The effects of linear order and prediction when learning in ambiguous contexts

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Although the environments in which natural languages are usually learned are characterised by noise and ambiguity, these factors have often been presented as a problem for learners. In a series of artificial language experiments Jenkins et al. (2024) found that learning in ambiguous contexts did not seem to hinder (and could even have aided) participants to successfully learn and generalize gender-marked affixes. In training, participants heard a prefix-noun-suffix NP while viewing two possible visual referents (target/foil), and learned simply by having to guess which referent matched the NP. Two sets of affixes were associated with semantic cues to two noun classes ('count vegetables' – e.g., carrots – versus mass 'spinach') and participants learned to generalize the affixes appropriately to unseen count/mass vegetables despite their receiving no feedback at all in training.

However, it is unclear from these results whether successful generalisation was also linked to using the affixes predictively, simply because the affix structure employed could not differentiate between whether generalisation depended on participants having learned to use the gender marked prefixes, their matched suffixes (or both). If prediction does in fact support generalisation, we hypothesized that learners would learn to generalise more when trained in a condition where prefixes are informative about the semantics of noun class that when suffixes are, if only because by the time a suffix is heard, the referent associated with its semantics has itself already been discriminated.

To test this, the original language was manipulated in order to make either only the prefixes or the suffixes informative about the association between mass / count vegetables and noun class. Across three experiments, we consistently found evidence of prediction in the prefix informative condition (Fig 1), as well as successful generalisation in the prefix informative condition but not the suffix informative condition (Fig 2; interestingly, performance on matching affixes to the nouns seen in the training set was strong across both conditions). These results were robust across different visual stimuli: vegetables with count/mass classes (Experiments 1 and 2), and feature-based "fribble" categories (Experiment 3), different affix forms: naturalistic (Experiment 1) vs more controlled affixes (identical forms used for each affix; Experiments 2 and 3) and stimuli with (Experiment 3) and without (Experiments 1 and 2) carrier phrases. Overall, the findings support the idea that prediction can drive learning of semantic classes, supporting the role of prediction in learning and generalisation.

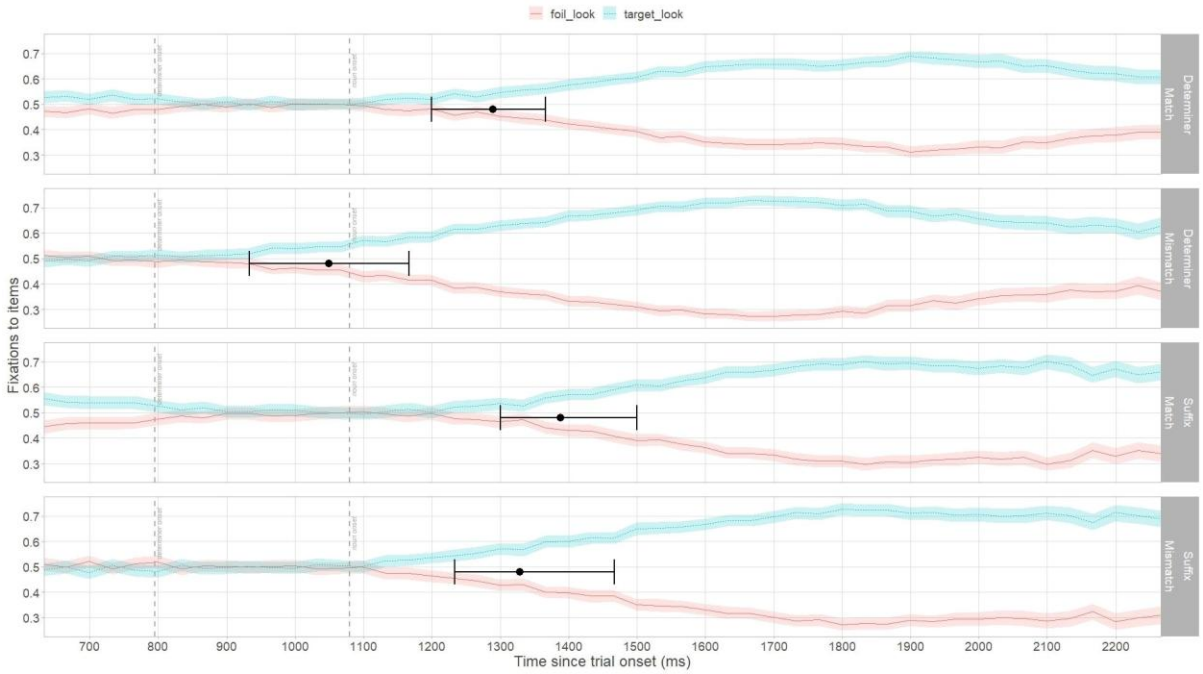

Figure 1. Eye-tracking data from the training phases in Experiment 1. Plot shows mean fixations to target and foil (with 95% confidence intervals). Divergence points in black (with confidence intervals) show where looks become consistently greater to the target than the foil (computed using non-parametric bootstrapping). Participants show greater looks to target item compared to the foil when the determiner is informative (top two panels), but not in suffix (bottom two panels). Similar patterns were found in Experiments 2 and 3.

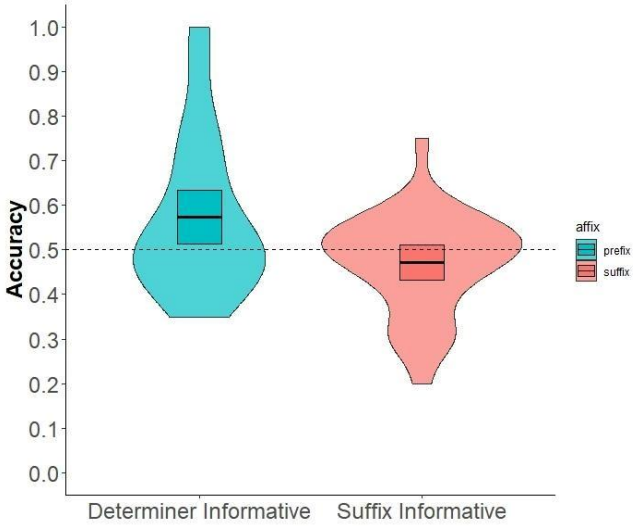

Figure 2. Accuracy in judging the grammaticality of gender-marked novel nouns based semantic cues In Experiment 1. Boxes show means and 95% confidence intervals. As can be seen participants performed above chance in the condition where the determiner was informative, but not when the suffix was informative. Similar results were found across Experiments 2 and 3.

References

Jenkins, H, Jenkins, Ramscar, M & Wonnacott, E (2020) Error-Based Learning of Grammatical Gender Systems Using Semantic Cues. AmLAP 2024