How do children learn words with multiple meanings?

Word learning in typical and clinical populations

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Abstract

Many words in Engish and other languages are polysemous, with multiple distinct, but related meanings (Rodd & Gaskell, 2002; McCarthy, 1997; Klein & Murphy, 2002; Floyd & Goldberg, *under review*). Previous research has shown that learners have a *polysemy advantage* in which related meanings of words are easier to learn than unrelated meanings of words (polysemy vs. homonymy) (Rodd et al., 2002). This is true for neurotypical children, but not necessarily for children with Autism Spectrum Disorder (ASD) (Jeppsen, Floyd & Goldberg, *in prep*). This may be due to a known deficit in generalization: individuals on the Autism spectrum are more likely to remember individual exemplars, rather than generalize across members of the same category (Soulières, Mottron, Saumier & Larochelle, 2007; Hillier, Campbell, Keillor, Phillips & Beversdorf, 2007). Our study aims to find a method to help ASD children better generalize across distinct but related meanings in order to learn polysemous meanings. This is especially relevant given the known delays in language learning in the ASD population (Tager-Flusberg, Paul & Lord). We designed an intervention and created an experiment that tests both neurotypical and ASD children on six polysemous meanings, pre- and post-intervention. The intervention consists of explicitly naming the similarities across the polysemous meanings as opposed to just naming different attributes of each object. We ran 14 neurotypical children in order to validate the paradigm before running it on the clinical population, which is the focus of this report. We expect that the intervention will be successful on the younger population of neurotypical children, and on the older ASD population and will increase children's performance from pre- to post-intervention testing. However, results show that for neurotypical children, there was about equal learning between the control and intervention condition groups. We discuss possible explanations, namely that neurotypical children may be able to spontaneously observe similarities between words and generalize among them, washing out possible effects of the intervention.

Keywords: polysemy, Autism spectrum disorder, neurotypical, generalization, word learning

Introduction

Generalization is important in learning many things, amongst them learning language. In language learning, one needs to be able to take a past occurrences that they have heard and apply them to new situations. This happens often when a child is beginning to learn language. Some argue that although children only hear a finite number of words and sentences, they are able to produce and understand an infinite number of grammatically-correct and sensical utterances, though work has contested this point (Goldberg, 2016). This is possible because children take past utterances, words, phrases, etc that they have heard, generalize them across multiple situations, and produce and comprehend them. For this reason, it is common to hear some children say "I eated the soup"; by taking the infinitive verb and adding the past tense conjugation of the infinitive (i.e., add -ed to the end of the infinitive),they make the infinitive a past tense verb (Clark & Clark, 1977). They had already heard this construction before, with similar familiar words such as play, talk, smile, and look, so they simply apply it to new verbs, not yet knowing that it is incorrect and that there is competing ending. Although this may seem very elementary, it is extremely useful in language learning, because in many cases the child would be correct in their generalization. Generalization helps us in the face of novel situations; creating a general rule for how language works in certain cases makes it easier to learn language because instead of memorizing a host of individual rules for each situation, one can just refer back to the rule (Goldberg, 2006).

Generalizations not only help us learn grammatical constructions, but they also help us learn vocabulary and new words. In Spanish, the word for tooth and clove are the same (*diente*). If a non-native speaker of Spanish is asked to grab a "tooth" of garlic from the fridge, but they have never heard of teeth being referred to in the context of garlic, they could take their past experience and understanding of what a tooth is and generalize it to mean not the whole garlic head, but just a clove, because cloves are small, white-ish, and many of them come together to be part of a larger structure, like teeth. Additionally, in English, if someone asks a young child to find a head of lettuce, but the child has never heard of a *head* being used to refer to lettuce before, they may take their understanding of what a head is to mean not just a single leaf, but a larger whole, and take the whole lettuce instead of a leaf of lettuce. These examples show how generalizations between past experiences and words of similar form help a child learn these words, and likely much of their vocabulary.

The word polysemy itself means “multiplicity of meanings of words” (Ravin & Leacock, 2006). It is different from synonyms in which the two words mean exactly the same thing (or at least nearly exactly). With polysemy, the words are related somehow, but still distinct. A prime example of this is the word run. Although a child runs, a motor runs, and water runs, they do not all do it in the same way. Yet, there is something about these three meanings of the word run that connects them, something related to an ongoing action. Similarly, a cap can be one of many things: a baseball cap or a bottle cap or a pen cap. Although all three are used in different contexts, they all have something in common, which is covering things.

Generalizations help to highlight the similarities between these polysemous words, which, research has shown, helps neurotypical children learn it (Jeppsen, Floyd & Goldberg, *in prep*). Previous research has also shown that ASD children struggle with generalizations (Mottron, Morasse, & Belleville, 2001; Mottron & Burack, 2001) and that they also struggle with the polysemy advantage (Jeppsen, Floyd & Goldberg, *in prep*). What has not yet been studied is how to help children on the Autism spectrum learn these polysemous words, and the impact that it could have on their language learning in general. This project aims to find a successful intervention that will highlight the similarities between the 3 instances of 6 polysemous words, therefore encouraging them to generalize. The intention is to create an intervention that could potentially be used in speech therapy and in the classroom which would better help ASD children with vocabulary learning and generalization.

Methods

In order to answer the question of what intervention will be successful in teaching ASD kids polysemous words, we created a child-friendly experiment labeled as a word-learning game given on a tablet. We ran the experiment on 14 neurotypical, full term, native English speakers of ages 3 and a half years to 4 years (*N*=14*; Mean age*=44.8 months*; sd for age*=1.62) with no hearing or vision loss. We tested the neurotypical children to validate the paradigm. The experiment consisted of an inclusion-exclusion block, a pretest, an exposure with control and intervention, and a posttest block.

The inclusion-exclusion block was designed to gauge whether the child understood the directions and was comfortable using the tablet for responses. In this block, the child was presented with a series of highly salient and familiar images in a translucent color. The audio said, “Which is the flower? Press the flower” and only allowed the child to respond after the audio finished saying the target item the first time around and once the images were fully saturated (the images went from translucent to fully saturated in order to communicate to the child they should not respond until they hear the full word). This occurred for 8 trials, and the target words were ball, foot, mouth, bus, flower, duck, banana, and shoe.

At the first timepoint (the **pretest** block) the participant heard audio which said, “Which is the cap? Press the cap.” This structure was used for all 6 polysemous words, which were *cap*, *sheet, horn, balloon, glasses,* and *collar*. There were 3 instances of each polysemous word for each of 2 English meanings and 1 novel Spanish meaning (e.g., a baseball *cap*, a bottle *cap*, and the

Spanish use of *cap*, a lid), totaling to 18 trials for the pretest. The Spanish meanings of the English polysemous words were chosen because we wanted to test both English extensions and other extensions. Each instance of the polysemous word was presented in its own trial, with 3 distractor items which were not polysemous, giving the participant 4 options to choose from. The order of the 18 trials and the distractor items in each trial were randomized. This block was designed to see how many of the polysemous words the participant knew before the intervention.

We created an intervention design that focused on highlighting the similarities between the polysemous words as opposed to looking at their individual qualities. The intervention was in the exposure block and was within-subject; each participant's learning was compared to themselves as opposed to how other participants perform. Four blocks were created in order to create 4 conditions. Condition 1 had 3 polysemous words in the control and 3 polysemous words in the intervention. Condition 2 swaps the control and intervention words. Condition 3 has another combination of 3 polysemous words in the control and 3 polysemous words in the intervention, and condition 4 swaps the control and intervention words in condition 3. In the control, there were 3 polysemous words and 3 instances of each. For each instance of the polysemous word in the control, individual characteristics of the word were pointed out, instead of the similarities across the polysemous words. So, the same polysemous word cap had 3 different descriptors depending on whether the image showed a baseball cap, a bottle cap, or a lid. In the intervention, the similarities between the three were highlighted. So, in another condition, for the same word cap, the audio said the cap "covers" for all three instances of cap (baseball cap, bottle cap, and lid), which will help the participant generalize features across the different instances of the same word.

At the second timepoint (the **posttest** block) the participant saw and heard an identical version to the **pretest** block, except the trials and distractor items were played in a randomized order, just as in the **pretest** block. The purpose of the posttest block was to see improvements in the participant's performance at two timepoints, from the pre to posttest, before and after the intervention.

Results

The experiment was run on 14 neurotypical, full term, native English speakers of ages 3 and a half years to 4 years (*N*=14*; Mean age*=44.8 months*; sd*=1.62 months) with no hearing or vision loss. Each subject's responses were recorded for each trial in the pretest and posttest blocks. The responses were also grouped by condition (either control or intervention). In the pretest and posttest block in the control condition, each subject could get 1, 2, or 3 responses correct. In the pretest and posttest block in the intervention condition, each subject could get 1, 2, or 3 responses correct. The average number of correct responses across trials were calculated for each condition and timepoint.

The graphs below show the participant's performance from pretest to posttest in each condition. The x axis displays the timepoint, grouped by condition. The y axis displays the average correct responses given by the participant, across trials. The colored dashed lines represent each individual participant's performance. The black line is the line of regression which is the average performance taken across all subjects across all trials. The gray shading is the margin of error (standard error). A positive slope on the lines shows improvement in performance from pretest to posttest in the task. A negative slope shows worsened performance from pretest to posttest. A horizontal slope shows no improvement from pretest to posttest in the word-selection task.

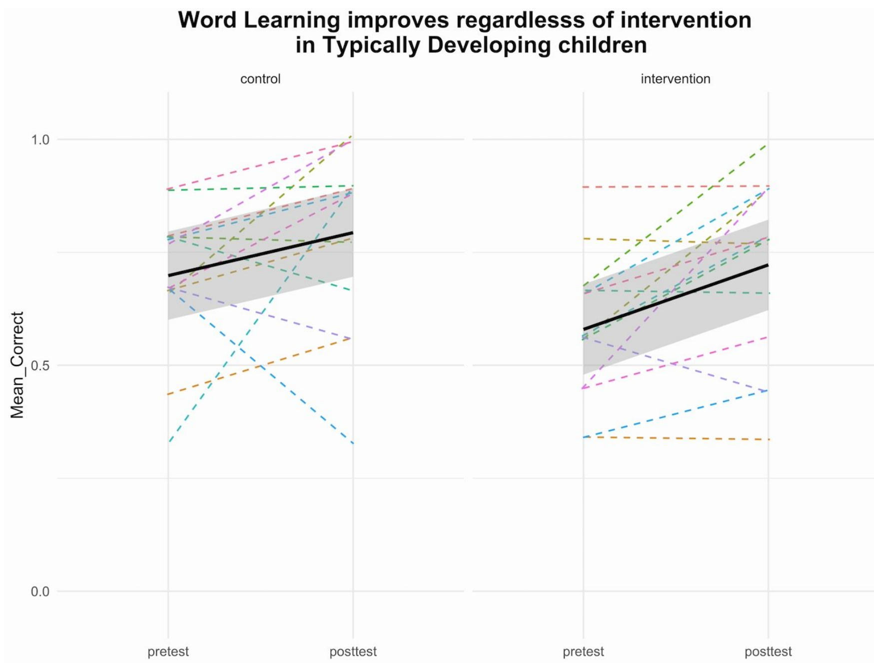

Figure 1: Performance on word-selection task before and after the intervention phase. This graph shows performance across English and Spanish word-meaning trials (all trials).

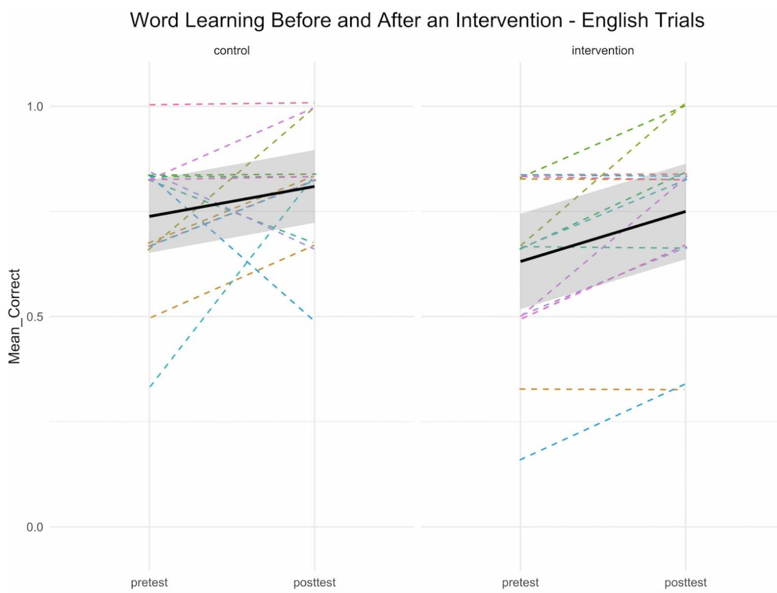

Figure 2: Performance on word-selection task before and after the intervention phase. This graph shows performance across English word-meaning trials.

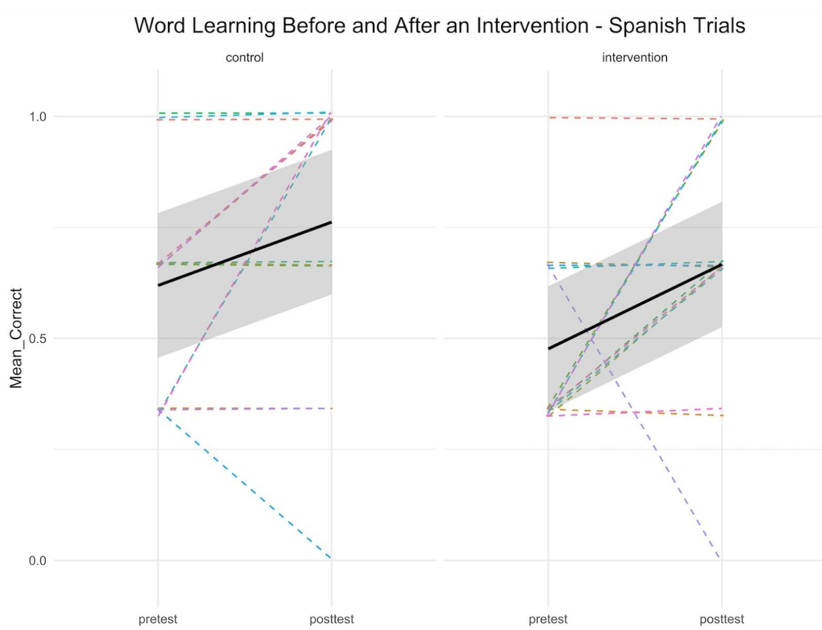

Figure 3: Performance on word-selection task before and after the intervention phase. This graph shows performance across English word-meaning trials.

The graphs show that between the control and intervention conditions in *Figure 1*, across all trials, there was indeed improvement in performance between the pretest and posttest in both conditions (Main effect of second timepoint improvement *beta*=0.14; *p*=0.107). Between the control and intervention conditions, there is no noticeable difference in performance. There is also no noticeable difference between the English and Spanish trials.

Conclusion and Future Directions

In this experiment, we focused on how a polysemy intervention helps children learn to generalize over and learn polysemous words. First, we tested 14 neurotypical children of ages 3 and a half to 4 years old in order to see if we would see an effect in the intervention. The results show us that the intervention did not show a noticeable effect in their performance. Although they improved between the pretest and posttest in all conditions, there was not a significant difference between the control and intervention in learning. In other words, the intervention was not that much more helpful in teaching neurotypical children the polysemous words than the control was.

The results suggest that, firstly, neurotypical children are able to do and learn from our task, since in all trials there was some improvement. Secondly, it suggests that neurotypical children are already spontaneously finding similarities between words. In both the control and intervention conditions they performed above chance (0.25) and the lack of a difference when we tried to intentionally teach them to see the words in a particular way shows that it was not very helpful. This may be because neurotypical children already find similarities between words, so they do not need an intervention to teach them how to do it. The intervention did not hinder them or worsen their performance but it also did not help.

The next step in this project will be to investigate if our intervention helps a population that does not spontaneously already find similarities between words. Future studies could also investigate how a successful polysemy intervention impacts ASD children's language and vocabulary in other language-learning areas more generally, such as in learning object categories.

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