

## **Adaptation to discourse patterns depends on relative frequency of competing structures**

Valerie J. Langlois & Jennifer E. Arnold (University of North Carolina – Chapel Hill)

valeriel@live.unc.edu

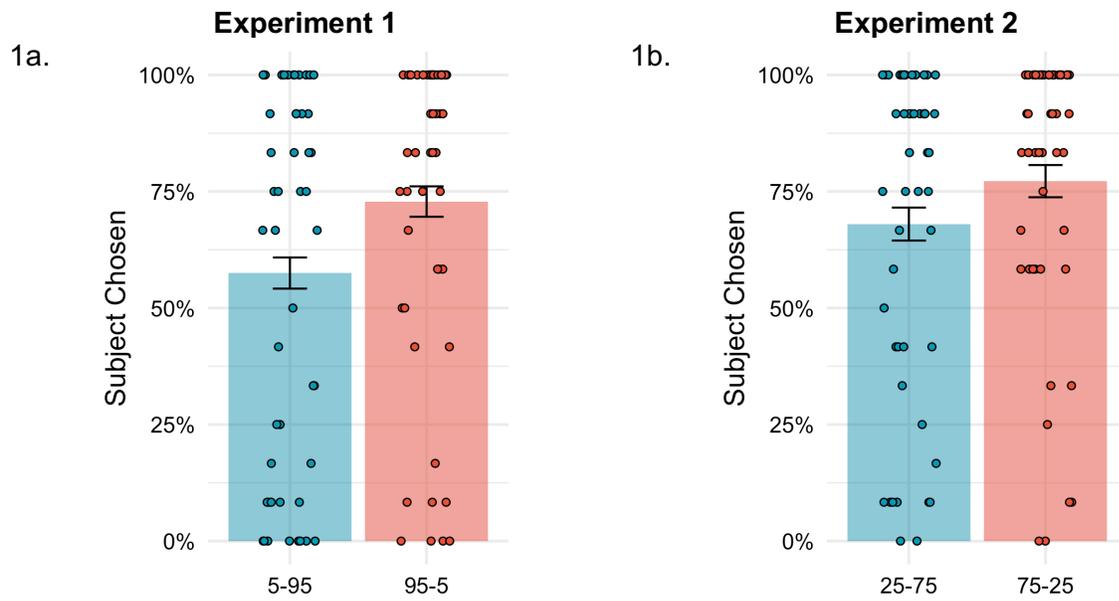
Comprehenders quickly interpret ambiguous third-person pronouns by following contextual constraints. In *Ana is cleaning up with Liz. She needs the broom*, there is a bias to assign the pronoun to the subject character *Ana* (e.g., Gernsbacher & Hargreaves, 1989; Järvikivi et al., 2005). There is evidence that this bias is modulated by experience, suggesting it may be learned from exposure to the more frequent patterns of pronoun reference. First, individuals with greater print exposure tend to follow the subject bias more consistently (Arnold et al., 2018). Second, exposure within a short (10-minute) experiment modulates interpretation biases. Williams & Arnold (CUNY 2019) exposed readers to stories with unambiguous pronouns that either always referred to the subject or always referred to the nonsubject, and people adapted to this pattern when interpreting ambiguous pronouns (for similar effects see Contemori, 2019; Kaiser, 2009). This demonstrates a causal link between exposure and pronoun comprehension. But Williams & Arnold used exposure sentences that all followed the same structure. Natural language is more variable. Can comprehenders adapt to partially predictive referential patterns? We test this by using Williams & Arnold’s task, and manipulate the relative frequency of sentences where the pronoun refers to the non-subject or the subject character.

Our key test items probed interpretation preferences for ambiguous pronouns, e.g. *Liz planted flowers with Ana. She watered the seeds*. Participants answered two comprehension questions, one of which measured pronoun comprehension (“Did Ana water the seeds?” 2AFC: Yes, No). The question always asked about the non-subject character (here, Ana). Thus, responding “No” signals that participants assigned the pronoun to the subject character (here, Liz). We know that people have a “yes” bias with this task, which means that the question format works against the general bias for people to assign the pronoun to the subject character, Liz, and increases variability in responses. Our question was whether this bias would vary as a function of the filler stories, and whether the consistency of the fillers would matter. The fillers were disambiguated by gender and referred to either the subject (e.g. *Liz ate french fries with Matt. She spilled ketchup on the table*) or the non-subject referent (e.g. *Liz ate french fries with Matt. He ...*). To control for previous linguistic experience, we measured print exposure with the Author Recognition Task (Stanovich & West, 1989), where participants selected the authors they knew from a list of real and fake authors.

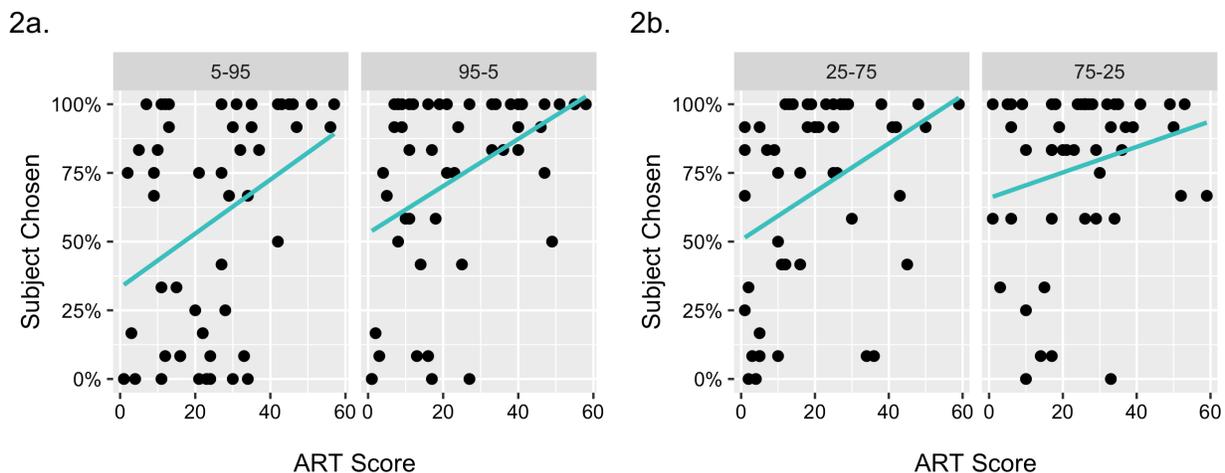
In each experiment, Mturk participants (100 for Exp. 1; 99 for Exp. 2) read 12 critical, ambiguous sentences and 40 filler sentences. We manipulated the frequency of the fillers referring to the subject and non-subject. Exp. 1 compared the 95-5 condition (95% subject fillers ( $n=38$ ); 5% non-subject fillers ( $n=2$ )) with the 5-95 condition. Exp. 2 compared the 75-25 (75% subject fillers ( $n=30$ ); 25% non-subject fillers ( $n=10$ )) and 25-75 conditions. Thus, the proportion of subject to non-subject fillers was more extreme in Exp. 1 than Exp. 2.

**Results:** In Exp. 1, participants were less likely to select the subject referent when 95% of the fillers had non-subject interpretations (Fig. 1a,  $p = .025$ ). However, this was not the case for Exp. 2. Participants in both the 25-75 & 75-25 condition were equally as likely to interpret the pronoun as the subject referent, even though there was a numeric trend in the expected direction (Fig. 1b). There was an overall main effect of ART in both experiments (Exp. 1:  $p < .01$ ; Exp. 2:  $p < .01$ ), replicating previous findings where participants with higher print exposure were more likely to interpret the pronoun as the subject (see Fig. 2a&b).

**Conclusions:** Exp. 1 replicated Williams & Arnold (2019), demonstrating that even in a short experiment, people learn to follow the dominant pronoun interpretation pattern. While this adaptation is impressive, Exp. 2 shows that it disappears when the filler items have more than a couple items in the competing structure. This raises questions about how people learn about the frequency of discourse patterns, and whether longer exposures can counteract the kind of variability encountered in natural language.



**Fig 1a&b.** Percentage of subject chosen for the different between-subject conditions (subject % to non-subject %). Each point represents the average subject chosen for a participant within the condition. Error bars represent 95% within-subject CIs.



**Fig. 2a&b.** ART score predicts subject responses across condition and experiment

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