



Category generalization in a new context: The role of visual attention



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ABSTRACT

Infants and children have difficulty categorizing objects in new contexts. However, learning in both same and varied contexts can help young word learners overcome contextual learning difficulties. We examined the relation between infants' visual attention to the category member and background context during learning and their ability to generalize a new category member in a new context. Of particular interest is how this relation is affected by learning in various contextual conditions. Infants (16–20 months; $n = 48$) were presented with eight novel noun categories in one of three contextual conditions (same context, varied context, or a combination of same and varied contexts), and tested for their generalization ability in a new context. Context was defined as the colored and patterned fabric upon which the object was presented. Results suggest that visual attention during learning is associated with category generalization ability in a new context only for infants whose learning took place in a combination of same and varied background contexts. The results are discussed in terms of the mechanisms by which context affects generalization.

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1. Introduction

Children's category generalization is affected by surrounding contextual information (Vlach & Sandhofer, 2011). Past research suggests that young children have difficulty generalizing category labels in a new context when learning takes place in *either* all of the same background context, or all varied background contexts. However, when learning takes place in *both* same and varied contexts, young children's ability to generalize category labels in a new context increases (Goldenberg & Sandhofer, 2013). Despite previous research, it is unknown how visual attention supports category generalization in a new context, specifically when learning takes place in different contextual conditions. To understand the role of visual attention, the current study examined infants' visual attention to the category member and the background context during a category generalization task to further understand the mechanisms by which context affects generalization.

1.1. Learning in context

Memory and generalization are affected by the context in which information is learned and tested. Specifically, recall is more accurate when information is recalled in the same context in which it was learned (e.g., Borovsky & Rovee-Collier,

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1990; Godden & Baddeley, 1975; Hartshorn et al., 1998; Hayne, MacDonald, & Barr, 1997; Hayne, Boniface, & Barr, 2000; Learmonth, Lamberth, & Rovee-Collier, 2004; Rovee-Collier & Dufault, 1991; Rovee-Collier, Griesler, & Early, 1985; Smith, 1982; Suss, Gaylord, & Fagen, 2012). Context dependency has been robustly demonstrated across a wide range of contexts, tasks and ages (Amabile & Rovee-Collier, 1991; Smith, Glenberg, & Bjork, 1978)

Likewise, young word learners' ability to generalize category labels is context dependent. When 2- and 3-year-old children were presented with category members one at a time in a distinct context (a colored and patterned fabric square on which the object was placed) and subsequently tested for generalization of the category label to a new category exemplar, performance was enhanced when training and testing took place in the same context (i.e., the same fabric) relative to a condition in which training and testing took place in different contexts (i.e., a new fabric; Vlach & Sandhofer, 2011).

One possible reason children's word learning is context dependent is that the to-be-learned information is strongly associated with the context in which it is learned. For example, participants tested by Vlach and Sandhofer (2011) may have associated the object-label pair with the fabric. When generalization performance was tested on a new fabric, the novice word learners had difficulty generalizing the object label to the new category exemplar because the fabric they had associated with the object-label pair during learning was not present (Goldenberg & Sandhofer, 2013).

Consistent with the possibility that context dependency is due to a lack of decontextualizing the to-be-learned information from the context, context dependency can be overcome (in some cases) by learning in varied contexts (Jones, Pascalis, Eacott, & Herbert, 2011; Smith et al., 1978). When 3- and 4-year-olds were presented with category exemplars across multiple varied contexts, for example, they were able to generalize the category label to a new exemplar in a new context (Vlach & Sandhofer, 2011), perhaps because variability helps decontextualize the learning process, increasing the likelihood that information can be generalized to new settings (Amabile & Rovee-Collier, 1991; Rovee-Collier & Dufault, 1991). Varied contexts, therefore, may signal to the child that the to-be-learned information (object-label pair) is not associated with any specific context.

However, 2-year-olds' category generalization performance is context-dependent even when learning takes place in varied contexts. When 2-year-olds were presented with category exemplars on multiple varied fabrics and tested on a never before seen fabric, generalization was not different from chance levels (Goldenberg & Sandhofer, 2013; Vlach & Sandhofer, 2011). The support to decontextualize that aided 3- and 4-year-olds (learning across multiple varied contexts) was not sufficient to aid 2-year-olds when generalization was tested in a new context. Goldenberg and Sandhofer (2013) suggest this difficulty is because when learning takes place in varied contexts, novice word learners have little support to aggregate the different instances in memory. Category learning requires the learner to aggregate similarities between the object-label instances. For example, to learn the category "spoon," the learner must aggregate what is similar across all instances of spoons (i.e., shape; Gentner & Namy, 1999). When learning takes place in varied contexts, there is little support for a novice word learner to aggregate the category exemplar instances; there is a lack of aggregative cues.

Redundant correlated cues, such as the category label and repetitive contexts, support aggregation of category exemplar features (Dueker & Needham, 2005; Smith & Yu, 2008; Thiessen & Saffran, 2003; Yoshida & Smith, 2005). The only aggregative cue provided when learning takes place in varied contexts is the category label, which may not be sufficient for novice word learners (Goldenberg & Sandhofer, 2013). Repetitive contexts, however, do support category learning. When 2-year-old children learned object labels in one repetitive context (on top of one colored and patterned fabric), and were tested for their generalization in the same context (on top of the same colored and patterned fabric as learning), they were able to successfully generalize (Vlach & Sandhofer, 2011).

Novice word learners, therefore, may need two distinct types of support when generalizing category labels in a new context in order to decontextualize the object label pair and to aggregate features common to the category exemplars presented during training. Support for decontextualization is provided by learning in varied contexts, signaling to the learner that object-label pairs are not to be associated with the context. Support for aggregation of the category exemplar features is provided by learning in the same repetitive context, which may highlight feature similarities. Goldenberg and Sandhofer (2013) found that 2-year-olds overcome context dependency when learning provided support to decontextualize (learning in varied context) and support to aggregate (learning in the same context). Yet decontextualization and aggregation will facilitate word learning only if infants attend to this information. Our goal in the present study was to examine how individual differences in visual attention to category members and contexts yield categorization under conditions that vary by context.

1.2. Visual attention

Learning categories requires attention to the right aspects of the learning situation (Samuelson & Smith, 1998; Smith, Jones, Landau, Gershkoff-Stowe, & Samuelson, 2002). Past research has focused on infants' attention to specific aspects of the object-label category, such as the object's features and syntactic properties. For example, when learning a new object-label category, young children reliably focus on features by which the category is organized. That is, early in word learning, children focus on object shape when learning to categorize (Smith et al., 2002).

When learning object categories in context, learners are presented with two distinct visual stimuli: the object and the background context. Infants presented with an object on a background context were found to attend to both the object and the background. Haaf, Lundy, and Coldren (1996) habituated 6-month-old infants to a stimulus presented on a colorful patterned background. The stimulus was presented on either the same background or varied backgrounds. Infants were slower to habituate when the background varied, suggesting that infants attended to both the background and the stimuli; longer

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