Solving a paradox of children's memory

Recently discovered patterns of brain development may explain some of the puzzles of childhood memory development

by Attila Keresztes
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Why do children have such poor memories, despite being excellent learners, for such a long time in the course of their development? Recent findings may offer an explanation.

Children are peculiar in many ways, but this one is a real riddle: They are champion learners with a catastrophically bad memory. How can this be? How can they acquire new knowledge much faster than adults, when at the same time they rarely hold on to specific memories for very long?

An answer to this question may provide insights that are important not only to parents, but also to policymakers in seeking to design age-appropriate education plans. In a recent opinion article published in Trends in Cognitive Science, my co-authors and I combine several novel experimental and neuroimaging findings with existing theories to provide one potential answer.

Knowledge acquisition often occurs through generalization. For instance, a child may generalize across different examples of dogs to learn what dogs are. Generalization may also be helpful in linking memories of events that have occurred in different contexts. Thus, for instance, children learn that their caregiver is the same from all angles. In contrast, specific events in one's life are often remembered by creating detailed, “high-resolution” memories (memory specificity).

Researchers have long suspected that knowledge acquisition and remembering everyday events represent two largely independent forms of memory: semantic and episodic. More recent theories have proposed that computational processes supporting generalization and specificity are at the heart of learning and remembering. In both cases, these forms of memory or computational processes are believed to be supported by different brain regions or networks.

Why do memories become more and more detailed as children grow older?

For at least three decades, and until recently, researchers believed that the brain region most crucial to memory specificity, the hippocampus (located in the mediotemporal lobes of the brain), matures around the end of the second year of life, and that the ability to remember specific details develops only thereafter. Today, however, we know that this is not the case.
This established view seemed to be in keeping with the fact that massive knowledge acquisition and poor memory specificity were typical of the first two years of life. However, it did not explain why the imbalance between generalization and memory specificity seems to persist into later periods of life, at least into early and middle childhood.

In particular, it seems that as children grow older, their memories are transformed from generalizations into highly detailed memories. The phenomenon that younger children tend to extract schematic knowledge at the expense of learning and recollecting specific events was noted many years ago by Jean Piaget, the famous Swiss developmental psychologist.

“How can children acquire new knowledge much faster than adults, when at the same time they rarely hold on to specific memories for very long?”

Scientists have sought to understand why the balance between generalization and memory specificity continues to shift as a child develops, and they have recently found clues in novel computational models as well as in groundbreaking developments in magnetic resonance imaging of the brain, which have made it possible to record images of the living human brain at an unprecedented level of resolution.

Recent findings from neuropsychology, experimental psychology and cognitive neuroscience, as well as novel computational theories, suggest that the hippocampus is necessary not just for specificity, but for generalization as well.

High-resolution magnetic resonance imaging studies show that the hippocampus continues to develop beyond the start of middle childhood (at around 6 years of age), and that this development is characterized by regionally specific changes within the hippocampus. These results suggest that continued hippocampal development is most robust in regions that have a specific role in performing neural computations that support memory specificity.

Memory specificity seems to develop more slowly than generalization

We and others have recently published data that suggest that generalization and specificity develop at different speeds. Memory specificity seems to develop more slowly than generalization, and indeed, memory appears to shift from generalization to specificity. In a recent study, we have also shown that this shift is partly driven by region-specific maturational changes within the hippocampus.

This distinction between the developmental trajectory of specificity and generalization goes beyond classical descriptions of memory development in cognitive psychology. It focuses on the development of particular computations that support memory, which are tied to the development of specific regions within the hippocampus. Thus it offers a potential mechanistic solution to the puzzle of why children continue to be excellent learners, yet have poor memories, for such a long time in their development.

As Chi T. Ngo and Nora Newcombe note in their recent study, this may be an evolutionarily adaptive solution, since it may be more important for children to use their resources to accumulate knowledge than to memorize specifics of their experiences.

But of course, cautions are in order. Most studies have measured the brains of children of different
ages (in cross-sectional studies), rather than measuring the brains of the same children at different ages (in longitudinal studies). Cross-sectional studies, however, may produce results that do not truly reflect development.

The findings of such studies may reflect differences in education rather than developmental changes, for example when some children have learned to write on a laptop while others have used paper and pencil.

To confirm our findings, it would therefore be important to conduct longitudinal studies designed to assess memory development while also looking at changes in regions within the hippocampus. Such studies, along with investigations of how connections develop between hippocampal regions and other cortical areas, would make it possible to trace the general path of memory development, as well as individual differences in that path.

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