Memory for details matures gradually

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Too many details: Principally, children usually remember experiences quite well. But in order to be able to remember details, their brain has to mature until the age of 14. Credit: Axel Griesch/MPG

In contrast to previous assumptions, the hippocampus, a brain structure

that is central to learning and memory, does not complete its maturation until adolescence. Scientists of the Max Planck Institute for Human Development, the Max Planck UCL Centre for Computational Psychiatry and Ageing Research, and the University of Stirling were able to show this for the first time using high-resolution magnetic resonance imaging. The study's findings were recently published in the scientific journal *Proceedings of the National Academy of Sciences* (*PNAS*).

If you ask younger children what they had for supper the evening before, they are likely to respond with a general statement rather than exact details. For instance, they say "cheese" rather than "cheddar." Children are good at categorizing experiences, but not as good at remembering details. Despite these observations, most researchers assumed that brain regions that are responsible for memorizing and recalling details are already fully mature by the age of six years. This new study now shows that the maturation process lasts until the age of about 14 years.

In order to reach this conclusion, the scientists of the Max Planck Institute for Human Development, the Max Planck UCL Centre for Computational Psychiatry and Ageing Research, and the University of Stirling utilized new high-resolution measurement and analysis techniques in magnetic resonance imaging (MRI). The hippocampus, a region deep inside the brain, plays a central role for memorization and recall of details, as well as general memory performance. Using high-resolution imaging the scientists were able to obtain information about the sizes of different subregions of the hippocampus.

The study involved 70 children and adolescents aged 6 to 14 years as well as 33 young adults aged 18 to 26 years. "Looking at the images, we quickly realized that the age differences in the subregions do not follow a standard pattern and a lot is still happening beyond the age of six," says Attila Keresztes, first author and scientist at the Center for Lifespan Psychology of the Max Planck Institute for Human Development.

A special task assessed whether the participants remember details of objects or their general characteristics. For instance, they were shown pictures of a telephone or a book. Later on in the task, these pictures were shown with minor changes and mixed between new pictures. The participants were then asked to indicate whether they had seen the respective object before, and if so, whether it had changed as compared to the first run.

The scientists also examined how the development of the hippocampal subregions is associated with age. In particular, two subregions showed age-related differences linked to differences in memory for details: the dentate gyrus, whose function consists in, among others, the separation of features so that they can be recalled separately, and the entorhinal cortex, whose cortical connections contribute to memory formation, stabilization, and retrieval.

"The insight that these two subregions and the hippocampus as a whole only complete their maturation in adolescence has changed our perspective on the development of learning and memory. We are now asking how the late maturation of the hippocampus influences its interactions with other brain areas. We will examine this in depth in further studies," says Markus Werkle-Bergner, project head at the Center for Lifespan Psychology of the Max Planck Institute for Human Development, who led this study together with Yee Lee Shing of the University of Stirling.

More information: Attila Keresztes et al. Hippocampal maturity promotes memory distinctiveness in childhood and adolescence, *Proceedings of the National Academy of Sciences* (2017). DOI: 10.1073/pnas.1710654114

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