

INTERDISCIPLINARY CREATIVITY OVER HISTORICAL TIME: A CORRELATIONAL ANALYSIS OF GENERATIONAL FLUCTUATIONS

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The interdisciplinary relationships among 15 kinds of creative achievement were examined over 130 generations of European history (controlling for linear, quadratic, and cubic time trends). A P-technique factor analysis located 3 major interdisciplinary clusters: (a) discursive (science, philosophy, literature, and music), (b) presentational (painting, sculpture, and architecture), and (c) rationalism-mysticism (physical science and general philosophy vs. religion and painting). A cross-lagged correlation analysis then indicated that minor discursive creators tended to inhibit the development of minor presentational creators in the next generation. Personological, interpersonal, and sociocultural explanations for the findings were discussed.

Keywords: interdisciplinary creativity, generational fluctuations, changes over time, correlational analysis.

McGuire (1973) has recently proposed that social psychology should expand its stock of research stools to include archival analyses (also see Webb et al., 1966). One reason for doing so, he argues, is that quasiexperimental designs such as cross-lagged correlation analysis have advanced to the point of permitting causal inferences from nonexperimental data (see Campbell & Stanley, 1966, p. 70; Kenny, 1973; Pelz & Andrews, 1964; Rozelle & Campbell, 1969). Though McGuire is currently working on an extensive project which may apply such techniques to archival data (personal communication, January 11, 1974), to date there appears little research in this vein (cf. Donley & Winter, 1970; McClelland, 1961, chapter 4). Hence in the present paper we attempt to respond to McGuire's recommendation by treating a substantive issue which (a) requires the use of archival data and (b) permits the employment of cross-lagged correlation analysis. The substantive interest is the interrelationships among creative individuals in various disciplines. For example, are the humanities and the sciences really two cultural traditions (cf. Snow, 1960)? Do major religious movements arise when creativity in other areas declines (cf. Toynbee, 1946)?

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More specifically, are science and religion antagonistic on both personological and socio-cultural levels (cf. Sorokin, 1957). Past research concerning the varieties of creativity and their social interconnections has tended to stress either personality traits or the characteristics of the creative product (cf., Cattell, 1963; Cox, 1926; Hudson, 1966; Koestler, 1964; Langer, 1942; MacKinnon, 1962; Roe, 1952; Schaefer & Anastasi, 1968). Here we will attack this problem from a different angle by asking two questions: (a) What types of creators are most likely to be contemporaries and (b) are there any causal influences between interdisciplinary clusters from one generation to the next?

METHOD

SAMPLE AND UNIT DEFINITION

Using a large number of histories, anthologies, and biographical dictionaries, a sample of over 5000 creative individuals and anonymous creative products was drawn which ranged over European history from 700 B.C. to 1899 A.D. The sampling procedure was basically that of Kroeber (1944), whose work also comprised one of the main resources (further details in Simonton, 1974). These individuals and products were then assigned to consecutive 20-year periods called "generations" (cf. Marias, 1968; Ortega y Gasset, 1962). The assignment of the individuals was based on the "peak productive age", that is, either the fortieth year after birth (cf. Dennis, 1966; Gray, 1966; Kroeber, 1944; Lehman, 1953; Simonton, 1975) or, if the birth date was unknown, the 25th year prior to the death date (cf. Cox, 1926, p. 36). So in all there are 130 generations, which is the sample size for statistical purposes.

FIELD DEFINITIONS

Using the foregoing units of analysis, 15 creativity measures were constructed in the following disciplines: Physical science, biological science, miscellaneous science, general philosophy, religion, miscellaneous philosophy, poetic literature prose literature, miscellaneous literature, painting, sculpture, architecture, miscellaneous art, musical composition, and miscellaneous music (detailed definitions in Simonton, 1974, chap. 2). The miscellaneous categories were used to handle those individuals or anonymous products which did not fit into the other categories as defined. An individual was tallied into more than one field if eminence was in fact achieved in more than one.

WEIGHTED AND UNWEIGHTED MEASURES

For each of the 15 categories of creativity two separate measures were created, unweighted and weighted. The unweighted measures were made by tallying individual creators or anonymous creations but once in any given generation. In other words, this measure concentrates only on pure quantity of creators composing each generation regardless of differences in

quality or eminence (i.e., primarily “minor” creators). The weighted measures were made by tallying individuals or anonymous creations more than once in any given generation according to achieved eminence. Achieved eminence was objectively determined by the number of citations in the source materials and similar criteria (details in Gray, 1958, 1966; Simonton, 1974; cf. Sorokin, 1957, pp. 232-234). Presumably the weighted measure estimates both quality and quantity of creativity from one generation to another (i.e., mostly “major” creators).

CONTROL VARIABLE TIME

All the variables tended to highly correlate due to a trend which was a linear, quadratic, and cubic function of time. Therefore, in order to examine the immediate generational fluctuations rather than any gross movements, that time trend was partialled out by (a) numbering the generations to produce the variable “time”, (b) squaring and cubing time to produce the variables “time squared” and “time cubed”, and (c) partialing out these three control variables from the inter-correlations among all 30 creativity measures, thus producing detrended data (full rationale in Simonton, 1974, chapter 2; also see Webb et al., 1966, pp. 52-57).

DATA QUALITY CHECKS

The reliability of the present data was checked against comparable measures compiled by Sorokin (1937). While some adjustments were often necessary due to different unit and field definitions, the following Spearman rank-order reliabilities can be reported (Simonton, 1974, chapter 2): Unweighted measures of physical science and biological science 0.87 and 0.93, respectively (for both $N = 26$, $p < .01$), combined weighted measures of philosophy and religion 0.71 ($N = 25$, $p < .01$), unweighted measures of painting and sculpture combined 0.76 ($N = 8$, $p < .05$), and unweighted measure of musical composition 0.60 ($N = 20$, $p < .01$). Thus, in all instances where some comparison was possible, Sorokin’s measures were all highly correlated with those of the present study.

RESULTS

FACTOR ANALYSIS

Both the weighted and the unweighted measures were subjected to a P-technique factor analysis (Cattell, 1953, 1966; Cattell & Adelson, 1951; Gorsuch, 1974, pp. 277-279). The program used provided principal factoring with iteration of the communality estimates (Nie et al., 1970). Only those factors with eigenvalues greater than 1 were rotated; a varimax rather than oblimax rotation was used since an orthogonal rotation seemed to have the simplest factor structure and interpretability (cf. Harman, 1967, p. 98). Table 1 shows the rotated factor matrix for the unweighted measures, Table 2 that for the weighted measures.

TABLE 1
ROTATED FACTOR MATRIX: UNWEIGHTED CREATIVITY MEASURES

<i>Variables</i>	<i>Factors</i>				
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>
Physical science	0.932	-0.017	-0.010	0.164	-0.211
Biological science	0.626	0.314	0.130	0.182	-0.049
Miscellaneous science	0.038	0.756	-0.090	-0.286	0.018
General philosophy	0.349	0.230	0.065	0.138	-0.552
Religion	0.068	0.090	-0.038	0.086	0.384
Miscellaneous philosophy	-0.130	-0.181	0.110	0.080	-0.040
Poetic literature	0.741	-0.106	-0.046	-0.126	0.070
Prose literature	0.910	-0.034	0.012	0.113	-0.100
Miscellaneous literature	0.970	-0.104	-0.027	-0.195	0.062
Painting	-0.099	-0.066	0.391	0.256	0.573
Sculpture	0.220	-0.152	0.689	0.233	0.026
Architecture	-0.039	0.066	0.505	-0.182	-0.005
Miscellaneous art	-0.175	0.506	0.069	-0.047	-0.038
Musical composition	0.276	-0.172	0.019	0.742	0.114
Miscellaneous music	-0.158	-0.166	-0.022	0.475	0.082
Percent of explained variance	49.9	21.4	11.6	9.2	7.9

TABLE 2
ROTATED FACTOR MATRIX: WEIGHTED CREATIVITY MEASURES

<i>Variables</i>	<i>Factors</i>				
	<i>I</i>	<i>II</i>	<i>III</i>	<i>IV</i>	<i>V</i>
Physical science	0.319	-0.241	0.035	0.158	0.319
Biological science	0.777	-0.009	-0.013	-0.085	-0.086
Miscellaneous science	0.502	0.088	-0.137	0.160	0.059
General philosophy	0.264	0.082	-0.095	-0.026	0.483
Religion	0.153	0.101	0.061	-0.036	-0.531
Miscellaneous philosophy	0.023	0.500	0.007	-0.018	0.004
Poetic literature	0.274	-0.086	0.063	0.762	0.082
Prose literature	0.930	-0.085	-0.162	0.302	0.083
Miscellaneous literature	0.571	0.009	-0.212	0.560	0.034
Painting	-0.010	0.210	0.630	0.108	-0.288
Sculpture	-0.020	0.489	0.426	-0.029	0.039
Architecture	-0.070	0.700	0.104	-0.031	-0.138
Miscellaneous art	0.011	-0.029	-0.217	-0.195	0.130
Musical composition	0.586	-0.182	0.025	0.402	0.087
Miscellaneous music	-0.176	-0.000	0.539	-0.081	0.051
Percent of explained variance	49.9	21.1	11.8	9.0	7.3

Rather than examine each separately it seems better to compare the two for any consistent results as follows:

(1) Both factor analyses extracted five orthogonal factors. For the unweighted measure the first factor consisted of physical science, biological science, general philosophy, poetic, prose, and miscellaneous literatures, and musical composition. For the unweighted measure the first factor is the same except for the addition of miscellaneous science.

(2) Both analyses extracted another factor consisting of the major visual arts. Thus the third factor of the unweighted measure consists of painting, sculpture, and architecture, while the second factor of the weighted measure consists of the same three fields with miscellaneous philosophy added.

(3) The fifth and last factor for both measures is also similar, if all the factor loadings of 1 have their signs reversed. This bipolar factor consists of physical science and general philosophy with positive factor loadings and religion and painting with negative loadings.

(4) Beyond the foregoing three factors there appear no factors which are shared by both weighted and unweighted measures. Thus for the unweighted measures in Table 1: (a) the second factor consists of miscellaneous science and miscellaneous art, and (b) the fourth factor consists of both types of musical activity. In contrast, for the weighted measures in Table 2: (a) the third factor consists of painting, sculpture, and miscellaneous music, and (b) the fourth factor consists of the three forms of literature plus musical composition.

The factor consisting primarily of physical and biological science, general philosophy, the three literatures, and musical composition appears similar to Langer's (1942) notion of "discursive" communications, whereas the factor consisting mainly of painting, sculpture, and architecture seems similar to her idea of "presentational" communications. Moreover, the bipolar factor consisting of physical science and general philosophy versus religion and painting seems interpretable as a "rationalism-mysticism" dimension (cf. Sorokin, 1957). For convenience let us retain these three designations for the major factors.

CROSS-LAGGED CORRELATION ANALYSIS

The final step in the analysis is to examine the causal associations among the major interdisciplinary clusters. In particular, we will focus on the causal relations between discursive and presentational clusters since these two factors replicated across both weighted and unweighted measures. The rationalism-mysticism factor was excluded since it contains disciplines already in the other two factors, a fact which confounds the causal associations beyond interpretation. Finally, to enhance the clarity of interpretation, miscellaneous science was excluded from the discursive factor and miscellaneous philosophy from the presentational factor since neither of these two disciplines associated with their respective clusters across both weighted and unweighted measures. In any case, the discursive and presentational clusters were defined by simple unweighted summation of the unstandardized values for their component disciplines, and then subjected to a cross-lagged correlation analysis using a special Fortran program called PANEL (Kenny, 1974). The appropriate test for cross-lagged correlation analysis is the Pearson-Filon test (Kenny, 1974), and the critical value of z used

here was set at 1.960, or a .05 level of confidence. Of the six possible cross-lagged comparisons among the weighted and unweighted measures of discursive and presentational creativity, only one met the assigned critical value: it is shown in Figure 1.

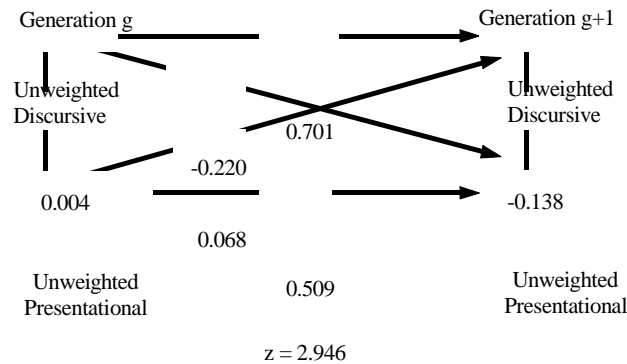


Figure 1: Cross-lagged correlation analysis of the causal relationship between minor discursive and presentational creators.

The two “synchronous” correlations (i.e., 0.004 and -0.138) appear to be either zero or slightly negative, while both measures exhibit strong autocorrelations between generations g and g+1. Most important, however, are the cross-lagged correlations: the correlation from the unweighted discursive factor at generation g to the presentational factor at generation g+1 is strongly negative, whereas the correlation from the unweighted presentational factor at generation g to the discursive factor at generation g+1 is essentially zero if not slightly positive. Moreover, the difference between these two cross-lagged correlations is significant at the .01 level of confidence. Therefore, the inference is that unweighted discursive creativity has an inhibitory effect one generation later on unweighted presentational creativity (see Kenny, 1973; Pelz & Andrews, 1964; Rozelle & Campbell, 1969). Transposed into more individual terms, minor discursive creators appear to discourage the emergence of minor presentational creators in the next generation.

DISCUSSION

Although we do not know what sociopsychological processes may underlie the present findings, four possibilities can be stated for the purpose of further research. First, the clustering of creators into different factors may reflect two independent interdisciplinary of interpersonal communication networks. For instance, because scientists, philosophers, poets, and even, to some extent at least, musicians, all employ “discursive” writing as a communicative medium, creativity in any one discipline may encourage creative activity in others; a similar

mutual-stimulation network may hold for visual artists. Second, there may exist personological grounds for some of the factors, such as the rationalism-mysticism bipolar factor. Thus physical scientists and philosophers may have personality traits diametrically opposed to those of painters and religious leaders (cf. Sorokin, 1957). Third, sociocultural variables may also be involved; that is, different political, economic, or cultural conditions may support different kinds of creativity, such as discursive and presentational (cf. Naroll et al., 1971; Simonton, 1974, chapter 3). Fourth, and finally, creativity may also entail intergenerational processes such as role-modeling. For example, the negative impact of discursive on presentational creativity may imply a negative recruitment process where scientists, philosophers, literators, and musicians are, in comparison with painters, sculptors, and architects, better able to attract successors from the next generation. All four of these possibilities deserve further research.

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