The pilot and autopilot within our mind-brain connection: Conscious vs. unconscious, habit vs. non-habit examined

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(Medical Xpress)—Have you ever driven to work so deep in thought that you arrive safely yet can't recall the drive itself? And if so, what part of "you" was detecting cars and pedestrians, making appropriate stops and turns? Although when you get to work you can't remember the driving experience, you are likely to have exquisite memory about having planned your day.

How does one understand this common experience? This is the question posed by Professor of Biology, John Lisman and his former undergraduate student, Eliezer J. Sternberg, now in medical school, in a recent paper in the *Journal of Cognitive Neuroscience*. Lisman explains that once a task such as driving has become a habit, you can perform another task at the same time, such as planning your day. But looking closer at these two behaviors, driving and planning, one can see interesting differences. The Habit system that is driving you to work is non-flexible: if the new parking regulations at work require you to go left instead or right, the likelihood that you'll go right is very high. On the other hand, if you heard yesterday that your boss has scheduled a group meeting for noon, the likehood that you'll plan your day accordingly is high. In other words, your non-habit system is flexible.

What interests Lisman and Sternberg is the relationship of the habit/non-habit systems to concepts of conscious vs unconscious. These concepts were popularized by Freud, who posited a duality of the human mind.

Behavior can be influenced by both the conscious system and unconscious system. Freud compared the mind to an iceberg——with the small conscious system above water and the larger unconscious system below. Modern cognitive neuroscience now accepts this duality.

The mind can be described as having an unconscious and conscious part. And the brain can be described as having both habit and non-habit systems. Lisman and Sternberg argue that these two views can be merged: there is a habit system of which we are unconscious and a non-habit system of which we are conscious.

This simple equation turns out to have enormous implications for research on the mind-brain connection. Experiments on consciousness are done in humans because you can ask them to report their awareness, something you can't do with animals. On the other hand, there are many invasive procedures for studying what's happening in the brain of animals. So how can you study consciousness in rats?

Lisman and Sternberg provide a simple answer—ask whether rats have habit and non-habits. Scientific literature demonstrates that rats indeed have both habits and non-habits. For instance, when a rat comes to a choice point on a maze (and the reward site is to left), rats display very different behavior depending on how much experience they've had with that maze. With relatively little experience, rats pause at the choice point and look both ways before making a decision; in contrast, a highly experienced rats zooms left without stopping. Experiments have shown that different parts of the brain are involved in these two phases. Lisman and Sternberg make two conclusions: first, that rats, like us, have conscious and unconscious parts of the brain and second, that from experiments on rats we can learn to identify the parts of the brain that mediate conscious vs unconscious processes.

In their paper, Lisman and Sternberg also discuss potential objections to

their hypothesis, and suggest further tests.

"Our tentative conclusion is that it is reasonable to equate the habit system with unconscious processing and the non-habit system with conscious processing," says Lisman. "We further argue that both systems are capable of sensory processing and action but utilize different brain regions, have access to different forms of memory, and excel at different computations."

For instance, only the conscious system can store and recall information from episodic memory system, a process mediated by a structure called the hippocampus.

The benefit of such a dual system, Lisman says, is that it gives an organism the ability to multitask; the unconscious system can execute background tasks, leaving the conscious system to perform more difficult tasks, such as mentally preparing for a presentation while driving to work.

"Understanding how different brain regions function together to produce behavior is a major goal of modern neuroscience," says Lisman. "If both the conscious and unconscious system can process sensory information and produce actions, there must be mechanisms that determine which system will control behavior."

In some cases, he says, the underlying logic is simple, as in multitasking, where the unconscious controls the routine behavior. But, in other cases, he says, the logic of control is less clear; you may decide to go on a diet yet suddenly find yourself removing ice cream from the freezer. The study of habit and non-habit behavior in animals provides a path toward understanding how conscious and unconscious systems compete for control.

Lisman says he hopes his effort to unify the understanding of conscious and unconscious systems and habit and non-habit systems will lead to a better understanding of what we are as human beings.

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