Hypnosis, Memory and the Brain

A new study points to specific areas of the brain affected by hypnosis. The technique could be a tool for exploring what happens in the brain when we suddenly forget.

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Credit: james steidl

Hypnosis has long been considered a valuable technique for recreating and then studying puzzling psychological phenomena. A classic example of this approach uses a technique known as posthypnotic amnesia (PHA) to model memory disorders such as functional amnesia, which involves a sudden memory loss typically due to some sort of psychological trauma (rather than to brain damage or disease). Hypnotists produce PHA by suggesting to a hypnotized person that after hypnosis he will forget particular things until he receives a "cancellation," such as "Now you can remember everything." PHA typically only happens when it is specifically suggested and it is much more likely to occur in those with high levels of hypnotic ability, or "high hypnotizable" people. Now a new study shows that this hypnotic state actually influences brain activity associated with memory.

High hypnotizable people with PHA typically show impaired explicit memory, or difficulty consciously recalling events or material targeted by the suggestion, and a dissociation between implicit and explicitmemory, so that even though they can't recall the forgotten information it continues to influence their behavior, thoughts and actions. The forgetting is reversible—when the suggestion is cancelled, their memories come flooding back. These last two features—the dissociation and reversibility—confirm that PHA is not the result of poor encoding of the

memories or of normal forgetting, because the memories return as soon as PHA is cancelled. Rather, PHA reflects a temporary inability to retrieve information that is safely stored in memory. That makes it a useful tool for research.

Researchers have used PHA as a laboratory analogue of functional amnesia because these conditions share several similar features. Case reports of functional amnesia, for instance, describe men and women who, following a traumatic experience such as a violent sexual assault or the death of a loved one, are unable to remember part or all of their personal past. However, as in PHA, they might still show "implicit" evidence of the forgotten events. For instance, they might unconsciously dial the phone number of a family member whom they can't consciously recall. (In contrast, explicit memories are those we consciously have access to, such as remembering a childhood birthday or what you had for dinner last night.) And, as suddenly as they lost their memories, they can just as suddenly recover them.

Forgetting in the Brain

But for the comparison between PHA and functional amnesia to be most meaningful, we need to know that they share underlying processes. One way to test this is to identify the brain activity patterns associated with PHA. In a groundbreaking study published in *Neuron*, neuroscientist Avi Mendelsohn and colleagues at the Weizmann Institute in Israel did just that using functional magnetic resonance imaging (fMRI). They carefully selected 25 people to participate in their experiment. Although all were susceptible to hypnosis, earlier testing had shown that half could respond to a PHA suggestion (labelled "the PHA group") and half could not (the "non-PHA group"). In the Study session of their experiment, participants watched a 45-minute movie. One week later, in the Test session, participants returned to the laboratory and were hypnotized while they lay within the fMRI scanner. During hypnosis, people in both the PHA and non-PHA groups received a suggestion to forget the movie until they heard a specific cancellation cue.

After hypnosis, participants' memories were tested twice while the fMRI scanner recorded their brain activity. For Test 1, they were asked 40 questions about the content of the movie (for example, the actress knocked on her neighbor's door on the way home) and 20 questions about the context in which they saw the movie (for instance, during the movie, the door to the study room was closed). These questions required a "yes" or "no" response. For Test 2, participants were asked the same 60 recognition questions, but first they heard the cue to cancel PHA. So Test 1 measured memory performance and brain activity while the PHA suggestion was in effect and Test 2 measured memory performance and brain activity after it was cancelled.

In Test 1 Mendelsohn and colleagues found that people in the PHA group (who could experience PHA) forgot more details from the movie than people in the non-PHA group (who could not experience PHA). But in Test 2, after the suggestion was cancelled, this memory loss was reversed. People in the PHA group correctly recognized just as many details from the movie as people in the non-PHA group. Somewhat surprisingly, however, the suggestion to forget was selective in its impact. Although people in the PHA group had difficulty remembering the content of the movie following the forget suggestion, they had no difficulty remembering the context in which they saw the movie.

This finding—that PHA temporarily disrupted some people's ability to recall the past—echoes decades of hypnosis research. What is entirely new in Mendelsohn et al.'s study is their demonstration that PHA was associated with a specific pattern of brain activation. Consistent with what normally occurs in remembering, when people in the non-PHA group performed the recognition task and successfully remembered what happened in the movie, fMRI showed high levels of activity in areas responsible for visualizing scenes (the occipital lobes) and for

analyzing verbally presented scenarios (the left temporal lobe). In stark contrast, when people in the PHA group performed the recognition task and failed to remember the content of the movie, fMRI showed little or no activity in these areas. Also, fMRI showed enhanced activity in another area (the prefrontal cortex) responsible for regulating activity in other brain areas.

So far, so good. For people in the PHA group, brain activation measured by fMRI correlated with the failure to remember. But what if reduced activation is always found in such people regardless of whether they are remembering or forgetting? We can rule this possibility out because people in the PHA group showed reduced activation only when they (unsuccessfully) answered questions about the content of the movie, not when they (successfully) answered questions about the context of the movie. Indeed, for the context questions, they showed the same activation as people in the non-PHA group. Perhaps then, the reduced activation reflects complete forgetting of the information, not just temporary suppression? We can rule this possibility out also because, in a neat reversal, people in the PHA group showed normal activation—just as those in the non-PHA group did—as soon as the suggestion was cancelled.

Hypnosis Is Real

Mendelsohn et al.'s study is important because it demonstrates that hypnotic suggestions influence brain activity, not just behavior and experience. Hypnotic effects are real! This fact has been demonstrated clearly in earlier work, for instance, by psychologist David Oakley (University College London) and colleagues, who compared brain activation of genuinely hypnotized people given suggestions for leg paralysis with brain activation of people simply asked to fake hypnosis and paralysis.

This latest study is also important because it starts to specify the underlying brain processes, which we assume are shared by PHA and functional amnesia. Mendelsohn et al. argued that the brain activation seen in PHA reflects a dampening—some form of rapid, early inhibition of memory material—due to heightened activity in the prefrontal cortex.

But how does the suppression mechanism decide what to suppress? In this study, movie content but not movie context was influenced by PHA. Memories involve the "what," "how," "when" and "where" of an event interwoven together, such that distinctions between content and context may be blurred (for example, "Was the movie shot with a hand-held camera?"). To make such fine discriminations, the brain's suppressor module presumably needs to process information at a sufficiently high level. Yet this module needs to act quickly, preconsciously suppressing activation of the information before it even enters awareness. Brain imaging technologies with superior temporal resolution to fMRI, such as magnetoencephalography (MEG), might help to resolve this seeming paradox of sophisticated, yet rapid, operations.

We also wonder how the suppression mechanism in PHA relates to the vast array of forgetting in the laboratory and in the world? Whereas some forgetting is seen as strategic, effortful and conscious (say, suppression), other forgetting is seen as automatic, effortless and unconscious (say, repression). Having mapped the common features of PHA and functional amnesia, we now need to explore and compare in greater detail their common processes (such as strategy use, motivation, level of awareness).

Finally, the neural underpinnings of PHA will be even clearer when we incorporate its most important aspect in imaging studies—the dissociation between implicit and explicit memory. In PHA (and in functional amnesia) the person is unable to explicitly recall certain information, yet we see evidence of this material on implicit measures. For instance, a participant given PHA may fail to recall the word "doctor," learned earlier, but will have no trouble completing the word fragment "d _ _ t _ r". Mendelsohn et al. did not assess implicit memory. Rather, they tested

recognition, which in a sense confounds explicit and implicit memory. We'd like to compare brain scans of a PHA group trying to explicitly recall the movie (they should show reduced activation, as above) with brain scans of the same group completing an implicit memory measure of the movie (they should show normal activation). This would be tricky to do—implicit measures of complex material such as movies and autobiographical memories are hard to find or construct. But it would contribute to a more complete neural picture of the processes involved in these fascinating forms of forgetting.

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