Young woman with amnesia unable to hold a single face in short-term memory

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A 22-year-old woman known as "HC" with amnesia since birth as a result of developing only half the normal volume of the hippocampus in her brain, has demonstrated to scientists that the ability to hold a single face or word in short-term memory is impaired. But there's a catch – only if the information is unfamiliar.

When presented with a face such as Hollywood celebrity Paris Hilton and asked to recognize the face a few seconds later, the woman could remember A-list party girl Hilton, but she was unable to remember novel, unfamiliar faces as well as healthy age, education and IQ matched control participants. Moreover, HC's short-term memory was even impaired for faces that were famous, but whom HC did not know, such as former U.S. first lady Hillary Clinton.

The single case study with the woman was led by Baycrest's Rotman Research Institute, in collaboration with the University of Toronto. The study is posted online in the science journal Neuropsychologia, ahead of print publication.

It is considered an important finding for understanding the nuanced workings of short-term memory in people with a devastating memory disorder such as amnesia. The study provides the first strong evidence that the short-term memory deficit in amnestic individuals is most apparent only when the individual is trying to recall new information that is "unfamiliar" to them. When information is already "familiar" from past repetitive exposure, it is more likely to be retained in short-term

memory, also known as "working memory".

Despite HC's severe memory impairment – the result of experiencing hypoxia (loss of oxygen) in the first week of life – she is a relatively normal functioning individual and college graduate, who is an avid film buff and celebrity watcher.

"This woman is missing 50 percent of the normal volume of her hippocampus with no obvious damage to other parts of her brain. This provides an extraordinary opportunity to generate new insights about how this crucial memory centre of the brain affects both short-term and long-term memory," said lead investigator Nathan Rose, a post-doctoral fellow in Cognitive Neuroscience at Baycrest's Rotman Research Institute.

"We wanted to test if HC's short-term memory was impaired, and, if so, whether this impairment only existed for novel stimuli. That is exactly what we found."

Amnestic individuals have profound deficits in long term memory and yet many seem to function fine by relying on their short-term memory which has traditionally been thought to be intact. However, a growing body of scientific evidence, including this latest study, is showing that "working memory" is also impaired in this population.

"Our findings add to the growing evidence that short-term memory is not intact in amnesia. However, to my knowledge, we are the first to directly test the hypothesis that short-term memory functions better if the information has some past familiarity to the person," said Rotman scientist Dr. Fergus Craik, a collaborator on the study and co-editor of the O*xford Handbook of Memory*.

That may explain why individuals with amnesia are often able to

compensate for their profound memory deficit in social settings by seeking out familiar cues to support short-term memory.

Rose conducted the study with Dr. Craik and Dr. Shayna Rosenbaum, an associate scientist at Baycrest's Rotman Research Institute and Associate Professor in the Department of Psychology at York University. Dr. Rosenbaum has previously studied HC and other unique cases of severe amnesia that have been a boon for scientific advancement in understanding human memory function.

Single cases with a clear pattern of specific brain deficits, such as HC, are incredibly rare and important for neuroscience. These cases enable researchers to generate more precise data that demonstrates a specific brain area is necessary for certain memory functions. Most individuals with amnesia typically present with diffuse damage in the brain which can complicate brain imaging and behavioural data interpretation.

The study In the study, HC and a control group of 20 undergraduate students participated in two experiments that tested their "working memory" – which is the ability to retain information (whether visual or verbal) for several seconds.

In the visuospatial experiment, participants were shown 40 famous faces and 40 non-famous faces and asked to recognize the faces after a short delay. HC had more difficulty than the control group in recalling non-famous faces ("unfamiliar" information) scoring 70% in accuracy compared to the control group's 81%. However, HC's recognition of famous faces ("familiar" information) was unimpaired relative to the controls; she scored 85% in accuracy – exactly the same as the control group. Drilling down, HC's "working memory" performance was most robust (89% accuracy) for famous faces with which she was most familiar (for example, Paris Hilton).

In the second experiment, short lists of number sequences (like phone numbers) were visually presented to participants. They were to remember the correct sequences immediately afterward. HC could do this task perfectly fine, but when a distractor sentence had to be read aloud prior to the presentation of each digit, her performance was impaired compared to the controls.

A third memory test involved reading and then recalling familiar and less familiar words in the English lexicon (direction/common, fledgling/less common), as well as non-words (firpking). HC was also impaired (compared to controls) on the word task, but the impairment was larger for less familiar words and non-words. She performed almost as well as the healthy controls for familiar words.

For clinicians involved in cognitive rehabilitation, this latest evidence suggests that presenting information in a familiar context to individuals with amnesia may provide a significant benefit to their short-term memory function.

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