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## MONITORING EXTERNAL MEMORY

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### ABSTRACT

The proposal that guides this research is that organizational structures of external memories, like those of internal memories, play an important role in monitoring knowledge. Previous evidence for such a relation was obtained in a laboratory experiment. Here, I report the results of a survey of faculty at Trinity University. They judged their confidence in knowledge related to their research and described their external memories (office files and bookshelves). The more confident among them had read and stored more information; they also maintained the more organized offices. In multiple-regression analyses, organization was the best predictor of confidence.

'In any culture information is stored in the minds of its members and, to a greater or lesser extent, in artifacts' (Roberts, 1964). Libraries, computer banks, and office files are the artifacts of our culture. These locations, as well as the minds of other people, provide external memories for each of us. As is the case with mind, external stores must be organized if information is to be retrieved effectively; consider library cataloging systems and data management systems. Such organizations are not merely external attributes but reflections of mind (see Bower, 1970, pp. 41-42), just as an external memory itself is a 'mechanical extension of our own memories' (Kochen, 1967, p. 205). And just as the organization of information in mind predicts confidence in remembering (Flavell & Wellman, 1978; Pratt, Luszcz, MacKenzie-Keating, & Manning, 1982), I propose that the organization of external memory predicts confidence in knowing.

The basis of a relationship between internal and external memories must be a shared organizational structure. In order to realize that information resides in an external store, some aspect of that information must also be stored internally. But we may or may not know its place within a structure, or how it is related to other information. Some research in my laboratory suggests that well-organized information in texts that have been skimmed and stored externally, produces overestimations of its knowledge, as well as higher realistic appraisals of knowledge, compared to estimations for disorganized information (Hertel, 1984). The degree

of organization was related to confidence in knowing answers to questions about the topics of the texts, even when such answers were not contained in the text. Why might such a relation occur? In discussing the deleterious effects of disrupting the macrostructure of stories on subjects' confidence in remembering them, Pratt et al. (1982) suggested that judgments of knowledge are based on initial attempts to retrieve the most general nodes of the stories' structures. If such nodes are available and accessible, subjects believe they know the story. By analogy, if an organizational structure of external memories is available and accessible in mind, we believe that, in a general sense, we know the information it contains. Unless the conditions for expressing confidence in knowing promote careful searches for the desired information, we base our judgments on the accessibility of higher-order information. As experienced organizers we confuse the likelihood of external retrieval with the likelihood of internal retrieval.

Is there evidence for such confusions outside the laboratory? Palkovitz and Lore (1980) discovered, as do we all, that college students are amazed by poor test performance after taking careful notes all semester. This finding provides some real-world support for the notion that confidence is related to having external memories, but does not address the issue of organizational structure.

To those of us who wonder why some of our colleagues exhibit high or low degrees of confidence in knowledge, in the absence of evidence for actual differences, the notion that confidence in knowledge might be related to the degree of organization of external stores is an appealing one. Accordingly, in an attempt to obtain evidence for such a relation in a real-world (or ivory-tower) setting, I conducted a survey of members of the faculty at Trinity University. At the outset I realized that I would have no measure of actual knowledge; nevertheless, the study described below suggests that the relation between confidence and external organization obtains in practical settings.

#### METHOD

A questionnaire was circulated to 73 faculty at Trinity University, who were reputed to be on campus during the summer months. First, participants were asked if they considered themselves to be engaged in research or scholarship beyond what is required for teaching and application (e.g., management training or clinical practice). If they were not so engaged, they were asked to stop responding. Following questions about the nature and frequency of the research, the next item pertained to confidence in knowledge: "Please indicate your confidence in your accumulation of knowledge of the literature specific to your research specialty." A seven-space scale, anchored by "not at all confident" and "extremely confident" followed the request.

The remainder of the survey contained a variety of questions about external stores of information--such as office files and bookshelves. The questions were designed to provide data regarding four characteristics of accumulated knowledge: (a) approximate amounts of information stored (i.e., number of books and journal

volumes, depths of files), (b) approximate proportions of this information also stored internally or "known" (i.e., the proportions of books and articles studied carefully or read), (c) reliance on information outside the office (i.e., number of journals monitored in the library, number of library books read or skimmed per month, amount of information maintained at home), and (d) the organization of their offices. In the last category, the participants described the ways in which their files and books were organized. Several participants, for example, indicated that their files on research were organized within a two-level structure of topics they pursue. The participants also rated the degree to which all information in their offices was accurately located within the structures they had described.

#### RESULTS

The results of this survey provide interesting clues about the correlation of external-memory variables with confidence in knowledge. First, I describe the characteristics of the sample, then the relations between confidence in knowledge and the characteristics of the responders' external memories. The focus here is on the characteristics of office files, books and journal volumes; characteristics of extra-office information were not reliably related to confidence in knowledge.

Although the rate of return was 50%, all but three responders described themselves to be engaged in research. Therefore, it may be reasonable to assume, given the variety of reasons for being on campus during the summer (teaching, committee work, and research), that many of the faculty who did not return the questionnaire were not active researchers. The faculty who returned the questionnaire were very evenly distributed across departments and divisions; physical sciences and mathematics, 9; social and behavioral sciences, 10; humanities, 11; and 3 unknown. All departments except education, religion, geology, art, music, drama, and communications were represented; the last five were not surveyed. The responders represented a full range of involvement in research, from sporadic and nonprogrammatic to frequent and programmatic. They worked on their research for an average of 13.49 hours a week. (The number of hours devoted to research was not correlated with confidence in knowledge.)

Table 1 provides the means of the variables of interest: rated confidence in knowledge within the research specialty and estimates and ratings regarding external stores of knowledge. Correlations of confidence ratings with the external characteristics are also reported in the table. Not surprisingly, the sample was moderately confident on the average. The depth of their files of research articles, the complexity of the file structures, and the degree to which materials were accurately located within that structure were each positively correlated with confidence. The number of years the files had been maintained (an indication of rank and longevity) and the percentage of those materials that had been read were not reliably related to confidence. In the category of books and journal volumes, however, the number of years that books had been collected and the number that had been read were reliably related to

Table 1  
Faculty Survey: Mean Ratings and Estimates of External  
Information and Correlations with Confidence in Knowledge

Item	Mean	r (n) <sup>a</sup>
Confidence in knowledge (7-pt scale)	5.36	--
Office files		
Estimated depth (inches)	75.70	.48 (25) *
Years maintained	9.47	.29 (28)
Percent read	62.62	.32 (22)
Complexity of structure (0 - 4)	1.35	.37 (28) **
Locational accuracy (5-pt scale)	3.66	.58 (27) **
Office books and journal volumes		
Estimated number	442.60	.52 (23) *
Years collected	12.41	.48 (25) *
Estimated number read	73.39	.57 (22) **
Complexity of structure (0 - 4)	1.33	.25 (26)
Locational accuracy (5-pt scale)	3.93	.59 (27) **

<sup>a</sup> This column presents the Pearson correlation coefficient for the relation of each external variable to rated confidence in knowledge. The number of pairs of scores is presented parenthetically. \*\* p < .01, \* p < .05 in two-tailed tests of significance.

confidence, as were the estimated number of books and their locational accuracy. From this table, then, one can observe that measures of the amount of external information, the percentage of these materials that also had been stored internally (read), and the organization of external memory are predictive of confidence in knowledge.

In order to examine the relative contributions of each category of external characteristics to predictions of confidence, I performed a series of multiple-regression analyses. File and book characteristics were examined separately; in each regression analysis the predictors were entered first in step-wise fashion and then hierarchically, according to their category.

The best equation for predicting confidence in knowledge from characteristics of files included estimates of their depth (Beta = .42), percentage read (Beta = .36), and locational accuracy (Beta = .54),  $R = .81$ ,  $F(3, 17) = 8.20$ ,  $MS_{res} = .417$ . The estimates of depth and ratings of locational accuracy each reliably accounted for separate sources of variation in confidence, beyond its relation to the other two variables in the equation.

Similarly, the best equation for predicting confidence from characteristics of books and journal volumes included the number of years collected (Beta = .28), the number of books read (Beta = .35), and ratings of locational accuracy (Beta = .39),  $R = .75$ ,  $F(3, 17) = 7.22$ ,  $MS_{res} = .512$ . Only locational accuracy reliably added to

the amount of variance accounted for by the equation containing the other two predictors.

#### DISCUSSION

The research I have described was focused on confidence in knowledge within particular domains, in contrast to feelings of knowing answers to specific questions (see Hart, 1965). Its topic is more properly included in the category of metaknowledge (knowledge about knowledge) to distinguish it conceptually from metamemory, which typically refers to knowledge about how and what we can remember, and metacognition, a more general term to denote knowledge about the workings of our minds (see Brown, 1975). Confusions about location in monitoring knowledge are somewhat similar to confusions in reality monitoring--confusions in distinguishing between mental representations of self-generated and perceived events (Johnson & Raye, 1981); however, the focus here is on monitoring knowledge rather than the source of its generation.

The results of this survey suggest that the more confident among us store more information, read more of it, and are, above all else, the better organized. Such an outcome must be viewed cautiously because the measures were estimated. (One potential difficulty is the possibility that those who overestimate their knowledge of research also overestimate on all indices of external memory. Such a generalized bias in the estimates and ratings was unlikely, however, given the range of covariances across pairs of predictors.) Of course, the correlational nature of the research prevents the conclusion that organization determines confidence. Unfortunately, the findings do not provide justification for arranging one's office before beginning work, on the grounds of maximizing confidence! Finally, the amount of actual knowledge, obviously undeterminable in this setting, might mediate in a causal linkage between the tendency to organize and the feeling of confidence.

There are other extensions of the role of organization in knowledge monitoring. One important type of external memory for many of us is the mind of another person. My colleagues and I (Wegner, Guillian, & Hertel, 1985) have extended this perspective to the domain of the long-term relationship and have referred to the resulting system as "transactive memory." One finding that emerged from this extension was that subjects in a list-learning experiment overestimated the amount they could recall when their partners in long-term relationships had studied categorically organized words related to their lists (Hertel, 1985). Such overestimations did not occur when the partners possessed unorganized information or when the partnerships were newly formed in the experimental setting. Apparently, an additional advantage of intimacy is the perception that one's partner can provide more effective retrieval cues.

More generally, considerations of external memory are important to the study of memory as it commonly operates outside the laboratory. Memory theorists usually ignore the context of external memory for the operation of mind. Yet, all but one location for storing information in the real world are external to the individual information processor. Ironically, she is responsible for their

management and therefore must create organizational structures that, in turn, may affect her ability to distinguish among her sources of knowledge.

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