Beads of Memory

November 01, 2008

Born with an “academic silver spoon” in his mouth and an uncanny ability to be in the right place at the right time, APS William James Fellow Award recipient Morris Moscovitch honed his interest in memory as an undergraduate at McGill University. Moscovitch was born in Bucharest but grew up in Israel and Montreal. In 1971, he began teaching at the University of Toronto and credits much of his success in the field to his early years of uninterrupted research. “I was too playful to do anything else but research. They didn’t trust me with a pencil, let alone the department’s budget,” Moscovitch joked during his award address at the APS 20th Annual Convention in Chicago.

Moscovitch’s contributions to psychology are unparalleled. Consistent with William James’ early musings on the underpinnings of memory, his research explores how memories are formed, organized, and retrieved and what neural substrates are implicated in that process. Moscovitch is widely known for developing the influential Multiple Trace Theory (formulated with Lynn Nadel), which has reshaped current thinking about the function of the hippocampus and the ways that memories are represented in the brain.

One of his first glimpses into the structure of memory arose from a patient who was a confabulator. Confabulation is the unintentional distortion of memories that are patently false and often inconsistent with other knowledge, memories, or context. Moscovitch describes this phenomenon as “honest lying” where patients are unaware that they are lying but insist on the truth of their words. Confabulation is often a result of damage to the basal forebrain and the frontal lobes.

Revealing the intricacies of confabulation, Moscovitch read from a transcript of a patient, H.W., who was 61 years old and in the hospital with ventromedial prefrontal cortex damage. When asked his age, H.W., said that he was “42…no, 62.” When asked how long he’d been married, H.W. replied confidently, “4 months.” When he remembered he had four children, he laughed and said “not bad for 4 months!” Moscovitch explained that H.W. realizes what he is saying is ludicrous, but he maintains that it is true because he believes it to be a salient memory.

Moscovitch with Asaf Gilboa and their collaborators showed that these distortions in memory extend past episodic memories into semantic memories. For example, when asked to retell common fairy tales, like Little Red Riding Hood, or Jack and the Beanstalk, only confabulators will make idiosyncratic errors. For example, when retelling Jack and the Beanstalk, a confabulator might say, “He was a passenger on this ship, so he had a beanstalk growing while he was on his way over to Europe.” Or, with Little Red Riding Hood, “Should be a chicken, she was a hen I presume, I think she was the leader of a group. They’re hunting for something in the woods.” Because they cannot recall the exact story line, confabulators will essentially embellish details about the characters so that it makes sense to them.

Moscovitch’s findings assert that that memories are not stored as whole representations of events, but as elements of the event that need to be reconstructed at retrieval into a coherent narrative. As Moscovitch

illustrates it, memories are stored like beads in a jar which are strung into a necklace at the time of retrieval. However, damage to certain areas of the brain impairs this retrieval.

Moscovitch explained that the hippocampus and related structures in the medial temporal lobe, along with structures in posterior neocortex to which they project, are necessary for storing the beads which are strung together in the prefrontal cortex. Since the 19th century, most investigators believed that "…the hippocampus is a temporary memory structure, needed only until memories are consolidated elsewhere in the brain," he stated. To that effect, in the event of serious brain damage, recent memories should be more vulnerable for distortion and loss because they are not consolidated and older memories should be safe and permanent because they have already been stored.

However, while on sabbatical at the University of Arizona, Moscovitch and APS Fellow Lynn Nadel, found that this is not entirely correct. In reviewing the literature, they noted that many people with medial temporal lobe damage actually showed remote memory losses that extended 20 to 30 years back, and sometimes even to early childhood. This applied only to memories concerned with detailed recollection of autobiographical events, but not to facts about public events or about themselves. Subsequent research confirmed that patients with temporal lobe damage were able to recall the gist of past events, such as what transpired in general terms, and maybe even the place and time of the event, but they were unable to recall perceptual and other details, such as what people were wearing, what the location looked like, what kind of day it was, and so on. Moscovitch noted the importance of the hippocampus and related structures in retrieving rich contextual details: "Not everything is damaged; [damage affected] primarily storage and retrieval of perceptual [and other contextual] details that you need to re-experience an event in its totality." This fits with the idea that the damage to the medial temporal lobes impairs re-experiencing a past event in detail so that you no longer can relive it in your mind's eye. Consistent with this idea, recent functional neuroimaging studies showed that the hippocampus is activated when detailed memories of past events are retrieved, no matter how long ago those events occurred.

Much emphasis is placed on the essential role of the hippocampus in storing and retrieving memories. When an event occurs, the information is picked up in the hippocampus; merely paying attention to something encodes it in the hippocampus. The hippocampus then forms an index that binds together the neural elements that gave rise to that experience and forms a memory trace. Qualifying this notion, Moscovitch describes the hippocampus as a "stupid structure" that automatically encodes all information that is apprehended consciously and retrieves information obligatorily in response to a proper, proximal cue. So, if you have a stupid structure at the center of memory, you're going to need a strategic structure that deals with it. This is where the prefrontal cortex comes in. The prefrontal cortex guides retrieval and monitors output from the hippocampus, thus making retrieval intelligent.

Intelligent recollection is central to maintaining a long, healthy life. Moscovitch reported research that implicates memory in a host of important activities. When faced with novel situations requiring problem solving, patients with damage to the hippocampus are at a disadvantage because they are unable to remember past mistakes or imagine the future. Memory loss is even implicated in regulating food intake. "If you can't remember your last meal, you will overeat."

Moscovitch is applauded for his international collaborations, innovative research techniques, and encouraging demeanor. He has renewed our interest in memory and underscored the importance of

working at the intersection of physiology and psychology when studying the brain.