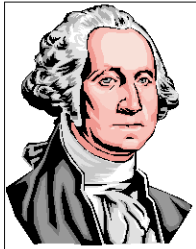
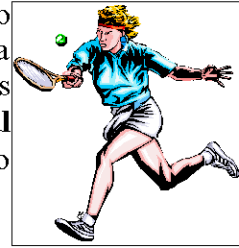


THE GENETICS OF LEARNING AND MEMORY

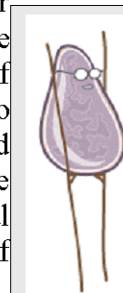
More Than One Memory

Are all memories alike? Think about some things you know how to do without conscious thinking – such as riding a bicycle, typing on a keyboard, hitting a tennis ball, driving a car... These examples are skills or experiences that rely on a kind of memory known as **procedural memory**. Procedural memories are the memories of *knowing how* to do something. What other procedural memories can you think of?



Other things we know as specific information we can recall, such as knowing your home address, your birthday, or who George Washington was. This second category of memory is called **declarative memory**. These memories involve *knowing that* a particular fact is correct. Declarative memories form our personal history. What other declarative memories can you think of?

Evidence for these different kinds of memory comes from several sources. As early as 1949, a philosopher at Oxford named Kyle had categorized memories of “knowing how” or “knowing that”, but he had no experimental evidence that our brains stored these types of memories differently. Evidence came in the 1960s and 1970s from observation of certain patients with memory problems. All of the patients had brain damage, either from surgical removal of some brain tissue or from damage caused by drinking too much alcohol. And all had amnesia, yet the amnesia was not complete. (For more about amnesia, see “**Remember Amnesia?**” in the Explore!Gallery). They had lost the memory of much of their personal history, but they could remember how to eat, brush their teeth, and get dressed. They also could learn new skills. The observation that patients could lose their declarative memory and retain their procedural memory led scientists to conclude that these two types of memory were separable.



Evidence and explanation are different things. Explanations are the result of critical and creative thinking about evidence gathered from carefully designed experiments and observations.

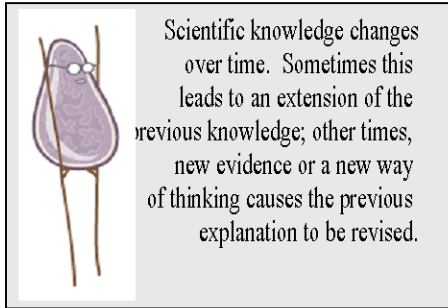
Both procedural and declarative memories can be observed in animals other than humans. One of the classic examples of procedural learning in animals is conditioning in cats – a pet cat will learn when it is being fed by associating food with the sound of a can being opened. The cat will come running every time it hears the owner opening a can. Even invertebrate animals such as sea slugs demonstrate procedural memory.

Some animals show examples of memory that resembles declarative memory in humans. For example, mice have strong ability to learn positions of things in their environment. This memory of space resembles human’s ability to remember facts and events, their declarative memory.

The Long And Short Of It

Memories differ in other ways, too. Both declarative and procedural memories are acquired by the brain and then stored for future use. A memory is first acquired as a temporary experience or fact. If it is properly processed, a version of the memory is then held for long-term storage.

One of first people to ask an answerable question about memory was a scientist named Donald Hebb. In 1949 Hebb asked: what is the difference in short-term and long-term



memories? From evidence he collected through his research, he concluded that short-term memory is active but lasts only briefly and makes no permanent physical change. Long-term memory results from actual structural changes in the nerve tissue. Many researchers have added evidence to this explanation. Some evidence for these differences in memory comes from brain injuries. Additional evidence for the way short and long-term memories form comes from experiments with normal and mutant animals such as fruit flies and mice.

Fifty years after Hebb began studying the differences between short-term and long-term memory, researchers including Eric Kandel received a Nobel Prize for discovering the molecular differences between short-term and long-term memory. (For more about the Nobel Prize, see “**Slugs Take The Prize**” in the Explore!Gallery).

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