

PROCESSING COORDINATION AMBIGUITY IN THE VISUAL WORLD

Paul E. Engelhardt¹, & Fernanda Ferreira²

¹Michigan State University, & ²University of Edinburgh

CURRENT STUDY

- Goals were (1) to determine whether garden-path effects are observed as participants listen to temporarily ambiguous coordination structures, and (2) whether topic-structure affects how the ambiguity is resolved.

BACKGROUND

- Research question: Are syntactic structures built according to parsing strategies (e.g. Minimal Attachment) or is parsing the result of a constraint-satisfaction process?
- Current evidence is mixed. Some work suggests that parsing heuristics determine initial syntactic decisions [1,2], but evidence for the early use of non-syntactic information argues for a constraint-satisfaction process [3,4].
- Coordination is an interesting syntactic phenomenon that has an important property: Structural preferences can be separated from verb argument preferences because coordination is an adjunct operation [5].
- Minimal Attachment (MA) instructs the parser to always build the simplest structure possible. Noun-phrase (NP) coordination requires fewer nodes than Sentence (S) coordination, and so MA predicts that (1) should be easier to parse than (2).

- (1) Sandra bumped into the busboy and the waiter last Saturday night.
 - (2) Sandra bumped into the busboy and the waiter told her to be careful.
- Constraint-based models assume that the parser will make use of all information sources immediately, constraints such as frequency or context can bias the parser to a more complex interpretation.

- The coordination ambiguity shown in (1) and (2) was translated into imperative form (see A - C) for presentation in the Visual World Paradigm.
- We began by examining the distributional evidence for imperative sentences containing *and*. The results showed that S coordinations were three times more frequent than NP coordinations (72% vs. 22%).

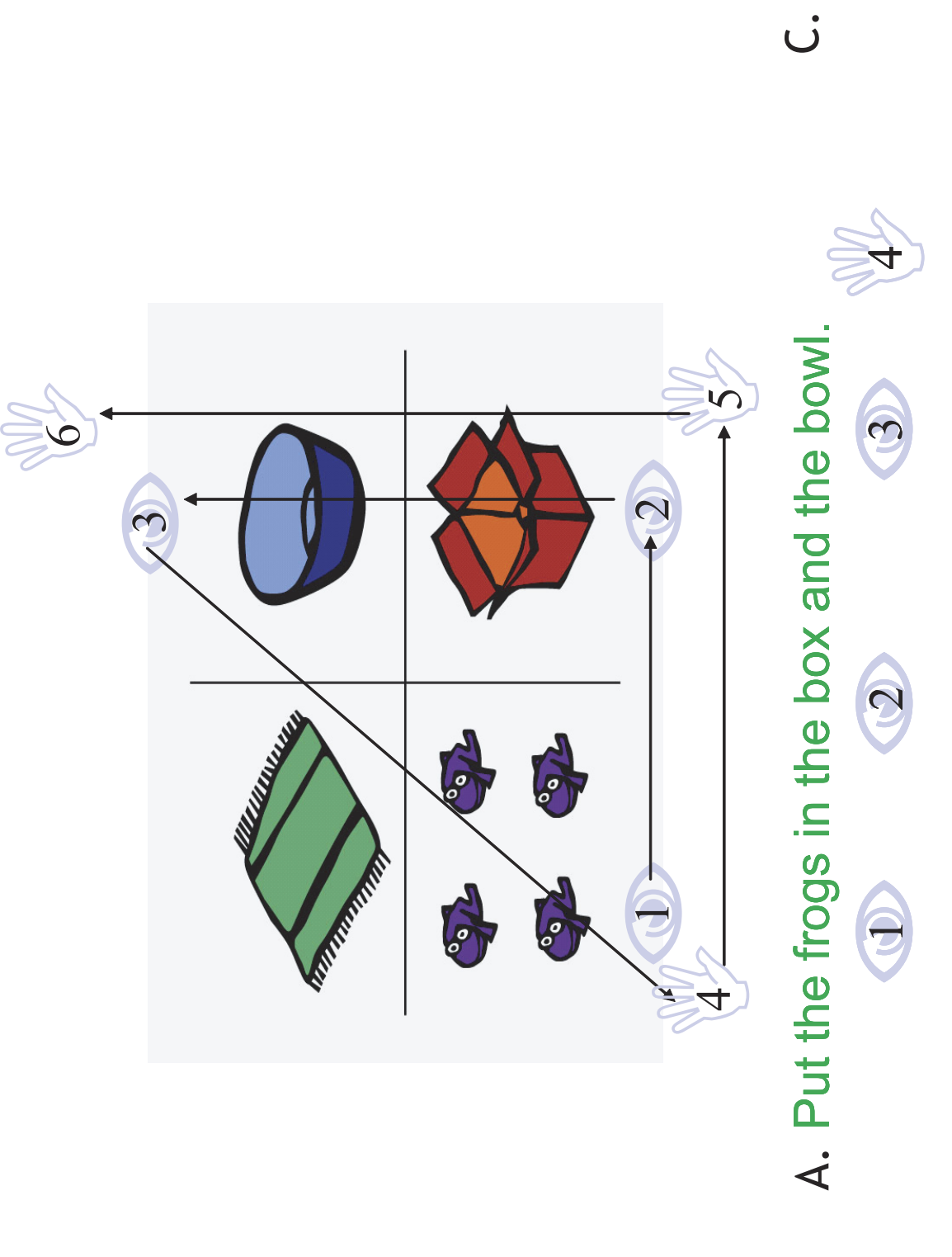
EXPERIMENT 1

- Minimal Attachment predicts that processing costs will be higher with the Ambiguous S instruction because it will require revision once the disambiguating prepositional phrase is heard [6,7]. A frequency-based explanation, in contrast, predicts that S coordination should be preferred because it is more frequent.

- Put the frogs in the box and the bowl (166) (153) (764). (NP-coordination)
- Put the frogs in the box and the bowl on the towel. (Ambiguous S)
- Put the frogs in the box and put the bowl on the towel. (Unambiguous S)

- Design was a single variable (Instruction type) with three levels: NP-coordination, Ambiguous S coordination, and Unambiguous S coordination.
- Predicted scan patterns are shown in Figures 1 - 3. Note the scan pattern for the Ambiguous instruction (B) is predicted to be similar to the NP-coordination instruction (A) until the disambiguating preposition, then it should shift to look like the Unambiguous instruction (C).

Figure 1. Predicted scan patterns for NP-coordination instruction.



METHODS

- 21 participants; 30 displays, half were fillers.
- The DV was the proportion of trials with a fixation to one of the four objects in the display. Probabilities calculated within each word, or following utterance offset, in length matched time bins.

RESULTS

- For the NP-coordination/Ambiguous S comparison, the disambiguating word is *prep2*.
- Figure 4 shows an immediate divergence between instructions. Looks to the frogs were greater in the NP-coordination instruction beginning at *prep2*(166) and continuing for the next two regions.
- Figure 5 shows that looks to the towel were greater during *prep2*(166), *the4*(153), and *NP4*(764).

- Comparison of the two S-coordination instructions revealed a divergence through the ambiguous NP. Figure 6 shows looks to the frogs increased in the Ambiguous condition and decreased in the Unambiguous condition.
- In summary, this experiment reveals an immediate, but short-lived garden-path effect through the ambiguous NP with the Ambiguous S instruction.

EXPERIMENT 2

- Instructions were either Ambiguous (B), or Unambiguous (C) S coordination. A topic-structure manipulation set up an expectation for either one or two topics as follows:

- The experimenter began each trial by stating “on this trial you will be primarily working with the frogs” (one topic) or “on this trial you will be

Figure 2. Predicted scan patterns for Unambiguous instruction.

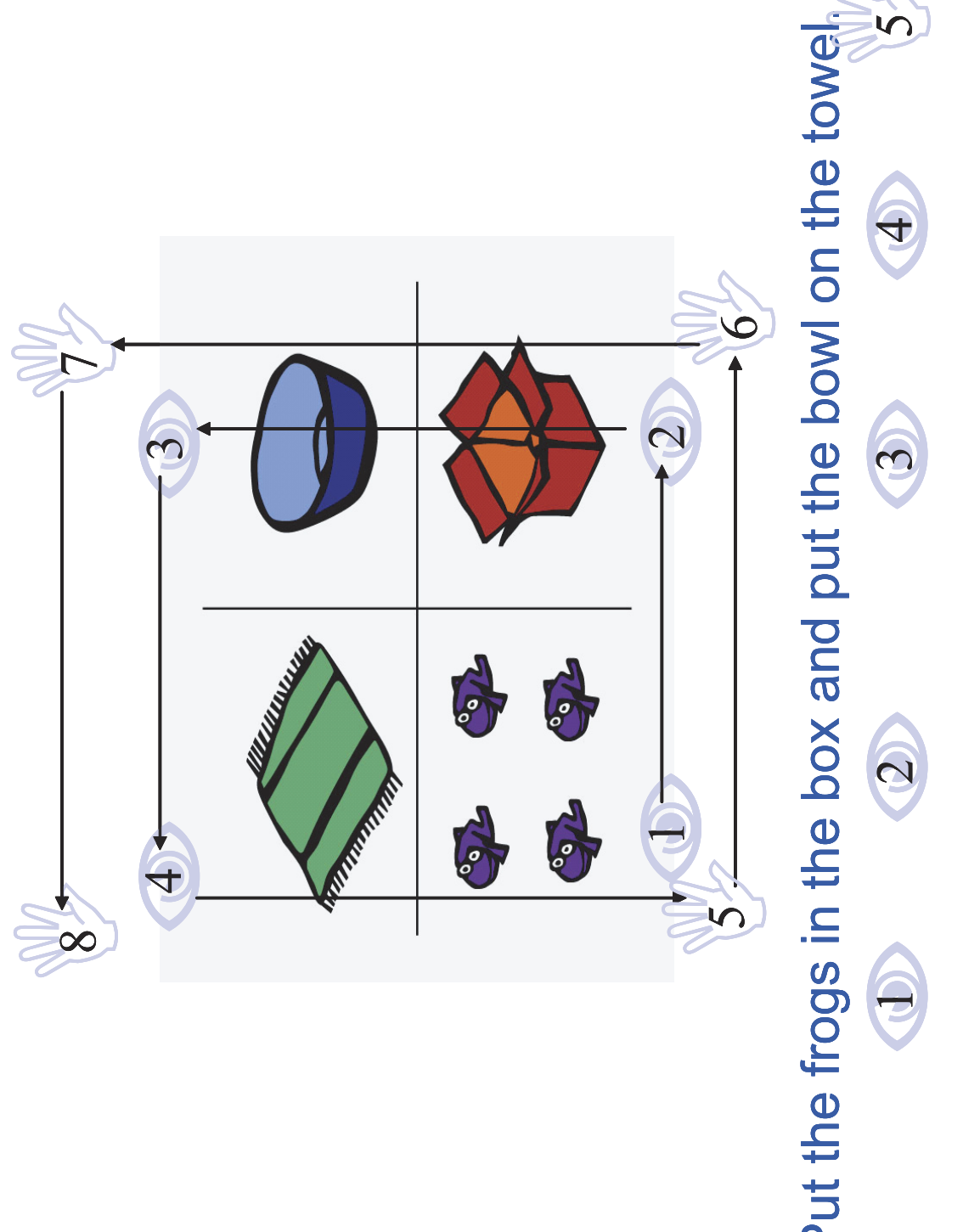


Figure 3. Predicted scan patterns for Ambiguous instruction.

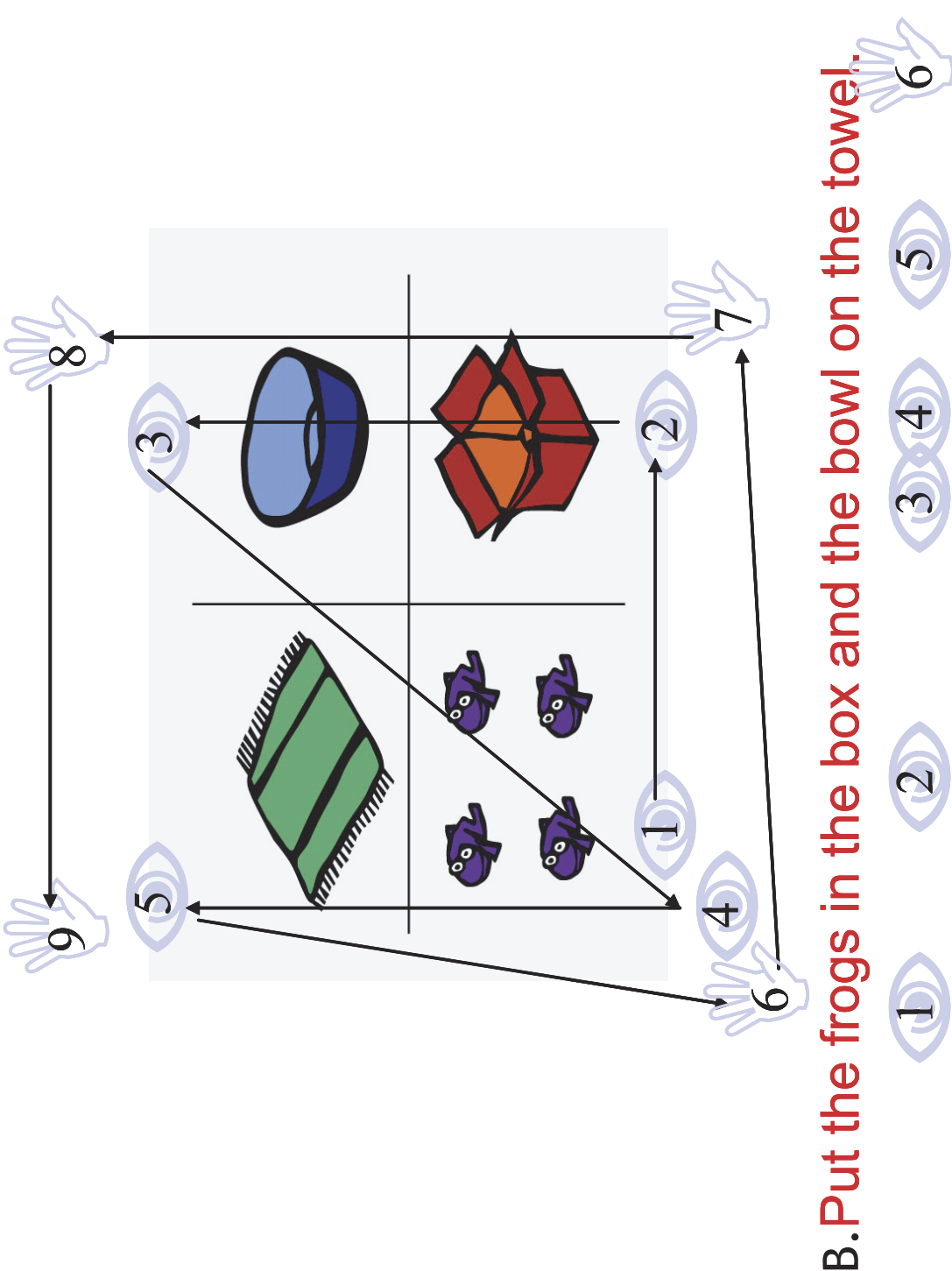


Figure 4.

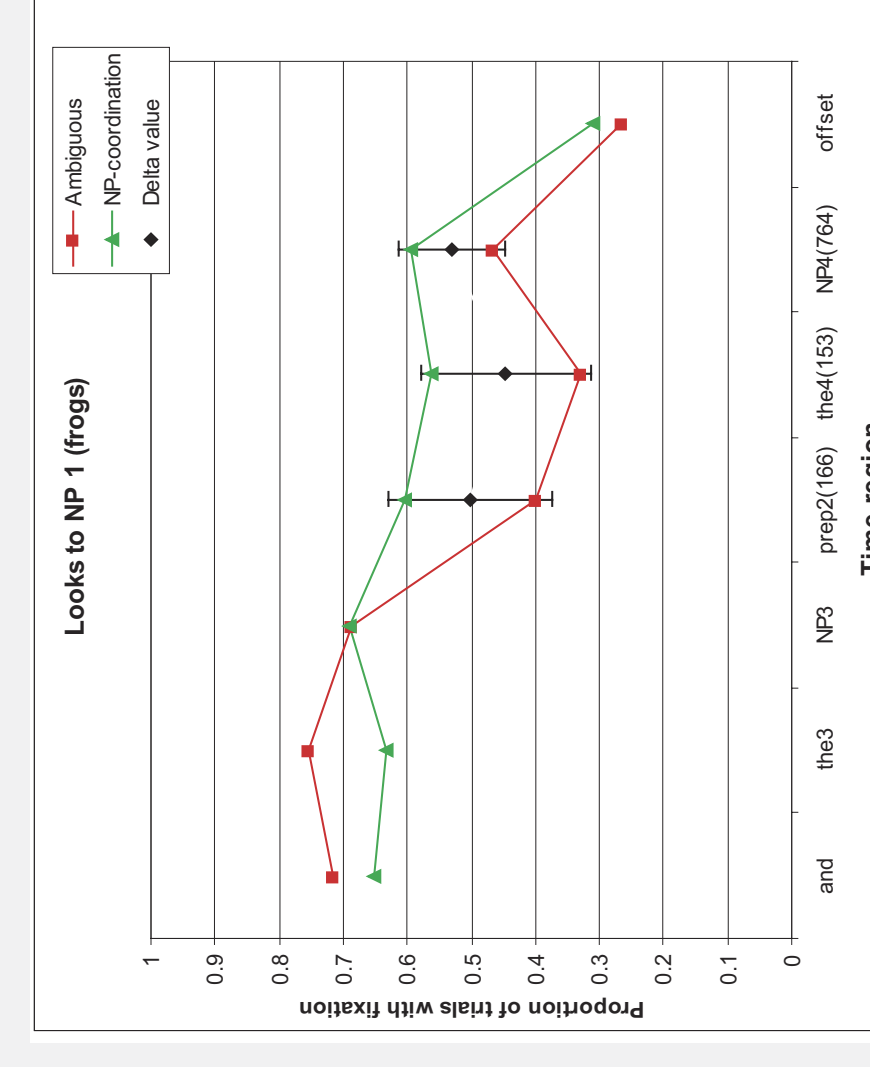


Figure 5.

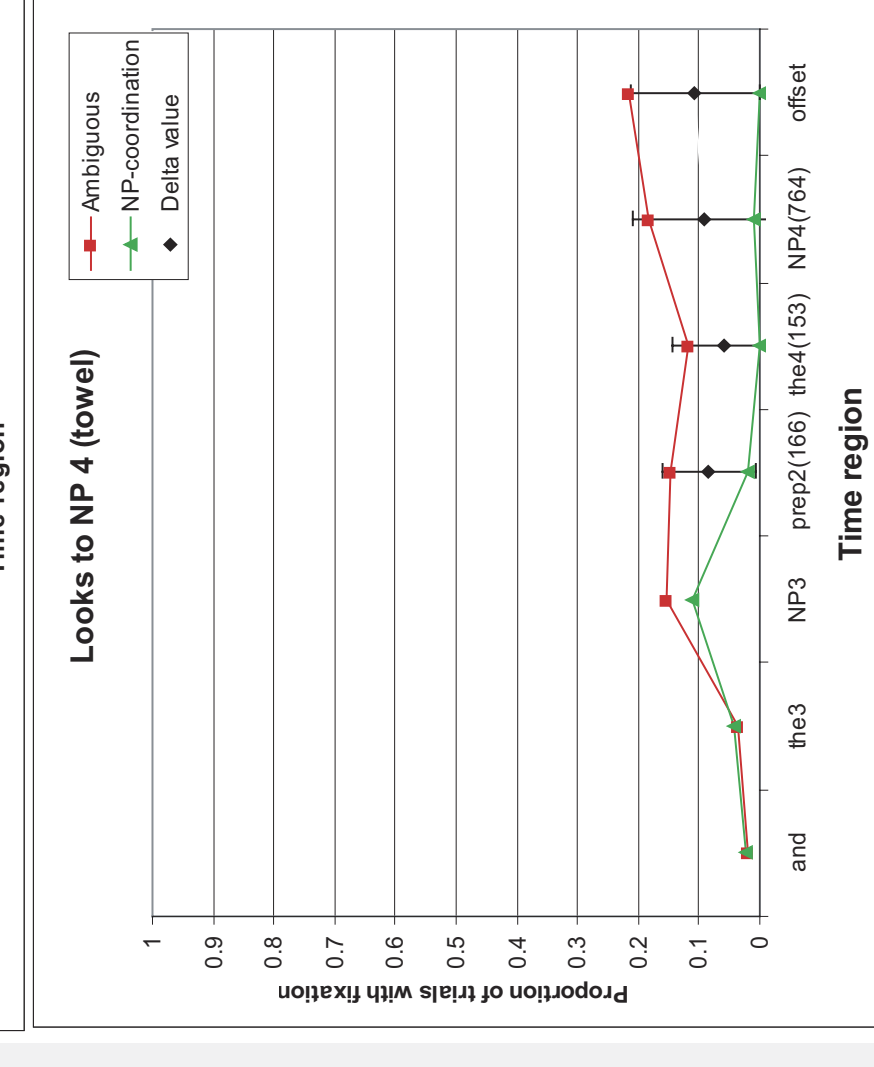
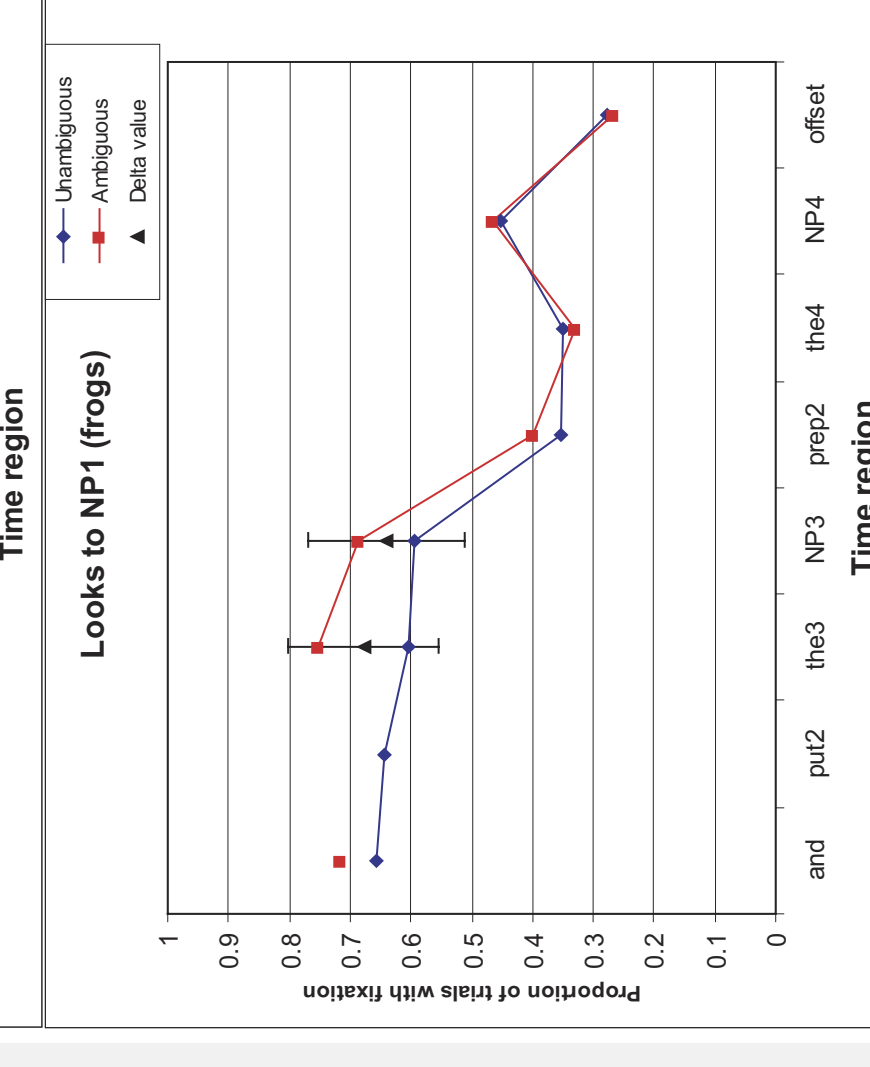


Figure 6.



primarily working with the frogs and the bowl (two topics).”

- If topic structure influences initial parsing, then a two-topic context should eliminate the garden-path. A one-topic context, in contrast, should make the garden-path more severe.

METHODS

- 24 participants; 40 displays, half were fillers. All other procedures same as Experiment 1.

RESULTS

- The results of a 2 x 2 ANOVA showed only a main effect of ambiguity during *the3* and a marginal effect at *NP3*.
- Figure 7 shows the results from the one topic context. Here we see a similar pattern of results compared to Experiment 1. There were more looks to the frogs during *the3* when the instruction was ambiguous.
- Figure 8 shows that with the two-topic context, there were no significant differences between instructions during the ambiguous NP, but the means indicate that a substantial effect of ambiguity remains.
- In summary, these data suggest that topic-structure had a minimal effect on parsing, consistent with the predictions of Minimal Attachment [cf.6].

CONCLUSIONS

- Experiment 1 showed an immediate tendency to interpret an ambiguous coordination structure in the simplest way possible. This garden-path is striking considering that two information sources could have biased towards the S coordination interpretation.
- First, the frequency of imperatives favors S coordination. Second, the Ambiguous S instruction was created from the Unambiguous S instruction, therefore the Ambiguous instruction had the prosodic features of S coordination. Nevertheless, we observed a preference for NP-coordination despite these two potentially biasing constraints, indicating that the preference for simplicity is quite robust.
- Experiment 2 showed that a two-topic context did not override the effect of ambiguity. This result provides additional evidence against models of parsing in which contextual information can guide initial syntactic decisions.
- The coordination ambiguity tested in these experiments provided a novel test of the relevant theoretical predictions because structural preferences are not confounded with verb argument preferences. When we remove the argument preference confound, the data clearly support a restricted parsing architecture in which primarily structural simplicity guides initial parsing.

Figure 7.

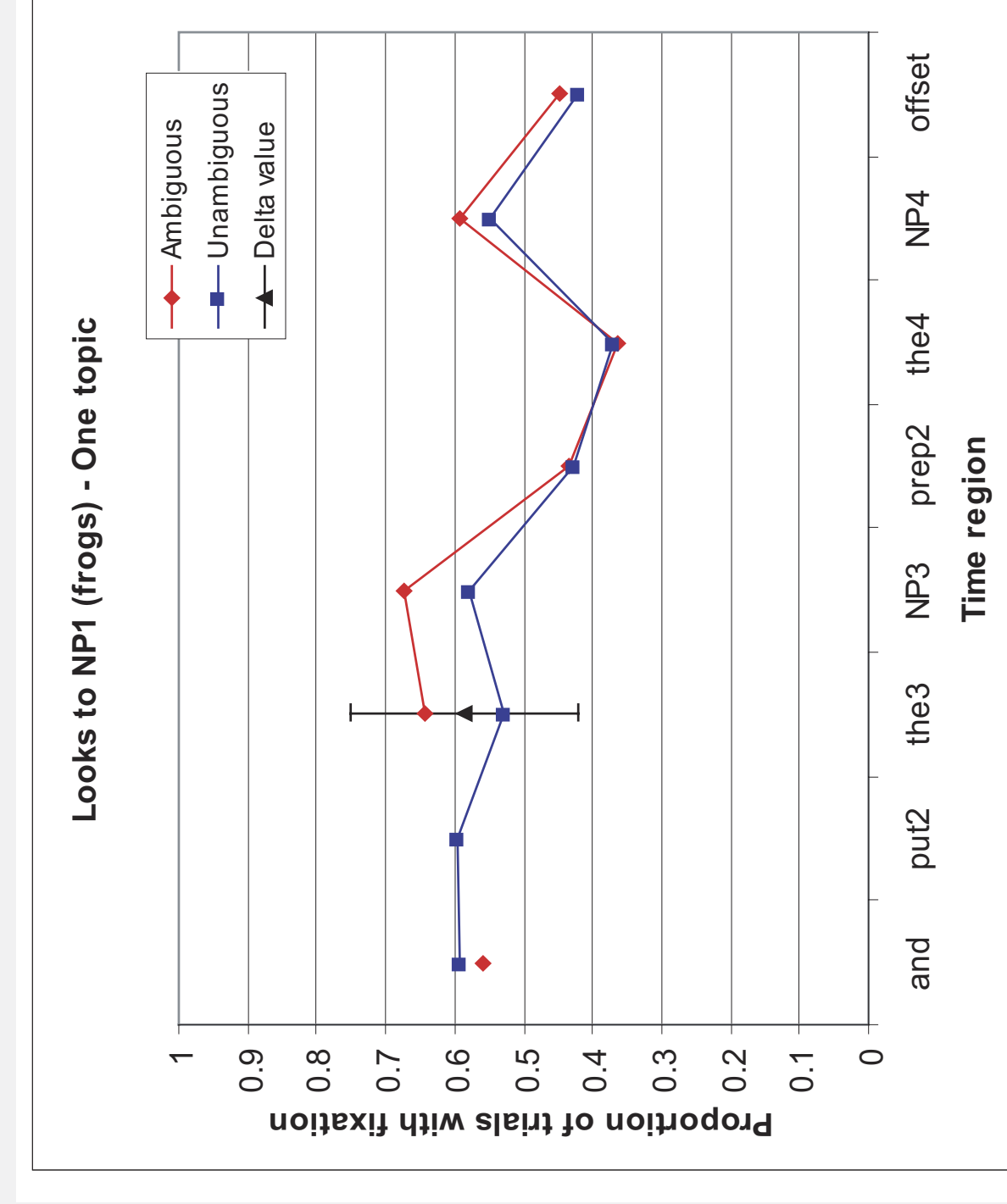


Figure 8.

