DEATH COMES AS THE END – EFFECTS OF CESSATION OF PERSONAL INFLUENCE UPON RATES OF CITATION OF ASTRONOMICAL PAPERS

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An attempt is made to investigate the extent to which direct, personal influence on students, colleagues, and mentors affects the frequency with which a scientist's papers are cited by others working in his field. The method used is an analysis of changes in citation rate between 1965 and 1984 to papers written over their entire careers by an index group of astronomers who died between 1969 and 1982. These citation histories are compared to those of papers written over the same period by a control group of astronomers who were still active at the end of 1984. Only papers written during the lifetimes of the index astronomers are considered.

The data show signs that the death of a scientist is followed by a few-year "sympathy period", during which citation rates rise, and then by a decade or more of gradual forgetfulness, during which citation rates drop off faster than those to papers written during the same period by living astronomers. The amounts of the rise and decline suggest that about 40% of astronomical citations are mediated by personal influence.

1. INTRODUCTION

Most of us believe that the frequency with which a scientific paper is cited depends primarily upon how useful it is to other workers in the field. Most of us also suspect, however (especially when our own papers go uncited), that there are other factors, related to where, when, and by whom the paper is published. One of these factors is direct, personal influence on mentors, colleagues, and students with whom the author communicates. Rao and Vahia [1] have gone so far as to suggest that this personal influence factor may be sufficiently important to account for the rough proportionality that exists between the number of authors of an astronomical paper and the number of times it is cited [2]. Along the same lines, the fact that astronomers typically write their most-cited papers between the ages of 50 and 60 [3] has been attributed by Woltjer [4] to the peaking of personal influence (in the form of directorships, editorships, chairmanships, etc.) during that decade.

The intent here is to probe the effect of personal influence on citation rates. The method is a comparison of the citation histories of papers written by 34 astronomers who died between 1969 and 1982 to the citation histories of papers written by a control group still active in astronomy at the end of 1984. The control individuals were matched as nearly as possible to the index ones in subdiscipline, gender, country of employment, and (most important) year in which career began. This last is important, because average citation rates to astronomical papers peak 5 yr after publication and decline monotonically, and roughly linearly, thereafter, with a half-life near 20 yr [5]. The death dates for the sample were constrained at one end by the appearance of the first cumulative issue of Science Citation Index including astronomical papers (1965–69) and, at the other end, by the time needed for the astronomical community to be aware of the death when writing papers published in 1984.

The usable sample is not very large, leading to a preliminary conclusion that investigations like this require a larger population (or an older one!) than the world's 7000 research astronomers (median age about 40) to achieve great statistical significance.

2. THE DATA

Nearly 200 members of the International Astronomical Union (whose Bulletin contains a semi-annual necrology) died between 1969 and 1982. Many of them, however, had retired from scientific activities long before; others had devoted most of their later attention to science education, administration, or policy matters, and so had ceased to publish research-oriented papers; and few, though active to the last, had begun their carers so early in the 20th century that no living individual could serve as a suitable control. As a result, the final sample consists of only 34 astronomers who died with their observing boots well polished and who were still being cited with some regularity in 1984. All but two members of the sample appeared as sole or senior of two or more cited papers published less than three years before death (and, in some cases several years after death, owing to the long lead times involved).

For each member of the sample, a control individual was chosen from among the membership of the IAU at the time the index individual died. The control sample is necessary to establish the rate at which citations to papers should drop off with time when the author remains normally influential. Thus first priority was given to matching the year of first published cited paper for index and control astronomers. These agree to within ± 1 year in all cases. Next priority went to matching subdisciplines (theory vs. observation; solar, planetary, stellar, and extragalactic studies, etc.). There were 26 good matches, 4 fair ones, and 4 poor. Gender matched in all but one case. Finally, an effort was made to choose control individuals whose careers took place largely in the same place as the sample individuals' (USSR; UK; continental Europe; USA/Canada; developing countries; early work in Europe followed by migration to USA; etc.). Here there were 22 good matches, 8 fair ones (e.g. US vs. Europe emigrated to US), and 4 poor ones. In only three cases was the match "fair" or "poor" in more than one parameter.

For each index individual, the data consist of the numbers of citations during the periods 1965—1969, 1970—74, 1975—79, and 1984 to papers of which he was sole or senior author, excluding obvious self-citations but including all identifiable variants of the name. There were 23,905 citations, an average of 703 per person (high 5279, low 68) and 43·9 per person per year. This is very close to the 1982 average citation rate of 41·4/yr for randomly-chosen members of the American Astronomical Society [6].

For each control individual, only those citations to papers written before the corresponding sample member ended his active career were counted, for the same periods and again excluding self-citations. There were 31,891 citations, an average of 938 per person (high 2325, low 217) and 58·6 per person per year. This is very close to the 1982 average rate of 54·4/yr for officers of the AAS [6].

It is worth noting that the control astronomers have a 33% higher average citation rate than the sample ones. This is an artifact of how the groups were chosen. The index astronomers automatically identified themselves by dying. But members of the control group had to be conspicuous enough to be readily identifyable in IAU membership lists as working in the same subdiscipline etc. as the corresponding index people. The effects of this difference should be removed by the statistical method described in the next section.

Table I presents only the raw data, which was fairly difficult to extract but fairly easy to analyze. It can be used to check the conclusions that follow or to test other hypotheses.

III. RESULTS AND DISCUSSION

The absolute citation rates range from 1—2 per person per year up to 360 and so are not readily interpretable except as measures of the enormous variability of scientists and science. What we want is a measure of how citation rates for the deceased astronomers have changed in comparison to those for the living ones.

Table 1

Numbers of citations 1965–79, 1984 to papers by index (deceased) and control (living) astronomers

date of death	index/*control* astronomers	first/last paper	numbers of citations 1965—69	1970—74	1975—79	1984
Oct 1968	Wrubel	1948	57	38	19	1
	King	1966	*105*	*111*	*300*	66
Nov 1969	Deutsch	1945	256	281	209	23
	Baum	1971	*158*	*162*	*118*	*23*
Feb 1970	Henyey	1937	157	138	117	12
	Schwarzschild	1972	*506*	*580*	*383*	*54*
Jul 1970	Bernas	1953	109	69	34	2
	Blamont	1970	*217*	*140*	*88*	*9*
Dec 1972	Cameron (R. C.)	1961	71	68	45	5
	Cowley (C. R.)	1972	*55*	*102*	*55*	*5*
Feb 1973	Bowen	1924	141	146	163	32
	Unsold	1973	*514*	*458*	*292*	*25*
Dec 1973	Hindmarsh	1954	38	141	142	6
	Pagel	1974	*176*	*230*	*176*	*5*
Jan 1974	Ferraro	1930	201	123	124	18
	Biermann (L.)	1972	*400*	*298*	*217*	*27*
Feb 1974	Zwicky	1923	415	776	712	105
	Luyten	1974	*224*	*172*	*263*	*53*
May 1975	Kiepenheuer	1934	120	104	78	3
	Goldberg (L.)	1975	*523*	*416*	*189*	*16*
Sep 1975	Kukarkin	1934	147	226	417	74
	Ambartsumyan	1976	*362*	*298*	*234*	*27*
Nov 1975	Pikelner	1947	240	347	224	19
	Shklovskii)*	1976	*779*	*750*	*438*	*52*
Jan 1976	Minkowski (R.)	1926	346	405	334	55
	Wilson (O. C.)	1975	*314*	*421*	*354*	*75*
Dec 1976	Menzel	1923	238	189	150	13
	Oort	1976	*489*	*661*	*576*	*104*
Apr 1977	Limber	1953	99	159	111	12
	Kraft	1976	*417*	*501*	*493*	*84*
Sep 1977	Huang (S. S.)	1937	157	215	248	32
	Kopal	1977	*953*	*561*	*711*	*100*
Nov 1977	Chalonge	1934	61	55	49	8
	Whitford	1976	*102*	*147*	*203*	*25*
Feb 1978	Thackeray	1933	168	244	258	51
	Stromgren (B.)	1978	*356*	*349*	*224*	*28*
Mar 1978	Lallemand	1935	83	73	39	7
	Kron (G. E.)	1976	*176*	*224*	*310*	*30*
Jun 1978	Kaplan (S. A.)	1945	190	337	352	41
	Sobolev	1979	*408*	*602*	*491*	*84*
Apr 1979	McCuskey	1938	64	80	95	11
	Popper	1976	*139*	*140*	*246*	*24*

Table 1 (continued)

date of death	index/*control* astronomer	first/last paper	numbers of citations 1965—69	1970—74	1975—79	1984
Sep 1979	Syrovatskii	1953	111	215	316	43
	Ivanov (V. V.)	1980	*110*	*248*	*329*	*28*
Dec 1979	Payne-Gaposchkin	1925	103	134	205	38
	McCrea	1977	*188*	*201*	*274*	*35*
Mar 1980	Myerscough	1962	27	23	17	1
	Jordan (C.)	1972	*62*	*278*	*402*	*46*
Apr 1980	Bullard	1930	367	641	528	75
	Cowling	1978	*417*	*297*	*270*	*42*
Apr 1980	Johnson (H. L.)	1947	1422	1777	1794	286
	Code	1980	*125*	*271*	*406*	*51*
Dec 1980	Wyatt	1950	30	23	41	10
	McNamara	1977	*121*	*97*	*100*	*5*
Mar 1981	Mueller (R. F.)	1960	144	178	152	22
	Anders	1978	*467*	*544*	*804*	*51*
May 1981	Tinsley	1967	11	86	464	69
	Trimble	1981	*28*	*187*	*311*	*66*
Oct 1981	Serkowski	1956	99	235	382	48
	Low	1980	*343*	*571*	*337*	*29*
Dec 1981	Whelan	1970	0	31	89	20
	Pringle	1979	*0*	*119*	*449*	*57*
Feb 1982	Neyman (J.)	1923	374	331	471	56
	Opik)*	1980	*461*	*503*	*382*	*38*
Aug 1982	Bappu	1951	30	48	38	18
	Blanco (V. M.)	1981	*121*	*236*	*363*	*56*
Nov 1982	Linfoot	1943	141	100	104	25
	Gascoigne	1972	*116*	*133*	*126*	*17*

*) *Since deceased.*

The relevant parameter is a double ratio: number of citations in 1984 to papers by deceased astronomer divided by number in last quinquennium he lived through (e.g. 1970—74), divided in turn by the same 1984 to 1970—74 (e.g.) ratio for papers published by the control, living astronomer during the active career of the deceased one. Independent of absolute numbers of citations, this ratio should be unity if death does not affect the influence of one's previous research, greater than unity if there is some sort of sympathy factor, and less than unity if the removal of the effect of personal contact diminishes scientific influence.

Let us call this double ratio R. It ranges from 0·03 to 4·88 with a median value of 0·86 for the 34 astronomers considered. The striking result emerges when we consider R for astronomers who ceased work in different years. Among the eight who stopped publishing before 1974, R's < 1 outnumber R's > 1 by 7 to 1. For the group who died between 1974 and 1978, R's of less than one again lead by 11 to 4, but among the 11 astronomers who ceased work most recently (1979—82), there are 9 R's > 1 and only 2 smaller ones. The medians for the three groups are 0·65, 0·87, and 1·45. One's impression is of a brief outburst of sympathy, followed by gradual forgetting of the deceased's contributions, at least in comparison with those of similar but still active astronomers. A "sympathy period" can also be identified for the first two groups,

who died between 1969 and 1978. An analysis like the present one carried out in the quinquennia immediately following their deaths would have found R's greater than unity leading by 5 to 3 in the first group and 9 to 6 in the second.

A number of colleagues with whom these results have been discussed have claimed that they are exactly what one expects in the wake of death — a brief period of memory and sympathy, followed by gradual forgetfulness. They are probably right, and perhaps the main lesson is that there is a lot of human nature in all of us.

The amounts by which the median R's for the various groups deviate from 1·0 suggest that about 40% of astronomical citations may be mediated by some degreee of personal influence. Rao and Vahia [1] reach a rather similar conclusion, using a very different data base and method.

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