UC Irvine
UC Irvine Previously Published Works

Title
Growth of Western Civilization: Epicyclical or Exponential?

Permalink
https://escholarship.org/uc/item/0dg7g4d7

Journal
American Anthropologist, 81(4)

ISSN
0002-7294

Authors
TAAGEPERA, REIN
COLBY, BENJAMIN N

Publication Date
1979-12-01

DOI
10.1525/aa.1979.81.4.02a00130

Peer reviewed

eScholarship.org Powered by the California Digital Library
University of California

Growth of Western Civilization: Epicyclical or Exponential?

REIN TAAGEPERA
BENJAMIN N. COLBY
University of California, Irvine

In a series of papers inspired by Kroeber's *Configurations of Culture Growth* (1944), Edward Gray presents some quantified indices of creativity that he relates to the rise and decline of Graeco-Roman and more recent European civilizations. Creativity is measured by grading philosophers, painters, sculptors, poets, dramatists, and other writers on an evaluational scale derived from the commentaries of historians and classical scholars. He also presents an epicyclical model with different economic and political cycles moving in concord or discord. Thus, one cycle might decline while another rises, or all cycles might rise or decline in harmony. For example the "developed" and "florescent" stages of all the Graeco-Roman cycles coincide twice. These are the Periclean and Alexandrian Museum periods, both generally considered high points of Greek creative civilization.

Gray then examines the course of modern Western civilization with the same type of epicyclical model. His overall economic cycle begins with a guild system, moves into a mercantile, industrial, and finally a monopolistic economic system. Superimposed on this cycle are two social cycles and four political cycles. Creativity for the political period that he calls the Developed Imperialist State is somewhat higher than would have been "predicted" by the regularity of his model, but the other peaks of empirical data seem to fit his model.

Though a number of negative comments have been published in the *AA* (Di Pietro 1973; Winfree 1974) concerning Gray's attempt to quantify creativity, they have been directed at the issue of whether creativity is measurable and, if so, whether Gray's measuring techniques are suitable. We tentatively accept Gray's admittedly crude measure of creativity (with qualifications that need not be mentioned here), but raise a more fundamental question. The neatly cyclical creativity curve that Gray (1966) presents for Western civilization is an artifact resulting from improper plotting technique.

Gray uses *unequal* time intervals for counting creative persons; then he plots the histogram of periods (which now are shown to be equal) without correcting for inequality of periods. Not surprisingly, relatively short periods show relatively few creative persons. It so happens that Gray tends to pick shorter periods when he expects little creativity, and longer periods when he expects a peak (see Table I). By subdividing his peak periods and lumping his valley periods, one could obtain any pattern one wants.

The proper (i.e., unarbitrary) way to plot Gray's interesting data is, of course, first to calculate the average creativity per year, by dividing the number of creativity points by the number of years in the interval. When these values (also shown in Table I) are plotted against time (see Figure 1), they show not cycles but an accelerating increase. In order to test whether this increase tends to follow the exponential pattern, the same data are replotted on semilog paper where exponential curves appear as straight lines (see Figure 2). The pattern, indeed, can be approximated by a straight line (on semilog paper), corresponding to the equation

$$C = 0.7\, e^{0.006\,(t\,-\,1000)} \qquad (1)$$

where C is creativity (number per year of creative persons of classes 1 to 7, weighted by relative importance), t is time in years A.D., and e is the basis of natural logarithms. The "rate constant" of 0.006 per year expresses the relative rate of increase in creativity over time: on the average, Gray's creativity index has grown by 0.6% per year since 850 A.D. The constants are purposely given with one-place precision only, because data reproducibility is not likely to warrant more precision. Linear correlation r^2 is visibly over .90, a feature that is common (and thus of little interest) in time series (in contrast to a set of mutually independent data points).

Once the general exponential trend has been accounted for, we can start looking for possible systematic deviations of the actual curve from the trend line. The only peaks clearly above the trend line (in Figure 2) occur around1400–1620, and possibly 1850–70 and 1890–1910; the latter are questionable because it is often hard to bracket the creative period of a genius with 20 years' precision. The only valleys clearly below the trend line occur in 1150–1400, 1650–1790, and possibly 1870–90 (again with reservations regarding 20 years' precision).

The peaks and valleys hypothesized (and found) by Gray are shown respectively by upward and downward arrows in Figure 2. The expected 850–1000 valley is actually seen to be a

TABLE 1. EVOLUTION OF GRAY'S CREATIVITY POINTS.

Period[a] (years A.D.)	Creativity Points[b]	Gray's Hypothesis[c]	Period Duration (years)	Creativity Points per year	C from Eq. 1[d]	Relative Difference (%)[e]
850-1000	84	V	150	0.56	0.45	+25
1000-1150	115		150	0.77	1.1	−30
1150-1350	886	P	200	4.4	3.1	+40
1350-1400	189	V	50	3.8	6.6	−43
1400-1500	1496		100	15.0	10.4	+44
1500-1620	3823	P	120	32	20	+59
1620-1715	3310		95	35	38	−10
1715-1765	1847	V	50	37	59	−38
1765-1790	1431	V	25	57	74	−23
1790-1815	1986		25	79	86	− 9
1815-1850	3533	P	35	101	103	− 2
1850-1870	2972		20	148	122	+21
1870-1890	2283	V	20	114	137	−17
1890-1910	4308	P	20	215	155	+39
1910-1935	2464		25	99	177	−44

[a] As chosen by Gray (1966:Figure 2).
[b] Number of creators weighted by magnitude (classes 1 to 7), as defined and measured by Gray (1966: Figure 2).
[c] P = expected creativity peak; V = expected "valley," by Gray (1966: Figure 1).
[d] At midpoint of the period.
[e] (Creativity points per year − C)/C × 100%.

productive period (compared with the general trend). The 1150-1350 salient peak in Gray's own plot (1966, Figure 2) may be caused by the long interval he chooses; it is largely a period of average creativity unless it can be shown that most creativity happened in the beginning of this long period. The valley of 1350-1400 may be real, unless it is a statistical fluctuation due to taking a 50-year period during an age where Gray otherwise deals in 100-to-200-year periods. The Renaissance peak, which Gray sees as beginning in 1500, actually begins in 1400. The 1715-90 valley is confirmed by Gray's data whereas the 1815-50 peak is not—but here we get into excessively short periods.

The same conclusions can be drawn from inspection of Table I, by comparing the peaks and valleys hypothesized by Gray with the actual deviations from the exponential trend, as shown in the "Relative Difference" column. What may look to the untrained eye like a vaguely cyclical alternation of "+" and "−" signs (respectively indicating peaks and valleys), is actually typical of random variation around a well-fitted trend curve.

When Gray's top-rated creators (his classes 5 to 7) or top-and-middle-rated ones (classes 3 to 7) alone are plotted, the pattern in Figure 2 is not altered. In particular, peak and valley positions do not change. Furthermore, the rate constant 0.6% remains valid. This means that in Gray's data the ratio of top creators and next-to-top creators remains the same throughout 850-1950.

Our conclusion is that Gray's own data fail to support his grand epicyclical hypothesis of Western civilization, once the artifactual treatment is eliminated. The same applies to Gray's earlier study (1958) of Graeco-Roman development, in which data are plotted in two ways: a histogram not normalized for unequal time periods but at least graphically showing the periods to be of uneven duration, and a correct histogram showing the creativity per half-century close to each other (Gray 1958: Figures 6 and 7). The latter plot shows only two peaks close to each other (instead of the postulated four), and one of them occurs in a postulated "formative" nonpeak stage. The rising part (950-400 B.C.) of the curve (not shown here) can be approximated by

$$C = 0.02e^{0.010\,(880\,-\,t)} \qquad (2)$$

where t is in years B.C. The deadline phase (400 B.C.-400 A.D.) is more irregular.

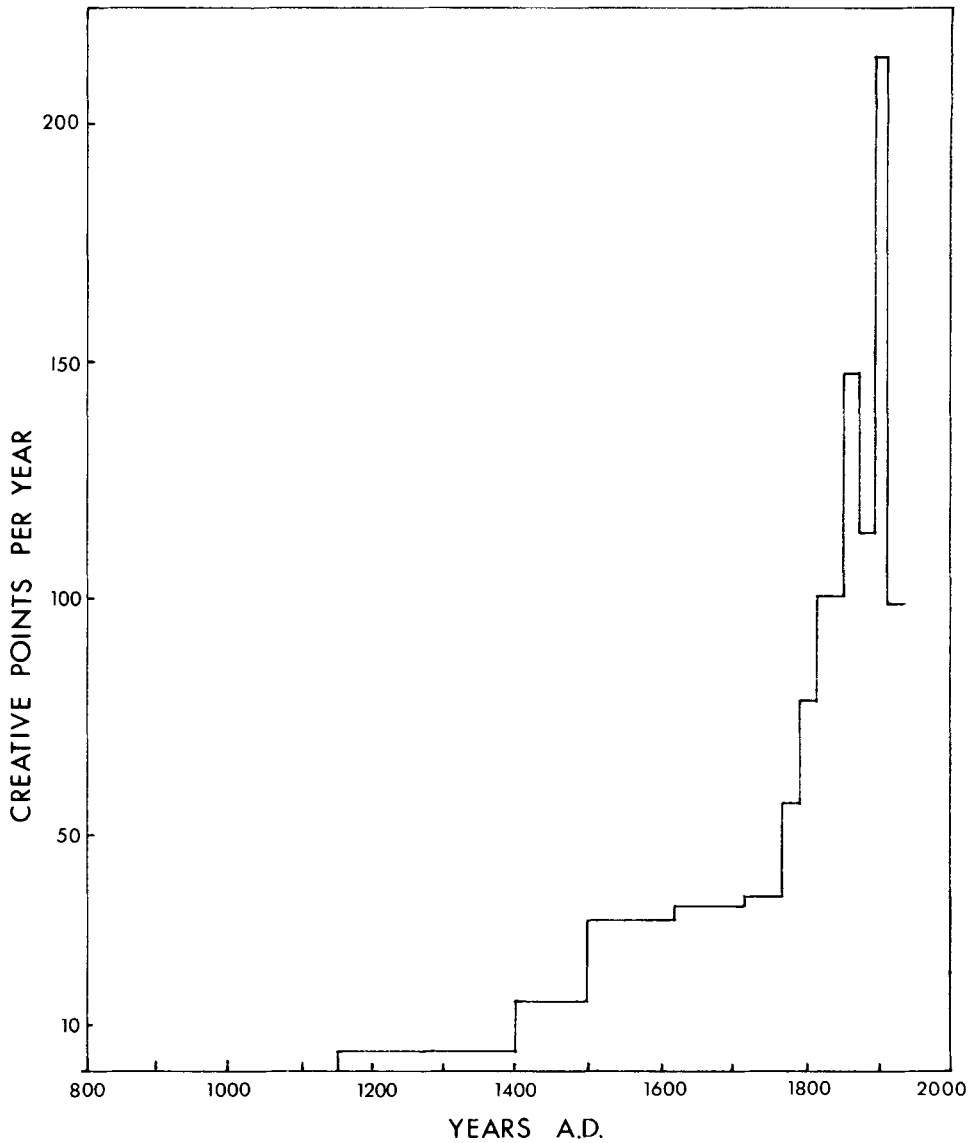

Fig. 1. Creativity in Western civilizations vs. time. Data from Gray (1966:Figure 2, Classes 1-7).

Studies of the growth and decline of civilizations are still in their infancy. A natural history of civilizations should do much to increase our understanding of cultural mechanisms and evolutionary process. To do that we must not let mistaken notions of cultural teleology influence the handling of the data.

The data compiled by Gray may be of great interest and value. The regular exponential growth in the creativity recorded is not likely to be an artifact of Gray's method of data collection, since he visibly does not use exponential analysis. The deviations from the general trend indicate empirically the periods of observed low or high creativity, and thus increase our insight into cultural history.

A major question remains: what do the observed data regularities mean? expansion of individual creativity? or population increase? or gradual loss of information from ancient times?

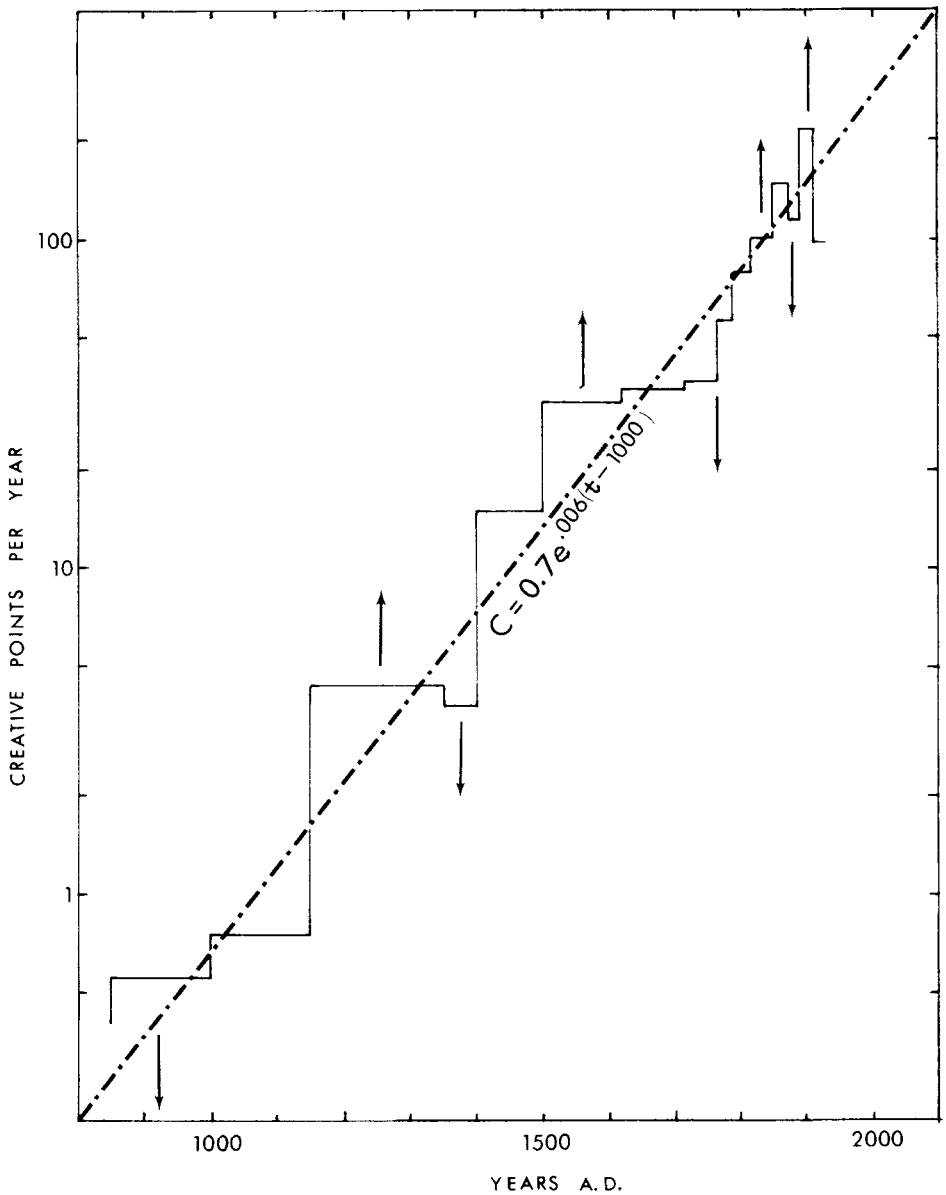

Fig. 2. Western creativity on logarithmic scale. Same data as in Figure 1. Arrows indicate peak and valley position postulated by Gray.

or our discounting of ancient achievements as less relevant, even if we have the information?

Dividing the *C* values from Equation 1 by population estimates reported by Durand (1977) on the basis of Clark (1968) for Europe, European U.S.S.R., and (since 1750) the Americas and Oceania, we get the following index of creativity per year and per one million population:

1000	1200	1500	1750	1900	A.D.
.02	.04	.20	.42	.28	

If Gray's data truly reflect creativity, then it would seem that Western *per capita* creativity

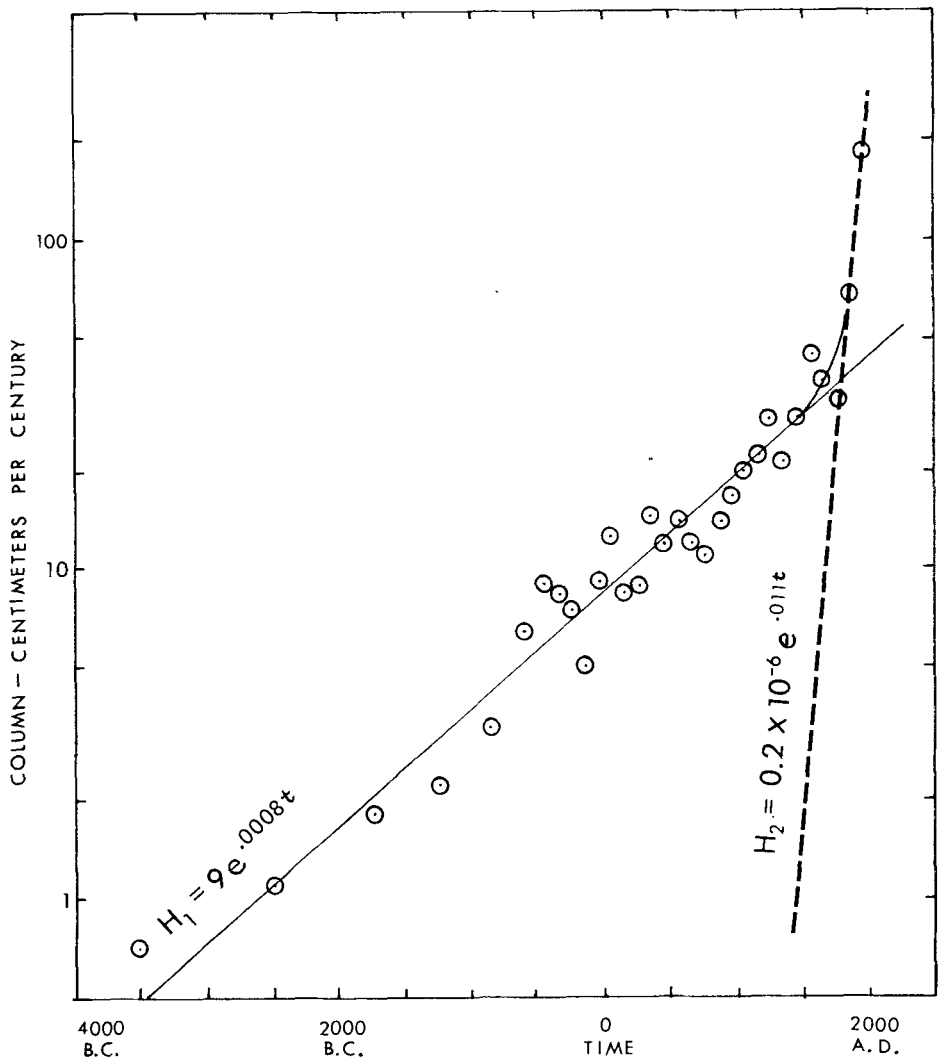

Fig. 3. The discount rate of history in CBS News Almanac 1978 Outline of World History.

peaked two centuries ago, at least as far as recognized creativity is concerned. The population overcrowding may actually lead to an inflation of geniuses, with potential creators often finding their ideas already published by someone else a few years earlier (Taagepera 1979).

However, it is highly likely that the apparent increase in creativity is due largely to the general fading of past history in our minds. Figure 3 shows an example not involving creativity: the number of column-centimeters spent per century of history by a brief outline of world history in a popular almanac (CBS 1978: 787–807). Clearly past history is gradually discounted in our minds, and not only for lack of information. The more recent a historical period is, the more importance it has for us.

The "fading curve" of history in Figure 3 could be expressed as a sum of two exponential terms:

$$H = 9e^{0.0008t} + 0.2 \times 10^{-6} e^{0.011t} \quad (3)$$

where t is time in years A.D., and H is the relative extent of coverage given to a century.

The second term expresses the steep drop in coverage during the most recent centuries, while the first term expresses the slower decrease for the past beyond 1500 A.D. On the whole, Gray's Western creativity index drops off much more steeply than the world history coverage in Figure 3. One thousand years ago the creativity index was down to 1/400 of the present one, a drop that the world history curve reached only 6,000 years ago. The relatively salient new records in coverage around 600 B.C. and 1500 A.D. coincide with steep increases in empire size (Taagepera 1978).

These observations raise further questions: Do all treatises of world history use comparable fading rates? Do cultural, political, and social histories use different rates? Do regional and national histories use different rates? Was history discounted at the same rate in 1900 as it is now, or is our present-oriented society discounting ancient history at a steeper rate?

For having inspired these vistas, Gray should be honored even while his epicycles have to be discarded.

References Cited

CBS
1978 The CBS News Almanac, 1978. Maplewood, N.J.: Hammond Almanac, Inc.

Clark, Colin
1968 Population Growth and Land Use. New York: St. Martin's Press.

Di Pietro, Robert J.
1973 On Creativity. American Anthropologist 75:312-313.

Durand, John D.
1977 Historical Estimates of World Population: An Evaluation. Population and Development 3:253-296.

Gray, Charles E.
1958 An Analysis of Graeco-Roman Development; The Epicyclical Evolution of Graeco-Roman Civilization. American Anthropologist 60:13-31.
1966 A Measurement of Creativity in Western Civilization. American Anthropologist 68:1,384-1,417.

Kroeber, A. L.
1944 Configurations of Culture Growth. Berkeley: University of California Press.

Taagepera, Rein
1978 Size and Duration of Empires: Systematics of Size. Social Science Research 7:108-127.
1979 People, Skills, and Resources: An Interaction Model for World Population Growth. Technological Forecasting and Social Change 13:13-30.

Winfree, R. Westwood
1974 A Comment on Gray's "Paradoxes in Western Creativity." American Anthropologist 76:340-341.

Submitted 25 August 1978
Accepted 19 April 1979
Revised version received 11 May 1979
Final revisions received 31 May 1979