Context and Attention in Sentence Processing

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INTRODUCTION

What can semantic ambiguity reveal about underlying sentence processing mechanisms?

Quantifier Scope Ambiguity (QSA)

Surface scope interpretation: **Inverse scope interpretation**:

***Every** kid climbed **a** tree*
Every N1 Verbed a N2

Two possible meanings:
Determined by the order of interpretation of quantifiers (i.e. Quantifier scope interpretation)

Disambiguation of QSA sentences
- Relies on number interpretation
- Kurtzman and MacDonald (1993) showed preference for plural interpretation.
- Dwivedi (2013; see also Dwivedi et al., 2010) showed no preference, concluding that people process sentences using a "heuristic first, algorithmic second processing strategy"

Heuristic vs. **Algorithmic** processing (Simon, 1956; Ferreira, 2003; Fodor, 1982)

PREVIOUS FINDINGS

- Using both behavioural and ERP methods, Dwivedi (2013) and Dwivedi et al. (2010) argued for shallow heuristic processing of QSA sentences, (resulting in no interpretation preference). As such, algorithmic computation of quantifier scope sentences is not a primary mechanism.

Dwivedi et al. (2010)

In off-line norming portion of ERP study, 32 ppts preferred a plural interpretation of *N2* (74% of the time, circled plural continuation sentence for *Every N1 Verbed a N2).* However, waveforms elicited during on-line reading did **not** show a preference for surface vs. inverse scope interpretation.

Dwivedi (2013)
In this self-paced reading study, the stimuli from the previous work were re-analyzed, such that:

- A by items analysis revealed that some sentences were heavily biased for surface scope interpretation
  - E.g., *Every kid climbed a tree* was interpreted as plural 100% of the time
- And some sentences were not biased for either interpretation
  - E.g., *Every jeweler appraised a diamond* was interpreted as plural 50% of the time.

Stimuli were separated by lexical-pragmatic bias and by task.

- *Experiment 1.* Heavily biased stimuli were presented without questions querying their Interpretation.
  - no difference in reading times (RTs) for any conditions (very shallow processing!)
- *Experiment 2.* Same plurally biased stimuli were presented, now with questions regarding interpretation
  - I.e., *How many trees were climbed? ONE SEVERAL*
  - RTs were faster for plural vs. singular continuation sentences. No effects of ambiguity (consistent with the lexical-pragmatic bias of QSA context sentence)
- *Experiment 3.* Non-biased (truly ambiguous) stimuli were presented with questions regarding their interpretation.
  - RTs were faster for continuation sentences following unambiguous vs. ambiguous context sentences. No effects for Number (ie effects were consistent with lexical-pragmatic bias of QSA context).
  - For both Exps 2 & 3, whereas RTs patterned with lexical-pragmatic bias of context sentences, question response accuracy rates showed a strong dispreference for inverse scope condition (AS).
  - In other words, reading times showed one pattern whereas question-response accuracy showed another.
  - Concluded that readers interpret QSA sentences using a heuristic mechanism. Algorithmic computation only occurs if required.

THE PRESENT STUDY

Does addition of a *pre-context* sentence modulate attention to change sentence processing mechanism of QSA sentences?

Relevance:

Perhaps participants do not deeply process QSA sentences such as *Every N1 Verbed an N2* because *Every*, which is a context-dependent quantifier, does not have a previously specified domain with which it can be interpreted (Westerståhl,1984; Diesing, 1992)

Hypothesis:

(i) Addition of a pre-context sentence, which would provide *Every* a context set, could result in greater attention in processing *Every*, and then rest of sentence—resulting in algorithmic first processing.

(ii) Alternatively, it could be the case that heuristic first processing is a general processing strategy, independent of grammatical requirements of lexical items, such that the addition of pre-context would not have an effect.

Predictions:

(i) Expect that inverse scope condition RTs are longer than control, whereas surface scope (plural) RTs will not differ. Question-response accuracy pattern should mirror RT pattern.

(ii) Pattern of on-line RTs and question response accuracy should replicate those in Exp. 2 of Dwivedi (2013).

METHODS AND MATERIALS

Participants

30 (23 female; mean age 20.7years) right-handed native English speakers from Brock University

Materials:

- 24 target sentences with 165 filler sentences
- A pre-context sentence with plural subject N1 was added to provide a context over which *Every N1* could quantify.
- N2: two types in pre-context:
  - *Ambiguous condition* - N2 was consistent with the scene depicted by QSA context sentence; this way did not bias for specific reading of N2 in QSA.
  - *Control condition*- synonym, or related word was used for N2, so *that/those tree(s)* would not be pragmatically anomalous. Avoided repeated names.
- All trials were followed by a question regarding sentence interpretation.
  - (E.g., *How many trees were climbed? ONE SEVERAL)*

		Context	
		Ambiguous	Control
Continuation	Singular	The kids spotted the park during the long walk. Every kid climbed a tree. The tree was in a playground.	The kids spotted the oak during the long walk. Every kid climbed that tree. The tree was in a playground.
	Plural	The kids spotted the park during the long walk. Every kid climbed a tree. The trees were in a playground.	The kids spotted the oaks during the long walk. Every kid climbed those trees. The trees were in a playground.

Procedure:

- Participants were instructed to read and answer corresponding questions.
- The pre-context sentence was displayed in full, while the QSA context and continuation sentences were displayed one by one in a self paced reading paradigm (cf. Just, Carpenter, & Woolley, 1982)

RESULTS

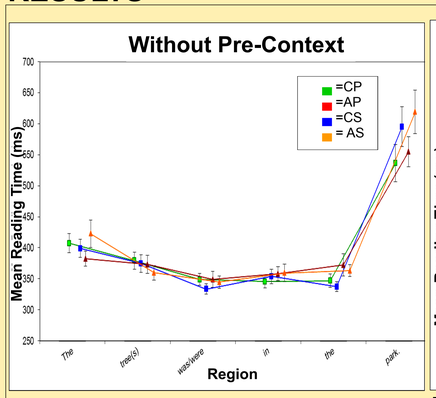

Figure 1. RT in ms at sentence 2 in Experiment 2 of Dwivedi (2013) (N=48). Points represent mean RTs per word, with vertical lines depicting the standard error of the means.

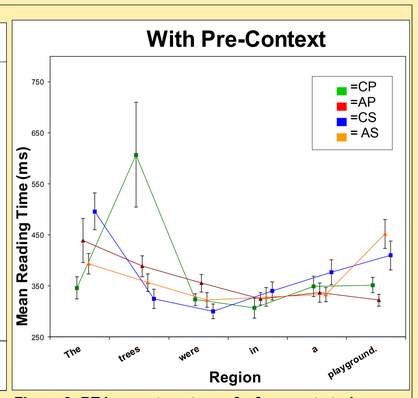

Figure 2. RT in ms at sentence 2 of present study (N=30). Points represent mean RTs per word, with vertical lines depicting the standard error of the means.

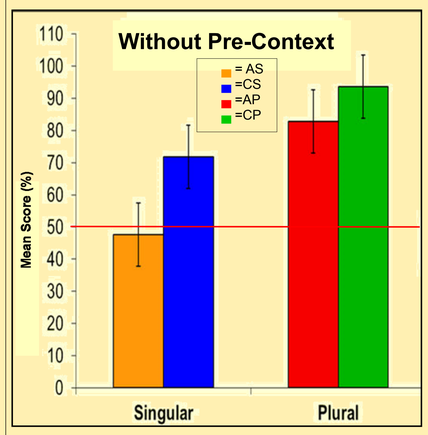

Figure 3. Mean comprehension question accuracy in Experiment 2 of Dwivedi (2013) (N=48). Vertical lines depict standard error of the means, and the horizontal line indicates an accuracy score of 50% (chance).

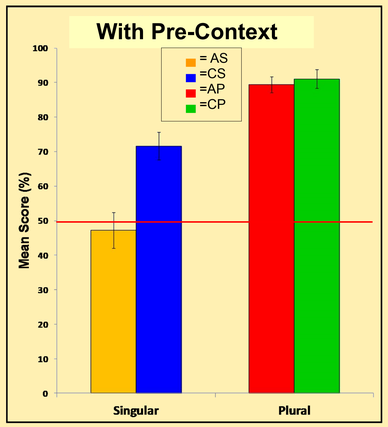

Figure 4. Mean comprehension question accuracy of present study (N=30). Vertical lines depict standard error of the means, and the horizontal line indicates an accuracy score of 50% (chance).

REFERENCES CONT'D

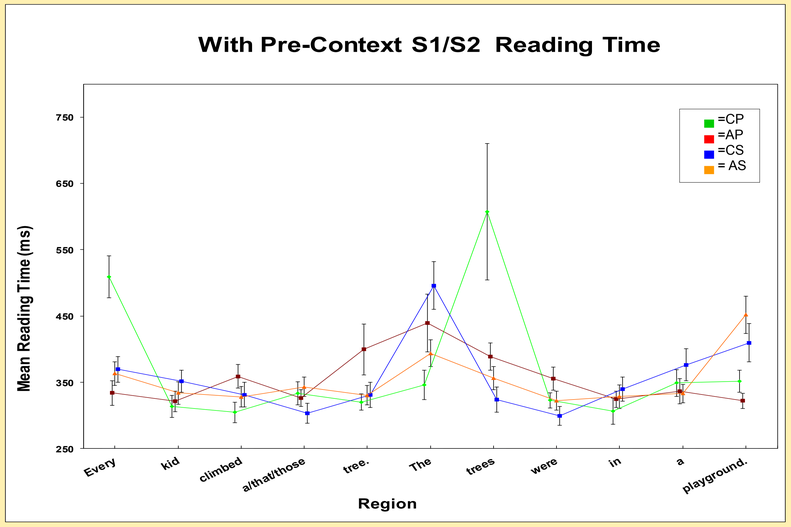

Figure 5. RT ms at sentences 1 and 2 of present study (N=30). Points represent mean RTs per word, with vertical lines depicting the standard error of the means.

DISCUSSION

- Preliminary findings indicate that the addition of pre-context sentence did not result in a different processing strategy by participants.
- Overall, we observed a mismatch between on-line RTs and question response pattern, as exhibited in previous Experiment 2 (Dwivedi, 2013).
- Furthermore, this RT pattern was replicated in a study with no questions at critical trials, indicating that our findings are due to addition of pre-context, and not due purely to task effects.
- ***Readers maintained a heuristic first, algorithmic second processing strategy in semantically ambiguous sentences.***
- Although we have evidence that readers did try and interpret *Every* (Fig. 5), this effort did **not** result in a change in sentence processing strategy.
- However, increased power is required to discern trend at EOS for AS vs. CS RTs (Figs 2 & 5).
- In addition, several interesting findings revealed regarding anaphoric resolution of singular vs. plural anaphors (using model of Sanford & Garrod, 1994; Garrod & Terras, 2000).
- Cost to integrating these anaphors, where this cost is greater for plural vs. singular definite NPs (either due to increased search space considerations and/or due to need to represent several vs. singular tokens in mental model).
- In addition, integration of definite plural NPs is delayed as compared to singular NPs (cf., Filik, Sanford, & Leuthold, 2008).
- Finally, we have shown that *Every* is indeed context dependent, such that empirical effects observed for interpretation of this quantifier are similar to those found for interpretation of ambiguous pronouns.

FUTURE STUDIES

- Investigate individual differences with respect to accuracy and WM measures to further explicate RT patterns exhibited (cf. Gibson et al., 2011)
- Investigate eye movements associated with stimuli (e.g., what is search procedure for definite NPs anaphors/context dependent quantifiers)
- Compare non-context dependent (i.e., weak) quantifiers, such as "many".
- Investigate sentence processing of non biased QSA sentences using appropriate pre-context stimuli.

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Acknowledgements: This work was partially supported by Brock Research Funds awarded to V. D. Dwivedi