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Cross-situational statistically based word learning intervention for late-talking toddlers

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ABSTRACT

Purpose: To explore the efficacy of a word learning intervention for late-talking toddlers that is based on principles of cross-situational statistical learning.
Methods: Four late-talking toddlers were individually provided with 7–10 weeks of bi-weekly word learning intervention that incorporated principles of cross-situational statistical learning. Treatment was input-based meaning that, aside from initial probes, children were not asked to produce any language during the sessions. Pre-intervention data included parent-reported measures of productive vocabulary and language samples. Data collected during intervention included production on probes, spontaneous production during treatment, and parent report of words used spontaneously at home. Data were analyzed for number of target words learned relative to control words, effect sizes, and pre–post treatment vocabulary measures.
Results: All children learned more target words than control words and, on average, showed a large treatment effect size. Children made pre–post vocabulary gains, increasing their percentile scores on the MCDI, and demonstrated a rate of word learning that was faster than rates found in the literature.
Conclusions: Cross-situational statistically based word learning intervention has the potential to improve vocabulary learning in late-talking toddlers. Limitations on interpretation are also discussed.

Learning outcomes: Readers will describe what cross-situational learning is and how it might apply to treatment. They will identify how including lexical and contextual variability in a word learning intervention for toddlers affected treatment outcomes. They will also recognize evidence of improved rate of vocabulary learning following treatment.

1. Introduction

1.1. Late-talking toddlers

Although there are slightly different definitions for this term, late-talking toddlers are children, typically between the ages of 24 and 35 months, who are late to develop language. Specifically, they have an expressive vocabulary delay.

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These children do not have a primary diagnosis to explain their poor language development (e.g., hearing loss, autism) and are often too young to be formally labeled with a primary language impairment. Approximately 13–19% of all children are late-talkers (e.g., Rice, Taylor, & Zubrick, 2008), although only 7% of kindergarten-aged children have a primary language impairment (Tomblin et al., 1997). Outcomes for late-talkers are debated, but there is evidence that even if these children are not diagnosed later with primary language impairment, language still may be a relatively weak skill for them. Children who were late-talkers perform less well on language measures than non-late-talking peers (e.g., Rescorla, 2011). During toddlerhood, this relatively large group of children is characterized by an ineffective word learning system and typically has not received services to train word learning techniques, making them an appropriate population in which to study learning-theory-based word learning intervention.

1.2. Components of word learning

Word learning is a process. At a simplistic level, a child must map a label to a referent. However, beyond a fast-mapping stage (i.e., the initial mapping of label to referent), a child must learn to correctly extend the label to other valid exemplars of the referent's category. Problems may arise at the level of the label, in which the child shows difficulty correctly parsing the acoustic stream or formulating the correct motor behaviors to accurately represent and or produce the lexical label. A child must also continually build his or her semantic representation of the referent, learn increasing details about the referent, and tease apart the salient component of an abstract representation. This is what allows a child to know that it is okay to use the word "bunny" to label a live white rabbit and a tasty chocolate rabbit, but not a dog. As a child learns words, he or she must master all of these components.

Learning theory characterizes how learners acquire rules or patterns from their environment. Specifically, in statistical learning theory, researchers are interested in the type of learning that happens when people are not explicitly trying to learn. This type of learning is called unguided learning or implicit learning. The point of implicit learning is that people are able to recognize patterns in input and track those patterns to extract words (e.g., Saffran, Newport, Aslin, Tunick, & Barrueco, 1997). Traditionally, research on statistical learning has been highly decontextualized (e.g., people listening to strings of nonwords with no visual context). However, researchers who are interested in how statistical learning applies to the more complex real-life word learning environment have included the concept of cross-situational learning (e.g., Smith & Yu, 2008). Cross-situational learning accounts for how people track statistical co-occurrence of label and referent across different contexts.

A model of early word learning developed by Yu and Ballard (2007) integrates the role of statistical learning of the language input that children hear. They propose that children track how often a word and a potential meaning co-occur across contexts. Children observe the contrasts of words and objects across situations, and in turn, derive the constant referent from many possibilities. To test their hypothesis, Yu and Ballard developed a computer simulation of word learning based on data from real child/adult interactions. The computer simulation demonstrated that learning was more efficient (i.e., the simulated learner was able to make more correct word-meaning associations) when the learner had access to the novel word in numerous contexts. These included both linguistic contexts (e.g., nice duck, that's a duck) and physical contexts (e.g., seeing a duck in contrast with other objects). Context was even more important than raw number of exposures.

This concept is mirrored in work with adults. Kachergis, Yu, and Shiffrin (2009) describe components that enhance statistical learning. Kachergis and colleagues determined that three factors were most responsible for success of cross-situational learning: word referent frequency, contextual diversity, and within-trial ambiguity. Word referent frequency related to the number of times that a word/referent pair was presented to a learner, with results showing that higher-frequency pairs were learned more easily than low-frequency pairs. Contextual diversity was characterized as the number of different pairs a particular word/referent pair was presented with. For example, a salt shaker and the word 'salt' appearing alone would have no contextual diversity. 'Salt' (word/referent) presented only with a pepper shaker and the word 'pepper' would have low contextual diversity. 'Salt' paired with 'pepper', 'salsa', and 'ketchup' (and their respective referents) would have higher contextual diversity. This was not a single trial issue, but related to cumulative exposures. Thus, if 'salt' was only ever presented in a field of two (e.g., salt and X), as long as the X varied across trials, it would be considered high contextual diversity. Higher contextual diversity was associated with better word learning than low contextual diversity. Within-trial ambiguity was characterized as how many other possible referents a label was paired with (i.e., participants were exposed to three words/three objects versus four words/four objects) for a single trial. Lower within-trial ambiguity was associated with better word learning than higher within-trial ambiguity. Kachergis et al. noted that if two of these three factors were controlled, then the influence of the third would be mitigated. The idea is that, by providing high intensity and high variability input, the learner is given sufficient opportunities to track patterns in order to make the appropriate associations between a label and referent. In doing so, the learner comes to extract the most salient features of the label-referent pair, because those are the elements that are stable within the input. This idea is echoed in findings from Pan, Rowe, Singer, and Snow (2005) who used individual growth trajectory modeling to show that vocabulary production in toddlers from low-income homes was positively related to maternal lexical diversity, defined as how many different words mother used, but not to overall maternal talkativeness. This is an example of lexical diversity, but recall that contextual diversity is important too.