

Revisiting the role of literacy on predictive processing during spoken language comprehension: Evidence from low-income Afro-Colombian speakers

Jessica Vélez Avilés & Paola (Giuli) Dussias

Past studies suggest that high-literacy individuals engage in linguistic prediction earlier than low-literacy individuals. However, because these studies have not consistently considered socioeconomic status (SES), a variable associated with poor language development, the predictive advantages for higher-literacy individuals might be confounded by SES differences. Here we conducted two eye tracking visual world experiments to isolate literacy effects from SES. We recruited Spanish-speaking participants from San Basilio de Palenque, an Afro-Colombian village located to the south of Cartagena, Colombia. To measure SES, we administered an in-house questionnaire—collecting information about average monthly income, occupation, and level of education, including mother's and father's level of education—and the MacArthur Scale of Subjective Social Status (Adler et al., 2000). Participants had uniformly low SES ($p = 0.902$) but differed in literacy level as determined by a Principal Component Analysis (PCA). Literacy was assessed using PROLEC-SE-R (Cuetos et al., 2016), a battery of standardized tests that measure literacy level. We implemented the PCA to create a literacy level index that explained the maximal amount of variance using the following measures: word reading (reaction time and accuracy), pseudoword reading (reaction time and accuracy), dictation (accuracy), and teacher-reported literacy level.

Experiment 1 examined prediction when the grammatical gender in a prenominal article could be used as a cue to predictive processing. Participants (higher literacy: $n=21$; lower literacy: $n=20$) heard instructions in Spanish ('*Encuentra el_{MASC}/la_{FEM}...*'/'Find the...') that named one of two objects displayed on a computer screen. Target objects in the spoken instructions were preceded by a feminine or a masculine article that agreed in gender with the two objects in the visual scene (same-gender; e.g., *pelota_{FEM}* 'ball' displayed alongside *galleta_{FEM}* 'cookie') or with only one of the two objects (different-gender; e.g., *pelota_{FEM}* 'ball' displayed with *zapato_{MASC}* 'shoe'). Experiment 2 used semantic and morphosyntactic cues to study the time course of predictive processing. A subset of the participants who took part in Experiment 1 (higher literacy: $n=17$; lower literacy: $n=17$) volunteered to participate in Experiment 2. Participants listened to Spanish sentences (e.g., *Mi hermana se comió/compró un pedazo de ese_{MASC} chocolate_{MASC}/esa_{FEM} pizza_{FEM}*/'My sister ate/bought a piece of that chocolate/pizza') while viewing four-pictures (e.g., a chocolate, a pizza, a hammock, and a book). The design followed a staged elimination of potential targets, with the audio offering cues to identify the correct target at three segments in the sentence: (1) at the verb (participants heard a constraining verb like 'eat' or a non-constraining verb like 'buy'), (2) at a partitive phrase (e.g., '*un pedazo de*'/'a piece of'), and (3) at a prenominal determiner (e.g., *ese_{MASC}* or *esa_{FEM}* 'that') that either matched (same-gender) or did not match (different-gender) the gender of the target noun.

Data were analyzed using a divergence point analysis that compared fixations to the target objects with competitors. The results of Experiment 1 (Figure 1) show that both literacy groups looked sooner at target objects on different-gender trials (when the display was informative) than on same-gender trials, consistent with findings from prior studies. In other words, we found that predictive eye movements occurred for lower and higher literacy speakers alike. Although literacy skill modulated anticipatory eye movements, the differences were quantitative: both literacy groups engaged in prediction at the earliest moment possible (i.e., before target word onset). The results of Experiment 2 (Figures 2-4) replicated the prediction effect found in Experiment 1: both literacy groups engaged in predictive processing, as evidenced by earlier looks to the target/competitor items when listening to constraining and less constraining contexts across all three segments. The analysis resulted in no significant differences in predictive eye movements between the higher and lower-literacy groups in each segment, underscoring the robustness of predictive processing across literacy levels. Taken together, these findings suggest that under conditions where SES is controlled and multiple cues support comprehenders' predictions, the effect of literacy on prediction disappears. Results are interpreted within the *Enhanced Literate Mind* model (Huettig & Hulstijn, 2024), with particular attention to socioeconomic status as a confounding variable in studies examining the effects of literacy.

References

- Adler, N. E., Epel, E. S., Castellazzo, G., & Ickovics, J. R. (2000). Relationship of subjective and objective social status with psychological and physiological functioning: Preliminary data in healthy white women. *Health Psychology*, 19(6), 586-592. <https://psycnet.apa.org/doi/10.1037/0278-6133.19.6.586>
- Huettig, F., & Hulstijn, J. H. (2024). The Enhanced Literate Mind (ELM) Hypothesis. *Topics in Cognitive Science*. <https://doi.org/10.1111/tops.12731>

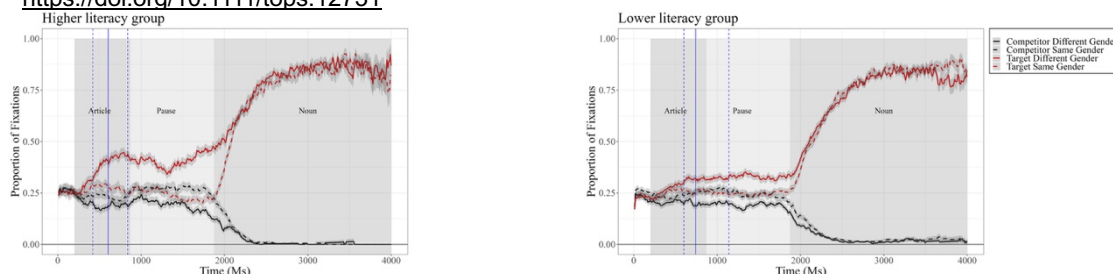


Figure 1. Proportion of fixation to targets and competitors over time for different-gender and same-gender trials (Experiment 1). Plotted are the proportion of fixations to target (red) and competitor (black) items in same- (dashed) and different-gender (solid) trials for high (left) and low (right) literacy individuals. Solid vertical lines indicate the mean of the first point of divergence and dotted vertical lines represent confidence intervals. The analysis showed that high-literacy speakers showed an earlier divergence point (mean = 605ms, 95% CI=[420, 840]) compared to low-literacy speakers (mean = 742ms, 95% CI=[600, 1140]) relative to the start of the audio ($p = 0.037$).

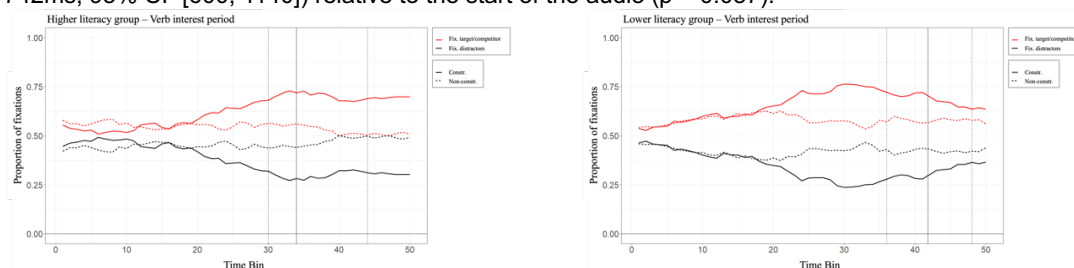


Figure 2. Proportion of fixations to target and competitor objects (averaged) and distractor objects over time for constraining and non-constraining trials in the **verb interest period** by literacy group. Plotted are the proportion of fixations to edible items (target and competitor) in the constraining (red solid) and non-constraining (red dashed) conditions. In the graph, 0 marks the onset of the verb. Solid vertical lines indicate the mean of the first point of divergence and dotted vertical lines represent 95% confidence intervals. The findings revealed no statistically significant difference in the verb region between higher and lower literacy individuals ($p = 0.498$).

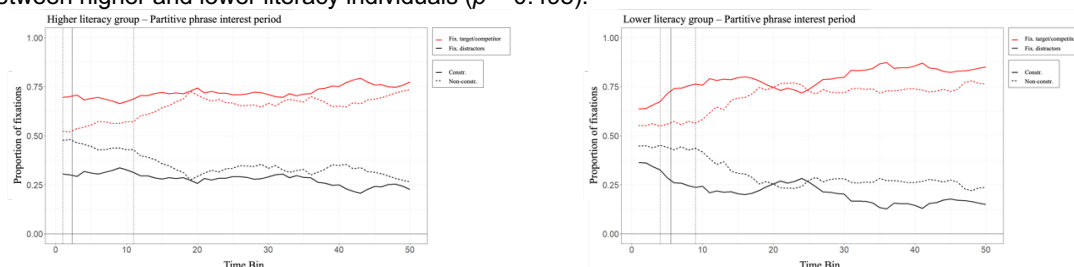


Figure 3. Proportion of fixations to target and competitor objects (averaged) and distractor objects over time for constraining and non-constraining trials in the **partitive phrase interest period** by literacy group. Plotted are the proportion of fixations to edible items (target and competitor) in the constraining (red solid) and non-constraining (red dashed) conditions. In the graph, 0 marks the onset of the partitive phrase. Solid vertical lines indicate the mean of the first point of divergence and dotted vertical lines represent 95% confidence intervals. The results indicate that literacy level did not modulate anticipatory processing at the partitive phrase region ($p = 0.363$).

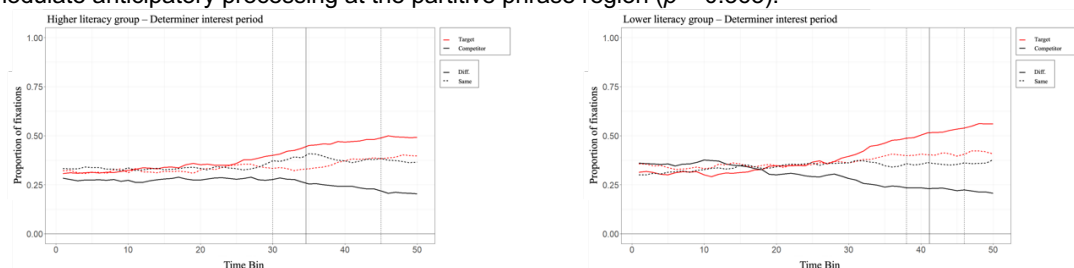


Figure 4. Proportion of fixations to target and competitor objects over time for the different- and same-gender trials in the **determiner interest period** by literacy group. Plotted are the proportion of fixations to target (red) and competitor (black) items in the same-gender (dashed) and different-gender (solid) conditions. In the graph, 0 marks the onset of the determiner. Solid vertical lines indicate the mean of the first point of divergence and dotted vertical lines represent 95% confidence intervals. The analyses did not reveal statistical differences between the higher and lower literacy individuals at the determiner region ($p = 0.263$).