

Official title of study: What Makes a Cup, a Cup? Generalizing Novel Words

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Study Protocol and Statistical Analysis Plan

Study Protocol:

The overall objective for this project was to test word learning from digital media to ascertain the degree to which digital contexts affect word-learning mechanisms. The central hypothesis was that digital media will have broad negative effects on language *because* it reduces the availability of multiple environmental cues during language acquisition, thereby disrupting the ability to retain and generalize words and grow one's vocabulary. To test the central hypothesis and achieve the objective, the specific aim for this study sought to identify the impact of digital media on the processes underlying generalization of novel words. That is, can children generalize words learned via digital media?

While children generally demonstrate an ability to reliably associate words and referents as young as 15-months-old (Fernald et al., 1998), the rate at which they succeed varies across individuals and contexts. For instance, stimuli that are 2D tend to be less rich and harder to learn (Barr et al., 2007). In a word mapping study testing children's real-time processing with a Referent Selection task, 100% of children completed a storybook condition, 80.25% finished all trials in a condition using a tablet, and only 56.75% completed an eye-tracking version with images displayed on a large TV monitor (Frank et al., 2016). The first take-away is that children's general ability to attend to words is different across contexts – this has critical implications for measuring and learning language. Importantly, while both storybooks and tablets use 2D static images, the ability of a child to engage with the device/form is drastically different. The second important finding from Frank et al. (2016) is the differences in successful word mapping across modalities for both known and novel words. Children were presented with an identical task in each condition. While there was no 3D stimuli control condition in this study, this is the first evidence that real-time processing abilities may be poorer on a tablet than in storybooks, suggesting digital media might be detrimental for word mapping.

A critical next step is the ability to generalize these words to new examples. For instance, once a child learns the word "cup" for their sippy cup, they must recognize that mom's coffee mug also goes by that name, otherwise they have not truly learned the word. How this process plays out in digital contexts is much lesser known as few studies have directly pitted 2D vs. 3D generalization. Ganea et al. (2008) showed poor transfer from cartoon images. No study, however, has examined generalization of words from images to real objects or the application of the shape bias to the transfer deficit.

Our approach to testing these ideas is to compare performance within and across modalities in a Novel Noun Generalization task (Landau, Smith, & Jones, 1988). There were four conditions: 3D exemplar and 3D generalization, 3D exemplar and 2D generalization, 2D exemplar and 3D generalization, and 2D exemplar and 2D generalization. Total proportion choice to shape across each condition was measured as the primary dependent outcome.

Statistical Analysis Plan (SAP):

The primary question of interest in this study is if there are differences in children's performance in both generalization across each of the conditions. Thus, condition is the primary independent variable and accuracy is the primary outcome variable. Initially, linear regressions were run to compare overall accuracy as well as t-tests against chance in each condition to confirm if children were above chance. This was followed by a more rigorous mixed hierarchical model predicting trial-by-trial performance from

conditions as a fixed factor and participant as a random effect. There were no adjustments for testing multiple variables as only a limited number of variables were tested as part of the plan.