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Implications of External Memory for Investigations of Mind

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SUMMARY

External memory—records of experiences that are maintained in repositories that are external to their users—provides context for many everyday cognitive acts. Some initial research has shown that such context influences learning, remembering, and judgements of knowing. The scope of both basic and applied memory research should be broadened in ways that address issues about the interaction of external memory and mind.

> [M]uch of our everyday knowledge resides in the world, not in the head.
>
> (Norman, 1988, p. ix)

With this claim, Norman means to imply that we use aspects of our everyday environment in much the same way that we use mental knowledge, and that the two sources of knowledge interact in ways that have important effects on our current experience. Norman was primarily concerned with how we make use, effectively or ineffectively, of everyday things (e.g. doors, video controls, computers) by way of the knowledge they directly convey. Rather than examining the use of *things*, I focus on the implications of external knowledge for the use of *mind*. Like uses of things, uses of mind are rarely invoked in impoverished spaces such as the cognitive laboratory, but often occur in knowledge-rich settings such as the modern office. Moreover, in everyday spaces people use not just their minds but also their external memory: records of past experiences that are maintained in repositories that are external to their users.

Acts of remembering, for example, typically involve both internal and external memory, although one type may receive emphasis. Consider the rare case of the expert storyteller or shaman, who needs at least a cultural milieu or perhaps even a message stick to produce his tale (Hunter, 1979; Wallace and Rubin, 1991). At the other, more commonplace extreme, consider the researcher who remembers the results of her experiments by accessing a computer file; to retrieve what she needs from the file she must use linguistic, statistical, and computer skills from internal memory. This interaction of physical and mental records is sometimes acknowledged in the design of external repositories (Landauer, 1987) or 'cognitive artifacts' (Nor-

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man, 1991). Such thoughtfulness is illustrated by the growing literature on software and menu design, as this should be guided by our knowledge of human cognition (Barnard, 1987; Norman, 1991). In constructing our mental 'repositories' (in theories of mind), however, we pay much less attention to external memory. We are beginning to take the mind into account in designing the world, but not the world into account in studying the mind. This is true in spite of the exponential rate at which external memory has grown and must be used to learn and remember in the last few decades—the 'information age'. Can current cognitive theories address adequately the fact that cognitive acts occur in information-rich environments, or must they be revised to answer questions posed from the perspective of the office worker?

The purpose of this article is to consider a few implications of external memory for the use of mind. In particular, I describe research and speculations about whether the presence of external stores are helpful or detrimental to the mental acts of learning, remembering, and judging knowledge. But first I explain what I mean by the term 'external memory' and describe some of its relevant dimensions.

EXTERNAL MEMORY

Just where *does* knowledge reside if not in the mind? Some of the more common repositories are books, computer and other office files, technical manuals, notes and lists, diaries, and the minds of other people. Certainly among the more interesting examples of external memory is Faraday's set of diaries and accompanying retrieval aids (Tweney, 1992). These repositories become external memories only through our encounters with them. My colleagues' computer files (and minds) certainly represent information, but they do not serve as my external memory unless, of course, I am given access. This idea is not new to modern cognitive psychology. Among others, Hunter (1979) implied that external repositories, which he called 'external aids', increase our knowledge through personal interaction.

The 'Space' of External Memory Research

Usually, when we think about external aids, such devices as strings around the finger come to mind (although no one actually seems to use them). Other examples are lists of things to do, usually containing short phrases that few other people could decipher (e.g. call HERR about PAM). These aids are clearly intended to be memory cues rather than repositories of knowledge. Indeed, we could conceive of a continuum that represents the extent to which the physical record recapitulates the event to be remembered. At one extreme is a mere fragment of the entire event to be remembered. A string is tied around a finger during a thought about a prospective event and remains to cue the procedure. At the other extreme, in theory, lies a complete record of the event (although duplication is impossible in practice). Close to this extreme, for example, is the record of an experiment published in a journal, or the videotape of a birthday party. Between the two extremes events can be placed according to the completeness of the record. Lecture notes record at least some of what the lecturer said.

Other continua can be incorporated into the problem space of external memory research. Johnson and Raye's (1981) distinction between externally and internally

generated (internal) memories can be extended to external records; clearly, the extent to which such a record has been generated by oneself or by others should have interesting implications for how its physical existence might affect mental acts. Further, the distinction between declarative and procedural knowledge might also inform effects from external memories. Herrmann and Petro's (1990) appendum of commercial memory aids includes several that function to store procedures rather than 'facts' (e.g. the hand calculator). The pills placed by the coffee pot or lecture notes by the office door also represent procedures, but they record the procedure only partially (just as a note on a lecture only partially records the full declaration). Therefore, a taxonomy of external memory might use the three-dimensional problem space of completeness of the record, source of its generation, and type of knowledge (procedural versus declarative). However, the portion of the problem space devoted to relatively complete external records is the current focus, because cognitive research habitually addresses the effects of partial cues (e.g. semantically or graphemically related words). I also emphasize declarative knowledge. (A portion of prospective memory research takes up issues in procedural knowledge, externally represented; see Kvavilashvili, 1992).

Finally, any treatment of the implications of external memory for the study of mind must also include a plethora of mental distinctions. Schoenpflug's (1986, 1988) research on decisions about whether to memorize text or to store it in computer files reminds us that the existence and nature of external devices can affect learning as well as remembering (or study as well as test). Moreover, in considering the lack of attention to external memory in cognitive research, one might find the study of attention to these devices *per se* to be a fruitful exploration. Do external memories affect cognitive procedures to a greater extent when we are more or less aware of them? The study of automatic compared to controlled influences of external memory might augment similar distinctions regarding the effects of past experience on current mental acts (see Jacoby, 1991).

Characteristics of external memories

Ironically, external memories *have* been considered in the construction of cognitive theory, in contrast to my previous claim. From Plato's wax tablet, to Broadbent's library, and Atkinson and Shiffrin's computer, they have provided the metaphors that guide the study of mind (Roediger, 1980). External devices are structural by nature, in that they occupy space in ways that the mind does not. Perhaps because these external repositories are structured in certain ways we have sometimes reasoned that the mind is similarly structured. Alternatively such external structures might be reflections of our own mentation of similarities and differences (Bower, 1970, pp. 41–42). We construct external devices in ways that make them useful to minds that work according to these principles. As an aid to future intentional use, for example, we organize our external memories because we understand something about the effects of organization on retrieval. Regardless, both types of repositories 'encode' similarity and difference; they appear to be organized (or not).

Organization is often conceived in semantic and lexical terms (e.g. bookshelves are arranged by topics and then alphabetically by surname), but both external and internal memories encode episodes as well. Things that co-occur in time and space are associated in external records; photo albums are an obvious example. Thus,

the degree of external organization, because it is a shared attribute, should affect cognitive acts of memory. Similarly, sensory characteristics of external records should be important, because to the extent that we also remember them they may determine where we search (Lansdale, 1991).

According to Norman (1988, p. 79), characteristics of external and internal knowledge establish tradeoffs in the choice of which to use. Aesthetic value, for example, might guide the choice of where to place one's knowledge; some things should not be seen. More importantly, perhaps, every repository is characterized by the degree of effort required for its use. Surely this procedural characteristic—and perhaps many others—has vast implications for normal acts of learning and remembering in the presence of external memory.

INTERACTIONS OF MIND AND EXTERNAL MEMORY

Effects on learning and remembering

Watkins (1990) and many others have addressed the fallacy in believing that we can separately examine the cognitive acts of learning and remembering—a fallacy attributable to the use of such spatial metaphors as storage and retrieval for mental phenomena. Yet cognitive procedures (however they are understood) might indeed by affected by the *real* acts of storing in and retrieving from external memory. Under what conditions do people eschew study in favour of external storage and rely on external memory for remembering, rather than mind?

Decisions to store knowledge externally depend not only on the nature of that knowledge but on assumptions about the relative ease of learning or storing and of remembering or retrieving. Schoenpflug (1986) viewed these matters in economic terms in performing a cost–benefit analysis of the trade-off between learning texts and storing them in computer files. For external knowledge to be effective in later tasks (e.g. writing a paper), both its location and its gist must also be learned. Consequently, there is no point in storing very simple records externally. Schoenpflug's subjects often chose to memorize the texts, except when the file name (location) matched the gist of the text.

Schoenpflug's findings contrast somewhat with common beliefs about everyday decisions to rely on external aids over mind. In examining such beliefs, Intons-Peterson and Fournier (1986) found that college students prefer external devices such as lists and maps to internal processes such as rehearsal and imagery (see also Harris, 1980). Compared to mind, the students thought that external devices were more dependable, accurate, and user-friendly, in general. This disparity between students' beliefs and the behaviour of Schoenpflug's subjects might reflect differences in the type and amount of information to be stored or learned. The students' external preference was stronger for storing procedure rather than declarations, for example, and for storing spatial rather than verbal information. More importantly, perhaps, the students' general beliefs about the greater ease of using external memory might ignore the lack of flexibility inherent in many external stores. Like computer files, lists and maps must be readily available if they are to be useful—that is, unless the maker and the user of the external record is the same person, in which case, the mere making of the record is an aid to learning; consider research on notetaking.

Research in educational psychology has shown that taking notes on lectures facili-

tates subsequent cognitive performances, regardless of the availability of the notes at the time of the test (see Einstein, Morris and Smith, 1985, for a review). Lists of things to do probably function similarly. Again, in these examples the user of the external record is also its creator, and so the record is doubly made. And, as is the case with internally generated memories, self-generated records might come to mind easily and thereby influence judgements about external aids. For example, when Intons-Peterson and Fournier's (1986) subjects judged the advantages of storing information externally, they perhaps thought more often about the records they had created, and remembered that they were useful. In this way availability heuristics (Tversky and Kahneman, 1973) might operate to mislead us about the real advantages and disadvantages of external storage. Plainly, such issues deserve to be pursued in the course of investigating the effects of external stores on decisions to learn.

Little is understood about the effects of external memory alternatives to learning, but much less is known about their influences on remembering. Some years ago Estes (1980) expressed the concern that external devices might reduce memory skills, and Estes is far from the first to do so (Plato, 1985, p. 520). Examples of this fear abound in the folk culture of the academy; our students' calculators and spell-checkers have made them forget how to multiply and spell, for example. In this context, Hertel and Holamon (1993) began to examine memory effects associated with the availability of external stores.

Hertel and Holamon asked college students to study obscure historical facts, each of which expressed the name of someone who accomplished a feat, the accomplishment, and its location (e.g. 'Pierre Reverdy wrote moralist poems in Narbonne'). Index cards, each containing one of the studied facts, were stored in a file box. Then the file box served as the subjects' external memory while they attempted to remember the names in response to being cued by accomplishments. For the present purpose, two experimental manipulations in an unreported pilot study were important. First, before the study phase, some subjects were told that the file would be available during testing whereas others were not. Second, half of each study condition was allowed to use the file on the test whereas the other half was not. We expected that each manipulation would affect the number of names truly recalled, but we were wrong. Regardless of study conditions, subjects recalled 30 per cent of the names, on average, when they were not allowed access and 34 per cent when they were (but *before* they searched the file). Although this difference was not reliable, its direction defies the expectation that people will rely on external devices for retrieval to the detriment of their own memory.

The main purpose of the experiments reported by Hertel and Holamon (1993) was to investigate the effects of the presence versus absence of the external memory on the number of facts recalled (before search or with search not allowed). A variety of file and cueing conditions were used. In one condition, for example, the facts in the file box were organized according to the type of accomplishment (art, music, literature, or science), and name recall was cued by the specific accomplishment (e.g. 'wrote moralistic poems'). The main finding in both experiments was that the subjects recalled more facts when the file was opened and placed on the table than when it was absent. In the latter case, the subjects were either reminded orally of the types of accomplishments (Experiment 1) or they were allowed to inspect a piece of paper that listed the types (Experiment 2). Regardless, the presence of the actual file produced a recall advantage. Of course, many issues remain to be addressed,

not the least of which is whether the results extend to more naturalistic and applied settings. For the present purpose, however, they illustrate the fallacy of assuming that external stores are bad for the mind.

Effects on judgements of knowing

Before the recall phase in the experiments just described, the subjects estimated the number of facts they knew. The estimates were performed in the same condition as was recall—either with the file present or absent—and they produced the same general finding. The presence of the file incurred higher estimates; subjects not only knew more but also realized it. This outcome, however, is just part of the story. For example, the effect of the file's presence on estimates was found only when the facts had been studied in mixed order. When they were studied in organized clusters, a reminder of the organization was sufficient to produce good estimates. Further, one can easily imagine situations in which external memory makes us feel smarter than we are. Having skimmed the abstracts in the latest issue of a professional journal, we might place it on the shelf with some confidence in 'having' knowledge. Our students may not know how to take a square root but probably, in some sense, believe that they do because they have a square-root key. Methods for pursuing such intuitions in research domains might draw from those developed by Nelson and his colleagues (Krinsky and Nelson, 1985) to study feeling-of-knowing and related judgements.

Offices provide a rich setting for applied research on external memory's connection to cognitive phenomena (Christie, 1985). Perhaps nowhere else can we expect such large 'natural' variation in both the size and the organizational state of external memory. Several years ago I conducted a survey of faculty across all academic disciplines at Trinity University (Hertel, 1988). Participants were first asked to rate their confidence in knowing about their research domain. Subsequently, I requested measures of external memory, such as amount (books and office files measured in feet), estimates of the percentage read, and degree of organization. Although measures of the amount and the percentage read gave a reliable prediction of confidence in knowledge, a measure of current organization was the best predictor, allowing for the other relationships. The most confident faculty had more external memory, had read a larger portion of it, but most of all kept it organized. Of course, in applied research we cannot know about the direction of the relationships between measures of external memory and cognitive phenomena. One might imagine, for example, that the more confident faculty might collect more material and, perhaps accurately, claim to have read more of it. Less clear, however, is the relationship between organization and confidence. It might be the case that organization is a by-product of confidence, but busy people often do not take the time to put everything away. These findings therefore *suggest* that physical boundaries of knowledge blur when one is judging knowledge.

Consequences of feeling knowledgeable

If 'having knowledge' turns out to be so ambiguous a term and misleading a state as I suggest, then a variety of consequences might be expected. When we feel knowledgeable, for example, are we not appropriately sceptical about the knowledge we

convey? Or does the feeling of knowing point directly to the correct and sometimes external source? Johnson and Raye's (1981) research on the origin of internal memories provides reason to suspect that source knowledge is often incomplete and inaccurate. Yet, in contrast to the source of mental memories, source can be made plain in the external realm.

One of my very confident colleagues has an office neatly full of external memories that are elaborately cross-referenced for multiple purposes. Another colleague's office literally appears as if it were struck by a tornado. Posted on this colleague's door (in both warning and self-defence) is a clipping that describes Lansdale's work on *Memoirs*, a computerized system that works much like piles of papers in a messy office (Under the volcano, 1992). Lansdale's analysis of messy offices stresses the rich contextual cues for location that are often absent from view in the tidy office. Perhaps this colleague is well aware that much of his knowledge is to be found outside his head.

In a different vein, confidence in knowledge is related to a general sense of well-being, especially for those who study or work in information-rich environments. To investigate the possible mediators of this assumed relationship, Anooshian, Ashbrook, and Hertel (1985) asked college students to complete a questionnaire about their experiences in remembering. Modelled loosely on Herrmann's (1982) memory inventory, the questionnaire requested ratings of agreement with several statements about general memory functions (e.g. 'In general, I believe I have a good memory') and several more specific statements about types of retrieval cues (e.g. 'When trying to remember something, I have an easier time when I happen to be thinking about something that is meaningfully connected to what I want to remember'). The subjects were categorized as newcomers to San Antonio—having arrived within the past 2 or 3 weeks—or residents for at least 1 year. Residents rated their general memory functions higher than did newcomers. Further, the residents' ratings of their general memory ability were related positively to a subsequent measure of self-confidence (or self-esteem). The newcomers, however, provided the more interesting data. Rather than general beliefs about their memory ability, awareness of the benefits of spatial cues (and not other types) predicted their level of self-confidence. Newcomers experience less self-confidence when they tended *not* to believe that physical context is an important factor in remembering. Anooshian *et al.* (1985) suggested that those who were aware of such benefits could attribute their cognitive difficulties to the new environment rather than to their own lack of ability.

For the present purpose, the study of relocated and stable students suggests that external memory might function like physical location, not just to cue recall, but to maintain confidence in knowledge and general feelings of worth. Also, these findings possibly extend to relocations of other types, such as changes in residence by older people who face the prospect of losing large segments of external memory when they move to small apartments or nursing centers (see Anooshian, Mamarella and Hertel, 1989). Similarly, recently divorced or separated people lose the sense of personal history that resides partly in the mind of the departing spouse; regardless of mood, they believe that their memory ability is worse (Hertel, 1985; Wegner, Giuliano, and Hertel, 1985).

CONCLUSIONS

In discussing the contextual dependency and flexibility of mind, Landauer (1987, p. 21) said it well: 'Since the mind does not have any set natural habitat, we need to study it in the habitats in which it frequently finds or wishes to find itself'. This essay has suggested that external memory, as part of the mind's natural habitat, influences whether we learn, how much we remember, and how much we think we know. I have used the term 'external memory' to refer to external records of experience. A broader view has been taken by Norman (1991), who addressed the role performed by a variety of cognitive artifacts—artificial devices that enhance cognitive ability. That role, simplified, is to change the nature of the cognitive tasks people perform. The question for memory researchers, then, is whether our current understanding of learning and memory applies in knowledge-rich environments, where metacognitive decisions and cognitive artifacts might change the nature of what it means to remember. Further, this question—crucially—might not be answered adequately by simply incorporating external devices into the design of the research. Other aspects of its design also pertain to the issue of applicability. Consider the research by Hertel and Holamon (1993).

Hertel and Holamon's experiments were typical laboratory studies of estimates of knowledge and accuracy of recall, with the added feature of external devices. The demands of the task included a request to learn a number of historical facts in a concentrated period of time and then to perform on tests of cued recall, also in a concentrated time period. This set of demands perhaps comes close to last-minute cramming for a memory-oriented test in a course on cultural history, but not much else.

To discover if the advantage of having an external memory would hold up in more naturalistic settings, we might use distributed study sessions that permit decisions about whether to learn or to store and distributed and shortened tests of both feelings of knowing and actual recall or retrieval. Then we (like Schoenpflug, 1986) might indeed discover that performance depends on the decision about where to store and to search and that those decisions might depend importantly on economy of effort. This research design would be much higher in ecological validity, but due to typical components of experimental control it might not tell us much about what people do in normal working conditions, in which external memory functions meaningfully rather than arbitrarily. For example, simulating expertise in the sense of external memory would surely be difficult. Applied research could question the findings established by the controlled experiment, or it could supply converging evidence. The results of the faculty survey (Hertel, 1988), for example, partly converge with the findings from the laboratory; faculty confidence was positively correlated with the amount and organization of external memory.

Herrmann and Gruneberg's (1993, this issue) point, as I take it, is to advise memory researchers to confront the logical and methodological difficulties associated with lack of control in order to ask important questions about how memory operates in the real world. Plainly, the real world is full of external memory, and people are constrained by time and cognitive limitations to use it. Memory researchers must not merely acknowledge these constraints, but should inquire about their interactions with mental phenomena and thereby broaden the scope of questions that we pose.

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