Using Search Engine Count Estimates as Indicators of Academic Impact: A Web-based Replication of Haggbloom *et al.*'s (2002) Study

Matthias Spörrle[1,*] and Andranik Tumasjan[2]

[1]*University of Applied Management (UAM), Am Bahnhof 2, D-85435 Erding, Germany*

[2]*Technische Universität München, Leopoldstr. 139, D-80804 München, Germany*

Abstract: Using a complex set of quantitative and qualitative indicators of scientific importance, Haggbloom *et al.* [1] compiled a ranking of the most eminent psychologists of the 20th century. The present study set out to replicate this rank-ordered list using simple search engine count estimates (SECEs) obtained from three popular internet search engines. In line with our expectations, our results revealed a small, but significant relationship between SECEs and the existing offline ranking when the query specified the scientist's field of research (i.e., psychology). Our results imply that SECEs may be considered easy to apply indicators of a researcher's impact.

Keywords: Scientometrics, internet, search engines, impact, scientific eminence, psychologist.

INTRODUCTION

The Internet is not only a powerful means of communication and information distribution, but also constitutes a significant resource for scientific analysis. Especially in the social sciences, web-based research has led to a variety of new data collection methods that make use of the novel technological features and possibilities of the Internet [2-4], analyze already existing content of web pages [5-7]; or use a combination of both [8]. For instance, Norenzayan *et al*. [6] reasoned that the popularity of certain folk tales would be reflected by the number of their mentions on web pages. Accordingly, the authors used page counts of the search engine *Google* as an indicator of the pervasiveness of these folk tales. As expected, when surveying the folk tales' pervasiveness offline (i.e., assessing participants' familiarity with these folk tales in a paper-and-pencil survey) the authors found high convergence of online and offline indicators of folktale popularity. Such findings indicate that the popularity of certain ideas in the "real world" might be also reflected by frequency indicators based on internet content [see also 9].

Applying this argument to the realm of scientific impact (e.g., the academic popularity of certain researchers' ideas) it can be plausibly assumed that the influence of scholars may also be validly estimated by examining internet content. Accordingly, a relatively new field of research measuring scientific impact using Internet indicators has emerged over the past years [10-17]. Webometric research traditionally used hyperlinks (analogously to offline citation bibliometrics) as indicators of scientific impact [cf. 18, 19], but recently also started to develop and apply more innovative measures of scientific eminence (such as the frequency of visits or downloads from academic sites, the number of files in academic sites' repositories or the number of pages of an academic site indexed by search engines; cf. [20]). For instance, Bagrow and ben-Avraham [21] examined the fame distribution of scientists and other groups (e.g., runners, programmers, actors) finding that the underlying *Google* data do not always allow for clear conclusions regarding the nature of the distribution (e.g., power-law function).

Consistent with these recent developments [22-24], Janetzko [25] has recently enhanced our methodological understanding of web-based research by examining the objectivity, reliability, and validity of search engine count estimates (SECEs; i.e., the number of results or "hits" one receives upon entering a search term in an internet search engine) for a number of concepts. Overall his findings demonstrate that these three classical goodness criteria can be considered satisfactory to good for SECEs. The present article builds on the previous work by applying the method of SECEs to the measurement of the scientific eminence of psychologists as reflected on the internet. In line with previous research, we argue that the frequency of a scientist's name on the internet (measured by search engine page counts) should to some extent reflect her/his scientific impact captured by traditional indicators (e.g., reputation among peer scientists). In order to test this assumption, we apply the SECEs method to the measurement of scientific eminence in our own discipline (i.e., psychology) as a first step. In particular, in order to validate our results against complex traditional indicators of scientific impact, the present study aims at replicating a rank-ordered list of the most eminent psychologists of the 20th century developed by Haggbloom *et al.* [1]. In the following, we describe the ranking procedure as well as the indicators of scientific eminence used in Haggbloom *et al*.'s [1] study.

Retrospectively appraising notable contributions to the field of psychology, Haggbloom *et al*. [1] compiled a list of the 100 most eminent psychologists of the 20th century (al-

*Address correspondence to this author at the University of Applied Management (UAM), Am Bahnhof 2, D-85435 Erding, Germany;
Tel: +49 (8122) 955 948 0; Fax: +49 (8122) 955 948 49;
E-mail: matthias.spoerrle@fham.de

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though they report only the first 99). The authors used three quantitative and three qualitative indicators of eminence to create their rank-ordered list. The quantitative indicators comprise the following measures. First, a journal citation frequency indicator was used adding citation frequencies across four previously published citation lists. Second, an introductory textbook citation frequency list was constructed using three lists. Third, a survey was mailed to the members of the American Psychological Association (APA) asking them to name the "greatest psychologists of the 20th century" in their opinion. The authors' qualitative indicators consisted of the following dichotomous variables: (1) election to the National Academy of Sciences, (2) recipient of the APA Distinguished Scientific Contributions Award or elected APA president (as of 1999), or both, and (3) existence of the scientist's surname as an eponym (e.g., Kelley's attribution theory). All six indicators were then used to calculate an elaborate composite score for each psychologist resulting in the final rank-ordered list [1]. Although it can be argued that this list is biased toward American psychologists (as Haggbloom *et al*. point out themselves), we argue that it is valid to use this list as reference data for our analyses for three reasons. First, even though the list might be biased toward American researchers, it is by no means restricted to them. For instance, just to name a few, Jean Piaget, Sigmund Freud, Kurt Lewin, Ivan Pavlov, Walter Mischel, John Bowlby, Konrad Lorenz, Alfred Adler, and Lev Vygotsky can be found on the list, too (cf. Appendix).

Second, science in general and psychological science in particular, is largely dominated by American researchers, especially in the second half of the 20th century (even in today's scientific market with increased competition, especially from Asian countries, North America still produces more than 30% of the world's scientific publications) [cf. 26, 27]. Thus, Haggbloom *et al*.'s [1] list can be considered to represent a substantial share of the worldwide scientific psychological community, since a large proportion of psychological science output in the 20th century was produced by scientists from North American institutions.

Third, we argue that it is implausible to assume that the basic relationship between SECEs and scientific impact as measured by offline indicators would change if one used a rank-ordered list of psychologists from other countries or if one used other languages. We posit that the more impact a scientist has on the internet, the more eminent he/she will be as measured by other indicators, independent of country of origin and language. Thus, this basic association should be robust no matter whether one examines American psychologists and an English language query or Chinese psychologists and a Chinese language query (if anything, examining scientists from American institutions should be relatively more valid than other approaches, as English is the most important language in science [28] as well as on the internet [29]).

The goal of the present study was to replicate Haggbloom *et al*.'s [1] rank-ordered list that was compiled based on complex offline resources by simply applying SECEs as indicators of scientific eminence. By doing so we provide first evidence that SECEs can be used as a simple indicator of scientific relevance.

METHOD

Search Engines

We used three search engines to correct for possible biases and establish a more reliable indicator of internet frequency. The web services were chosen to meet two criteria: (1) Frequent usage within the Internet community and (2) relatively high levels of independence from each other thus reducing the overlap of the search results. Three search engines that met these criteria were selected (Janetzko, 2008): *Google* (www.google.com), *Yahoo* (www.yahoo.com), and *MSN* (www.msn.com).

Search Queries

Three different types of internet search engine queries for the $N = 99$ psychologists' names were used: (1) first name and surname (e.g., Albert Bandura), (2) first name and surname and the word "psychology" (e.g., Albert Bandura psychology), and (3) first name and surname and the word "psychologist" (e.g., Albert Bandura psychologist). Note that the search queries including only the name might very well obtain a large number of web pages which have nothing to do with the psychologist of that name (especially in cases, in which the psychologist has a quite common name, e.g., George Miller). Adding the words "psychology" or "psychologist" was assumed to increase the probability that the internet pages retrieved will actually refer to the famous psychologist.

The queries were entered without further restrictions (e.g., no phrase search) to ensure that all websites on which the first name, the surname, and "psychology" or "psychologist" are mentioned together (no matter in which conjunction) are taken into account. Otherwise results would have been limited to pages where the strings "first name surname psychology/psychologist" are mentioned together in form of coherent phrases.

Procedure

The query was done automatically by using a self-written internet spider. All queries were submitted at five times between April and May 2007. Even though this period of time is a few years after the data collection of our reference work of Haggbloom *et al*. [1] we think that – given the time it takes to build or abolish scientific reputation – our data should still to some extent reflect their ranking.

RESULTS

The absolute frequencies (i.e., the SECEs) obtained by the internet spider were ranked in order to correct for extreme values and non-normal distribution as well as to allow for the computation of parametric correlation coefficients (for details on the application of parametric correlation coefficients on rank transformed data see [30]). Overall, the three internet search engines' rankings revealed high convergence across the three types of search query. All computed correlations between the search engines' rankings for each type of query ranged between $r = .92$ and $r = .98$. Thus, in line with existing evidence all three search engines produced similar rankings for the SECEs [cf. 25]. Moreover, the five meas-

Table 1. Correlations Between Haggbloom *et al.*'s [1] Ranking and Rankings for the Three Types of SECEs for all Three Search Engines and Their Mean Averages

Indicator	First Name + Surname[2]				First Name + Surname + Psychology[3]				First Name + Surname + Psychologist[4]			
	Google	MSN	Yahoo	Mean Ranking	Google	MSN	Yahoo	Mean Ranking	Google	MSN	Yahoo	Mean Ranking
Haggbloom *et al.*'s ranking[1]	.10	.12	.10	.10	.18	.26*	.22*	.20*	.18	.29*	.26*	.21*

* $p < .05$ (two-tailed).

[1] Haggbloom *et al.*'s [1] rank-ordered list of the 100 most eminent psychologists of the 20th century.

[2] Replicated SECEs-based rank-ordered list (averaged across three search engines) based on query of scientists' first name and surname (e.g., Albert Bandura).

[3] Replicated SECEs-based rank-ordered list (averaged across three search engines) based on query of scientists' first name and surname and the word "psychology" (e.g., Albert Bandura psychology).

[4] Replicated SECEs-based rank-ordered list (averaged across three search engines) based on query of scientists' first name and surname and the word "psychologist" (e.g., Albert Bandura psychologist).

urement replications revealed a highly reliable rank order for each of the three search engines (ICCs were between .98 and 1.00). Therefore all five measurements were mean averaged for each of the three search engines in order to form three overall internet rankings for the three types of search query.

Subsequently, we computed correlation coefficients between Haggbloom *et al.*'s [1] ranking and the rankings that resulted from the three types of query (see Appendix A for Haggbloom *et al.*'s ranking and Appendices B-D for all SECEs based rank-ordered lists). As can be seen from Table **1**, simply querying for a scientist's name resulted in positive but non-significant correlation coefficients ($.10 < r < .12$). However, significant correlations in line with our expectations emerged when querying for a scientist's name in combination with his/her scientific discipline (i.e., psychology; $.18 < r < .26$, $p < .05$) or his/her profession (i.e., psychologist; $.18 < r < .29$, $p < .05$). Hence, the present results indicate that our ranking procedure based on simple SECEs is reliable and that the resulting rank-ordered list is significantly associated with the respective offline criterion of scientific eminence (i.e., the ranking provided by Haggbloom *et al.*). Comparing the correlations between the three different kinds of search query indicates that specifying the field of research/profession increases the relationship between the SECEs ranking and Haggbloom *et al.*'s [1] offline ranking, thus indicating that the SECEs indicator's predictive validity can be improved when the scientist's field is also specified in the query.

Even though the correlations based on SECEs data which include the author's scientific field resulted in significant relationships with Haggbloom *et al.*'s [1] list, these correlations are of a small to moderate effect size at best [cf. 31]. Therefore, we performed an exploratory examination of the obtained rankings to find possible explanations for this comparatively weak association. Examining the ranking data clearly indicates that rare names are actually ranked remarkably accurately by the SECEs-based approach (e.g., the difference between the ranking of Haggbloom *et al.* and the internet ranking based on the name together with the word "psychology" for Hobart Mowrer and Herman Witkin was smaller than 5 ranks). In contrast, for names consisting of very frequent first names and surnames, relatively large discrepancies were observed. For instance, for James Gibson, Allen Edwards, John Dewey, and John Garcia the difference was larger than 70 ranks (in all of these cases the SECEs-based rank was substantially higher than the Haggbloom *et al.* indicator). In these four cases the first name as well as the surname is extremely common and sometimes even several well-known persons of the same name exist (e.g., within the English edition of Wikipedia there are currently [May 2011] more than fifteen entries on persons called James Gibson). Simply removing these four cases from the analysis resulted in a substantial increase of the mean ranking correlation with the offline indicator from $r = .20$, $p < .05$, to $r = .30$, $p < .005$. Thus, this analysis suggests that especially the common names lead to a decrease of the validity of the SECEs-based indicator.

DISCUSSION

This research aimed at investigating the use of search engine count estimates (SECEs) as indicators of scientific reputation by comparing the SECEs obtained from specific queries with a ranking from a highly sophisticated offline index of scientific eminence from the field of psychology [1].

Our results indicate that the rankings based on SECEs are positively and significantly associated with Haggbloom *et al.*'s [1] offline ranking. Additionally specifying the scientific field (i.e., psychology) or the profession (i.e., psychologist) of an author query both resulted in a considerably higher relationship than querying only the author's first name and surname. This finding indicates that webometrics research examining the impact of scientists might be well-advised to integrate general descriptors of the scientist's field in the search query in order to increase the validity of this approach.

Although we were able to detect significant positive correlations between the SECEs-based indicators and Haggbloom *et al.*'s [1] elaborate offline measure in line with our predictions, these relationships were small. We suggest two explanations for this result. First, our exploratory data analysis indicates that especially queries of common first names and surnames reduce the associations between the two indi-

cators, since these common names generally receive very high frequencies (even when words such as "psychology" are included) independent from the scientific status of the researcher. Removing just a few cases with combinations of extremely common names resulted in substantial increases of the relationship between the online and the offline indicators. A second potential explanation for the relatively weak associations lies within the data itself. The 99 authors queried are all very influential psychologists. Given the thousands of psychologists working in academic settings – in 1972 the total membership of the APA, the largest organization of psychologists in the United States, was more than 35,000 [32] – our small sample can only be regarded as the very top section of psychological scientists. Therefore, compared to the total population of academic psychologists, the psychologists of our sample may very well be considered as being very close to each other in terms of their substantial scientific eminence. Keeping this potential ceiling effect in mind, the medium-sized correlations obtained in this study seem to be rather promising. Even when examining only this small group of only the highest ranking psychologists, simple and easily obtainable SECEs are significantly associated with the authors' scientific eminence.

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Preliminary analyses of these data were presented in a poster session at the 29th International Congress of Psychology 2008, Berlin, Germany [see 33].

APPENDIX

Comparison of Haggbloom *et al.*'s [1] ranking with the ranking results based on the three SECEs

Scientist	Haggbloom *et al.*'s [1] Rank[1]	First Name + Surname + Psychology[2]	First Name + Surname + Psychology[3]	First Name + Surname + Psychologist[4]
Burrhus Skinner	1	33	25	24
Jean Piaget	2	34	21	20
Sigmund Freud	3	16	8	9
Albert Bandura	4	68	46	50
Leon Festinger	5	89	78	74
Carl Rogers	6	13	15	15
Stanley Schachter	7	72	74	79
Neal Miller	8	11	16	14
Edward Thorndike	9	61	59	59
Abraham Maslow	10	40	31	26
Gordon Allport	11	65	47	46
Erik Erikson	12	48	34	29
Hans Eysenck	13	86	69	69
William James	14	1	1	1
David McClelland	15	30	33	33
Raymond Cattell	16	85	77	75
John Watson	17	3	4	3
Kurt Lewin	18	47	36	36
Donald Hebb	19	77	81	77
George Miller	20	2	2	2
Clark Hull	21	21	28	28
Jerome Kagan	22	70	63	68
Carl Jung	23	19	10	13
Ivan Pavlov	24	55	57	57
Walter Mischel	25	92	93	95

Appendix. Contd….

Scientist	Haggbloom *et al.*'s [1] Rank[1]	First Name + Surname + Psychology[2]	First Name + Surname + Psychology[3]	First Name + Surname + Psychologist[4]
Harry Harlow	26	37	54	53
Joy Guilford	27	63	52	44
Jerome Bruner	28	58	44	45
Ernest Hilgard	29	93	88	90
Lawrence Kohlberg	30	67	56	54
Martin Seligman	31	43	30	31
Ulric Neisser	32	96	91	93
Donald Campbell	33	9	13	11
Roger Brown	34	4	5	5
Robert Zajonc	35	88	87	87
Endel Tulving	36	97	95	94
Herbert Simon	37	15	14	16
Noam Chomsky	38	14	17	19
Edward Jones	39	5	3	4
Charles Osgood	40	39	61	60
Solomon Asch	41	79	80	78
Gordon Bower	42	44	49	52
Harold Kelley	43	26	18	17
Roger Sperry	44	51	64	66
Edward Tolman	45	69	76	76
Stanley Milgram	46	62	42	40
Arthur Jensen	47	22	26	25
Lee Cronbach	48	78	55	51
John Bowlby	49	59	40	41
Wolfgang Kohler	50	52	73	81
David Wechsler	51	45	43	43
Stanley Stevens	52	17	22	21
Joseph Wolpe	53	66	94	92
Donald Broadbent	54	60	84	84
Roger Shepard	55	32	37	37
Michael Posner	56	25	29	32
Theodore Newcomb	57	71	83	82
Elizabeth Loftus	58	56	48	48
Paul Ekman	59	46	45	47
Robert Sternberg	60	36	27	30
Karl Lashley	61	83	86	88
Kenneth Spence	62	38	39	39
Morton Deutsch	63	41	50	49
Julian Rotter	64	87	97	97

Appendix. Contd….

Scientist	Haggbloom *et al.*'s [1] Rank[1]	First Name + Surname + Psychology[2]	First Name + Surname + Psychology[3]	First Name + Surname + Psychologist[4]
Konrad Lorenz	65	35	51	58
Benton Underwood	66	53	90	89
Alfred Adler	67	27	24	27
Michael Rutter	68	23	41	42
Alexander Luria	69	75	79	83
Eleanor Maccoby	70	95	92	91
Robert Plomin	71	90	85	85
Stanley Hall	72	8	6	7
Lewis Terman	73	82	75	72
Eleanor Gibson	74	31	38	38
Paul Meehl	75	91	89	86
Leonard Berkowitz	76	64	66	64
William Estes	77	24	35	35
Eliot Aronson	78	74	71	65
Irving Janis	79	57	67	67
Richard Lazarus	80	28	32	34
Gary Cannon	81	18	19	18
Allen Edwards	82	10	11	10
Lev Vygotsky	83	81	65	62
Robert Rosenthal	84	20	23	23
Milton Rokeach	85	98	96	96
John Garcia	86	6	9	8
James Gibson	87	7	7	6
David Rumelhart	88	84	72	80
Luis Thurston	89	50	82	71
Margarete Washburn	90	76	68	70
Robert Woodworth	91	49	70	73
Edwin Boring	92	54	62	63
John Dewey	93	12	12	12
Amos Tversky	94	80	60	61
Wilhelm Wundt	95	73	53	55
Herman Witkin	96	94	98	98
Mary Ainsworth	97	42	58	56
Hobart Mowrer	98	99	99	99
Anna Freud	99	29	20	22

[1] Haggbloom *et al.*'s [1] rank-ordered list of the 100 most eminent psychologists of the 20th century.
[2] Replicated SECEs-based rank-ordered list (averaged across three search engines) based on query of scientists' first name and surname (e.g., Albert Bandura).
[3] Replicated SECEs-based rank-ordered list (averaged across three search engines) based on query of scientists' first name and surname and the word "psychology" (e.g., Albert Bandura psychology).
[4] Replicated SECEs-based rank-ordered list (averaged across three search engines) based on query of scientists' first name and surname and the word "psychologist" (e.g., Albert Bandura psychologist).

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