
The Explosion of Knowledge, References, and Citations

Psychology's Unique Response to a Crisis

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The knowledge explosion has created enormous difficulties for researchers to be aware of, access, and process the volume of new literature. Electronic literature retrieval systems and specialization on narrow topics have been strategies used to cope with these problems. In this study, the authors examined the additional effects of the knowledge explosion on researchers' writing, referencing, and citing. Counts of references within sampled empirical journal articles in sociology, physics, biology, and experimental and social psychology revealed impacts of the knowledge explosion in all disciplines but the greatest effects within psychology. Detailed analyses indicated that substantial changes in the numbers of references and citations and in their format and use within the research article are psychology's unique response to the knowledge explosion.

The information explosion is upon us! In academia, the phenomenon has taken the form of a knowledge explosion. Estimates of its magnitude vary, but all leave the reader with the impression of a seemingly uncontrollable expansion of research literature. Price (1961) observed in the early 1950s that the scientific literature had been increasing exponentially. The number of abstracts published by the 12 leading publishers of secondary scientific information (the American Psychological Association [APA] is one of these) had increased from about 555,000 in 1957 to 2.24 million in 1977 and 3.7 million in 1997 (Kaser, 1998)! In psychology, publishers have subdivided journals, increased the number of issues per year of some journals, and added new multidisciplinary and specialized journals to an ever-increasing scientific literature. Thorngate (1990) estimated that psychologists were publishing articles "at the rate of about 100 per day, about one every 15 minutes" (p. 262).

The knowledge explosion has generated four problems for researchers who must monitor published articles for incremental new knowledge as the basis for their original research. The first problem is how a researcher is to maintain awareness of all the relevant new literature. This was soon addressed by electronic databases that indexed the published literature by bibliographic reference and citations (Garfield, 1955). Access to the literature became the second problem for researchers as libraries limited in space

and funds could no longer maintain holdings of all new journals. This problem is being addressed by libraries pooling resources and by increasing electronic availability of full-text journal articles. The third problem that researchers have had to face is reading and processing all of the new information. Within psychology, Thorngate (1990) predicted researchers would choose to read narrowly within their research interest, summaries rather than in-depth or complete works, current literature to the exclusion of the older classics, and primarily writings by famous persons or articles with catchy titles. Indeed, specialization has become commonplace in both teaching and research (Moghaddam, 1997).

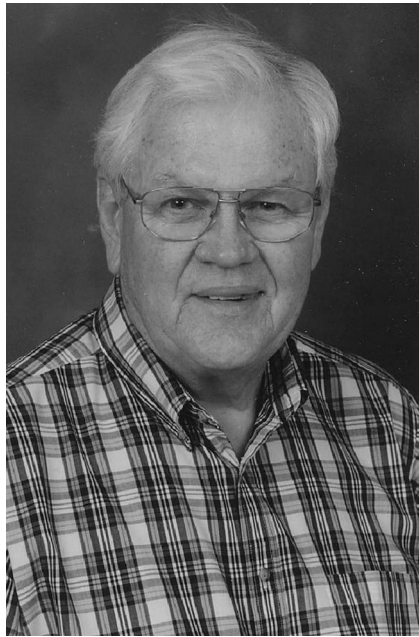
The fourth problem is how researchers can cope with the large volume of literature within their own writing. The prospect of a literature explosion leading to changes in the nature of research reports, especially in the number and form of cited references, has yet to be addressed. Two sets of data collected for entirely different purposes have provided preliminary evidence of changes in published psychological research. Vohra and Adair (1991) reported an expanding discrepancy emerging between developed and developing countries in the average number of references cited in research articles, resulting primarily from dramatic increases in the numbers of references cited by developed-world psychologists. Reis and Stiller (1992) found a striking threefold increase in the number of references per study in the *Journal of Personality and Social Psychology (JPSP)*

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over the previous three decades. The data from both studies suggested that the effects of the knowledge explosion extended beyond simply keeping up with the volume of literature to altering the format and text of new research articles.

In this article, we report data collected to assess psychology's response to the knowledge explosion in comparison with other disciplines. In Study 1, the reference practices in social psychology, experimental psychology, and three other disciplines were compared. In Study 2, detailed examinations of references and citations were undertaken on a smaller sample of articles in an attempt to understand the changes that have occurred in psychological research reports.

Study 1: Referencing Practices in Psychology and Other Disciplines

A Basic Understanding of Referencing Patterns

On the basis of statistical analyses of references in published research articles, Price (1965, 1986) projected that the average number of references within each article would be determined by the amount of prior literature and that this number should gradually rise as the amount of prior literature increases. Price (1965) concluded that the references cited would not be evenly distributed over the entire literature. Half of the citations¹ would be concentrated on references within the most recent five years, whereas the other half would be spread across the remaining previous literature. Citation of recent literature, called the *immediacy effect* or *Price Index*, represented the "research front," that is, references to articles from the cutting edge of the research topic. The immediacy effect was found to vary as a

function of the discipline's relative dependence on either the current or the classical literature.

Innes (1973) reported that within the *Journal of Experimental Psychology (JEP)* for the years 1945, 1955, and 1965, 40% of the references were to articles less than five years old. Xhignesse and Osgood (1967) observed in more than 20 different psychology journals that the proportion of citations to the current literature was large and had increased over the previous decade. Both of these data sets were from the periods well before the recent expansion in research literature.

Study 1 was undertaken to address basic questions about the scholarly response to the knowledge explosion over the past several decades. These data would enable us to determine whether the number of references per article continued to rise, the percentage of the referenced literature that was current had increased, the older research literature had begun to be ignored, and referencing differed in amount or pattern within subfields of psychology. To test whether changes in referencing practices were unique to psychology, we selected three distinctly different disciplines for comparative analysis.

Method

General procedure. References were counted within each sampled empirical article for the periods 1972–1974, 1978–1980, 1984–1986, 1990–1992, 1996–1998, and 2000. These dates and intervals were selected within the context of previous studies (J. G. Adair, Puhana, & Vohra, 1993; Vohra & Adair, 1991), extended through 1996–1998, and brought up to date by the inclusion of data for the year 2000. Brief reports, book reviews, editorials and commentaries, secondary analyses of data, and reviews of the literature were excluded from our analyses. The total number of references, the numbers of references that were current (within 5 years of the date of publication), and references that were older (20 or more years old) were recorded. For example, to determine the current references for a 1990 journal, 5 years were subtracted from the year of the journal, and all references dated from 1985 to 1990 and in-press articles were counted as current references. Older references for that same journal article would be 1990 minus 20, or articles dated 1970 or older. The data were collected by two raters, Neharika Vohra and an undergraduate assistant. Rare disagreements were resolved by recounts.

Psychology journals. References were counted within articles published in three social psychology journals: *JPSP*, the *Personality and Social Psychology Bulletin (PSPB)*, and the *Journal of Experimental Social Psychology (JESP)*. Data were collected from two additional social journals (*PSPB* and *JESP*) to test the generality of previous

¹ Although referencing someone and citing someone have been used interchangeably in the past to refer to the process of acknowledging priority credit to another, in the research to follow in this article a sharper distinction must be made between the references listed at the end of each article and the form in which these are presented as citations within the body of the text.



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findings within *JPSP* (Reis & Stiller, 1992). Comparable data were collected from empirical articles reporting on human research in *JEP*. After its division in the mid-1970s into four topical journals, only two of the journals—*JEP: Human Perception and Performance* and *JEP: Learning, Memory, and Cognition*—reported human experimental research. Those two journals were surveyed for this study. For purposes of continuity, rather than being reported separately, the data for these two journals were combined and reported as frequencies for *JEP*.

Journals from other disciplines. On the advice of university colleagues and on the basis of the journal impact measures found in the science and social science editions of *Journal Citation Reports* (1997), journals from sociology, biology, and physics were selected for counts of reference patterns: *American Sociological Review* (*ASR*), *Developmental Biology* (*DB*), and *Physical Review: Part B* (*PRB*). *ASR* predominantly publishes empirical research reports. *DB* is one of the premiere journals within biology. *PRB* publishes research in solid-state physics.

Procedures. Sampling procedures were devised to ensure the samples of articles would be random for each of the selected journals for each time period. Because of differences in the numbers of articles and subdivisions into topical sections in some journals, different sampling procedures were adopted for each journal. Each of these procedures was also designed to ensure that each sample size would be sufficient to yield stable values. Target sample sizes for each journal for each year were $n = 36$ for *JPSP*, *DB*, and *PRB*; $n = 24$ for *JEP*; and $n = 30$ for *PSPB* and *JESP*. For the latter two journals, the sample sizes summed over the three-year period were less than $n = 90$ because of a lesser number of articles published in some years. Hence, the sample sizes for *JESP* were $n = 85$ in 1990–1992 and

$n = 80$ in 1996–1998. Because *PSPB* only began publication in 1974, the sample size for the first time period was 30 articles. Within *ASR*, all empirical articles were surveyed, resulting in sample sizes of 112, 111, 108, 150, 135, and 34, respectively, across the six periods of data collection.

Results and Discussion

The reference explosion. The mean numbers of references per article for each time period for each sampled journal are reported in Table 1. Although data were collected for all journals for the year 2000, it seemed prudent to base interpretations of trends on the periods with stable three-year averages. The single trend that was striking by its consistency across all journals over the nearly three decades of published research was the systematic increase in the average number of references per article. The sole exception was the 1990–1992 mean for *ASR*. Across all journals, the dramatic consistency was undoubtedly due to a systematic variable that affected all disciplines: the ever-expanding amount of research available to reference that is characteristic of the knowledge explosion. However, it is not sufficient to conclude that there are more references today because there is more prior literature to cite.

Three distinct patterns emerged within the data. First, increases in referencing were most noticeable and far greater within psychology journals. Dividing the mean number of references per article in 1996–1998 by the mean number of references per article in 1972–1974 revealed an 8-fold increase in the average number of references per article in *PSPB*, nearly a 4-fold increase in *JEP*, a 3.2-fold increase in *JPSP*, and a 3.1-fold increase in *JESP*. The high rate of change in *PSPB* was additionally due to the journal's transformation from a publication for brief articles to one that publishes more substantial research reports. More-

Table 1
Mean Number of References per Article in Selected Journals in Psychology, Sociology, Biology, and Physics

Journal	Time period					2000
	1972–1974	1978–1980	1984–1986	1990–1992	1996–1998	
<i>JPSP</i>	18.0	27.8	33.4	44.1	56.8	66.6
<i>JESP</i>	15.2	20.3	30.2	34.5	46.7	45.4
<i>PSPB</i>	5.6	10.3	20.0	27.7	44.8	50.6
<i>JEP</i>	12.4	23.1	30.9	43.0	49.9	53.0
<i>ASR</i>	32.7	47.4	51.3	50.1	52.6	61.3
<i>DB</i>	28.1	31.3	34.9	42.3	47.6	53.2
<i>PRB</i>	26.6	28.2	30.2	31.0	38.0	33.9

Note. *JPSP* = *Journal of Personality and Social Psychology*; *JESP* = *Journal of Experimental Social Psychology*; *PSPB* = *Personality and Social Psychology Bulletin*; *JEP* = *Journal of Experimental Psychology*; *ASR* = *American Sociological Review*; *DB* = *Developmental Biology*; *PRB* = *Physical Review: Part B*. The sample sizes for all journals for each time period are reported in the *Method* section of Study 1.

over, the rates of increase over each time period were substantial. Within *JPSP*, for example, referencing increased in the range of 20% to 54% across each sampled time period. The journals from sociology, biology, and physics also increased 1.6-, 1.7-, and 1.4-fold, respectively. These lesser rates of increase were due, in part, to the higher rates of referencing already present in these journals by 1972–1974.

Second, referencing practices in biology and physics, although beginning at slightly higher levels than any of the psychology journals, showed only modest changes in referencing until more recent time periods. Increases in referencing in *PRB* were so modest as to be regarded as random fluctuations until the 1996–1998 period, when there was a substantial increase (22.6%). Within *DB*, referencing increased only about 11%–12% in most time periods until 1990–1992, when there was a 21.2% increase. The third pattern was that referencing in *ASR* was different from that in all the other journals. *ASR* started with the greatest number of references of the sampled journals; references in *ASR* then showed a 45% jump in 1978–1980 and leveled off with even a slight decline in 1990–1992.

The explanation for the contrasting levels of referencing in physics and in the social sciences may be found in the striking differences in their journal acceptance rates (Cole, 2000). Social science journals tend to reject three quarters or more of all submissions, whereas *Physics Review* accepts for publication about four out of every five submitted manuscripts. In addition, there are page charges for authors who publish in this journal, and more stringent publication norms likely contributed to the presence of fewer references as compared with the other journals in our study.

Within psychology, the impetus for increased referencing likely comes from its hypercritical manuscript review process oriented toward specifying reasons why a manuscript should be rejected rather than toward identifying contributions that merit its publication (Higgins, 1992). This reviewing style encourages authors to preempt criticisms and to promote their credibility with additional referencing (Madigan, Johnson, & Linton, 1995). Alternatively, Reis and Stiller (1992) have claimed that the increased referencing in *JPSP* was due to the greater complexity of more recent social psychological research, as documented by increases in the lengths of method sections and articles, in numbers of subjects per study, and in numbers of studies and references per article. However, the meaning of increased referencing as only a correlated finding is regarded to be unclear (West, Newsom, & Feinaughty, 1992) or more likely a regulatory problem of the editorial process than because of scientific advance (Higgins, 1992). More referencing also has become trendy, the thing to do after observing the referencing practices of others (West et al., 1992; Schneider, 1992).

Current references. The mean percentage of current references per article for each of the sampled journals is reported in the top half of Table 2. All of the journals in 1972–1974 and 1978–1980 and *PRB* and *DB* across all time periods conformed to Price's (1986) claim

Table 2
Mean Percentages per Article of References That Were Current^a and Older^b

Journal	Time period					
	1972–1974	1978–1980	1984–1986	1990–1992	1996–1998	2000
Current references						
<i>JPSP</i>	40.7	44.4	38.4	32.6	30.4	30.9
<i>JESP</i>	49.2	42.3	39.9	31.2	29.2	33.7
<i>PSPB</i>	56.8	47.1	42.1	31.2	27.3	24.4
<i>JEP</i>	59.7	46.1	37.4	33.9	29.1	31.2
<i>ASR</i>	37.0	41.9	36.0	31.2	29.1	27.1
<i>DB</i>	50.2	53.5	49.7	51.6	56.5	54.2
<i>PRB</i>	49.1	45.4	45.7	50.0	45.4	42.8
Older references						
<i>JPSP</i>	6.0	10.9	12.0	15.4	18.4	19.4
<i>JESP</i>	7.2	9.5	9.6	14.7	18.3	18.1
<i>PSPB</i>	4.1	6.1	10.0	13.8	16.6	18.9
<i>JEP</i>	4.4	9.8	8.9	16.1	19.7	19.5
<i>ASR</i>	9.8	10.8	12.6	18.2	18.5	18.4
<i>DB</i>	11.0	8.1	8.5	9.2	7.8	6.5
<i>PRB</i>	5.9	9.2	11.1	11.4	15.5	19.6

Note. *JPSP* = Journal of Personality and Social Psychology; *JESP* = Journal of Experimental Social Psychology; *PSPB* = Personality and Social Psychology Bulletin; *JEP* = Journal of Experimental Psychology; *ASR* = American Sociological Review; *DB* = Developmental Biology; *PRB* = Physical Review: Part B. The sample sizes for all journals for each time period are reported in the Method section of Study 1.

^a Current references = within 5 years of article publication date.

^b Older references = 20 or more years since the article was published.

that approximately 40% or more of all references would be to the current research that defines and provides the guiding direction for the research problem. But then, in the final three time periods, a consistent pattern of decreasing percentages of current references emerged among the four psychology journals and *ASR*. In all cases (*JPSP* = 31%; *PSPB* = 42%; *JESP* = 31%; *JEP* = 36.9%), the percentage of references to the current research literature in 1996–1998 had declined by approximately one third from its 1978–1980 levels.

The contrasts with physics (no change) and biology (5.6% increase) were dramatic. *PRB* and *DB* remained constant at about the level of referencing that Price (1986) had identified as typical of scientific research. Within a rapidly developing field such as biology, research is even more driven by current developments; hence, 50% or more of all the references in *DB* were to work published within the past five years.

The decline in the percentage of references to the current literature in psychology was an artifact of the increase in total references within each article. The absolute number of current studies referenced actually increased for most journals. For psychology journals, the increased

mean numbers were substantial: *JPSP* went from 12.3 in 1972–1974 to 17.2 in 1996–1998, *JESP* went from 8.6 to 13.7, *PSPB* went from 4.9 to 12.2, and *JEP* went from 10.4 to 15.3. Similar absolute increases in the current literature referenced were found in biology (16.7 to 26.8) and physics (from 12.8 to 17.3). It was only in the sociology journal (*ASR*) that the absolute numbers of current research references declined (from 19.9 to 15.3).

Older references. The percentages of references that were 20 or more years old are presented in the bottom half of Table 2. Totally contrary to expectations (Thorngate, 1990), for all journals except *DB*, the 1996–1998 data showed a substantially greater percentage of references to the older literature than did the 1972–1974 sample. For most of the journals (except 1984–1986 in *JEP*), these increases were systematic. In 1996–1998, for example, nearly one in every five references in *JEP* was to works published 20 or more years ago. The proportion of references that were older in *JPSP*, *JESP*, and *ASR* were nearly at the same level. Moreover, the magnitude of increase had been 4-fold in *JEP* and *PSPB* and more than 3-fold in *JPSP*. In physics, there was a 2.5-fold increase, but in biology, the trend, if any, had been in the opposite direction—a decline in the referencing of older literature.

Factors promoting the reference explosion. The fact that the reference explosion was minimally evident within physics suggested that an increase in the number of references per article had not been an inevitable consequence of the knowledge explosion nor of the technological advances available to scholars in all disciplines. In psychology, the rapid development and expansion of PsycLIT that provided ready access to potential references for psychologists throughout the 1990s may be a consideration, but other disciplines have developed similar databases. Word processing programs have made it possible to insert citations into the text at any time with little effort, but that is true for all authors. The reasons for both absolute and differential increases in referencing are manifold and require further research and analysis.

Study 2: A Closer Look at Referencing and Citing in Psychology Journals

The reasons for increasing references to older works within psychology articles were explored by more refined analysis of the dates of older references. In addition, the specific uses made of each reference were examined, through careful study of their citation within the body of the text, for clues to explain increased referencing. Variations in the number and pattern of citations over time could also provide evidence for systematic changes in the nature of research or style of writing. These were the objectives of Study 2.

Method

All of the analyses described below were based on data from subsamples of 30 articles per journal for each three-year time period randomly selected (10 articles per year) from the *JEP* and *JPSP* articles that had been included in Study 1.

Analysis of older references. To identify the primary sources of increases in older references, we made separate counts of the references that had just fallen into the category of older research, that is, 20–24 years old; that were truly old, that is, 30 or more years old; and that were in between, that is, 25–29 years old.

Citation analyses. Counts were made within the text of each article of the total number of citations and the numbers of both solitary (i.e., individual citations within parentheses) and batched-together or in-groups citations (i.e., two or more citations enclosed within a set of parentheses or presented in a series separated only by commas within a sentence). In addition, counts were made of the number of instances of solitary and in-groups citations. In making the latter counts, “(Smith, 1999; Smith & Brown, 1998; Smith & Jones, 1995),” for example, was counted as three in-groups citations but as one instance of an in-groups citation.

Results and Discussion

The overall mean numbers for the subsamples of total and older references per article, reported in Tables 3 and 4, varied somewhat from the original study results but were similar in their consistent increases over the years and in the levels they attained in 1996–1998.

Referencing and citing the older literature.

The pattern of older references in *JPSP*, presented in Table 3, was almost the mirror image of the pattern in *JEP*. Whereas the *JPSP* data showed a noticeable increase in the percentage of references to studies that were 30 or more years old, within *JEP*, the greatest increases, especially since 1990–1992, came from the research literature that had just turned 20 or more years old. These differences

Table 3

Mean Percentages of Older References in Subsamples of the Journal of Personality and Social Psychology and the Journal of Experimental Psychology

Years of publication	Time period				
	1972–1974	1978–1980	1984–1986	1990–1992	1996–1998
<i>Journal of Personality and Social Psychology</i>					
20+ years	5.5	9.4	11.3	15.2	19.8
20–24 years	2.8	4.6	4.3	5.4	5.9
25–29 years	0.5	2.0	3.0	3.7	3.7
30+ years	2.2	2.8	4.1	6.1	10.2
<i>Journal of Experimental Psychology</i>					
20+ years	4.5	11.4	10.0	15.7	21.1
20–24 years	1.6	3.7	2.9	5.7	9.8
25–29 years	0	2.5	1.4	4.8	5.5
30+ years	2.9	5.2	5.7	4.5	5.7

Note. $n = 30$ articles for each time period.

Table 4

Reference and Citation Means per Article for Subsamples of the Journal of Personality and Social Psychology and the Journal of Experimental Psychology

References/Nature of citations	Time period									
	1972–1974		1978–1980		1984–1986		1990–1992		1996–1998	
	M	%	M	%	M	%	M	%	M	%
<i>Journal of Personality and Social Psychology</i>										
References ^a	19		28		36		46		65.1	
Citations										
Total	29		47		59		74		116	
Solitary	15	50.7 ^b	23	49.0	28	47.0	33	45.0	44.1	38.0
In-groups	14	49.3	24	51.0	31	53.0	41	55.0	71.3	62.0
In-groups instances	5.3	26.8 ^c	9	28.0	11	29.0	14	30.0	24	35.0
<i>Journal of Experimental Psychology</i>										
References ^a	13		25		28		46		51.1	
Citations										
Total	23		48		54		96		111	
Solitary	12	52.0 ^b	26	53.0	27	50.0	38	40.0	43.1	39.0
In-groups	11	48.0	23	47.0	27	50.0	58	60.0	67.5	61.0
In-groups instances	5	29.2 ^c	8.7	25.0	10	28.0	18	32.0	23.2	35.0

^a Mean references based on subsamples of $n = 30$ differ from the means for the full samples reported in Table 1.

^b Calculated as the percentage of all citations (number of solitary + in-groups citations).

^c Calculated as the percentage of all instances of citations (number of solitary + in-groups instances).

were counter to the interpretation that increases in the percentage of references to older research were simply due to the greater amount of older literature available to cite.

A simple functional analysis of citations of older references in both journals over the most recent time period revealed that older citations were rarely used in an explicit historical manner (< 1% of the citations in both journals) and infrequently referred to an established methodology (12.6% of the citations in *JPSP* and 7.3% in *JEP*). Although citations of older references typically were used to document factual statements, these were often included as within-groups citations (55.5% in *JPSP* and 57.6% in *JEP*) and usually accompanied by citations to recent work to convey the thread of research activity across time or laboratories.

Numbers of citations. As evident in Table 4, substantial increases in the number of references were exceeded over the years by correspondingly large increases in the number of citations. Within *JEP*, the average has risen from 1.77 citations for every reference (23 citations per article) in 1972–1974 to 2.14 citations per reference (111 citations) in 1996–1998. In *JPSP*, the average number of citations per article rose from 29 to 116 over the same time period.

Solitary versus in-groups citations. From a pattern of primarily solitary citations in 1972–1974 (see Table 4), more than 60% of the citations in 1996–1998 were within groups. In *JPSP*, the average number of soli-

tary citations within each article increased threefold as compared with the fivefold increase in the number of citations appearing within groups. In *JEP*, a more dramatic sixfold increase occurred with the average numbers of in-groups citations as compared with a threefold increase in solitary citations. Whereas a solitary citation might have sufficed to document a source for a specific point, in-groups citations were now being used to convey the same message in the text.

The number of instances of in-groups citations also reported in Table 4 increased more than fourfold between the 1972–1974 and 1996–1998 time periods in both *JEP* and *JPSP*. An average of more than one third of all instances of citations by 1996–1998 were in groups. Data also suggest that the average size of (i.e., the number of citations within) each in-groups citation had expanded over time. The timing of this increased volume of citations corresponded to the wider availability of PsycLIT and PsycINFO on CD-ROMs in the mid-1980s (VandenBos, 1992) and the subsequent expansion of the databases to the historical literature back to 1887.

Changes in the use of references and citations and in the written research article. Beyond the specific purpose of documenting the source of an observation or statement, in-groups citations were now being introduced for completeness or to convey factual information, for example, to show that several studies have arrived at similar results or conclusions. Additionally, in-

groups citations may be introduced to enhance the author's credibility or to enhance the manuscript's appearance and presentation. In the latter two cases, increased in-groups citations may be gratuitous because the function of each citation could be served by any of the other citations with which it is grouped.

Changes in the nature of empirical research articles have also resulted from the reference explosion. On the one hand, the flow of written text is frequently interrupted, with large numbers of in-groups citations making articles more difficult and less enjoyable to read. On the other hand, increases in total number of references, citations, and in-group citations lead to the impression that empirical research articles have changed from merely introducing a topic to presenting more complete minireviews of the research area (Conway, 2001; Suls, 2001).

The range of references and citations in contemporary research. Although the numbers of references and citations within each article continued to vary widely (e.g., in *JPSP* in 1996–1998, there was still an article with only 14 references and 24 citations), it was the articles with extremely large numbers that were setting the higher standard. Indeed, in *JPSP* in 1996–1998, four articles had more than 150 references, including an article with 176 references and 346 citations. This article, published in 1996, reported a single experiment with 80 undergraduate students in a 2×2 experimental design. The list of references at the end of the study required almost five full journal pages. A total of 346 citations were contained on all but two pages of text (in the Results section). Compounding the extremity of this example were a large number of self-citations—61 citations to two articles by the senior author, plus 21 citations to other examples of the senior author's work. Although the contribution of the reporting researcher may play a greater role with increased specialization, this number of repetitive self-citations clearly is excessive.

In *JEP* in 1996–1998, the number of references ranged from 15 to 108 and the number of citations ranged from 37 to 237. In 1996–1998, the five articles with the greatest numbers of citations in *JEP* ($n = 237, 224, 197, 182, 163$) even exceeded all but one of the most extreme cases of citations for *JPSP* ($n = 346, 185, 162, 158$). Unusual citation practices also were found within *JEP*, where, for example, a 1996 article contained 147 citations, more than 80% of which were grouped with other citations, with 58% to the same six references.

These extreme examples should not be dismissed as outliers in the statistical sense. Each of these articles received peer review and editorial scrutiny before manuscript acceptance. Publication indicated that the reviewers and editors regarded the format and content of the articles acceptable and the number of references and levels of citations appropriate.

General Discussion

Analysis of the pattern and extent of referencing and citations within published psychological research over nearly three decades has revealed extensive changes. Among

these is an explosion in the number of references and citations. Editors have expressed concern about the rising number of references and citations (Form, 1988; Suls, 2001), even to the point of concluding that they “are getting out of hand” (Form, 1988, p. vii). Although likely true for the journals from the other disciplines that we surveyed, the knowledge, reference, and citation crisis appears to be particularly acute for psychology.

Gatekeepers of Referencing Practices

Publication Manual of the American Psychological Association. The standards for writing style and format for journals within psychology are prescribed for authors and editors by the *Publication Manual of the American Psychological Association*. The manual has changed the guidelines for referencing over the years. For example, the 1967 revision (APA, 1967) introduced the present reference system of citations including the author's name and date of publication within the body of the text and a reference list at the end of the article. However, it did not provide guidance for what to reference or cite, except for the statement that in contrast to a dissertation, “a scientific article has the function *only of communicating the author's original contribution* [italics added]” (APA, 1967, p. 14).

Subsequent editions of the manual have provided general instructions for writing the introduction and the scope of referencing. In the second edition of the manual (APA, 1974), authors were instructed to “cite only *those selected* [italics added] studies pertinent to the specific issue; avoid references with tangential or general significance *to the problem* [italics added]” (APA, 1974, p. 16) and were reminded that the reader “does not require a complete digest *with each new paper* [italics added]” (p. 16).

Emphasized words (in italics) were omitted in subsequent editions, although the manual has consistently required authors to “demonstrate the logical continuity between previous and present work” and “to acknowledge the contributions of others” and advised against including “an exhaustive historical review” (e.g., APA, 1983, p. 25). However, instructions for more substantial references and citations were added to the fourth edition (APA, 1994): “A scholarly review of earlier work provides an appropriate history,” and “citation of . . . relevant earlier works is part of the author's scientific and scholarly responsibility” that is “essential for the growth of a cumulative science” (p. 11). These instructions were tempered by almost contradictory instructions that “the reference list should be succinct, not exhaustive; simply provide sufficient references to support your research” (APA, 1994, p. 20). This ambiguity gave authors and editors freedom to define appropriate levels and hence increased variability in referencing practices.

Moreover, sections on plagiarism and how to avoid it through appropriate references and citations were introduced to the text of the publication manual in the fourth edition (APA, 1994, pp. 292–294). Hence, the earlier admonitions to be focused and succinct in the references cited has been replaced in practice and in the teaching of schol-

arly writing by the need to carefully document every statement made by the author. Although there has been variability in practice, a new consensus seems to have emerged of referencing and citing at substantially increased rates.

Editors and reviewers. Editors of journals and the two or three experts who read, review, and recommend rejection or approval of manuscripts submitted for publication are the gatekeepers who monitor and define by their decisions standards for acceptable practice in each academic discipline. With 80% rejection rates in psychology journals, these gatekeepers are thought to be formidable. With references having been identified as one of the most important factors guiding editorial acceptance or rejection (Brewer, Scherzer, Van Raalte, & Pettipas, 2001), it is interesting that practices and standards have been allowed to vary and change. Editors and reviewers have not played the limiting function that should be the role of gatekeepers.

Pros and Cons of Increased Referencing

The average number of references and citations in each article are likely maintained at high levels because they serve useful functions. Some are of personal value to the author—they enhance the author's credibility, convey a positive scholarly image, and increase the likelihood of manuscript acceptance in a competitive environment. The practice is also of value to the reader. A contemporary article retrieves the complete literature on a topic, puts it into an interpretative context, and thereby helps the reader to cope with the vast amount of new knowledge.

By contrast, there are reasons why excessive referencing and citation may be inappropriate. Journal page allocations consumed by reference lists—as many as three to five pages in some articles—could have been devoted to expanding the number of articles that are published. There is the potential for overlap and even duplication in literature reviews within introduction sections. Research results also may not appear as salient when embedded within an extensive literature overview. Probably the biggest criticism of reference overload is the poor quality of writing that is tolerated in the interests of embedding, for example, 18 citations in a single sentence or 56 citations on a single page (as in the 1996 article from *JPSP* described above).

Limits to Referencing?

Are there limits to increased referencing? With a continued knowledge explosion, there is no evidence that these trends are ending, yet some of the numbers we have observed suggest it is time to question the consequences of continued increases. It would seem that there should be some appropriate level of referencing that allows researchers and readers to reap the benefits of scholarly documentation without the disadvantages of excessive and gratuitous citations. Physics seems to have been able to achieve this balance. The concern in psychology is that without constraints or clear guidance, most writers will continue to add references and the problem will be exacerbated.

A personal observation on our own writing process illustrates this dilemma. Earlier in this article, we initially cited Cole (2000) to document the low rejection rate of

physics journals. John G. Adair urged adding R. K. Adair (1982) to make the same point. Moravcsik (1982) was identified as yet another potential citation. The urge to include all of these was considerable: They illustrated the breadth of our knowledge of the literature and our attention to detail that would likely impress the editor and reviewers. But, having just noted the gratuitous nature of some references, we paused to consider whether the point was sufficiently documented by a solitary citation. We decided it was; although important, the point was, after all, a relatively tangential one to the development of our thesis.

This anecdote illustrates the strength of authors' motivations to insert additional and possibly gratuitous references and the ease with which it can be accomplished. The lack of response to the previously mentioned admonition to authors to limit referencing by the editor of *ASR* (Form, 1988) underscores the futility of author self-controls as a solution. Possibly editors should follow the lead of the *American Psychologist*, which has set a desired page limit of 25 manuscript pages, including references, to require authors to choose between their own golden words or additional references.

In addition to individual editor action, broad discipline guidance is required to keep the amount and nature of referencing appropriate. Reconsideration and redrafting of the relevant instructions within the *Publication Manual of the American Psychological Association* followed by strict adherence to an explicit norm by editors and reviewers are warranted. This redrafting should include guidance on the extent of historical context necessary for an empirical study, the appropriateness and form for in-groups citations, the new functions that citations may serve, and the balance between proper crediting to avoid plagiarism and blanket citation of all research.

Regrettably, the fifth edition of the publication manual (APA, 2001) failed to confront these issues and provided no new guidance for authors and editors. On the basis of previous revision cycles, we estimate it will be at least another seven to eight years before the problem could be addressed in the next edition. By that time, at the rate of growth over the two preceding periods of data collection, the reference lists in *JPSP* and *JEP* will average between 75 and 95 references per empirical article. Psychologists truly have created an explosion of references in their response to the knowledge explosion.

REFERENCES

- Adair, J. G., Puhan, B. N., & Vohra, N. (1993). Indigenization of psychology: Empirical assessment of progress in Indian research. *International Journal of Psychology*, 28, 149–169.
- Adair, R. K. (1982). A physics editor comments on Peters and Ceci's peer-review study. *Behavioral and Brain Sciences*, 5, 196.
- American Psychological Association. (1967). *Publication manual of the American Psychological Association* (Rev. ed.). Washington, DC: Author.
- American Psychological Association. (1974). *Publication manual of the American Psychological Association* (2nd ed.). Washington, DC: Author.
- American Psychological Association. (1983). *Publication manual of the*

- American Psychological Association (3rd ed.). Washington, DC: Author.
- American Psychological Association. (1994). *Publication manual of the American Psychological Association* (4th ed.). Washington, DC: Author.
- American Psychological Association. (2001). *Publication manual of the American Psychological Association* (5th ed.). Washington, DC: Author.
- Brewer, B. W., Scherzer, C. B., Van Raalte, J. L., & Pettipas, A. J. (2001). The elements of (APA) style: A survey of psychology journal editors. *American Psychologist*, 56, 266–267.
- Cole, S. (2000). The role of journals in the growth of scientific knowledge. In B. Cronin & H. Barsky Atkins (Eds.), *The web of knowledge: A festschrift in honor of Eugene Garfield* (pp. 109–142). Medford, NJ: Information Today.
- Conway, L., III. (2001). Number and age of citations in social-personality psychology over the lifespan of the field: Older and wiser? *Dialogue*, 16(2), 14–15.
- Form, W. (1988). On references. *American Sociological Review*, 53, vii.
- Garfield, E. (1955, July 15). Citation indexes for science: A new dimension in documentation through association of ideas. *Science*, 122, 108–111.
- Higgins, E. T. (1992). Increasingly complex but less interesting articles: Scientific progress or regulatory problem? *Personality and Social Psychology Bulletin*, 18, 489–492.
- Innes, J. M. (1973). The utility of a citation index as a measure of research ability in psychology. *Bulletin of the British Psychological Society*, 26, 227–228.
- Journal Citation Reports on CD-ROM—Science edition [Computer software]. (1997). Philadelphia: Institute for Scientific Information.
- Journal Citation Reports on CD-ROM—Social Science edition [Computer software]. (1997). Philadelphia: Institute for Scientific Information.
- Kaser, R. T. (1998). Secondary information services—Mirrors of scholarly communication: Forces and trends. In A. Henderson (Ed.), *Electronic databases and publishing* (pp. 9–23). New Brunswick, NJ: Transaction.
- Madigan, R., Johnson, S., & Linton, P. (1995). The language of psychology: APA style as epistemology. *American Psychologist*, 50, 428–436.
- Moghaddam, F. M. (1997). *The specialized society: The plight of the individual in an age of individualism*. Westport, CT: Praeger.
- Moravcsik, M. J. (1982). Rejecting published work: It couldn't happen in physics! (or could it?). *Behavioral and Brain Sciences*, 5, 228–229.
- Price, D. J. (1961). *Science since Babylon*. New Haven, CT: Yale University Press.
- Price, D. J. (1965, July 30). Networks of scientific papers. *Science*, 149, 510–515.
- Price, D. J. (1986). *Little science, big science . . . and beyond*. New York: Columbia University Press.
- Reis, H. T., & Stiller, J. (1992). Publication trends in *JPSP*: A three-decade review. *Personality and Social Psychology Bulletin*, 18, 465–472.
- Schneider, D. J. (1992). Publication games: Reflections on Reis and Stiller. *Personality and Social Psychology Bulletin*, 18, 498–503.
- Suls, J. (2001). Report from the editor of the *PSPB*: Turning the corner. *Dialogue*, 16(2), pp. 4, 28.
- Thorngate, W. (1990). The economy of attention and the development of psychology. *Canadian Psychology*, 31, 262–271.
- VandenBos, G. R. (1992). The APA knowledge dissemination program: An overview of 100 years. In R. B. Evans, V. S. Sexton, and T. C. Cadwallader (Eds.), *The American Psychological Association: A historical perspective* (pp. 347–381). Washington, DC: American Psychological Association.
- Vohra, N., & Adair, J. G. (1991, June). *Reference patterns in social psychology journals*. Poster session presented at the annual meeting of the Canadian Psychological Association, Calgary, Alberta, Canada.
- West, S. G., Newsom, J. T., & Fenaughty, A. M. (1992). Publication trends in *JPSP*: Stability and change in topics, methods, and theories across two decades. *Personality and Social Psychology Bulletin*, 18, 473–484.
- Xhignesse, L. V., & Osgood, C. E. (1967). Bibliographic citation characteristics of the psychological journal network in 1950 and in 1960. *American Psychologist*, 22, 778–791.

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