How prediction promotes children's word learning

Tracy Reuter (Princeton), Arielle Borovsky (Florida State University) & Casey Lew-Williams (Princeton)
treuter@princeton.edu

Error-based theories of language learning posit that prediction errors generated during language processing promote learning (1,2). Children who generate more robust predictions tend to have larger vocabularies (3,4,5). While these correlational findings suggest that prediction supports language learning, there is currently no direct empirical evidence. That is, prediction may be either a cause or a consequence of language learning (6). In the present study, we investigated the relation between prediction and learning directly, measuring whether and how prediction influences children's learning of novel words. In particular, we assessed two different possibilities. One possibility is that the ability to generate predictions to expected outcomes supports language learning, as predictions could automatically redirect attention to novel information. If this is the case, we hypothesized that children who generate more predictions to expected, highly probable outcomes would learn novel words more successfully. A related possibility, and a crucial test of error-based accounts, is that predictions influence learning *via prediction error*. That is, children may differ in two ways: (1) the degree to which they generate predictions to highly probable outcomes and (2) how successfully they redirect attention to the correct referent when their prediction is wrong. If this is the case, we hypothesized that children who showed greater recovery from prediction error would learn novel words more successfully, compared to children who simply generated strong predictions, but were less successful in recovering from the error.

We developed a novel word-learning paradigm to evaluate these hypotheses. In an eye-tracking task, 3-5-year-old children (n=56) saw pairs of objects (one familiar, one novel), and listened to pre-recorded sentences. In the constrained condition, sentences cued predictions to the familiar object (e.g., *"Yummy! Let's eat soup. I'm going to stir it with a…"*). Critically, half of these trials referenced the familiar object (e.g., *"spoon"*), and half referenced the novel object (e.g., *"cheem"*). In the unconstrained condition, sentences were neutral (e.g., *"Neat! Look over there. Take a look at the spoon/cheem").* Children saw 6 blocks of trials, and each block included 2 familiar objects and 2 novel objects (Figure 1).

We measured children's recognition of novel objects on test trials as a function of their predictions and prediction errors on learning trials. Analyses focused on trials in the constrained condition in which the novel object was the target referent. We defined prediction as looks to the familiar object before the novel label was spoken (i.e., the pre-noun window). We defined prediction error as a difference score in looking to the novel object between the post-noun and pre-noun windows. Children with larger difference scores were those whose eye movements revealed they had experienced an error at noun onset, because they had predicted the familiar object but then redirected attention to the novel object. We defined test accuracy as target looks in the post-noun window on test trials. We expected that prediction and prediction error would correlate positively with test accuracy.

We found that prediction in learning did not correlate with test accuracy (r=0.04, p=0.755). However, prediction error was marginally correlated with test accuracy (r=0.27, p=0.052). As shown in Figure 2, this correlation was significant for 3-year-olds (r=0.53, p=0.034) and 4-year-olds (r=0.56, p=0.011), and null for 5-year-olds (r=0.04, p=0.889).

These results are consistent with the hypothesis that simply generating predictions is not sufficient to explain how children learn novel words. Prediction error – operationalized here as redirecting visual attention from the incorrect, familiar referent to the novel referent – may be particularly important for learning. This study provides a crucial test of error-based learning, and shows for the first time that the ability to efficiently revise inaccurate predictions supports young children's language learning.

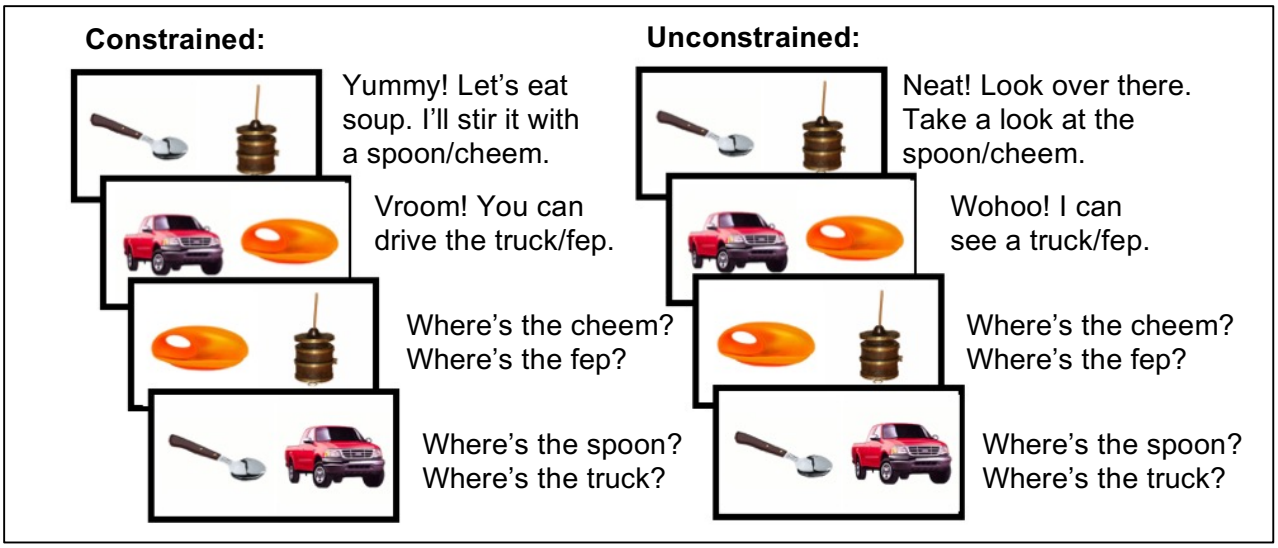

Figure 1: Sample block of constrained condition (left) and unconstrained condition (right).

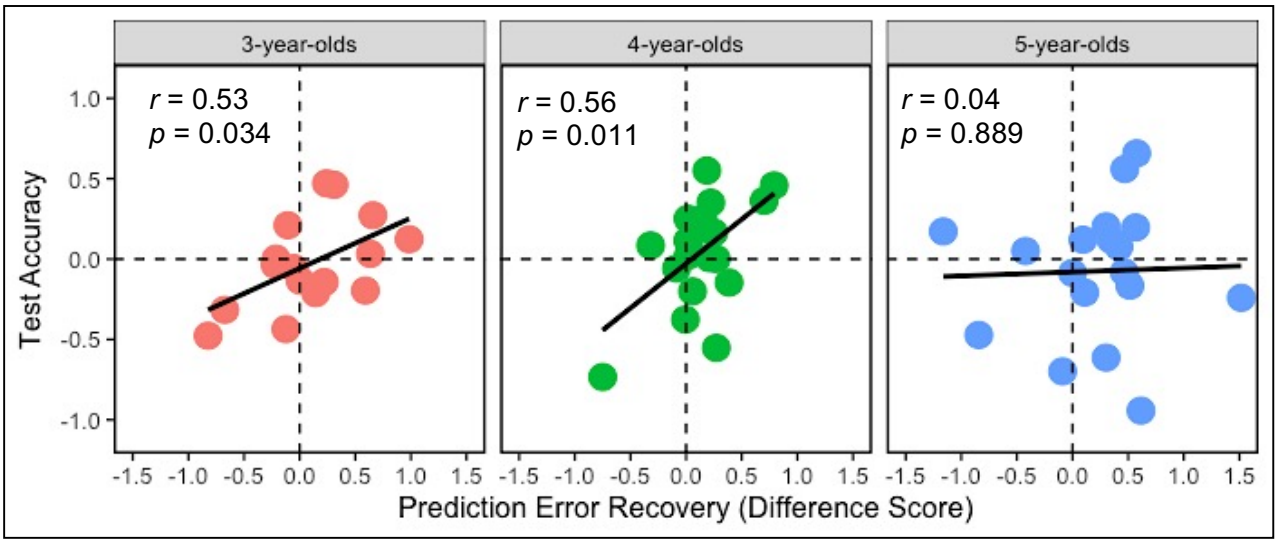

Figure 2: The relation between prediction error recovery and test accuracy.

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