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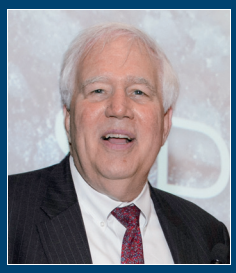
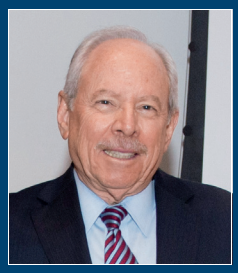
On Free Speech and Academic Freedom

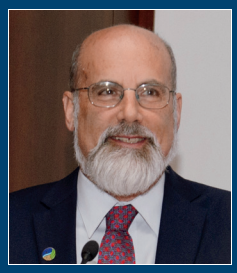
Joan W. Scott

A Reading and Discussion of the Play *Paradise*

Rebecca Saxe, Paula T. Hammond, and Saba Valadkhan







Communicating Science in an Age of Disbelief in Experts

Richard A. Meserve, Mary Sue Coleman, Alan I. Leshner, Joe Palca, and Matthew P. Scott

ALSO:

Memory Processes and Aging

Fergus Craik

In this essay, I review some of my work that attempts to understand the changes in human memory that take place from young adulthood to old age. I am an experimental psychologist by training, so the research and ideas I will describe are at the level of experience and behavior rather than at the levels of brain function or molecular changes, although I will make occasional references to how changes in mental function may relate to underlying changes in the brain.

I take a "processing view" of memory and cognition. Basically, this means that I think of memory processes as *activities* of the mind and brain rather than as structural entities. When we experience an event for the first time, the various sights, sounds, smells, and other senses evoke complex patterns of activity in the brain. These sensory patterns are interpreted in terms of our previous experiences, and the resulting perceptual and conceptual activities are gradually "consolidated" over time to form structural records whose correlates are presumably molecular changes in neurons and their interconnections.

In my view, the learning or "encoding" aspects of memory are nothing more than those initial perceptual and conceptual processes; memory retrieval consists essentially of the attempt to reinstate the same pattern of perceptual/conceptual processing that took place during initial encoding. In this scheme, then, remembering is a form of perceiving rather than a separate "mental faculty." Memories reflect the information we attend to, and the level of meaningful interpretation that we apply to our perceptions.

Successful retrieval of the original event depends on how well and how fully the original patterns of neural activity can be reinstated. In turn, successful reinstatement depends on such things as being in the same place and in the same frame of mind at the time of retrieval as when we first experienced the event. The same context at retrieval evokes part of the initial complex of neural activity, and we assume that the brain has an inherent tendency to carry out "pattern completion" processing on partial representations of well-encoded previous experiences, and so it reinstates the original pattern to some extent at least.

Memory loss is one of the most frequent complaints of people as they age, although there are wide individual differences in the amount of age-related loss, and also substantial differences depending on the type of memory used in a particular situation. The experiments carried out in my laboratory over the years have attempted to illustrate these differences and provide a coherent account of them in terms of the processing notions described earlier. With regard to differential age-related losses as a function of different memory tasks, what we and others have shown is that age decrements are substantial in tasks involving episodic memory, working memory, source memory, and prospective memory. Episodic memory is the label for remembering events that occurred anytime from minutes to years ago; it is memory as we normally think of it, that is, memory of personal experiences. Working memory refers to information held in conscious awareness, especially if we carry out some operation – like mental arithmetic – on the material we are holding. Source memory is the ability to remember where and when some event occurred or the circumstances in which we learned some new information. It is obviously possible to remember a fact, but be unable to recollect where and when we learned the fact. Finally, prospective memory is remembering to carry out an intention at a future time, either when some event is encountered (e.g., conveying information to a friend when you meet her) or after some specified time (e.g., "I must phone my wife in thirty minutes"). These types of memory all show substantial losses and inefficiencies in older adults.

On the other hand, some memory tasks are performed almost as well by individuals in their seventies and eighties as by those in their twenties and thirties. Such tasks include recognition memory, procedural memory, and memory for facts and accrued knowledge – referred to by cognitive psychologists as "semantic memory." Recognition memory involves re-providing items or events to the experimental participant; for example, "which of these forty words are the twenty words that I recently had you learn?" The task thus differs from a recall task in which the participant is simply asked to recall the twenty words without any hints or reminders. Procedural memory refers to remembering some mental or physical skilled procedure, such as skating, driving a car, playing a musical instrument, or playing chess. Success at these tasks does not require that you remember where and when you learned the skill, only that you are still able to perform the task successfully. Similarly, semantic memory – remembering a body of learned knowledge – does not require memory of the time and place of original learning but simply error-free access to the facts themselves.

One way that I have characterized differences between these two classes of memory tasks is in terms of the degree of "environmental support" that each task involves. The idea here is that aspects of the current context, or aspects of the task itself, can help to reinstate

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the appropriate pattern of mental and neural processes at the time of retrieval. So if a learned item is re-presented in a recognition test it helps to drive the system back into the same configuration that it held during the encoding process. Similarly, remembering details of an earlier event is aided by returning to "the scene of the crime." On the other hand, it is clearly possible to remember events in contexts far removed from the original happening – we can reminisce about childhood episodes or recent vacations in our present-day living rooms. I have suggested that this aspect of remembering relies on "self-initiated activities" of the mind/brain, and that such self-initiated processing helps to bootstrap the system into the configuration that yields the experience of confident remembering. Thus, as many people have suggested, memory retrieval is a process of reconstruction. In my view, the processes of environmental support and self-initiated activities play complementary roles in achieving this reconstruction. It follows that as environmental support increases, there is less need for self-initiated processing; the two sources of support trade off against each other.

With regard to aging, my suggestion is that self-initiated processing becomes progressively more difficult to accomplish as a person grows older, and therefore older adults must rely progressively more on environmental support for successful remembering. Age-related difficulties with self-initiation are attributed to inefficiencies of frontal lobe functioning; it is well established that the frontal lobes are among the earliest brain regions to suffer the negative effects of aging. The suggestion, then, is that the memory tasks performed poorly by older adults, especially unaided recall of episodic memories, recollection of the source of factual information, and prospective remembering at a later time, are all tasks that are not well supported by the external environment and therefore require substantial amounts of self-initiated activity, which older adults find more difficult to carry out.

Other researchers have pointed out that this greater age-related dependence on environmental support comes at a cost – a loss of internal control. Whereas I have talked in terms of the environment playing a greater role in reinstating memories, other colleagues have shown that increased environmental support helps older adults establish and maintain the cognitive representations necessary for thought and action. While younger adults are able to rely on frontal brain processes to provide self-initiated or internal control, older adults lose this ability to some degree and must therefore rely more on the external environment to provide control of cognitive operations. In many ways, this age-related reversion of control to the environment reverses a general evolutionary trend for control of behavior to become progressively more internalized in higher organisms. That is, the behavior of simpler organisms is often triggered or guided by external stimuli, whereas the behavior of more evolved species is increasingly controlled internally. In this sense, then, the processes of human aging force older adults a notch down the evolutionary ladder!

Various colleagues in my area of research have pointed to other age-related problems of cognitive processing. One such notion is that older adults are less able to inhibit unwanted material; this is seen in less efficient focusing of attention ("lack of concentration"), resulting in poorer memory encoding, and a greater vulnerability to interfering sources of information during memory retrieval. Others have illustrated the undeniable fact that mental processes slow with age, and have suggested ways in which this slowing may affect memory. Still others have shown that older adults have a particular problem with associative information – linking names to faces, for example. Unlike some other problems of aging, the decrement in associative information may be attributable to medial-temporal regions of the brain, especially the hippocampus. A final theory of age-related changes in memory is therefore likely to embrace a number of ideas at the level of cognitive psychology and also a number of structures and processes at the level of brain anatomy and physiology. This greater knowledge will enable us to understand memory pathologies more fully and may hopefully provide us with techniques and devices to compensate the cognitive losses that accompany aging. Speaking as an older adult myself, I hope this happens soon! ■

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