Understanding hypothetical events in discourse

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INTRODUCTION

What are the underlying mechanisms that allow for language comprehension to occur efficiently?
What is the time-course of these mechanisms?

Language comprehension proceeds using **Heuristic first, algorithmic second** processes **(Dwivedi, 2013)** (c.f., Kahneman, 2011; Ferreria, 2003; Fodor, 1982)

- Dwivedi (2013) showed that on-line reading times were sensitive to (word-based) heuristics
- Evidence of algorithmic processing *only at questions*
- Examined quantifier scope ambiguous sentences such as *"Every kid climbed a tree"*
- Algorithmic computation of quantifier scope effects were only observed at question-response accuracy rates.
- On-line reading times did not show effects expected using grammatical rule of quantifier scope computation, replicating Dwivedi et al. (2010) ERP study.

Word-based heuristics?
- *John spread the warm bread with #socks.*
- Violation of event knowledge

Syntactic algorithmic rule?
- *The spoilt child *throw the toy on the floor.*
- Violation of grammatical rule.

Semantic algorithmic rule?
- See quantifier scope (Dwivedi et al, 2010a; 2013); Modal subordination (Dwivedi, 1996; Dwivedi et al., 2006; Dwivedi et al., 2010b).
- Semantic theory does use compositional rules, just like syntax. Need to tease apart semantic anomaly (#) from syntactic anomaly (*)

In the present work, we examine another kind of sentence to further investigate our model.

PREVIOUS FINDINGS

		Modal	Non-Modal
Context	Hypothetical	John is considering writing a novel. It might end quite abruptly.	John is considering writing a novel. # It ends quite abruptly.
	Factual	John is reading a novel. It might end quite abruptly.	John is reading a novel. It ends quite abruptly

Dwivedi et al. (2006) -- beyond the semantic P600 effect

- In Dwivedi et al. (2006), we investigated semantically anomalous discourses as above, using five different modal types: *might, would, should, must, may.*
- We note that this semantic anomaly (see #) is described via grammatical rule of Modal Subordination (see Roberts 1987; 1989).
- Evidence of a "**semantic P600 effect**" at the Verb "*ends*" for Hypothetical –Nonmodal condition (focus of previous study)
- In addition, **a slow negative waveform,** strongly left-lateralized, was also (unexpectedly) observed for Factual-Modal conditions at the V+1 "*quite*" position.
- We argued that **this slow negativity** was the cost associated with switching event types (factual to modal) (Kluender & Kutas, 1993; Rösler, et al., 1998; Ruchkin, et al., 1988)
- This finding is our current starting point.
- In Dwivedi (1996), it was shown and argued that *would* vs. *should* grammatically require "conditional" or Hypothetical contexts in order to be understood.
- Perhaps this neurophysiological effect is driven by the mismatch at "*would*".
- Presently we further investigate this mismatch; in addition, we further test our model: **Heuristic first, algorithmic second**

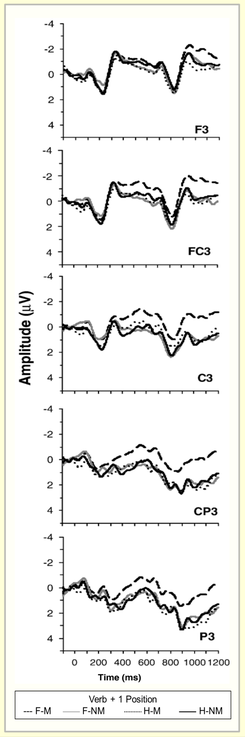

Figure 1. Grand average ERP waveforms at left-lateral sites measured at the Verb + 1 position for conditions F-M (factual-modal), F-NM (factual-non-modal), H-M (hypothetical-modal), and H-NM (hypothetical-non-modal). Taken from Dwivedi et al. (2006). Negative voltages plotted up.

THE PRESENT STUDY

- According to Stump (1985), *would* prefers hypothetical context for semantic interpretation. This is not the case for *should.*
- Interpretation of *would* vs. *should* sentences examined in Hypothetical vs. Factual contexts; mini 2-sentence discourse is followed by comprehension questions.

Hypotheses
- If language processing proceeds along heuristic first mechanism, no differences expected in word-by-word RTs.
- Algorithmic effects are *only expected at (non-superficial) questions.*
- Two levels of predictions:
  - First, regarding modal type and context: should observe facilitation effect for *would* sentences in Hypothetical but not Factual contexts. No such difference expected for *should.*
  - Second, regarding Dwivedi 2013 model: these effects should only be observed at questions, not during sentence comprehension.

METHOD

		Modal Type		Comprehension Question
		Should	Would	
Context	Hypothetical	The reporter is daydreaming about a possible interview question. It should cause a public uproar.	The reporter is daydreaming about a possible interview question. It would cause a public uproar.	The reporter is imagining a potential promotion. *True* *False*
	Factual	The reporter regrets the interview question. It should cause a public uproar.	The reporter regrets the interview question. It would cause a public uproar.	The reporter is sorry about the interview question. *True* *False*

Participants
- 48 right-handed native English speakers from Brock University (39 female, mean age 20.8 years, range 18 to 30 years)

Materials
- 32 2-sentence scenarios with follow-up questions
- Divided into 4 lists via Latin Square design
- Correct answers were counterbalanced for left-right position on screen, and for True vs. False

Procedure
- Non-cumulative self-paced reading task (Just, Carpenter, & Wooley, 1982) followed by true-false questions

RESULTS

Self-Paced Word-by-Word Reading Time Results
- A repeated measures ANOVA was conducted for S2 Reading Times
- No main effects or interactions associated with Context or Modal (all *Fs*<2).

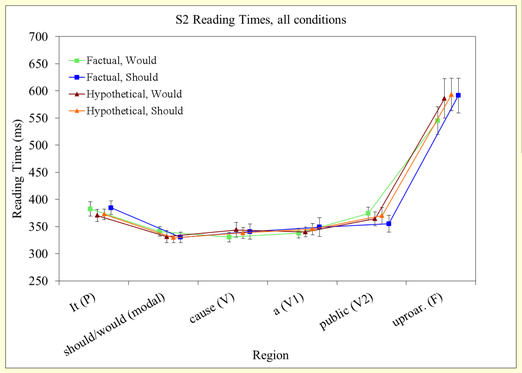

Figure 2. Word-by-word S2 reading times for all four conditions.

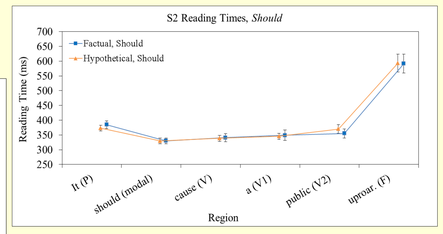

Figure 3. Word-by-word S2 reading times for *should* conditions.

Figure 4. Word-by-word S2 reading times for *would* conditions.

RESULTS

Question-Response Results

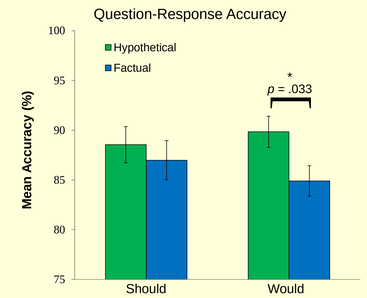

Figure 5. Mean accuracy (%) for Hypothetical vs. Factual *should* and *would* conditions.

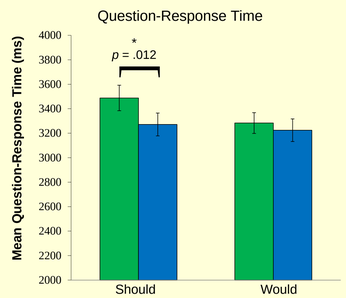

Figure 6. Mean question-response time (ms) for Hypothetical vs. Factual *should* and *would* conditions.

DISCUSSION

- Sentences embedded in discourse are not processed deeply, exhibit "good enough" processing (cf. Barton & Sanford, 1993; Daneman, Lennertz & Hannon 2007)
- *Would* sentences show facilitation effect for question-response accuracy when algorithmic properties are met.
- *Should* sentences show a cost for building (the-not-grammatically-required) hypothetical context for comprehension.
- **Language processing for such sentences exhibits: Heuristic first, algorithmic second processing** (Dwivedi, 2013)
- Allocation of attentional resources determines depth of language processing (Kemtes & Kemper, 1999)
- As a result, RT data show sensitivity to heuristic properties of sentences
- **Application of semantic (algorithmic) rules only occurs if required**
- This computation is independent of event/lexical/conceptual-semantic interpretation
- Therefore, algorithmic processing does not apply first
- In other words, these streams do not apply in parallel, nor is there a primacy for grammatical considerations.
- Not all human brains perceive language as linguistic professors!
- Important to use converging methodologies (on-line behavioural and ERP, as well as off-line ratings)

FUTURE STUDIES

- Examine other sentence types in order to test heuristic first, algorithmic second model (see Dwivedi, E. Gibson, et al., in prep)
- Investigate individual differences associated with such processes (see Dwivedi et al, 2015).

SELECTED REFERENCES

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