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Developmental Cognitive Neuroscience

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Description

Developmental cognitive neuroscience is an evolving field that investigates the relations between neural and cognitive development. Lying at the intersection of diverse disciplines, work in this area promises to shed light on classic developmental questions, mechanisms subserving developmental change, diagnosis and treatment of developmental disorders, and cognitive and neuroscientific topics traditionally considered outside the domain of development. Fundamental questions include: What are the interrelations between developmental changes in the brain (e.g. in connectivity, chemistry, morphology) and developmental changes in children's behavior and cognitive abilities Why, and how, is learning enhanced during certain periods in development? How is our knowledge organized, and how does this change with development?We discuss preliminary investigations of such questions and directions for future work [1].

Adult Neuropsychological Model

It is argued that the static adult neuropsychological model is inappropriate for explaining the development of many atypical children whose brains cannot be considered in terms of a normal brain with parts intact and parts impaired. Rather, their brains develop differently from normal children from the very outset. I illustrate this with two examples from Williams syndrome, showing how equivalent behavioral outcomes stem from different underlying processes [2].

In the past few years connectionist models have greatly contributed to formulating theories of cognitive development. Some of these models follow the approach of developmental cognitive neuroscience in exploring interactions between brain development and cognitive development by integrating structural change into learning. We describe two classes of these models. The first focuses on experience-dependent structural elaboration within a brain region by adding or deleting units and connections during learning. The second models the gradual integration of different brain areas based on combinations of experience-dependent and maturational factors. These models provide new theories of the mechanisms of cognitive change in various domains and they offer an integrated framework to study normal and abnormal development, and normal and impaired adult processing [3].

Across ontogenetic development, individuals gather manifold experiences during which they detect regularities in their environment and thereby accumulate knowledge. This knowledge is used to guide behavior, make predictions, and acquire further new knowledge. In this review, we discuss the influence of prior knowledge on memory from both the psychology and the emerging cognitive neuroscience literature and provide a developmental perspective on this topic. Recent neuroscience findings point to a prominent role of the Medial Prefrontal Cortex (mPFC) and of the Hippocampus (HC) in the emergence of prior knowledge and in its application during the processes of successful memory encoding, consolidation, and retrieval. We take the lateral PFC into consideration as well and discuss changes in both medial and lateral PFC and HC across development and postulate how these may be related to the development of the use of prior knowledge for remembering. For future direction, we argue that, to measure age differential effects of prior knowledge on memory, it is necessary to distinguish the availability of prior knowledge from its accessibility and use [4].

As humans, we do not store verbatim copies of experiences in our memory. Rather, we integrate new incoming information from the surroundings in relation to our pre-existing knowledge about the world. This knowledge is accumulated across ontogenetic development through experiences during which the individual detects regularities in the environment. Growth in knowledge is one of the most prominent aspects in ontogeny and exerts its influence on memory functioning across the whole lifespan (Craik and Bialystok, 2006). The importance of prior knowledge for memory has been introduced in the classical work of Piaget (1929) and Bartlett (1932). Bartlett (1932) showed that humans, while recalling a specific event, often construct these memories based on their knowledge about the world, thus illustrating the susceptibility of human memories to errors due to their reconstructive nature. In his work with children, Piaget (1929) showed that, in addition to the assimilation of new information into existing knowledge frames (or schemata), knowledge has to be updated frequently in order to adapt to changing demands of the environment, a process he called accommodation. Despite the long-standing recognition of the important role of prior knowledge, most psychological and cognitive neuroscience experiments are designed with the implicit assumption that learning and memory take place in a tabula rasa state of the brain. So far, surprisingly little is known about how the interaction between pre-existing knowledge and new incoming information takes place within the brain. This developmental cognitive neuroscience perspective shall guide future investigations of age-related changes in the use of prior knowledge for remembering in brain and behavior simultaneously. Throughout the review, we use the term prior knowledge in a broad sense as stored knowledge and beliefs about the world that have been acquired by an individual. This knowledge can be declarative (i.e., semantic, episodic) or non-declarative (e.g., implicit or procedural). We hereby acknowledge that differences among related terms such as conceptual knowledge, rule knowledge, associative knowledge, and schema are not being considered. Visual attention has long been regarded as a tool for studying the development of basic cognitive skills in infancy and early childhood. However, over the past decade, the development of attention in early life has emerged as an important topic of research in its own right. This essay describes recent changes in the methods used to study attention in infancy, and in the nature of inferences about the early development of attention, as both research and theory in the area have become progressively integrated with models of attention from cognitive science and neuroscience [5].

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