Not all cues are equal: retrieving gender and number in Brazilian Portuguese sluiced sentences

Introduction. The resolution of long-distance grammatical dependencies requires retrieving a linguistic antecedent from memory [4]. Well-studied cases of retrieval include subject-verb dependencies, which can be separated by intervening information such as relative clauses (1), however, this process can be observed in a variety of structures. In this study, we investigate how grammatical information such as gender and number affect retrieval processes in Brazilian Portuguese sluiced sentences.

(1)   <u>The child</u> that eats a lot of candy <u>visits</u> the dentist frequently.

We appeal to models of cue-based retrieval, in which all potential antecedents for a retrieval cue are accessed and matched through a rapid cue-matching procedure to resolve grammatical dependencies [4]. When the retrieval cue overlaps with more than one item in memory, however, the matching procedure is disrupted, resulting in decreased retrieval accuracy and speed known as similarity-based interference (SBI). Although it is generally assumed that all types of cues contribute equally to SBI, the present studies demonstrate that gender and number provoke asymmetrical SBI effects. These results raise a concern for most cue-based retrieval models in that certain grammatical cues appear to be weighted differently during the retrieval process.

Current Study. Sluicing is a typologically-common form of clausal ellipsis following a *wh*-expression (e.g., *Mary loved someone$_i$, but I don't know who$_i$*) in which the *wh*-remnant (*who*) is paired with a correlate (*someone*) in the matrix clause. Brazilian Portuguese (BP) sluices are ideal for testing gender and number as a retrieval cues, as both features can be overtly expressed on the wh-remnant. Gender features can be included on the wh-remnant by adding a pronoun, (*quais deles/delas* – which$_{PL}$ of them$_{M/F}$), whereas without the pronoun, only number features are present (*qual/quais* – which$_{SG/PL}$). Sluices in English show a strong preference to associate the *wh*-remnant with the most structurally local correlate, known as the *Locality Bias*, which has not been previously shown in Romance languages [1]. Previous research [2,3] found that violations of the Locality Bias (retrieving a subject correlate) increases SBI, as the target must be retrieved over an interfering NP (distractor). Using the fact that gender and number features are marked explicitly in BP, we explored two hypotheses: (i) any morphological feature that is overtly shared between competing correlates and a retrieval cue will contribute to SBI effects, which (ii) will increase when the target correlate violates the Locality Bias.
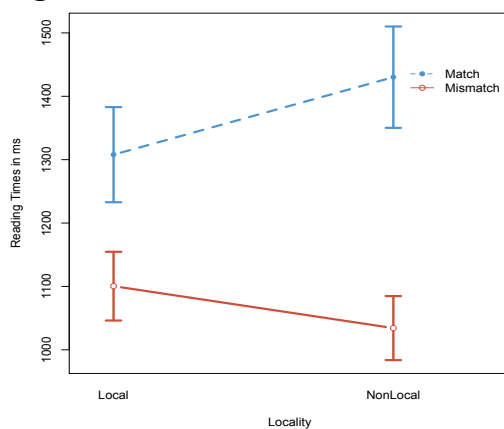
Self-paced reading experiments. In two experiments, we used a 2x2 design crossing *Locality* (Local, Non-Local) and *Distractor Cue* (Match, Mismatch) to create 24 sluices (Tables 1). In each trial, participants read the sentence phrase by phrase in self-paced reading, provided an acceptability rating (1-7), and selected which whether the Local or non-Local noun was the correlate to the remnant. In all items, the target correlate was an indefinite animate noun and the distractor was a definite animate noun, which could not have served as the correlate.

Table 1: Sample item from Experiment 1 (from 24 quartets) - "/" indicates analysis region
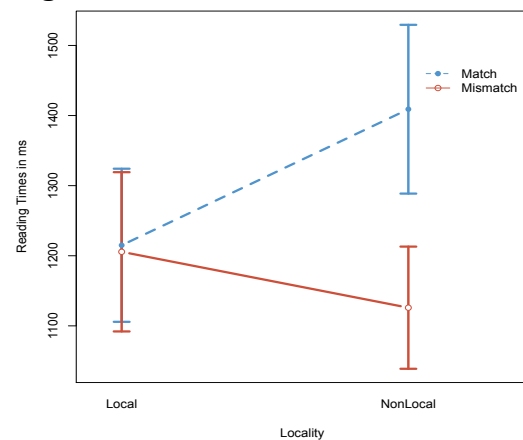*"/" indicates analysis region – critical, spillover and final regions in bold*

Na empresa nova/... At the new company/...	
Object Correlate – Gender Match	**Subject Correlate – Gender Match**
...as empreendedor<u>as</u>/ demitiram/ algumas funcionári<u>as</u>... the entrepreneurs F. PL./ fired/ some employees F. PL.	...algumas empreendedor<u>as</u>/ demitiram/ as funcionári<u>as</u>... some entrepreneurs F. PL./ fired/ the employees F. PL.
2. Object Correlate – Gender Mismatch	**Subject Correlate – Gender Mismatch**
...os empreendedor<u>es</u>/ demitiram/ algumas funcionári<u>as</u>... the entrepreneurs M. PL./ fired/ some employees F. PL.	...algumas empreendedor<u>as</u>/ demitiram/ os funcionári<u>os</u>... some entrepreneurs F. PL./ fired/ the employees M. PL.
...mas eu não posso dizer/ **quais del<u>as</u> / pois tenho medo/ de ser demitido tambem.** ...but I can't say **/ which PL. ones of them F. PL. / as I am afraid. / of getting fired as well.**	

In **Experiment 1** (N=32)**,** the *wh*-remnant was overly marked for **gender** (*quais deles/delas* – which ones of them$_{M/F}$). In the spillover and final regions, we observed slower reading times when the distractor had the same morphological gender as the target (*p*'s<0.05), as well as an interaction between Locality and gender cue match (*p*'s<0.05), indicating an increased reading time penalty for non-Local targets that matched in gender with the distractor. In **Experiment 2** (N=12; data collection ongoing) the *wh*-remnant was only overtly marked for **number** (*qual/quais* – which $_{SG/PL}$). In the spillover region, there was a penalty for violating the Locality Bias (*p*<0.01). The final region showed a reading time penalty for number cue match (*p*<0.05) and the expected penalty for non-local targets that matched in number with the distractor (*p*<0.05). In both experiments, offline comprehension question accuracy decreased when the Locality Bias was violated (*p's*<0.01) and distractor cues matched with the target (*p's*<0.01), but there were no interactions.

Figure 1: Interaction in Final Region - Experiment 1

Figure 2: Interaction in Final Region - Experiment 2

Conclusions. Our results show that both gender and number are reliable retrieval cues in BP and support the claim that the Locality bias modulates similarity-based interference effects in ellipsis structures, supporting our initial hypotheses. Although both gender and number cues are employed during retrieval, gender showed earlier effects of SBI than number did, suggesting that these cues do not behave identically during the retrieval process. Our findings align with previous studies showing that the amount of information contained in a retrieval cue affects the strength of retroactive SBI effects, as well as the time-course in which these effects appear, whereby SBI effects are seen earlier for highly informative retrieval cues [2,3]. The time-course differences found in the present study may indicate that gender is more accessible in BP than number, speeding retrieval of the correlate. Overall, our findings suggest that the retrieval mechanism is sensitive to fine-grained linguistic information and that not all cues are equally accessible at the point of retrieval.

2. Condensed References
[1] Frazier, L., and Clifton, C. Jr. (1998). Comprehension of sluiced sentences. *Lang. Cogn. Process.* 13, 499–520; [2] Harris, J. A. (2015). Structure modulates similarity- based interference in sluicing: An eye tracking study. *Frontiers in psychology*, *6*.; [3] Harris, Jesse A. (2019). Alternatives on demand and locality: Resolving discourse-linked *wh*- phrases in sluiced structures. In: Clifton, C., Fodor, J.D., & Carlson, K. *Grammatical Approaches to Language Processing - Essays in Honor of Lyn Frazier.* Springer Studies in Theoretical Linguistics.*;* [4] Van Dyke, J. A., & Lewis, R. L. (2003). Distinguishing effects of structure and decay on attachment and repair: A cue-based parsing account of recovery from misanalyzed ambiguities. *JML*, *49*(3), 285-316