MEMORY FUNCTIONS

Defined generally, memory is the capacity to preserve and recover information. Yet neither memory's operation nor its structures are easily understood without some consideration of function. Like other biological systems, the capacity to remember evolved because of its fitness-enhancing properties. Memory helped solve adaptive problems that, in turn, increased the chances of survival and genetic transmission. As a result, memory's operating characteristics likely bear the imprints of the specific selection pressures that shaped their development.

For example, seasonal variation in the availability of food leads some birds to store small quantities of food in widely scattered locations. Food-storing birds, such as Clark's nutcrackers and marsh tits, later show a remarkable ability to locate and recover this food during the harsh winter season. In laboratory tests, these birds perform better on some tests of spatial memory, and show larger hippocampal volume, than do other non-storing species (Clayton, 1995). The mechanisms that produce these differences have yet to be identified fully, and learning potentially plays a role in the development of these abilities, but few question the tight functional link between mnemonic ability and the particular environmental and/or selection pressures faced by the organism (Heyes, 2003). To understand how memory works—its "tunings"—it is essential to attend closely to the functional problems that memory needs to solve.

In the human domain, cognitive psychologists historically have given little attention to the functions of memory, choosing instead to focus on the structural properties of memory systems and tasks. It is common for researchers to propose various memory systems, such as working memory, procedural memory, and semantic memory, but without detailed consideration of the specific problems that those systems emerged to solve. Similarly, a great deal is known about how to improve memory—e.g., form a visual image, space repetitions of material, practice retrieval through testing—yet very little is known about how or why these particular sensitivities developed. What were the adaptive problems, ancestral or ontogenetic, that helped shape memory's sensitivity to imagery or to the spacing of repetitions? Anderson and Schooler (1991) have speculated that our memory systems may be tuned to remember how events naturally occur and recur in the environment; this may help to explain how the accessibility of stored material changes with time, but analyses of this sort are rare and capture only a small portion of the ultimate functions of remembering.

What, then, are the true functions of memory? From an evolutionary perspective, of course, one is encouraged to focus on memory's fitness-enhancing properties. Memory mechanisms must be geared especially to helping us perform actions that enhance our reproductive fitness. The emphasis here is placed on memory's ability to increase the adaptive value of behavior in the present, particularly as it applies to survival and reproduction, not simply as a device to recover intact records of the past. The past can never occur again, at least in exactly the same form, so there is questionable adaptive value in designing a system simply to recover the veridical past. Instead, memory processes are likely engineered to use the past in the service of the present, or perhaps to predict the likelihood of events occurring in the future. There is substantial evidence that remembering is a constructive process, a blending of the present with the past (e.g., Schacter & Addis, 2007). In addition, growing behavioral and neural evidence indicates that memories of the past play a vital role in the envisioning of future events (Szpunar & McDermott, 2008).

More controversial, though, is the notion that our memory systems show content-specificity—that is, they are tuned to remember some kinds of information better than others. Psychologists usually appeal to general memory processes, such as encoding, storage, and retrieval, and assume that these processes operate similarly across materials and domains. Successful retention is determined mainly by the degree of "match" between the conditions present at encoding and those existing at the point of the retrieval query (Tulving & Thomson, 1973). Encoding processes establish a memory record that, in turn, determines the range of retrieval cues that will be effective in providing later access to that record (i.e., those cues that match the ones present at encoding). Although some kinds of situations may engender richer or more elaborate memory records, and thus create records that are more likely to be matched in later environments, the memory processes themselves are assumed to be domain-general, or insensitive to content.

Yet from a fitness perspective, not all occurrences are equally important. It is much more important to remember the appearance of a predator, the location of food, or the recent activities of a prospective mate than it is to remember events and activities that do not relate directly to fitness. Indeed, Klein (2007) has argued that the ability to relive past experiences through episodic memory, which may be a uniquely human characteristic, is an evolved adaptation designed specifically to help us interact in the social world. Ancestrally, humans lived in small bands and needed the ability to develop a sense of personal identity and to differentiate effectively among other members of the social group (e.g., track coalitional structure, identify cheaters, develop accurate personality assessments, track the activities of kin versus nonkin); the capacity to remember is a vital ingredient of each of these tasks. One can also imagine memory playing a critical role in navigational abilities—everything from recognizing landmarks to remembering diagnostic weather patterns or relevant constellations.

Empirically, recent evidence indicates that processing information in terms of its relevance to fitness can produce excellent retention—better retention, in fact, than most (if not all) known encoding techniques (Nairne, Thompson, & Pandeirada, 2007). In the relevant experiments, participants were asked to imagine themselves stranded in the grasslands of a foreign land without basic survival materials. They were then given random words and asked to rate the relevance of each to finding steady supplies of food and water and gaining protection from predators. Later, surprise memory tests for the rated materials revealed uniformly high retention. For example, a few seconds of survival processing produced better free recall than established memory encoding procedures such as forming a visual image, self-generating the material, or relating the information to a personal autobiographical memory (Nairne, Pandeirada, & Thompson, 2008). Moreover, it is the fitness relevance of the processing that seems to matter; for example, using a scenario in which participants are asked to imagine gathering food for survival produces better memory than a scenario in which participants are asked to gather food as part of a scavenger hunt. Memory is apparently tuned to remember information that is processed for fitness.

Recognizing the fitness-enhancing properties of memory, however, tells us little about the proximate mechanisms that actually produce behavior. Some evolutionary psychologists have proposed that the mind contains thousands of cognitive adaptations, each uniquely sculpted by nature to solve some specific end (Tooby & Cosmides, 1992). Just like the organs of the body are specialized to perform particular functions—i.e., pump blood, filter impurities, manufacture insulin—so too might mnemonic "organs," be specialized to recognize and retain information particularly relevant to fitness. This "Swiss Army knife" model of the mind allows ample room for memory adaptations, much like those that have been proposed for non-human animals (e.g., birds' abilities to learn the signature songs of conspecifics). At the same time, it is notoriously difficult to establish the existence of true cognitive adaptations (i.e., specialized mechanisms that have been sculpted by the processes of natural selection), so considerable caution needs to be exercised in theory development.

The survival experiments described earlier, along with other work demonstrating that it is comparatively easy for people to associate predatory snakes and spiders with fear-eliciting stimuli (Öhman & Mineka, 2001), are representative of how functional aspects of memory can be explored empirically. One begins by speculating about the adaptive problems that our memory systems need to solve, such as remembering the location of food or predators, and then generating relevant empirical predictions. Presumably, if the adaptive problems are correctly identified, their "footprints" should be found in the operating characteristics of memory processes (e.g., memory is enhanced after survival-based processing). This kind of task analysis, in which one generates *a priori* empirical predictions based on a consideration of recurrent adaptive problems, helps to circumvent a common criticism of evolutionary psychology—namely, that evolutionary reasoning is often nothing more than a collection of post-hoc "just so" stories (Gould & Lewontin, 1979).

Even if one chooses not to focus on evolutionary determinants of remembering, however, there is still considerable merit in adopting a truly functional perspective. As noted, it is rare for memory researchers to consider function or, more importantly, the role that function potentially plays in the actual design and operation of memory systems. Even if our memory systems are shaped primarily by current or developmentally-based selection pressures, rather than ancestral environments, the act of remembering will still be purposeful and goal-directed. Thinking functionally i.e., asking questions about the "why" of remembering, is apt to open new research pathways and, ultimately, it should provide the necessary empirical and theoretical structure to discover "how" memory operates as well.

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SUGGESTED READINGS

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See also: Declarative Memory; Episodic Memory; Spatial Memory