simonton, 1988b).

same but for a shorter career duration: The first hit comes around age 31, the best around 41, and the last at age 50, with the age of maximum productivity at about 37, in which year nearly four works appear, this when the average number of hit compositions in a lifetime is a bit over a dozen. As anticipated, the biggest discrepancies between the themes and works statistics concern the productivity counts. For instance, the variance of lifetime output for themes is over 50 times larger than that for works. Interestingly, the placements of the three landmarks for classical music are quite in keeping with those found in the mathematical and physical sciences, a similarity that may reflect the inherently abstract and logical nature of creativity in all of these domains (Simonton, 1991a). It requires emphasis, however, that averages across 120 notable composers are being dealt with here; the cross-sectional variation on all indicators is quite substantial. Especially conspicuous is the fact that the ranges for the first, best, and last hits overlap, so that a precocious composer may be "over the hill" at an age when a "late bloomer" has yet to initiate his ascent (e.g., Mascagni vs. Bruckner). These appreciable individual differences are precisely what would be anticipated if the career course is dictated more by professional age than by chronological age (Simonton, 1991a).

Associations among career assessments. The zero-order product-moment correlations are also presented in Table 1. Along the diagonal are the coefficients between the alternative thematic and compositional indicators. Despite the rather contrary operational definitions, the congruence is patent. The most consensus can be seen in lifetime output, which shows that counting themes indicates approximately the same about the upshot of a whole career as does counting works. The concordances are somewhat less for the ages of first and last hit, but they remain sufficiently high that the general demarcation of the onset and termination of a creative life is fairly secure. Even the correspondences for age at best hit, age at maximum output, and maximum annual output are still moderate. Hence, the two rival sets of creativity measures are describing the same careers.

This last conclusion is reinforced by the fact that the pattern of correlations within each set of measures is reflected fairly well across the diagonal. With the exception of the correlation between the ages of first and last hit, which lacks theoretical import, the associations among the four age measures are uniformly positive, in keeping with prediction. Lifetime output in both cases correlates positively with maximum annual output and age at last hit, and negatively with age at first hit. As expected, if the career peak is uncorrelated with latent creative potential, the ages at the best hit and maximum output correlate neither with the maximum annual output nor with the total lifetime output. Thus, not only are the two sets of measures describing the same careers, but they are also describing the 120 careers in much the same fashion. The only disconcerting deficiency in the entire pattern is the failure of the maximum annual output to provide significant positive correlations with the age at last hit for either themes or works. Suspecting that this may have been a consequence of the failure to correct for differential life span—because two composers in particular, Mozart and Schubert, were both highly prolific and short-lived—the partial correlations were calculated with life span statistically controlled. Introducing this suppressor variable increased these two suspect correlations to .30 ($p < .01$) for themes and .24 ($p < .05$) for works without substantively altering the other correlations seen in Table 1.

Before too much credence is given to these associations, one must ask whether these results could represent some artifact of historical time. As will be seen shortly, many of the 12 variables in Table 1 correlate with year of birth and therein could introduce spurious relationships. Fortunately, computation of the first-order partial correlations holding birth year constant reveals that the coefficients are hardly altered and the overall pattern is not changed at all. Besides the fact that the correlations show no consistent tendency to either decrease or increase, the average absolute difference between zero-order correlations and first-order partials is only .02, with a maximum discrepancy of .07 and with one fourth of the coefficients identical to the second decimal place. Consequently, year of birth has no role in generating the order seen in Table 1 (see also Simonton, 1991a).

Partial correlations can be examined to test another expectation about the implicit structure in Table 1. According to the theory described at the beginning of this article, the correlation between age at first hit and age at last hit should become nega-

Table 1
Basic Statistics and Correlations for Career Measures

Measure	1	2	3	4	5	6	*M*	*SD*	Range
1. Age at first hit	.61***	.49***	.12	.48***	−.39***	−.46***	30.76	10.06	8–60
2. Age at best hit	.44***	.54***	.59***	.42***	−.02	−.01	40.78	12.55	16–80
3. Age at last hit	.26**	.62***	.68***	.38***	.14	.22*	50.99	15.02	18–86
4. Age at maximum output	.44***	.75***	.60***	.53***	−.14	−.15	37.46	12.48	16–84
5. Maximum annual output	−.30**	.02	.15	−.02	.54***	.72***	3.67	3.17	1–21
6. Lifetime output	−.39***	.09	.20*	.01	.84***	.79***	12.32	19.76	1–135
M	26.28	39.68	51.74	39.58	20.18	102.60			
SD	7.86	10.83	13.72	11.59	18.38	141.72			
Range	5–47	18–76	18–80	11–76	1–104	1–812			

Note. Correlations on the diagonal are between themes and works measures, those below the diagonal among themes measures only, and those above the diagonal among works measures only.
* $p < .05$. ** $p < .01$. *** $p < .001$.

tive once the age at best hit is partialed out (Simonton, 1991a). When this test is performed on the works indicators, the outcome clearly supports this prediction, obtaining a negative first-order partial of $-.24$ ($p < .05$). Adding further statistical control for life span and even birth year only enlarges this correlation to $-.29$ ($p < .01$). The analysis for the themes measures is more complicated but still confirmatory. Partialing out age at best hit from the association between the ages of first and last hit reduces the initially positive correlation to a bit less than 0 ($r = -.01$), and only after adding both life span and birth year as further controls is there a significant negative third-order partial ($r = -.21$, $p < .05$). Because the original theory predicts that negative correlations of any form will not arise if initial creative potential correlates with career onset (or with age at best work), these results are still acceptable.

Career course, training onset, and success. Table 2 displays the actual correlations between birth year and the dozen measures examined in Table 1. Notwithstanding a consistent tendency for the more recent composers to exhibit younger ages and lower output levels, only 5 of the 12 are statistically significant, with a maximum percentage of variance shared at 10%—and with no congruence across thematic and compositional variables. Hence, for these windows on the creative career, no linear trend distinguishes the composers spread over almost four centuries. The remaining correlations in Table 1 have more substantive interest. Most significant, it is rather apparent that the ages at first lessons and at first composition are dependable correlates of the age at first hit, indicating that creative output cannot emerge in a burst of inspiration but rather ensues after ample and arduous preparation, just as hypothesized. How much preparation it takes is indirectly suggested by the means: Whereas the first hit appears somewhere between ages 26 and 31, lessons tend to begin around age 9 and composition just before 17 (albeit with considerable variation). These figures hint, if anything, that Hayes (1989) may have underestimated the preparatory time required before a composer can produce a masterpiece. In any case, the ages of lessons and composition evidently have little consequence for the remaining three age variables, and so the principal impact of these training factors is to determine when a career gets launched rather than when it peaks or ends. Even so, both training variables correlate consistently with the two individual difference variables, maximum annual and lifetime output. The younger a composer is when he begins formal training and later composition, the higher his annual productivity when he approaches his career peak and the higher his final list of creative accomplishments.

This anticipatory connection will be more carefully scrutinized later, so for the moment I will make three final observations on the correlations seen in Table 2. First, apparently a composer's life span has minimal relevance for predicting individual differences in output, whether overall or career peak—but it is germane to the prediction of the ages of first, best, and last hit, along with the age of maximum output. It must be recognized, however, that it is not easy to specify the causal direction in these correlations (see also Simonton, 1977b, 1991a). Although the age at death very likely determines the age at last hit—if one can assume that creative potential never dries up—it may be safer to infer that it is age at first hit that determines the age at death. The latter assertion is not tantamount to claiming that early creativity causes early death, but only that precocious output permits a composer to die young and still earn recognition from posterity. If Franz Schubert, for example, had waited until the normal age to produce his first masterpiece, he would probably be no more famous than Kallinikov is today, because Schubert died in his 31st year.

Second, many of the career measures correlate with the differential eminence of the 120 composers. The more famous creators start producing masterpieces early, generate their last hit late in life, reach an exceptional rate of output at their career peak, and, not surprisingly, conclude by chalking up an impressive inventory of hits. On the other hand, the comparative acclaim of the composers has no consequence for determining when the career peak will appear in their lives, whether one identifies that optimum as being of a single magnum opus or fertile production. This result is again consistent with the notion that creative potential, which is ultimately realized in social distinction, is orthogonal to the career climax (Simonton, 1991a). To be sure, one modest exception appears in the form of the small positive correlation between eminence and age at best hit, but the proper response brings one to the third and final observation regarding Table 2: Because all the correlations there are zero-order, room exists for the insertion of artifacts owing to mutual dependencies on year of birth. However, just as was found for Table 1, when the first-order partials are computed the correlations are virtually identical, with one important exception—the associations in the last column that involve eminence. The cause for this discrepancy is that of all the variables to be investigated in this study, eminence had by far the strongest association with year of birth, namely $-.56$, replicating the classicist bias detected earlier for 696 composers (Simonton, 1977b). Accordingly, when birth year is partialed out of these correlations, it can be seen that the more eminent composers still claim hits early and late in life and that their maximum annual output and lifetime output remain outstanding; however, they cannot be differentiated at all from their lesser known colleagues regarding the ages of best hit and maximum output. Thus, the seeming contradiction of theoretical expectation represented an artifact.

Musical and compositional preparation. Returning to the initial years of a creative life, Table 3 offers the results for musical and compositional preparation. Brief inspection of the basic statistics shows that the average amount of musical preparation is anywhere between 17 and 22 years, with a range between 0 and 48 years, whereas the average amount of compositional preparation falls somewhere between 10 and 14 years, with a range between 0 and 43 years. This individual variation translates into noticeable contrasts in career outcomes, as seen in correlations between the preparation measures and birth year, maximum annual output, lifetime creativity, and eminence. Because the preparation measures include age at first hit in their definition, correlations with the career landmark variables are not shown; these essentially repeat what has already been shown in Table 1. It is immediately apparent that individual differences in productivity and distinction are consistently associated with preparation of either kind across both themes and works. In particular, the shorter the interval between first lessons or first composition and first hit, the higher the expected maximum annual output, lifetime productivity, and posthumous reputation. To be sure, in three instances the coefficients

Table 2
Correlations Between Career Measures and Other Individual Differences

Measure	Birth year	Age at Lessons	Age at Composition	Age at Death	Eminence
Age at first hit					
Themes	−.21*	.37***	.46***	.36***	−.25**
Works	−.10	.36***	.45***	.23*	−.30**
Age at best hit					
Themes	−.30**	.04	.14	.21*	.22*
Works	−.12	.03	.24**	.32***	.14
Age at last hit					
Themes	−.33***	−.02	.08	.47***	.38***
Works	−.09	−.06	.05	.46***	.31**
Age at maximum output					
Themes	−.29**	.15	.13	.22*	.15
Works	−.06	.15	.19*	.28**	−.10
Maximum annual output					
Themes	−.23*	−.31**	−.21*	−.22*	.59***
Works	−.06	−.19*	−.21*	−.15	.38***
Lifetime output					
Themes	−.20	.33***	−.28**	−.18	.69***
Works	−.06	−.34***	−.30**	−.13	.53***
M	1823.22	9.17	16.61	65.51	3.70
SD	76.46	3.58	5.86	14.62	3.79
Range	1524–1913	2–19	4–32	26–92	0.20–11.49

* $p < .05$. ** $p < .01$. *** $p < .001$.

fall short of statistical significance. Yet, it is possible to take advantage of statistical suppression to render all 20 correlations significant. If year of birth is partialed out, every coefficient either remains the same or increases in absolute magnitude, with an average enhancement of .03 and a maximum of .10, making all pass conventional levels. A long period of musical and compositional preparation indeed indicates an inferior prognosis for productivity and distinction, at least once historical placement is controlled for statistically.

Regression Analysis

The two empirical issues that remain can be best assessed through multiple regression equations. The first question concerns the direct antecedents of eminence, and the second concerns the direct antecedents of total lifetime output.

Table 3
Correlations With Musical and Compositional Preparation Measures

Measure	Musical Themes	Musical Works	Compositional Themes	Compositional Works
Birth year	−.18*	−.08	−.09	−.01
Maximum annual output				
Themes	−.18*	−.19*	−.15	−.18*
Works	−.30**	−.34***	−.22*	−.29**
Lifetime output				
Themes	−.26**	−.29**	−.20*	−.25**
Works	−.26**	−.37***	−.19*	−.32***
Eminence	−.13	−.21*	−.13	−.22*
M	17.11	21.59	9.67	14.15
SD	7.33	9.39	7.35	9.06
Range	0–37	4–48	0–35	0–43

* $p < .05$. ** $p < .01$. *** $p < .001$.

Predicting eminence. Is the sole direct predictor lifetime output, all other variables affecting posthumous reputation indirectly through that one variable? Even if the answer does not have direct relevance for evaluating the theoretical framework underlying the predictions, it does allow determination of whether compositional eminence has the same foundations as scientific eminence. Hence, a hierarchical analysis was performed where eminence was first regressed on lifetime output plus birth year, and then the remaining five career variables were added, namely the maximum annual output and the ages at first, best, and last hit and at maximum output. After deleting the nonsignificant predictors for both themes and works, a composer's fame was found to be a function of birth year, lifetime output, age at first hit, and age at last hit, as can be seen in Table 4. These findings differ from what was found for scientists, because their eminence is not determined by the location of the two career landmarks of first and last work (Simonton, 1991a).

On the other hand, the results for these 120 composers are consistent with an earlier investigation (Simonton, 1977b) that discovered that the differential eminence of 696 classical composers was a function of birth year, total productivity, and creative longevity. Because the last variable was defined as the difference between the ages at last and first masterpiece, that outcome is algebraically equivalent to the current result. In that earlier study, it was suggested that a composer with an exceptionally lengthy career may gain additional credit from posterity by going through one or more stylistic changes, such as is evident in the careers of many long-lived composers. Posterity thus receives two or more composers for the price of one. For

Table 4
Multiple Regression Equations for Predicting Eminence

	Themes		Works	
Measure	*b*	*β*	*b*	*β*
Birth year	−0.022	−.442**	−0.027	−.544**
Lifetime output	0.013	.484**	0.068	.353**
Age at first hit	−0.100	−.207*	−0.083	−.220*
Age at last hit	0.053	.193*	0.053	.211*
Constant	42.156		51.822	
R^2		.708**		.623**

Note. The unstandardized partial regression coefficients are designated by *b*, the standardized ones by *β*. The adjusted R^2s for themes and works, respectively, are .698 and .610.
* $p < .01$. ** $p < .001$.

example, because Beethoven went through three distinct stylistic periods, there is "something for everyone" in the sense that some may appreciate the formal elegance, precision, and reserve of his classicist first period, others the rambunctious rebellion and proclamation of his romantic middle period, and still others the more serene depth and experimentation of his reflective late period. In any case, this creative transformation may be far less conspicuous in the sciences, where creators usually devote their whole lives to the elaboration and promulgation of some central theme or metaphor (see Holton, 1973; Simonton, in press; cf. Gruber & Davis, 1988). However, before much is made of this contrast between the two creative domains, one can infer from the standardized regression coefficients that the impact of either career landmark is only around half that found for lifetime productivity, and hence the latter variable still serves as the more potent antecedent of posthumous reputation (cf. Simonton, 1991b).

Predicting output. According to the model presented in the Introduction, the total productivity at the end of a career should be a function of three factors: the age at first hit, the maximum annual output, and the age at last hit. These three variables demarcate the beginning, the peak, and the termination of the career course for the curves shown in Figure 1. Unlike the previous analyses, the results clearly confirm expectation. Again using a hierarchical regression, lifetime output was a function of the three specified variables and these alone, not even birth year entering the equations. For the thematic measures, the total production of hits was a negative function of age at first hit ($b = -3.617$, $\beta = -.201$), $t(116) = -3.784$, $p < .001$, and a positive function of age at last hit ($b = 1.413$, $\beta = .528$), $t(116) = 2.676$, $p < .01$, and of the maximum annual output, ($b = 5.809$, $\beta = .753$), $t(116) = 14.549$, $p < .001$, with $R^2 = .736$ ($p < .001$, adjusted $R^2 = .729$, and constant = 7.350). Likewise for the works measures, the lifetime output was a negative function of age at first hit ($b = -0.491$, $\beta = -.250$), $t(116) = -3.765$, $p < .001$, and a positive function of age at last hit ($b = 0.214$, $\beta = .163$), $t(116) = 2.630$, $p < .05$, and maximum annual output ($b = 3.731$, $\beta = .599$), $t(116) = 9.006$, $p < .001$, with $R^2 = .581$ ($p < .001$, adjusted $R^2 = .570$, and constant = 2.836).

It is striking that the absolute value of the unstandardized coefficient for age at first hit is roughly double that for age at last hit for both themes and works. According to the age curves observed empirically and predicted theoretically, the slope of the prepeak ascent should be greater than the slope for the postpeak descent, and consequently changes in the career location of the first landmark should have more impact than changes in the location of the last landmark (Simonton, 1989a). In particular, by applying differential calculus to the equations that generate the age curves shown in Figure 1, it can be shown that the slope at the point of first hit should be approximately twice as steep as the slope at the point of last hit (see Figure 1). Therefore, this comparison provides indirect support on behalf of the age curves that have guided the central deductions.

Discussion

It has been shown here that the career pattern for classical composers is, in all essentials, the same as that observed earlier for scientists and inventors. This replication succeeded despite the shift not only in domain of creativity, but in the operational definitions besides. Furthermore, the demonstration went beyond mere replication by introducing new variables relevant to a complete evaluation of the proposed theoretical framework. Naturally, it still should not be claimed that the theoretical model that generated Figure 1 has been conclusively proven. Nonetheless, the current results, in conjunction with a considerable body of other research published over the past century, expand an intricate matrix of relationships that impose strong constraints on the range of possible explanations (see Simonton, 1988a, 1991a). For example, any explication must also handle the cross-culturally invariant differences in the age curves across disciplines, the skewed distribution of lifetime productivity and maximum output rate, and the probabilistic connection between quantity and quality that holds both within and across creative careers. On the basis of the whole collection of well-established findings, a long inventory of offered theories has been rendered empirically untenable. For instance, one must reject explanations that specify developmental changes in creativity in terms of chronological age or assume that quality (or creativity) has a different age function than quantity (or productivity). Especially critical for any theoretical alternative is the necessity of specifying at least three independent factors underlying individual differences in career trajectories: career onset, disciplinary activity, and something that serves the same causal function as creative potential (see Simonton, 1991a).[3]

[3] One may be rightfully wary of any theory that hypothesizes inherently unmeasurable variables. To the casual observer, for example, there may appear a certain circularity in using lifetime output, maximum output rate, and other observables as indicators of initial creative potential to test theoretical predictions, without access to alternative indicators that are independent of the theory being evaluated. However, there is nothing intrinsically unscientific about hypothesizing latent variables so long as they lead to empirical propositions that can be objectively discriminated from what one would predict in the absence of these unobserved contructs (see, e.g., Simonton, 1991b). In this sense, the epistemological status of creative potential is approximately the same (albeit not nearly so secure) as that of the atom in the physical sciences or the gene in the biological sciences. The pattern of relationships predicted by the current model is so distinctive that it is difficult to conceive how a theory would explicate the same findings without

Unfortunately, the present study has also pointed to the operation of another variable that is not encompassed by the a priori model. Closer examination of the Hayes (1989) hypothesis revealed that the amount of musical preparation, defined here as the difference between the age at first hit and that at first lessons, was inversely proportional to such criteria as the maximum output rate, lifetime productivity, and ultimate fame. Apparently, the greater the composer, as manifested in the adulthood career, the less time required to obtain the initial creative potential or domain-specific expertise. One might try to dismiss this negative correlation as the mere upshot of the association between musical and compositional preparation, given that the latter is predicted by theory to correlate negatively with the same outcome variables. But this account will not do inasmuch as musical preparation tends to be more strongly related to these criteria than is compositional preparation. A better interpretation, perhaps, is to draw upon a developmental reality frequently discussed in studies of giftedness. In the original conception of IQ, relative standing was viewed as the ratio of mental age to chronological age; a high-IQ child was then conceived as one who could master the broad domain of cultural information and skills at a far faster rate than a low-IQ child whose expertise acquisition was "retarded." This idea dominated Terman's (1925) classical longitudinal study of intellectually gifted children as well as Cox's (1926) retrospective analysis of 301 geniuses of history. Even today, after IQ has been standardized according to score distributions rather than a literal "intelligence quotient," the speed of information processing has been treated as a distinctive attribute of precocious children (e.g., Cohn, Carlson, & Jensen, 1985; Jensen, Cohn, & Cohn, 1989). Galton's (1883) old hypothesis that genius is at least in part a matter of being "quick witted" has modern counterparts (see also Vernon, 1987). This very cognitive quickness may imply a more rapid acquisition of creative potential and, accordingly, a richer supply of that potential as well—which is then actualized as prolific and influential output in adulthood.

No doubt, more empirical labors will be expended before one can settle on an explanation, and subsequent investigations must grapple with many other empirical issues besides this single question. Certainly, it would be advantageous to replicate the relationships on other disciplines besides science and music, especially on those artistic endeavors less abstract and formal than musical creativity tends to be. And it seems mandatory to examine gender differences, given that women made up only 1% of the scientists sample and 0% of the composers sample. But beyond replications, an effort must be made to widen even further the developmental scope of the analysis. Previously, it was suggested, for example, that research should discern the developmental factors behind career onset, choice of discipline, and the acquisition of creative potential (Simonton, 1991a), and the present inquiry has responded by introducing new variables, age at first lessons and age at first composition, that directly bear on two of these theoretically important variables. Yet, in a sense, the causal sequence has been pushed farther back without being pinned down. Although the onset of composition can legitimately be interpreted as a function of the onset of serious training in a specific domain, and thus age at first lesson made an exogenous influence, surely there must be events or circumstances that accelerate or delay the commitment to the mandated apprenticeship. Why did some rush to begin training as toddlers, whereas others procrastinated until their late teens? The earlier examination of 696 classical composers suggests one possibility, because creative precocity was then shown to be a positive function of the availability of suitable role models during a composer's early developmental period (Simonton, 1977b). Consequently, age at first lessons and the ensuing practice of composition might be inserted as intervening variables between having predecessors to emulate and the early start to a distinguished career. But many other childhood experiences are also likely candidates in this search for developmental antecedents (Simonton, 1987).

The final end of the quest would be a panoramic picture of the paths by which creative genius grows and prospers. Despite the apparent progress in tracing the overall course of creative preparation and production from birth to death, many details must be filled in to replace a sketch in pencil with a portrait in oil.

introducing latent variables that correspond closely with what are here styled initial creative potential and age at career onset (see Simonton, 1991a).

References

Barlow, H., & Morgenstern, S. (1948). *A dictionary of musical themes.* New York: Crown.

Barlow, H., & Morgenstern, S. (1976). *A dictionary of opera and song themes* (rev. ed.). New York: Crown.

Blom, E. (Ed.). (1966). *Grove's dictionary of music and musicians* (10 vols., 5th ed.). New York: St. Martin's Press.

Brannigan, A. (1981). *The social basis of scientific discoveries.* Cambridge, England: Cambridge University Press.

Cohn, S. J., Carlson, J. S., & Jensen, A. R. (1985). Speed of information processing in academically gifted youths. *Personality and Individual Differences, 6,* 621–629.

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

Encyclopaedia Britannica. (1974, 15th ed., 30 vols.). Chicago: Encyclopaedia Britannica.

Farnsworth, P. R. (1969). *The social psychology of music* (2nd ed.). Ames: Iowa State University Press.

Feldman, D. (1986). *Nature's gambit.* New York: Basic Books.

Galton, F. (1874). *English men of science.* London: Macmillan.

Galton, F. (1883). *Inquiries into human faculty and its development.* London: Macmillan.

Gardner, H. (1985). *Frames of mind.* New York: Basic Books.

Gilder, E., & Port, J. G. (1978). *The dictionary of composers and their music.* New York: Ballantine.

Gruber, H. E., & Davis, S. N. (1988). Inching our way up Mount Olympus: The evolving-systems approach to creative thinking. In R. J. Sternberg (Ed.), *The nature of creativity* (pp. 243–270). Cambridge, England: Cambridge University Press.

Halsey, R. S. (1976). *Classical music recordings for home and library.* Chicago: American Library Association.

Hayes, J. R. (1989). *The complete problem solver* (2nd ed.). Hillsdale, NJ: Erlbaum.

Holton, G. (1973). *Thematic origins of modern science.* Cambridge, MA: Harvard University Press.

Illing, R. (1963). *Pergamon dictionary of musicians and music* (Vol. 1). New York: Pergamon Press.

Jensen, A. R., Cohn, S. J., & Cohn, C. M. G. (1989). Speed of information processing in academically gifted youths and their siblings. *Personality and Individual Differences, 10,* 29–34.

Kuhn, T. S. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago: University of Chicago Press.

Moles, A. (1966). *Information theory and esthetic perception* (J. E. Cohen, Trans). Urbana: University of Illinois Press. (Original work published 1958)

Over, R. (1989). Age and scholarly impact. *Psychology and Aging, 4,* 222–225.

Raskin, E. A. (1936). Comparison of scientific and literary ability: A biographical study of eminent scientists and men of letters of the nineteenth century. *Journal of Abnormal and Social Psychology, 31,* 20–35.

Sadie, S. (Ed.). (1980). *The new Grove dictionary of music and musicians* (20 vols.). London: Macmillan.

Sainsbury, J. S. (Ed.). (1966). *A dictionary of musicians from the earliest times.* New York: Da Capo Press.

Scholes, P. A. (Ed.). (1955). *The Oxford companion to music* (9th ed.). London: Oxford University Press.

Simon, H. A. (1986). What we know about the creative process. In R. L. Kuhn (Ed.), *Frontiers in creative and innovative management* (pp. 3–20). Cambridge, MA: Ballinger.

Simon, H. A., & Chase, W. G. (1973). Skill in chess. *Scientific American, 61,* 394–403.

Simonton, D. K. (1976). Biographical determinants of achieved eminence: A multivariate approach to the Cox data. *Journal of Personality and Social Psychology, 33,* 218–226.

Simonton, D. K. (1977a). Creative productivity, age, and stress: A biographical time-series analysis of 10 classical composers. *Journal of Personality and Social Psychology, 35,* 791–804.

Simonton, D. K. (1977b). Eminence, creativity, and geographic marginality: A recursive structural equation model. *Journal of Personality and Social Psychology, 35,* 805–816.

Simonton, D. K. (1980). Thematic fame, melodic originality, and musical zeitgeist: A biographical and transhistorical content analysis. *Journal of Personality and Social Psychology, 39,* 972–983.

Simonton, D. K. (1984a). Creative productivity and age: A mathematical model based on a two-step cognitive process. *Developmental Review, 4,* 77–111.

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

Simonton, D. K. (1985). Quality, quantity, and age: The careers of 10 distinguished psychologists. *International Journal of Aging and Human Development, 21,* 241–254.

Simonton, D. K. (1986). Aesthetic success in classical music: A computer analysis of 1,935 compositions. *Empirical Studies of the Arts, 4,* 1–17.

Simonton, D. K. (1987). Developmental antecedents of achieved eminence. *Annals of Child Development, 5,* 131–169.

Simonton, D. K. (1988a). Age and outstanding achievement: What do we know after a century of research? *Psychological Bulletin, 104,* 251–267.

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

Simonton, D. K. (1989a). Age and creative productivity: Nonlinear estimation of an information-processing model. *International Journal of Aging and Human Development, 29,* 23–37.

Simonton, D. K. (1989b). The swan-song phenomenon: Last-works effects for 172 classical composers. *Psychology and Aging, 4,* 42–47.

Simonton, D. K. (1990). *Psychology, science, and history.* New Haven, CT: Yale University Press.

Simonton, D. K. (1991a). Career landmarks in science: Individual differences and interdisciplinary contrasts. *Developmental Psychology, 27,* 119–130.

Simonton, D. K. (1991b). Latent-variable models of posthumous reputation: A quest for Galton's *G. Journal of Personality and Social Psychology, 60,* 607–619.

Simonton, D. K. (in press). The leaders of American psychology, 1879–1967: Career development, creative output, and professional achievement. *Journal of Personality and Social Psychology.*

Slonimsky, N. (Ed.). (1956). *The international cyclopedia of music and musicians* (7th ed., rev.). New York: Dodd, Mead.

Slonimsky, N. (Ed.). (1958). *Baker's biographical dictionary of musicians* (5th ed.). New York: Schirmer.

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

Vernon, P. A. (Ed.). (1987). *Speed of information-processing and intelligence.* Norwood, NJ: Ablex.

Wallach, M. A. (1985). Creativity testing and giftedness. In F. D. Horowitz & M. O'Brien (Eds.), *The gifted and talented* (pp. 99–123). Washington, DC: American Psychological Association.

Zusne, L. (1976). Age and achievement in psychology: The harmonic mean as a model. *American Psychologist, 31,* 805–807.

Received October 5, 1990
Revision received December 20, 1990
Accepted January 10, 1991 ■