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Short Communication

Developmental Patterns in Perceptual Organization: Insights from Local Integrative and Action Perception Dimensions

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DESCRIPTION

Two pertinent dimensions emerge for exploring developmental patterns in perceptual organization. In the local integrative dimension, our investigation using a contour integration task suggests a gradual development of spatial integration. Additionally, children employing the Ebbinghaus illusion exhibit reduced contextual modulation of a local target [1]. In the action perception dimension, we propose a relatively slower development of the perceptual system, mediated by the ventral visual stream, compared to the development of the action system, mediated by the dorsal visual stream. In summary, the data suggest that long-range neuronal connectivity supporting perceptual organization in the posterior pole of the brain and the ventral visual pathway is not fully developed in young children [2].

The paper aims to present recent findings on the development of perceptual organization and provide a theoretical framework for these findings. Two dimensions, namely local integrative and action perception are explored for mapping developmental patterns in perceptual organization. In the local integrative dimension, the focus is on the slow development of spatial integration, particularly in posterior cortical areas of the occipital lobe [3]. The action perception dimension hypothesizes a relatively slower development of the perceptual system (ventral visual stream) compared to the action system (dorsal visual stream). The data suggest that long-range neuronal connectivity supporting perceptual organization in the posterior pole of the brain and the ventral visual pathway is not fully developed in young children.

From local to integrative

The study reviews existing knowledge on visual development in the first year of human life, highlighting early preferences for moving stimuli, flicker sensitivity, processing complex motion information, chromatic discriminations, onset of stereopsis, and increasing acuity. Visual acuity, particularly vernier acuity, continues to develop beyond the second year, emphasizing the importance of the temporal characteristics of stimuli in developmental curves.

The focus then shifts to contour integration as a paradigm for studying information integration across the visual field. The study employs a contour integration task using Gabor signals to investigate long-range interactions supporting spatial integration [4]. The results indicate the participation of these interactions in object-related processing and reveal developmental patterns in spatial integration in children aged 5 to 14 years. The findings suggest a slower development in children compared to adults and raise questions about the underlying mechanisms.

Contour integration

The study delves into contour integration, emphasizing the role of long-range interactions in spatial integration. The contour integration paradigm involves the use of stimuli with continuous paths of Gabor signals embedded in noise. The results suggest the involvement of intrinsic horizontal connections in the primary visual cortex and feedback connections from extrastriate cortex. The experiments also involve testing very young subjects and different patient populations to understand the developmental pattern of spatial integration.

Normal development of contour integration

Over 400 children with normal vision are tested with contour-integration cards, revealing a significant improvement in performance between ages 5 and 14. The study investigates the effect of practice and learning specificity, indicating that learning is specific to visual cues of orientation and color. The results also suggest that long-range interactions span a shorter spatial range in children than in adults.

Abnormal visual development and contour integration

The study explores the impact of abnormal binocular input on contour-integration performance. Results indicate reduced performance in contour integration in adults with a history of

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abnormal binocular input, even in the absence of amblyopia. The type and severity of the deficit depend on the type and timing of input abnormality and the treatment history of the patients.

Is contextual integration less efficient in children

The study predicts reduced susceptibility for contextual influences in children based on the limited range of perceptual spatial integration and reduced contextual integration observed. Experiments involving the Ebbinghaus illusion support this prediction, showing that children are minimally affected by the context of inducers compared to adults.

From action to perception

The paper explores the two major specialized subsystems of vision the dorsal (occipitoparietal) stream specializing in spatial vision and the ventral (occipitotemporal) stream specializing in form vision. Goodale and Milner's reinterpretation highlights the functional dissociation between the two streams, where the dorsal stream mediates the control of visually guided actions, and the ventral stream permits perceptual and cognitive representations of objects.

The study proposes a hypothesis that the development of the ventral visual stream mediating perception is delayed compared to the dorsal stream mediating action. This hypothesis is based on anatomical indications, human anatomical analysis, phylogenetic considerations, and the assumed greater need for early availability of structures mediating the visual control of action.

CONCLUSION

Although crucial visual functions begin to emerge within the initial year of life, the process of visual development appears to continue until the conclusion of childhood. The progression of distinct visual functions and the maturation of neuroanatomical circuits involved in visual information processing are not uniform. Within our investigation, we identified two pertinent dimensions for exploring the developmental patterns of perceptual organization. Utilizing a contour integration task to examine the local–integrative dimension, our findings indicate that long-range spatial interactions, crucial for integrating orientation information across the visual field, have a more limited spatial range in children compared to adults, reaching adult-like levels only by the conclusion of childhood. This developmental trajectory of a key integrative function suggests that contextual integration is likely to be underdeveloped in young children. This hypothesis is corroborated by observed reduced contextual modulation of a local target in children, as demonstrated through the Ebbinghaus illusion. The visual performance of subjects aged 4–5 in our experiments mirrors that of adults with dysfunction in the ventral visual stream, exhibiting relatively advanced visuomotor coordination but facing challenges in perceptual organization. In summary, our data point to the conclusion that the long-range neuronal connectivity supporting perceptual organization within the posterior pole of the brain and in the ventral visual pathway is not fully developed in young children.

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