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ON THE ADAPTIVE ASPECTS OF RETRIEVAL FAILURE IN AUTOBIOGRAPHICAL MEMORY

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ABSTRACT

The frequent retrieval failures that characterize human memory are typically viewed as nothing more than a weakness of the system. Without continued access, even the most overlearned items of information, such as a home phone number from our past, eventually become non-retrievable. We argue herein, however, in the context of a new "theory of disuse," that the loss of retrieval access with disuse is, overall, an adaptive feature of the system. The efficient retrieval of currently relevant information is facilitated by the loss of access to out-of-date information.

Studies of autobiographical memory, as well as our own personal experiences, demonstrate a remarkable loss, over time, of retrieval access to items of information that were once highly overlearned and readily accessible. Phone numbers we have had in our past, the names of close friends from a certain era in our lives, combination-lock numbers that we may have used hundreds of times, concepts and terms in physics or chemistry or biology that were once accessible without effort are only a few examples of the kinds of information that, with disuse, become inaccessible over time. It is not that such once highly-overlearned information is lost or erased from memory in some absolute sense, but, rather, that without cues and aids of one kind or another we become unable to find the target item in our memory.

Such retrieval failures are illustrative of the fallibility of the retrieval process in human memory. According to the modal view of human memory among today's theorists, loss of retrieval access is a central weakness of the system. It is argued that as storage devices we are spectacular--far more impressive than the largest computer (Landauer, 1983), with no apparent limit on the amount of information that can be stored, or on how long that stored information remains in memory--but that as retrieval devices, we are spectacularly unreliable, with most of the total information in our memories being non-retrievable at any one point in time. That is, "we are far better at storing information than at retrieving it" (R.A. Bjork, Los Angeles Times, 3/18/84).

It is only from one perspective, however, that retrieval failure is simply a weakness of the system. That perspective, held by nearly all laypersons and too many researchers, assumes (explicitly or implicitly) that the singular problem in using one's memory effectively is to remember information. As we move through life, however, minute-by-minute, day-by-day, year-by-year, we need to

keep our memories current to be effective. We need to remember our current phone numbers--not an earlier phone number we may have had--we need to remember where reverse is on this car, what the trump suit is on this hand, and so forth. To remember where we left the car yesterday, or a week ago, is not useful or adaptive in finding the car today. In short, we need to update the system (R. Bjork, 1978). We need some means to set aside, segregate, or suppress information that is out of date and, hence, a source of errors and interference. The fact that information in memory, without periodic access, becomes non-retrievable is critical, in our opinion, to keeping the system current and efficient. It is in that sense, we argue below, that retrieval failure is adaptive in autobiographical memory.

A NEW THEORY OF DISUSE

One of the most thoroughly discredited of the various "laws" psychologists have put forward over the years is Thorndike's (1914) law of disuse. Thorndike argued that learned habits, without continued practice, fade or decay from memory with the passage of time. We need not review here the compelling evidence marshalled by interference theorists (e.g., McGeoch, 1932) against the notion that memory traces decay and that such decay takes place as a function of time alone. We feel, however, that there is much to be said for a modified theory of disuse that incorporates the following assumptions:

1. Whereas there is, in practice, no limit on the amount of information that can be stored in long-term memory, there is a limit on retrieval capacity--that is, on the total number of items of information in memory that are retrievable at any one point in time.

2. An item in memory can be characterized by two "strengths," a storage strength and a retrieval strength. The former measures, in a general way, how well learned an item is; the latter measures the current ease of access to the item in memory.

3. Retrieving an item from memory makes that item more retrievable in the future (increases its retrieval strength), and, given the first assumption, also makes some other item(s) less retrievable (decreases their retrieval strength). (Such competition is governed by similarity relationships and category membership.)

4. The increment in an item's retrieval strength owing to a retrieval of that item from memory is a decreasing function of its current retrieval strength and an increasing function of its storage strength. The decrement in an item's retrieval strength owing to the learning or retrieval of other items is greater the higher the item's current retrieval strength and the lower the item's current storage strength.

"PREDICTIONS" OF THE THEORY

It should be apparent, in terms of the foregoing assumptions, that an item in memory, however well learned, becomes inaccessible if not used (retrieved) periodically. It does not become inaccessible owing to the passage of time, but because the retrieval strengths of other items, via learning and/or retrieval practice, are being incremented. The item in question is not staying competitive, so to speak, for the limited retrieval capacity that governs the system.

We are fond of telling laypersons that our memories are not like a box in the sense that storing some information leaves less room for additional information. Rather, we say, a more appropriate analogy is that our memory is like a scaffolding structure of some kind such that the more developed (or elaborated) the structure the more additional ways there are to add (or attach) new information. Our new theory of disuse, however, says that there is some truth to the box analogy--on the retrieval side. David Starr Jordan, an ichthyologist and President of Stanford University may have had a legitimate complaint when he said that every time he learned the name of a student, he forgot the name of a fish. Given the limits on retrieval capacity assumed by our theory, an ichthyologist who spent substantial time learning and retrieving a large number of students' names could well lose access to the names of some fish.

The theory also predicts a number of standard experimental findings, because it was designed to do so. Among those findings are the following:

1. An an act of retrieval is a memory modifier, both in terms of making the retrieved item more retrievable in the future (see, e.g., Bjork, 1975; Landauer & Bjork, 1978) and in terms of making certain other items less retrievable in the future (e.g., Bjork & Geiselman, 1978; Roediger, 1978; Roediger & Neely, 1982). Those effects are a consequence of Assumptions 1 and 3.

2. The positive consequences of an item's retrieval are greater the more difficult or involved the act of retrieval (e.g., Bjork, 1975; Gardiner, Craik, & Bleasdale, 1973.) That result is simply assumed (Assumption 4).

3. The theory predicts both unlearning (Melton & Irwin, 1940) and spontaneous recovery (Postman, Stark, & Fraser, 1968). Unlearning of a first list as a consequence of learning a similar second list comes about because increasing the accessibility of second-list responses decreases the accessibility of first-list responses. Spontaneous recovery occurs (at least in a relative sense) because with disuse of both List 1 and List 2, the loss of List-1 retrieval strength will be offset by the greater loss of List-2 retrieval strength (as a consequence of Assumption 4).

4. Finally, with a little additional specification, the theory can account for a variety of spacing phenomena.

ADAPTIVE CONSEQUENCES FOR AUTOBIOGRAPHICAL MEMORY

For most of us, retrieving our home phone number from memory does not pose a problem. Access to the correct number is rapid and accurate, even though we may have had a number of such numbers during our lives, some of which may have been our home phone number for years. We do not, as certain computer routines would, retrieve all numbers with the "home phone" tag and then apply some decision procedure to select the current one from the list. The out-of-date numbers, as a consequence of disuse, have apparently become non-retrievable and, hence, non-interfering.

In general, the theory of disuse we propose says that the items in memory that are readily accessible to us are those items we have been using (retrieving) lately. As in the home-phone example above, that will typically be adaptive. The items that have been retrieved frequently in the recent past will tend to be those items

most relevant to our current interests, problems, goals, and station in life. On a statistical basis, those same items will be maximally relevant to the near future as well. Items that have not been retrieved in the recent past, on the other hand, will tend to be those that are not as relevant to our current situation and, statistically, are not likely to be as relevant to our near future either. So, in general, those things we are likely to need to recall in the near future will tend to be accessible to us, and those things that are irrelevant or interfering or out-of-date will be inaccessible—which will enhance not only the accuracy of our retrieval of target information, but also the speed of that retrieval. It is an interesting fact that some computer scientists are working on search algorithms that give high priority to items in the computer's memory that have been accessed frequently (and recently) in the past. Such items are checked first for whether they satisfy the search conditions, and less-frequently accessed items are checked later. In general, such an algorithm saves search cycles.

It is also adaptive that items lose retrieval strength rather than storage strength with disuse. Because they are non-retrievable they are non-interfering, but they are recognizable when presented, and they are relearnable at an accelerated rate should they become pertinent again. In that sense, loss of retrieval access has a number of desirable characteristics as an updating mechanism when compared to the kind of destructive updating built into computers (for an expansion of that argument, see Bjork, in press).

Another adaptive aspect of the system has to do with the fact that we can retrieve normally inaccessible information if retrieval is aided by the reinstatement of situational or environmental cues. Given that the information is retrieved in the presence of such cues, it will then become more accessible, as will all information tied to that context, and information tied to other contexts will become less accessible. Such dynamics are, of course, adaptive because by virtue of the very fact that we have returned to a prior environment or situation (and have left our customary context) the information that we now want to be accessible is that information tied to the old context. Those most important aspects of "context," of course,--those having to do with our physical, mental, and social self--we take with us into any situation.

Finally, spontaneous recovery (relative or absolute) can be adaptive as well. Consider any of the cases where a new number or name or procedure has replaced an old number or name or procedure. Examples might be learning a new last name for a woman friend who has married, or switching from an old to a new word-processing program. With use of the new name or program, it will become more accessible in memory and the old name or program will become less accessible. Assume, however, that we stop using the new name or program. What would that tend to mean? It could mean that we have moved away from the friend in question, or that we have switched to yet another word-processing program, but in many other cases the change in circumstances that stops our using the new name or program also involves the old name or number becoming relevant again (our friend divorced her husband and went back to her maiden name, the new word-processing program was on a machine that was only temporarily available to us, and so forth). In such cases, the recovery in the

accessibility of the old name or program as a consequence of our not using the new name or program will be adaptive. The greater the degree of our original learning of the old information, the greater the extent of such recovery. The latter property, derivable from the fourth assumption in our theory of disuse (and, possibly, a kind of corollary of Jost's Law, 1897), will also tend--in a statistical sense--to be adaptive as well.

CONCLUSIONS

Retrieval of information from our long-term memories is a highly fallible process. The frequent retrieval failures we suffer in the everyday operation of our memories are a distinguishing characteristic of human memory. Such failures, however, reflect more than simply a weakness of the system; they are the negative aspect of a process that has an important adaptive side as well. That process we label herein as a new "theory of disuse"--information in our memories that is not periodically used (retrieved) gradually becomes inaccessible.

The loss of retrieval access to unused information in our memories is adaptive for autobiographical memory in several ways. (a) Information that is non-retrievable is also noninterfering. As we move through life and changes in jobs, friends, responsibilities, geographical location, and so forth, the names, numbers, procedures, and factual information of most importance to us change as well. The loss of retrieval access to out-of-date information of those types facilitates the speed and accuracy with which we can retrieve the information of most relevance to our current station in life. (b) Because only retrieval access is lost, rather than the stored information per se, the "out-of-date" information remains recognizable and relearnable. Should that information become relevant and pertinent again, it can--via a small amount of retrieval practice--be brought back to a state of ready accessibility.

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