Episodic Memory

Episodic memory refers to the memory of an event or "episode." Episodic memories allow us to mentally travel back in time to an event from the recent or distant past (remote memories). Episodic memories include various details about these events, such as what happened, when it happened and where it happened. To help understand this concept, try to remember the last time you ate dinner at a restaurant. The ability to remember where you ate, who you were with and the items you ordered are all features of an episodic memory. Other examples of episodic memory include remembering where you parked your car this morning or the more remote memory of where you were when you heard about the September 11th attacks.

Episodic memory is typically thought to fall under the larger umbrella of declarative memory, meaning that episodic memories can be explicitly or consciously recalled. However, studies have suggested that details of episodic memories can be recognized even without conscious recollection of the event. Episodic memory is distinct from another type of declarative memory called semantic memory. Semantic memory refers to your fund of general knowledge. To build upon a previous example, remembering where you parked your car is an example of episodic memory; your general knowledge and concepts about what a car is and how an engine works are examples of semantic memory. Episodic and semantic memory are each related to different systems in the brain, although they are often considered to be functionally related. Episodic memory can be thought of as a process with several different steps, each of which relies on a separate system of the brain. The recollection of experiences is contingent on three steps of memory processing: encoding, consolidation/storage and retrieval.

Encoding

The initial step in forming an episodic memory is called encoding, which is the process of receiving and registering information. Encoding is necessary for creating memory representations of information or events that you experience. The process of encoding is dependent on the degree that you attend to an event or information. That is, if you are not attending to an event while it is happening because you are distracted, then you are less likely to remember the details from the event. Attention is a necessary component for effectively encoding events or information. Encoding of episodic memories is also influenced by how you process the event. Encoding of information can be strengthened by an "elaboration process," which can involve making connections between the information at hand or relating the information to your personal experiences. For example, if you
were asked to remember and buy 10 items at the grocery store, you would likely remember more of the items if you used a strategy of making a mental connection between the items rather than if you were to simply repeat the items a couple of times. Using mnemonics or creating associations between the thing to be remembered and your personal experience can also enhance the encoding of memories. For example, if you were introduced to someone named Charlie, you might make a connection that this is the same name as your uncle as a strategy to help you remember the person’s name. Overall, effective encoding is one of the processes necessary for the recollection of events or information.

Consolidation

Memory consolidation, the next step in forming an episodic memory, is the process by which memory traces of encoded information are strengthened, stabilized and stored to facilitate later retrieval. Consolidation is most effective when the information being stored can be linked to an existing network of information. It is also strengthened by repeated access of the information to be remembered. The neural pathways from the hippocampus to the cortex underlie the process of consolidation and storage. The number of neurons that are dedicated to a particular memory, as well as the frequency with which they fire together, help to strengthen the memory traces within the cortex. This process of consolidation occurs over the course of days to weeks and is subject to reorganization when new, relevant information is learned. This reorganization assists in the storage of the new information, but also continues to strengthen the previously assimilated information. When a memory trace has been consolidated, the memory trace can be stored for later retrieval indefinitely.

Retrieval

The last step in forming episodic memories is called retrieval, which is the conscious recollection of information that was encoded. Retrieving information from episodic memory depends upon contextual information or cues and whether the information was encoded and stored into memory. Thus, if the information was not properly encoded because you were distracted, you may be less likely to remember details of the event or information. Emotional, semantic knowledge, olfactory, auditory and visual factors can act as cues or contextual information to help in the retrieval of episodic memory. For example, when recalling where you parked your car you may use the color of a sign you parked near and/or the floor of the parking structure as cues. Research also states that episodic retrieval can be associated with a sense of re-experiencing (i.e., recollection?) of the event. In order to remember where you parked or did not park your car, you have to mentally travel back to the moment or time you parked.
Anatomy of episodic memory

One way in which we learn about the function of brain structures is by studying the effect of damage to these structures. Our current understanding of the anatomy of episodic memory was influenced by the study of epilepsy patient H.M. who underwent resection, or surgical removal, of the hippocampus and surrounding structures. The hippocampus, named after its resemblance to a seahorse, is a brain structure located in the inner (medial) temporal lobe. Following this surgery to reduce his seizures, he was no longer able to form new memories, implicating the hippocampus in episodic memory. Further studies have confirmed the role of the hippocampus and surrounding structures in episodic memory. We now are beginning to develop an even more nuanced understanding of the role of smaller subareas within the hippocampus proper (e.g. CA1, CA3, dentate gyrus), although consensus about the most appropriate model has not been reached.

The hippocampus does not function in isolation, but rather works in harmony with a network of other brain areas. One important network is referred to as the default mode network, which includes several brain areas including frontal and parietal regions. The default mode network has been implicated in episodic memory functioning. The hippocampus, its surrounding regions and the default mode network are susceptible to many types of neurological insults. One particular type of insult commonly seen in older adults is Alzheimer’s disease. Alzheimer’s disease pathology most often originates in medial temporal structures including the hippocampus and is known to affect default mode network connectivity. Indeed, episodic memory impairment is a hallmark sign of Alzheimer’s disease. In addition to the hippocampus and default mode network, other brain structures that play a role in episodic memory are the thalamus, mammillary bodies and the amygdala. The amygdala is thought to encode the emotional valance of memories. Specifically, the amygdala enhances encoding by orienting attention to emotionally relevant events. Furthermore, the amygdala enhances the consolidation of events that elicit an emotional response.

The brain regions associated in the default network can become activated when examining the different processes involved in episodic memory. In the brain, PET and fMRI studies have found that episodic retrieval is associated with activation in the right prefrontal cortex. As noted above, higher order functions, such as organization, reside in the frontal regions of the brain and are important for retrieval. Thus, neurologic insults to this region that impact organization may affect an individual’s ability to retrieve episodic memory. In addition, some studies indicate that superior parietal regions are involved in determining the relevance of cues and activation of the inferior parietal cortex is involved in recollection or re-experiencing of the event. The hippocampus is also activated in episodic retrieval of remote events.

Episodic Memory Impairments
There are a wide range of neurologic diseases and conditions that can affect episodic memory. These include, but are not limited to subarachnoid hemorrhage, trauma, hydrocephalus, tumors, metabolic conditions including vitamin B1 deficiency, infectious and inflammatory conditions such as Hashimoto’s encephalopathy, and neurodegenerative diseases such as Alzheimer’s disease. As mentioned, episodic memory is also influenced by an individual’s ability to attend to the environment. Therefore, any conditions that disrupt attention can also impair the encoding of information. Attention is impacted by many conditions such as head injury, Lewy body dementia and delirium. Non-neurologic issues such as medications, anxiety, depression or pain also adversely impact episodic memory.

Neuropsychological Testing

A common way to assess episodic memory is by using neuropsychological tests, including pen-and-paper, verbal and computer-based tasks. These measures give a clinician an objective method for evaluating how well a patient’s episodic memory is functioning compared to their peers. Neuropsychologists evaluate both verbal and visual episodic memory. Asking an examinee to remember a list of words or recall a story are common methods for assessing verbal episodic memory. Asking an examinee to copy a figure, and then recall it at a later time, is a common test of visual episodic memory. Neuropsychological evaluation complements other aspects of a comprehensive evaluation and is often able to detect deficits that are not captured using gross, neuroanatomical imaging.

December 8, 2014

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