Journal of Experimental Child Psychology 132 (2015) 65–83

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

The impact of signal-to-noise ratio on contextual cueing in children and adults

Yingying Yang, Edward C. Merrill *

Department of Psychology, University of Alabama, Tuscaloosa, AL 35401, USA

ARTICLE INFO

Article history:
Received 25 July 2014
Revised 19 December 2014
Available online 14 January 2015

Keywords:
Children
Contextual cueing
Signal-to-noise ratio
Animal silhouettes
Spatial learning
Implicit learning

ABSTRACT

Contextual cueing refers to a form of implicit spatial learning where participants incidentally learn to associate a target location with its repeated spatial context. Successful contextual learning produces an efficient visual search through familiar environments. Despite the fact that children exhibit the basic ability of implicit spatial learning, their general effectiveness in this form of learning can be compromised by other development-dependent factors. Learning to extract useful information (signal) in the presence of various amounts of irrelevant or distracting information (noise) characterizes one of the most important changes that occur with cognitive development. This research investigated whether signal-to-noise ratio (S/N) affects contextual cueing differently in children and adults. S/N was operationally defined as the ratio of repeated versus new displays encountered over time. Three ratio conditions were created: high (100%), medium (67%), and low (33%) conditions. Results suggested no difference in the acquisition of contextual learning effects in the high and medium conditions across three age groups (6- to 8-year-olds, 10- to 12-year-olds, and young adults). However, a significant developmental difference emerged in the low S/N condition. As predicted, adults exhibited significant contextual cueing effects, whereas older children showed marginally significant contextual cueing and younger children did not show cueing effects. Group differences in the ability to exhibit implicit contextual learning under low S/N conditions and the implications of this difference are discussed.

* Corresponding author. Fax: +1 205 348 8648.
E-mail address: emerrill@ua.edu (E.C. Merrill).

http://dx.doi.org/10.1016/j.jecp.2014.12.005
0022-0965/

Introduction

Except for artificially constructed situations, all of our experiences are embedded in context and our memories of those experiences are contextually bound. Think about daily memory experiences (e.g., remembering where your keys are) and everyday search tasks (shopping in a grocery store). The keys may be "on the table and next to the coffee cup," whereas the rye bread is "in the bakery aisle on the middle shelf." Although remembering a target per se is important, the spatial context is the place where the item resides and where the memory or search task is finally completed. We not only pay attention to spatial context but also benefit from learning within contexts if they do not change, especially in everyday activities. It would be a bad shopping experience if your grocery store shuffled some of its goods to a different aisle every day even if what you were looking for might still be in the same absolute location. Empirical research in visual search has indeed suggested that individuals can be drawn to a target object location if it has been *consistently* associated with the locations of the non-target objects in the same visual environment. This is reflected in what has been termed "contextual cueing" effects (Chun & Jiang, 1998). Simply put, individuals can use a target object's spatial context to "cue" the relative location of that object.

In a classic demonstration of contextual cueing, participants were shown displays containing a target (the letter T rotated 90 degrees) and several distracters (the letter L rotated 90 degrees). They were required to identify which direction the target T was pointing. Although the participants were unaware of it, some of the spatial configurations of the distracters were consistently associated with the target location across trials and, thus, always predicted the location of the target (the repeated condition). In contrast, other configurations of the distracters were random from trial to trial (the new condition). After some exposure to the repeated and new displays, response times were much faster in the repeated condition than in the new condition. Of additional interest, tests conducted at the end of the study indicated that the participants could not distinguish between the repeated and new configurations (e.g., Chun & Jiang, 1998, 2003; Chun & Phelps, 1999; Jiménez & Vázquez, 2011), thereby suggesting that contextual cueing was implicit in nature (but see Smyth & Shanks, 2008).

Making use of regularities in familiar visual environments, which is the primary characteristic of contextual cueing, is important for young children as well as adults. In fact, young children are likely to exhibit greater problems than typical adults when they are in unfamiliar environments and cannot make use of environmental cues. Despite the extensive research conducted on contextual cueing in the adult literature (for a recent review, see Huang & Grossberg, 2010), there are relatively few studies that evaluate the developmental course of contextual cueing and the properties that influence developmental variations in contextual cueing. Initial studies 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 of the letters T and L and the procedure of presenting both repeated and new displays throughout, as developed by Chun and Jiang (1998); Vaidya and colleagues (2007) did not find contextual cueing in 6- to 13-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 explicitly memorizing all of the individual features of the environment. For instance, Merrill, Conners, Roskos, Klinger, and Klinger (2013) asked children to touch a cartoon Jiminy Cricket among a set of Disney cartoon characters. In addition, the new displays were not presented until the test phase (see also Travers et al., 2013). They found significant contextual cueing in children as young as 6 years (see also Dixon, Zelazo, & Rosa, 2010). Thus, these discrepant results call for a closer examination of the factors that facilitate and interfere with the expression of contextual cueing in children.

On the one hand, it might not be surprising that children as young as 6 years demonstrate the basic competence of acquiring spatial invariance without awareness. This conclusion is consistent with the proposition that implicit learning in general should be age independent (e.g., Amso & Davidow, 2012; Clohessy, Posner, & Rothbart, 2001; Don, Schellenberg, Reber, DiGirolamo, & Wang, 2003; Meulemans & Van der Linden, 1998; Reber, 1992; Saffran, Aslin, & Newport, 1996; Thomas & Nelson, 2001). On the other hand, this position is qualified by two other studies (Couperus, Hunt, Nelson, & Thomas, 2011;