Use of discourse cues during garden-path resolution is modulated by verb argument structure

Ana Besserman, Elsi Kaiser {pianibes, emkaiser} @usc.edu University of Southern California

Temporarily ambiguous sentences such as "While Anna bathed the baby spit up on the bed" cause comprehension difficulties, due to a misparse of "the baby" as the object of "bathed" and subsequent reanalysis of this noun as the subject of "spit up". Earlier work (e.g. Christianson et al.'01, Patson et al.'09) showed that the incorrect parse (Anna dressed the baby) lingers even after disambiguation. Prior studies used optionally transitive verbs (OPT, e.g. *hunt*) and reflexive absolute transitive verbs (RAT, e.g. *bathe*). Both verb types cause garden-pathing, but differ in fundamental ways whose consequences for real-time processing are not yet fully understood:

RAT and OPT verbs differ in their properties when used without an overt object. RATs (e.g. *Anna bathed*) are interpreted reflexively (*Anna bathed herself*). The object is known: It is coreferential with the subject. In contrast, OPTs without an overt object (e.g. *The man hunted*) make reference to an unspecified object (hunted *something*). This unspecified object could be interpreted as something in prior/following discourse. Given this difference between RAT and OPT verbs, we hypothesize that (i) processing the patient/object of **RAT verbs** operates on the syntactic and semantic levels and can be largely independent of discourse representations, but (ii) processing the patient/object of **OPT verbs** makes reference to discourse representations.

To test this, we investigated whether discourse properties of the ambiguous noun affect garden-path processing with RATs and OPTs. NPs have different distributions and grammatical roles depending on *definiteness and givenness* (e.g. Comrie'79, Prince'92) which affects real-time processing (e.g. Warren'02, Vasishth'03). If verb type modulates the relevance of these discourse factors as we hypothesize, reanalysis with OPT verbs should show sensitivity to the discourse properties of the 'object NP' (noun initially misparsed as the object, but which turns out to be the subject of the following verb) but RAT verbs should show no sensitivity to such discourse factors.

Experiment: 48 English speakers participated in a word-by-word self-paced reading study (24 targets, 12 OPT, 12 RAT; 50 fillers). Targets (ex.1-2) were adapted from Christianson et al. (2001). We added a context sentence that either introduced the critical entity (1b) or didn't introduce any entities (1a,c). We manipulated (i) Ambiguity (presence vs. absence of a comma, following Christianson et al.), (ii) Verb type (RAT/OPT) and (iii) NP type of the critical entity (Indefinite+New, Def+Old; and Def+New, used in prior studies). The critical region was the disambiguating verb (e.g. *ran/cried*) and the four following words (to detect spillover effects).

OPT	Indef	(1a) It was a beautiful afternoon. While the man hunted (,) **a deer** *ran into the woods near the house*.
	Def+ Old	(1b) A deer was drinking water by the lake. While the man hunted (,) **the deer** *ran into the woods near the house*.
	Def+ New	(1c) It was a beautiful afternoon. While the man hunted (,) **the deer** *ran into the woods near the house*.
RAT	Indef	(2a) The heat was almost unbearable. While the mother undressed (,) **a baby** *cried very softly in the bedroom*.
	Def+ Old	(2b) A baby was lying on the bed. While the mother undressed (,) **the baby** *cried very softly in the bedroom*.
	Def+ New	(2c) The heat was almost unbearable. While the mother undressed (,) **the baby** *cried very softly in the bedroom*.

Results: Reading times were analyzed with mixed-effects regression using R. **RAT conditions** show significant ambiguity slowdowns at all 5 positions (the expected garden-path,

solid vs. dotted lines in the boxed region of Fig.2), and no significant effects of the discourse/NP-type manipulation. In **OPT conditions**, in addition to a significant ambiguity effect at the disambiguating verb and the four spillover words (solid vs. dotted lines), there are significant effects involving the discourse/NP-type manipulation on the second spillover word (Fig.1). In particular, conditions with indefinites (triangles, Fig.1) show a significantly larger ambiguity-related slowdown than conditions with definite nouns (regardless of Old/New distinction), which we attribute to indefinites being more frequent objects than definites (Prince'92).

In sum, our results suggest that reanalysis with OPT verbs is sensitive to the 'object' noun's discourse properties, whereas RAT verbs seem to show no sensitivity to these factors. The parser's sensitivity to discourse patterns is rapidly modulated by verb argument structure during on-line processing, suggesting a close relationship between different aspects of linguistic representation.

Figure 1. OPT verbs - Reading time per word in milliseconds

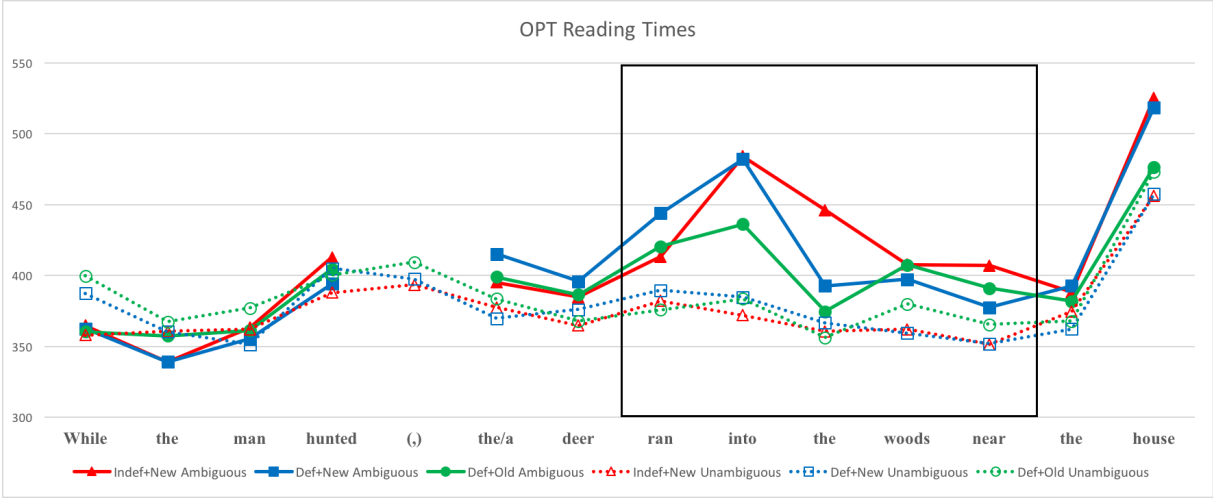
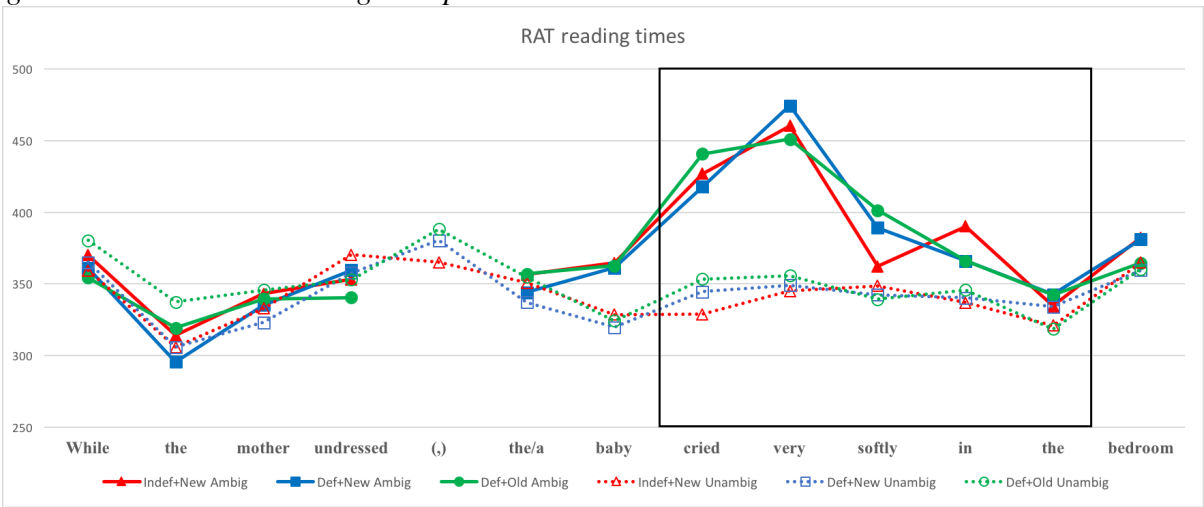


Figure 2. RAT verbs - Reading time per word in milliseconds



References ||| Christianson et al. (2001). Thematic roles assigned along the garden path linger. *Cog Psych*. ||| Patson et al. (2009). Lingering Misinterpretations in Garden-Path Sentences *JEP:LMC*. ||| Prince, E. F. (1992). The ZPG letter: Subjects, definiteness and information status. ||| Warren, T. & Gibson, E. (2002). The influence of referential processing on sentence complexity. *Cognition*. ||| Vasishth, S. (2003) The referential (in)accessibility of definite/indefinite subjects and objects. *CUNY Conference*.