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Near or far: The effect of spatial distance and vocabulary knowledge on word learning

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ABSTRACT

The current study investigated the role of spatial distance in word learning. Two-year-old children saw three novel objects named while the objects were either in close proximity to each other or spatially separated. Children were then tested on their retention for the name-object associations. Keeping the objects spatially separated from each other during naming was associated with increased retention for children with larger vocabularies. Children with a lower vocabulary size demonstrated better retention if they saw objects in close proximity to each other during naming. This demonstrates that keeping a clear view of objects during naming improves word learning for children who have already learned many words, but keeping objects within close proximal range is better for children at earlier stages of vocabulary acquisition. The effect of distance is therefore not equal across varying vocabulary sizes. The influences of visual crowding, cognitive load, and vocabulary size on word learning are discussed.

1. Introduction

During the first three years of life, children learn hundreds of words (Fenson et al., 1994), particularly names for objects (Samuelson & Smith, 1999). In real life, many of these object names are learned in cluttered environments—in stark contrast to immaculate laboratory environments, where only a handful of objects are present at any one time. Recent research demonstrates that children retain new words (Horst, Scott, & Pollard, 2010) and learn new concepts (Fisher, Godwin, & Seltman, 2014) better when their learning environments are less cluttered. However, even in relatively uncluttered environments, children still encounter many ambiguous naming situations where a target object is seen among several other objects when it is named. As the number of objects presented increases, the space between the objects decreases, especially in laboratory-based tasks where space is typically restricted. In the current study, we control for the number of objects present and demonstrate that the spatial distance between objects may influence early word learning, but that the effect is mediated by pre-existing vocabulary knowledge.

Numerous studies have demonstrated the importance of space in attentional learning. Both infants and adults form associations between the spatial locations of visual and auditory information presented simultaneously (Richardson & Kirkham, 2004; Richardson & Spivey, 2000). That is, they "spatially index" the location where visual information is presented and look to the same location when the same auditory information is presented again even in the absence of the visual stimuli. However, memory for object locations is affected by the space between the objects. Observers demonstrate better memory for object locations when the objects are spatially separated compared to when the objects are in close proximity to each other—even when the number of objects is controlled for (Franconeri, Alvarez, & Enns, 2007).

Object locations also influence word learning in children. Specifically, children use spatial locations to bind a name to an object—even when the name and object do not occur together. Samuelson, Smith, Perry, and Spencer (2011) presented 18-month-old children with two novel objects consistently to either side of a table. After removing the objects, the experimenter stated a name three times (e.g., "modi") while pointing to the space previously occupied by one of the objects. Later when asked to select the "modi," children systematically chose the object corresponding to that location. In follow-up experiments, inconsistent object locations interfered with children's ability to form name-object associations. Benitez and Smith (2012) also found that children were better at retaining novel words if they were consistently presented with objects in the same locations rather than in varied locations.

Empirical evidence suggests that keeping target objects at a distance from competitors during naming could facilitate word learning as it

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could help children disambiguate a speaker's referent from other objects that may be present. For example, in a series of experiments, Horst and Samuelson (2008) presented 24-month-old children with disambiguation/referent selection trials with novel and familiar objects and tested children's retention of the novel objects' names after a 5-minute delay. In the final experiment, children were given feedback after each referent selection trial. For children in the follow-in labeling condition, the experimenter followed the child's gaze and named the target object when the child looked at it, thus the objects remained in close proximity to each other during the feedback phase. However, for children in the ostensive naming condition the distance between the objects increased as the target was held up and away from the competitors before the experimenter pointed to it. Only children in the ostensive naming condition retained the novel names. In a follow-up study, objects remained in close proximity to each other during the feedback phase and children who received ostensive naming with pointing, but without moving the objects, demonstrated poor retention (Axelsson et al., 2012). Similarly, using a head-mounted camera to examine children's visual perspectives during interactions with parents, Pereira, Smith, and Yu (2014) also found that clear, uncluttered views of objects during naming events led to better retention of object names. This was particularly the case if the same clear object view was held before, during, and after the naming event.

However, there may be cases when presenting objects in close proximity to each other *does* facilitate learning. Oakes and Ribar (2005) argue that when short-term memory capacity is limited (i.e., during early childhood), the ability to quickly shift attention between images or objects in space could be critical to encoding. Thus, large distances between objects may make it difficult for children to see both the targets and competitors simultaneously. Indeed, encountering category exemplars simultaneously in close proximity promotes adult category generalization as it aids in comparing and contrasting exemplars (Spencer, Perone, Smith, & Samuelson, 2011). Thus, encountering objects in close proximity may help young children learn object names.

In addition, there is some evidence that a larger vocabulary is associated with better word learning. For example, Bion, Borovsky, and Fernald (2013) found that children with larger productive vocabularies looked longer at a novel target during disambiguation and retention trials (but see Mather & Plunkett, 2009). According to the critical mass effect (e.g., Bates & Goodman, 1997), children who have acquired more words have stronger phonological representations, and this allows them to more readily build on their knowledge. Torkildsen et al. (2009) found that children with larger vocabularies demonstrated word learning in fewer trials than children with smaller vocabularies. Similarly, the speed of response when comprehending words correlates with lexical and grammatical development in 12- to 24-month-old children (Fernald, Perfors, & Marchman, 2006). Larger vocabulary size is also positively associated with novel noun generalization, and this is argued to be due to an increased ability to focus on the relevant, defining features of categories as vocabulary increases (see Smith, Colunga, & Yoshida, 2010 for a review). However, whether spatial distances between objects has differential effects on children's ability learn novel object names as a function of overall vocabulary size has yet to be investigated.

In the current study, we explored the effect of spatial distance between objects on children's ability to learn names for objects. Children were taught names for three novel objects. For half of the children, names were introduced when targets and competitors were within a close proximal range to each other and for the other children, names were introduced when objects were spatially distant to each other. All children received the same word learning test trials. If the spatial distances between the objects during naming influence children's ability to learn the objects' names, then we should find differences in children's word learning depending on whether the objects had been in close proximity to each other or spatially separated.

2. Method

2.1. Participants

Forty monolingual, British–English-speaking, typically developing children between 21 and 28 months ($M = 24$ m, 13 days, $SD = 1$ m, 28 days) participated. Four additional children were tested but their data not analyzed due to fussiness (2) and experimenter error (2). Twenty children were randomly assigned to each of the two conditions: near (11 boys) and distant (9 boys). There were no differences between conditions in age ($t(38) = 1.95$, $p = .92$, two-tailed, (near: $M = 24.14$ months, $SD = 52$ days; distant: $M = 24.12$ months, $SD = 67$ days) or total productive vocabulary ($t(38) = 0.07$, $p = .94$, two-tailed, (near: $M = 314$ words, $SD = 171$ words; distant: $M = 319$ words, $SD = 198$ words). There was no difference between conditions in maternal education levels, Fisher's Exact Test = 0.318, $p = 0.99$. Three mothers in the near condition and four mothers in the distant condition had completed high school (GCSEs and/or A-levels) and/or completed a vocational diploma. Ten mothers in each condition had completed an undergraduate degree and/or an undergraduate degree with a postgraduate certificate (e.g., Postgraduate Certificate in Education (PGCE), an additional teaching qualification). Five mothers in each condition completed a Master's degree and two mothers in the near condition and one in the distant condition completed a doctoral degree. Parents were reimbursed for travel and children received a small gift (e.g., a coloring book) for participating.

2.2. Stimuli

Three novel objects served as stimuli: a blue massager (*pabe*), a red gardening funnel (*yok*), and a yellow cup-and-ball toy with the ball glued to the side of the handle for better spatial placement control (*dite*) (see Fig. 1). Novel objects were on average 6.2 cm × 9.3 cm × 13.7 cm. Novel words were chosen to be short, easy to pronounce and distinctive (Deák & Toney, 2013). We introduced children to three novel names to enhance the likelihood that children would disambiguate objects at test on the basis of each name rather than on the basis of selecting the only novel object presented with a novel name (see Axelsson & Horst, 2013 for a discussion). Each object was assigned the same name for all children to reduce experimenter errors (Capone & McGregor, 2005). Six familiar toy-like objects served as stimuli for the warm-up trials: a bus, an airplane, a penguin, a tiger, a pair of children's sunglasses and a baby shoe.

2.3. Procedure and design

2.3.1. Naming phase

The child sat in a booster seat at a small table with a 67.7 cm × 120 cm white surface. The experimenter sat across from the child and the parent sat next to the child and completed the MacArthur Communicative Development Inventory (MCDI, (Klee, Marr, Robertson & Harrison, 1999). The experimenter set the three novel objects on the table and named each object in a random order. Each object was only named when the child was looking at the object and it was the focus of the child's attention. Each time an object was named, the experimenter repeated the name three times in close succession. For example, the experimenter might name an object by saying, “Look at this *pabe*. It's a *pabe*. Have a look at the *pabe*.” Each object was named three separate times yielding a total of 9 repetitions for each word. Previous studies suggest that 5–10 repetitions of ostensive naming support word learning when one word is introduced to 12- to 24-month-old infants (Hollich, Hirsh-Pasek, & Golinkoff, 2000; Woodward, Markman, & Fitzsimmons, 1994) or even four times when two names are introduced