Learning to remember our past: The development of the spatial and temporal components of episodic memory.

Episodic memories for autobiographical events that happen in unique spatiotemporal contexts are central to defining who we are. Yet, before 2 years of age, children are unable to form or store episodic memories for recall later in life, a phenomenon known as infantile amnesia. In order to better understand the emergence and maturation of episodic memory in children from 2 to 7 years of age, we have studied the development of allocentric spatial memory, a fundamental component of episodic memory. We have found that whereas basic allocentric spatial memory abilities are reliably observed in children after 2 years of age, coinciding with the offset of infantile amnesia, the resolution of allocentric spatial memory acquired over repeated trials improves from 2 to 4 years of age. Moreover, although by four years of age children are capable of learning and remembering allocentric spatial information on a single-trial basis, as required for episodic memory formation, children continue to exhibit improvements in both temporal and spatial resolution until at least 7 years of age. Our parallel investigations of the neuroanatomical and molecular development of the monkey hippocampal formation suggest that the early maturation of the CA1 region of the hippocampus, which receives direct projections from the entorhinal cortex, likely underlies the emergence of basic allocentric spatial capacities, and thus likely also underlies the offset of infantile amnesia, marking the point when children are capable of forming multi-component relational memories. In contrast, our data suggest that the protracted period of neuronal addition and maturation in the dentate gyrus, and the late maturation of specific layers in different hippocampal regions that are located downstream from the dentate gyrus, particularly CA3, underlie the slow and protracted improvements in spatial and temporal resolution observed in children from 2 to 7 years of age, and thus likely also underlie the improvements in episodic memory seen in children of this age. Altogether, our molecular, neuroanatomical and behavioral findings support the hypothesis that the differential maturation of distinct hippocampal circuits underlies the differential emergence of specific "hippocampus-dependent" memory processes, culminating in the emergence of adult-like episodic memory concomitant with the maturation of all hippocampal circuits.