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Novel names extend for how long preschool children sample visual information

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ABSTRACT

Known words can guide visual attention, affecting how information is sampled. How do novel words, those that do not provide any top-down information, affect preschoolers' visual sampling in a conceptual task? We proposed that novel names can also change visual sampling by influencing how long children look. We investigated this possibility by analyzing how children sample visual information when they hear a sentence with a novel name versus without a novel name. Children completed a match-to-sample task while their moment-to-moment eye movements were recorded using eye-tracking technology. Our analyses were designed to provide specific information on the properties of visual sampling that novel names may change. Overall, we found that novel words prolonged the duration of each sampling event but did not affect sampling allocation (which objects children looked at) or sampling organization (how children transitioned from one object to the next). These results demonstrate that novel words change one important dynamic property of gaze: Novel words can entrain the cognitive system toward longer periods of sustained attention early in development.

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Introduction

There is a wide range of evidence that the words we hear guide our visual attention. When infants, children, or adults hear a known word, they look at scene elements that in some way match the word's meaning (e.g., Bobb, Huettig, & Mani, 2016; Dahan & Tanenhaus, 2005; Huettig & Altmann, 2011; Huettig & Hartsuiker, 2008; Lukyanenko & Fisher, 2016; Mani, Johnson, McQueen, & Huettig, 2013), and indeed this is the phenomenon behind one method used to study the words infants know (e.g., Bergelson & Swingley, 2012; Fernald, Zangl, Portillo, & Marchman, 2008). Known words also have effects in a variety of tasks designed to measure attentional processes (e.g., Brace, Morton, & Munakata, 2006; Kirkham, Cruess, & Diamond, 2003; Towse, Redbond, Houston-Price, & Cook, 2000; Yerys & Munakata, 2006). For example, 3-year-old children are faster at finding a visual target when cued with a relevant word compared with when cued only with a relevant picture (Vales & Smith, 2015). This phenomenon is hypothesized to reflect a mechanism, illustrated by the schematic in Fig. 1A, whereby words prompt the recall of previously learned information to yield a visual representation in working memory that guides visual attention (Vales & Smith, 2015). In brief, known words direct visual attention to scene elements by activating visual information associated with the meanings of the words. However, *novel* words also influence children's visual attention (e.g., Fulkerson & Haaf, 2003; Sloutsky & Robinson, 2008; Waxman & Braun, 2005; Waxman & Markow, 1995). Given that they are unlikely to activate previous visual information, what are the mechanisms by which novel words guide visual attention?

One way that a novel word may guide visual sampling is by its similarity to known words. For example, hearing a novel noun—for example, "That's a dax"—directs children's attention to things similar in shape (Landau, Smith, & Jones, 1988; Markman, 1989; Samuelson & Smith, 1999). In fact, there is a large literature on novel word learning by young children in which novel words are offered in sentence frames and conversational contexts, and when children hear such a novel word they are biased to attend to some specific object, event, or property that is consistent with the frame such as a noun, verb, or adjective (e.g., Brown & Bellugi, 1964; Fisher, 1996; Gleitman, 1990; Mintz, 2003; Weisleder & Waxman, 2009). For example, sentences such as "He gorped it" direct attention to transitive actions (Thothathiri & Snedeker, 2008; Yuan & Fisher, 2009). One could propose that these novel word effects work in fundamentally the same way that children understand known words (see Fig. 1B) (Colunga & Smith, 2005; Goldberg, 2006; McMurray, Horst, & Samuelson, 2012; Xu & Tenenbaum, 2007) because in many of these tasks children are shown a novel visual event, it is labeled, and how long children look at the novel event is measured. Thus, this abstract meaning account suggests that novel words direct attention toward visual properties consistent with the frame in which the novel words are inserted (e.g., shape or action above). But not all effects of novel labels are so easily explained in terms of specific perceptual properties, and in fact some have argued that words often influence attention—not directly but rather through conceptual or inferential pathways (see, e.g., Waxman & Gelman, 2009).

Here, we pursued a somewhat different idea as to how novel words may directly influence visual processing and attention (see Fig. 1C)—not by directing attention *to specific* visual information but rather by influencing how visual information is *generally sampled*. By this sampling hypothesis, words activate not just internal representations that may drive attention to specific perceptual information but also the internal networks that drive the dynamics of looking behavior (Gottlieb, Hayhoe, Hikosaka, & Rangel, 2014; Hayhoe & Ballard, 2014), changing how information is sampled regardless of any specific perceptual, semantic, or conceptual knowledge about the word. We aimed to provide direct evidence that the inclusion of a *novel* name by itself might change globally how children sample the information provided (the visual sampling hypothesis; Fig. 1C). This evidence points to a general mechanism whereby labels—especially novel ones that do not elicit previous knowledge—change how children sample visual information in systematic and important ways. Thus, it is possible that novel words may first generally entrain children's attentional system with subsequent consequences for other aspects of cognitive development.

Prior work suggests several dimensions of gaze dynamics that are malleable to contextual manipulations similar to the inclusion of a label (Gottlieb et al., 2014; Hayhoe & Ballard, 2014). These include