Semantic attraction in sentence processing

Kaylin Smith, Ye Ma, Yan Cong, Alan Beretta (Michigan State University)

smit2297@msu.edu

Models of combinatory processing largely maintain a syntacto-centric view, in which syntactic analysis precedes and guides semantic interpretation [1;2]. When the syntactic structure is unambiguous, the semantic analyzer is thought to be incapable of making the first commitments to combinatory processing [3;4]. Constraint-based models, however, assume that semantic interpretations can override syntactic cues when they are ambiguous, but not when they are unambiguous. Kim & Osterhout ('K&O') [5] found that, in role reversals that have a plausible thematic relationship between a noun phrase and verb (e.g., *the hearty meal was devouring*), strong *semantic attraction* (i.e., *meal - devour*) leads to a syntactic repair of *-ing* to *-ed* despite licit syntax, when compared with passive control sentences (e.g., *The hearty meal was devoured*), as evidenced by a semantic-thematic P600 at the critical verb. Role reversals with no thematic relationship (e.g., *The dusty tabletops were devouring*) elicited a typical N400 for semantic violation. The current study conducted two related experiments: 1) an *exact* replication of K&O, and 2) a *conceptual* replication (i.e., minimal extension of K&O's paradigm, different ROIs and time windows), which eliminated auxiliary verbs to determine whether the semantic P600 would replicate when provided fewer syntactic cues to predict a passive structure.

In Experiment 1, twenty-six right-handed native English speakers provided acceptability judgments for stimuli presented using Rapid Serial Visual Presentation ('RSVP'). Our methodology was identical to K&O (i.e., stimuli, number of electrodes, regions of interest, procedure, time windows, statistical tests, corrections). We did not find a main effect of stimulus type in the 400-600 ms window (p[GG]>.05), although a broadly distributed negativity was visually observed for the no-attraction violation condition (Figure 1). A significant main effect of stimulus type was found in the 600-900 ms window (p[GG]<.05). Simple effects analyses revealed that ERPs to attraction violation verbs were more positive than passive control verbs at midline sites (p<.05), and ERPs to no-attraction violation verbs were also more positive than passive control verbs at medial-lateral sites (p<.05). ERPs to attraction violation verbs were not significantly different from those to no-attraction violation verbs (p>.5).

In Experiment 2, forty right-handed native English speakers provided acceptability judgments for stimuli presented using RSVP. Ninety-six three-condition sets were constructed (Table 1). Signals were recorded with a 32-channel cap and mastoid referenced. The following ROIs were used in repeated measures ANOVAs: anteriority (anterior, posterior) x laterality (left, right). Testing the N400 and P600 windows, we did not find a significant main effect of stimulus type in the 400-600 ms window (p[GG]>.05), but a significant main effect of stimulus type in the 600-900 ms window emerged (p[GG]<.05) (Figure 1). Main effects of laterality (p<.05) and anteriority (p<.01), along with an interaction between the two (p<.001), were found. Simple effects analyses revealed that the no-attraction condition was significantly more negative than the passive control over each ROI in the 600-900 ms window (p<.05).

In our direct replication, we replicated the semantic P600 for the attraction violation condition, and found an additional positivity for the no-attraction violation condition in the 600-900 ms window [6]. In our conceptual replication, eliminating the use of auxiliaries removed the P600 for the attraction violation condition and resulted in a broadly distributed negativity for the no-attraction violation condition. The absence of the semantic P600 via manipulation of auxiliaries has been found by Kim & Sikos [7] (i.e., *was devouring → would devour*), who instead found a left anterior negativity for the attraction violation condition. Our results for the

attraction violation condition support a proposal put forth by Kim & Sikos-- that sentences with little lead-in context (in our case, the absence of past tense auxiliaries from the K&O stimuli) may be less syntactically fragile, resisting syntactic reanalysis in sentences with strong semantic attraction. Taken together, our results support a language processing model which incorporates two cognitive mechanisms-- a syntactic and semantic analyzer-- that operate in parallel.
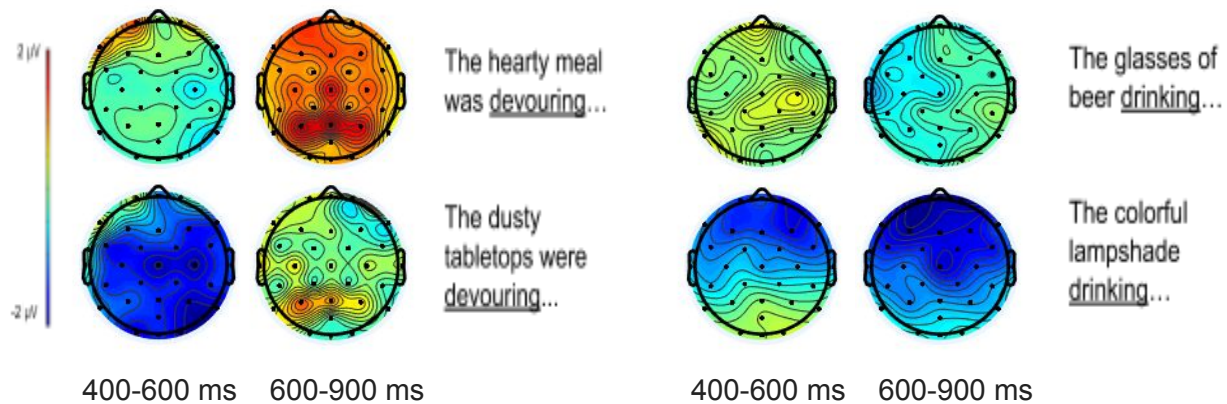

Figure 1. Difference wave scalp plots for Experiment 1 (left) and Experiment 2 (right). Row 1: Attraction Violation-Passive Control; Row 2: No Attraction Violation-Passive Control.

Table 1. Example of Experiment 2 stimuli.

Condition	Sentence
Attraction Violation	*The glasses of beer drinking in the restaurant reminded Bill of Germany.*
Passive Control	*The glasses of beer drunk in the bar had a hoppy flavor.*
No-Attraction Violation	*The colorful lampshade drinking in the corner brightened the room.*

References
[1] Altmann, G. T. M., & Steedman, M. (1988). Interaction with context during human sentence processing. *Cognition, 30,* 191-238. [2] Trueswell, J. C., Tanenhaus, M. K., & Garnsey, S. M. (1994). Semantic influences on parsing: Use of thematic role information in syntactic ambiguity resolution. *JML, 33,* 285-318. [3] Frazier, L. (1987). Sentence processing: A tutorial review. In M. Coltheart (Ed.), *Attention and performance XII: The psychology of reading.* Hillsdale, NJ: Erlbaum. [4] Rayner, K., Carlson, M., & Frazier, L. (1983). The interaction of syntax and semantics during sentence processing. *Journal of Verbal Learning and Verbal Behavior, 22,* 358-374. [5]. Kim, A., & Osterhout, L. (2005). The independence of combinatory semantic processing: Evidence from event-related potentials. *JML*, *52*(2), 205-225. [6] Kuperberg, G., Caplan, D., Sitnikova, T., Eddy, M., Holcomb, P., 2006a. Neural correlates of processing syntactic, semantic and thematic relationships in sentences. *Lang. Cogn. Processes, 21*, 489–530. [7] Kim, A. & Sikos, L. (2011). Conflict and surrender during sentence processing: An ERP study of syntax-semantics interaction. *Brain & Language, 118,* 15-22.