Neural mechanism may underlie an enhanced memory for the unexpected

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The human brain excels at using past experiences to make predictions about the future. However, the world around us is constantly changing, and new events often violate our logical expectations. "We know these unexpected events are more likely to be remembered than predictable events, but the underlying neural mechanisms for these effects remain unclear," says lead researcher, Dr. Nikolai Axmacher, from the University of Bonn in Germany.

Dr. Axmacher and colleagues, whose new study is published by Cell Press in the February 25 issue of the journal *Neuron*, investigated the relationship between novelty processing and memory formation in two key brain structures, the hippocampus, and the nucleus accumbens. The hippocampus plays a key role in memory formation while the nucleus accumbens is involved in processing rewards and novel information. Previous work had suggested that information transfer between these structures may be associated with enhanced memory for unexpected items or events.

Obtaining direct information on the electrical activity of these structures deep in the brain is usually impossible in humans. However, the researchers used the opportunity to record from two groups of patients with electrodes implanted in these regions: Epilepsy patients awaiting surgical treatment of severe epilepsy, and patients with treatment-resistant depression undergoing deep-brain stimulation. Both groups of participants studied pictures of faces and houses in grayscale that were usually presented on a red or green background, respectively.

Occasionally, a picture would have an "unexpected" configuration, such as a face on a green background. Subjects were subsequently tested for their memory of the expected and unexpected items.

The researchers discovered that unexpected stimuli enhanced an early and a late electrical potential in the hippocampus and the late signal was associated with a memory for the unexpected picture. In the nucleus accumbens, there was only a late potential which was larger during exposure to unexpected items. "Our findings support the idea that hippocampal activity may initially signal the occurrence of an unexpected event and that the nucleus accumbens may influence subsequent processing which serves to promote memory encoding," explains Dr. Axmacher.

The authors are careful to point out that one limitation of their study is that the recordings from the hippocampus and nucleus accumbens came from two separate groups of subjects, so their data provide an indirect measure of the functional connectivity between these two brain areas. However, their findings do provide fascinating new insight into this complex brain circuit. "Taken together, these are the first results that speak to the relative timing of expectation effects in different regions of the human brain, and they support models of accumbens-hippocampus interactions during encoding of unexpected events," concludes Dr. Axmacher.

More information: “Intracranial EEG Correlates of Expectancy and Memory Formation in the Human Hippocampus and Nucleus Accumbens.” Publishing in Neuron 65, 541-549, February 25, 2010. DOI 10.1016/j.neuron.2010.02.006

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