

Is 4-Year-Olds' Language Learning Driven by Prediction Errors? Evidence From Eye-tracking

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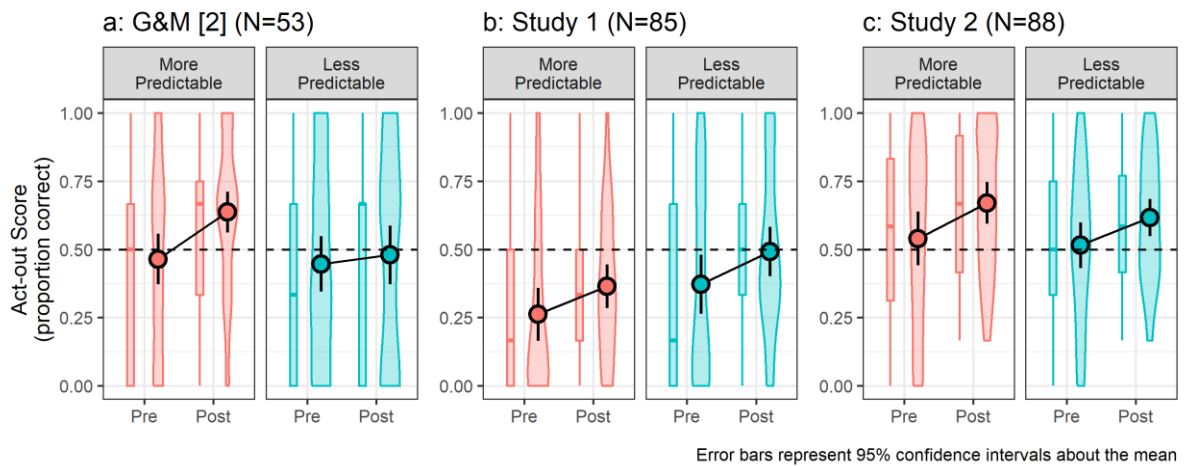
The role of prediction errors in language learning is unclear [1]. To investigate their influence on English 4-year-olds' developing comprehension of sentence structure, we focus on double object datives (DOs); sentences in which the recipient of a transfer action (e.g., giving) precedes the theme (e.g., the given object), e.g., "Bluey will give the monkey [recipient] a nut [theme]". In [2], 4-year-olds exposed to sentences encouraging generation of stronger incorrect linguistic predictions (inanimate themes: more predictable condition) showed (marginally) greater improvement in comprehension of DOs (measured by the percentage of accurate "act outs" of pre and post-test sentences) than those exposed to sentences that did not encourage strong predictions (animate themes: less predictable condition, Fig. 1a). In two studies, we replicate and extend [2], additionally using eye-tracking to directly measure prediction error, defined as the extent to which children revise initially incorrect predictions upon encountering prediction-mismatching linguistic information (predict-and-revise score; [3] and Fig. 2).

Study 1 ($N=85$) used only sentences with animate (vs. inanimate) themes in pre- and post-tests (which showed the greatest pre-post accuracy improvement in [2]). Unlike [2], we did not find more improvement in DO understanding for those in the more predictable ($n=42$, M_{pre} accuracy=25%, M_{post} =35%) compared to the less predictable ($n=43$, M_{pre} =39%, M_{post} =50%) training condition (pre-test accuracy*condition predicting post-test accuracy, $b=-0.08$, $SE=0.12$, $z=-0.66$, $p=.508$, Fig. 1b). However, eye-tracking data ($n=75$) showed that children who made stronger incorrect predictions that they then revised showed greater improvements in DO understanding relative to their peers ($b=0.07$, $SE=0.03$, $t(70)=2.11$, $p=.039$, Fig. 2a). Study 2 (current $n=88$, target $N=90$) aimed to more closely replicate the design of [2] (test sentences included animate and inanimate themes), but it confirmed the results of Study 1 (Fig. 1c): There was no greater pre- to post-test improvement in the predictable condition ($n=44$, M_{pre} =54%, M_{post} =67%; unpredictable, $n=44$, M_{pre} =52%, M_{post} =62%). Crucially, as in Study 1, eye-tracking data ($n=76$) showed that children who made and revised stronger incorrect predictions also experienced greater improvement in DO understanding (in the more predictable condition where incorrect predictions are more likely: pink line in Fig. 2b).

Together, these novel findings provide clear evidence that children's gains in DO comprehension are driven by prediction error, but they also suggest that individual differences influence the degree of error-based learning. We will preview ongoing work (Stage 1 Registered Report) that aims to shed light on verbal and non-verbal abilities that relate to these individual differences in processing and learning (target $N=95$).

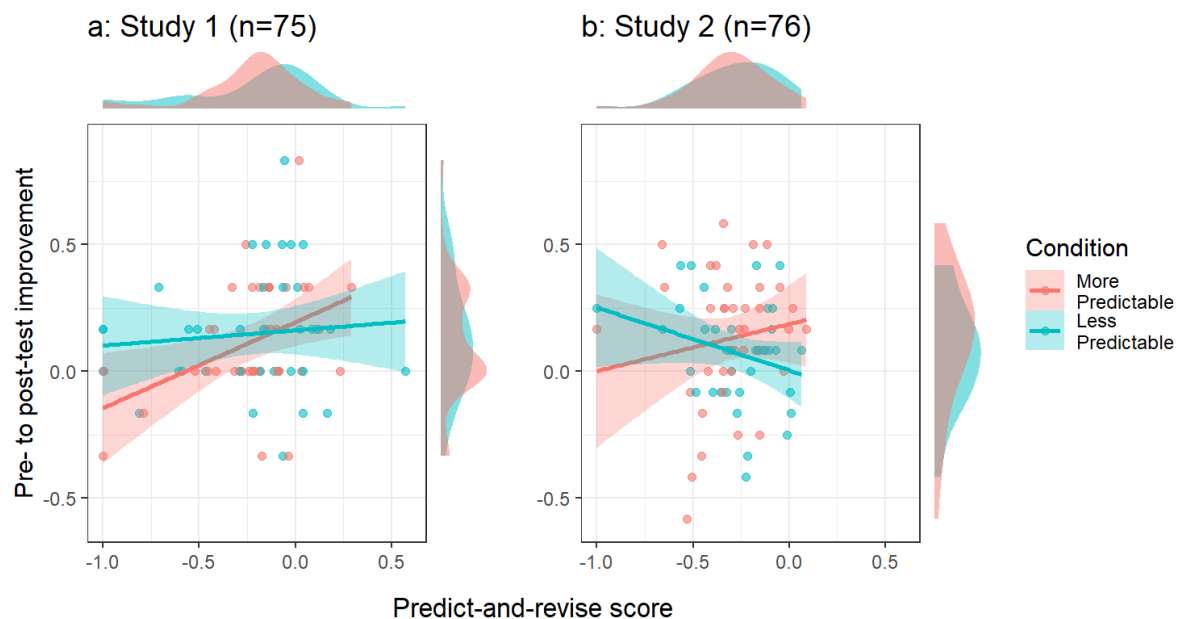
Figures and Tables

Figure 1. Pre- and post-test act-out accuracy by condition across studies



Note. Pre and post-tests consisted of (a) 3 inanimate theme and 3 animate theme trials, (b) 6 inanimate theme trials, and (c) 6 inanimate theme and 6 animate theme trials.

Figure 2. Relationship between predict-and-revise score and pre-post difference in accuracy acting out the DO across studies



Note. Study 1 data available at

https://osf.io/wh6xm/overview?view_only=bd834deab3e7486aa04e01c12dc001c7.

References

- [1] Ryskin, R., & Nieuwland, M.S. (2023) *Trends in Cognitive Sciences*, 27(11), 1032-1052.
- [2] Gambi, C., & Messenger, K. (2023). *Languages*, 8(4), 276. [3] Reuter, T., Borovsky, A., & Lew-Williams, C. (2019) *Developmental Psychology*, 55(8), 1656-1665.