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The impact of distracter–target similarity on contextual cueing effects of children and adults

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ABSTRACT

Contextual cueing reflects a memory-based attentional guidance process that develops through repeated exposure to displays in which a target location has been consistently paired with a specific context. In two experiments, we compared 20 younger children's (6–7 years old), 20 older children's (9–10 years old), and 20 young adults' (18–21 years old) abilities to acquire contextual cueing effects from displays in which half of the distracters predicted the location of the target and half did not. Across experiments, we varied the similarity between the predictive and nonpredictive distracters and the target. In Experiment 1, the predictive distracters were visually similar to the target and dissimilar from the nonpredictive distracters. In Experiment 2, the nonpredictive distracters were also similar to the target and predictive distracters. All three age groups exhibited contextual cueing in Experiment 1, although the effect was not as strong for the younger children relative to older children and adults. All participants exhibited weaker contextual cueing effects in Experiment 2, with the younger children not exhibiting significant contextual cueing at all. Apparently, when search processes could not be guided to the predictive distracters on the basis of salient stimulus features, younger children in particular experienced difficulty in implicitly identifying and using aspects of the context to facilitate with the acquisition of contextual cueing effects.

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Introduction

The ability to learn spatial layouts is integral to a number of important everyday activities. For example, shopping is much easier when you shop the same supermarket regularly. It is also much easier to find your car after work if you can remember the general (or even exact) location of your

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car in the parking lot. During recent years, it has become increasingly clear that learning spatial layouts can be done in at least two fundamentally different ways. First, it is possible to learn spatial layouts by explicitly memorizing the locations of objects in the environment, as evidenced in tests of visuo–spatial working memory (Meneghetti, De Beni, Gyselinck, & Pazzaglia, 2011; Nori, Grandicelli, & Giusberti, 2009). Second, it is possible to learn spatial layouts in an incidental, virtually implicit manner, as evidenced by the phenomenon of contextual cueing (Chun & Jiang, 1998; Jiang & Chun, 2001). In our research, we focus on developmental variations in this second form of spatial learning. Although challenges to the claim that contextual cueing reflects a purely implicit process have been made (e.g., Smyth & Shanks, 2008), it is reasonable to suggest that many young adult participants who exhibit facilitation effects based on the spatial regularities found in complex visual stimuli do so without explicit awareness of the covariation between the target and other items in the displays.

Both natural and manmade environments incorporate spatial regularities associated with the relative location of objects. For example, the most common places to find berries in the woods can look very similar to each other, with berries in a location with an opening to sunlight and near the water. As a result, when searching for berries in the woods, you may be drawn to the "non-berry" features of the environment that signal that berries can be found nearby. In manmade cities, traffic signals along the streets are commonly found in the same relative locations (exceptions can lead to accidents). Learning about these regularities and what they predict make it possible for an organism to function efficiently in new environments as long as those regularities are maintained. More specifically, attention can be guided to objects that can provide benefit or information without calling on explicit and effortful learning processes to do so. The ability to use this information is important to the general cognitive processing efficiency of both children and adults. Hence, it is important to evaluate the relative abilities of children and adults to engage in implicit spatial learning. It is also important to be able to identify what factors, if any, may interfere with this type of learning for younger individuals relative to older individuals. Contextual cueing, as studied in laboratory settings, provides a means for evaluating age-related variations in the implicit associative learning of spatial information.

Contextual cueing refers to a form of attentional guidance where individuals are drawn to the location of a target object that has been consistently associated with the locations of the non-target objects in the visual environment (Chun & Jiang, 1998). Hence, it is the expression of the learning of associations between a specific target location and the spatial arrangement of the context in which the target is embedded. In Chun and Jiang's (1998) typical study of contextual cueing, participants were shown displays containing a target (e.g., the letter T rotated 90 degrees) and several distracters (e.g., the letter L rotated 90 degrees). They were required to locate and identify which direction the target T was pointing. What participants did not know was that some of the configurations of the distracters were consistently associated with a specific target location across trials and, thus, always predicted the location of the target (repeated display condition). In contrast, some configurations of the distracters were random from trial to trial (new display condition). Fig. 1 depicts a simplified example of the general paradigm. After several exposures to the repeated displays, participants responded faster to the repeated displays than to new displays. This difference in response time was assumed to be due to participants using the spatial layouts to implicitly predict the location of the target in each repeated display as a function of their repeated exposure to them. Tests of explicit memory for the layouts that were conducted after the experiments indicated that participants could not distinguish between the predictive and nonpredictive configurations, suggesting that contextual cueing in this and similar procedures does not rely on explicit memory.

Initial studies of contextual cueing in children seemingly demonstrated that the mechanisms responsible for contextual cueing were less well developed in children relative to young adults (e.g., Vaidya, Huger, Howard, & Howard, 2007). Using the stimuli and procedure developed by Chun and Jiang (1998), Vaidya and colleagues (2007) did not find contextual cueing in 10-year-old children. However, by adapting the basic procedure and stimuli specifically for children, more recent research has demonstrated that children, as well as adults, benefit from an ability to learn spatial layouts without the requirement to explicitly memorize all of the individual features of the environment. For example, Dixon, Zelazo, and Rosa (2010) found intact contextual cueing in school-aged children (5–9 years old). Children were asked to touch a red cartoon fish (the target) among a set of non-target red and blue cartoon fish. The authors observed contextual cueing under these conditions and sug-

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