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Children inhibit global information when the forest is dense and local information when the forest is sparse

Claire-Sara Krakowski [a,b,c,d,1], Grégoire Borst [b,c,d,e,1], Julie Vidal [b,c,d], Olivier Houdé [b,c,d,e], Nicolas Poirel [b,c,d,e,*]

[a] Laboratoire d'Etude de l'Apprentissage et du Développement (LEAD), UMR 5022, Centre National de la Recherche Scientifique, Université de Bourgogne, 21078 Dijon, France
[b] Laboratoire de psychologie du développement et de l'éducation de l'enfant (LaPsyDÉ), CNRS, UMR 8240, 75005 Paris, France
[c] Université Paris Descartes, Sorbonne Paris Cité, 75005 Paris, France
[d] Université de Caen Normandie, 14000 Caen, France
[e] Institut Universitaire de France (IUF), 75005 Paris, France

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ABSTRACT

Visual environments are composed of global shapes and local details that compete for attentional resources. In adults, the global level is processed more rapidly than the local level, and global information must be inhibited in order to process local information when the local information and global information are in conflict. Compared with adults, children present less of a bias toward global visual information and appear to be more sensitive to the density of local elements that constitute the global level. The current study aimed, for the first time, to investigate the key role of inhibition during global/local processing in children. By including two different conditions of global saliency during a negative priming procedure, the results showed that when the global level was salient (dense hierarchical figures), 7-year-old children and adults needed to inhibit the global level to process the local information. However, when the global level was less salient (sparse hierarchical figures), only children needed to inhibit the local level to process the global information. These results confirm a weaker global bias and the greater impact of saliency in children than in adults. Moreover, the results indicate that, regardless of age, inhibition of the most

* Corresponding author at: Laboratoire de psychologie du développement et de l'éducation de l'enfant (LaPsyDÉ), UMR 8240, Centre National de la Recherche Scientifique, Université Paris Descartes, 75005 Paris, France.
E-mail address: nicolas.poirel@parisdescartes.fr (N. Poirel).
[1] These authors contributed equally to this work.

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salient hierarchical level is systematically required to select the less salient but more relevant level. These findings have important implications for future research in this area.

Introduction

Human cognitive resources are limited (Broadbent, 1958), and for this reason an individual cannot pay attention to every detail of a visual scene. To perceive and understand the complex visual world, children and adults need to focus their attention on relevant information while ignoring irrelevant information (Krakowski et al., 2016; Poirel, Krakowski, et al., 2014). Visual information in our environment is organized hierarchically, and most visual patterns can be either individuated or integrated in a more global structure. Importantly, children and adults do not process visual information in the same way (Poirel, Mellet, Houdé, & Pineau, 2008). Global structures appear to receive more weight in the competition for attentional resources than the details they contain in adults than in children (Krakowski, Borst, Pineau, Houdé, & Poirel, 2015). The developmental difference in the global precedence effect with age might be at the root of developmental differences observed in other cognitive domains such as perspective-taking abilities and development of the ability to adopt an allocentric spatial perspective (Poirel, Vidal, et al., 2011). In addition, studying which information has precedence during visual processing, its evolution with age, and how inhibitory control allows children (and adults) to focus on relevant visual information is a critical challenge for developmental psychology and for education. For instance, knowing which information receives greater precedence at different ages is critical for education because the visual environment of a classroom and its visual organization have an impact on learning abilities in children (Fisher, Godwin, & Seltman, 2014). In adults, global structures appear to receive more weight in the competition for attentional resources than the details they contain (Krakowski et al., 2015). In a classical study, Navon (1977) used hierarchical letters (i.e., one global letter such as H composed of several local letters such as S) and demonstrated the existence of a global advantage effect in adults (the global level is processed more rapidly than the local level) and a global interference effect (the local processing is slowed down when the global and local elements are in conflict). The findings suggested that adults perceive the "forest before the trees" (Navon, 1977; Poirel, Pineau, & Mellet, 2008). It has also been shown that global advantage and global interference effects may be explained by bottom-up and top-down mechanisms, respectively (Beaucousin et al., 2011, 2013; Hegdé, 2008; Poirel, Pineau, et al., 2008). How does this global visual bias develop through childhood? Studies have reported evidence of a local visual bias until 6 years of age, with an adult-like global bias occurring at approximately 9 years of age (Dukette & Stiles, 1996, 2001; Poirel, Cassotti, Beaucousin, Pineau, & Houdé, 2012; Poirel, Leroux, Pineau, Houdé, & Simon, 2014; Poirel, Mellet, et al., 2008) or later (Enns, Burack, Iarocci, & Randolph, 2000; Scherf, Behrmann, Kimchi, & Luna, 2009). Other studies have demonstrated global processing abilities as early as 5 years of age even if global abilities continue to develop until adolescence to reach an adult-like performance (Krakowski et al., 2016; Krupskaya & Machinskaya, 2012; Mondloch, Geldart, Maurer, & De Schonen, 2003). Taken together, these studies suggest that global information appears to be less available and more difficult to process in children than in adults. In particular, it has been shown that differences in the sensitivity to global information in children were a result of the density of the hierarchical figures; children showed a local bias in a sparse condition of density, whereas a global bias was evidenced in children when presented with a denser condition (Dukette & Stiles, 2001; Kimchi, Hadad, Behrmann, & Palmer, 2005). Adults were less affected by density variations in hierarchical stimuli, which suggests a more stable visual global bias that is effective at approximately 9 years of age (Dukette & Stiles, 2001; Poirel, Mellet, et al., 2008). Consistent with the idea of immature global attentional processing in children, school-aged children appear to have more difficulty with integrating distant elements as a whole (Burack, Enns, Iarocci, & Randolph, 2000; Enns & Girgus,