



THE INFLUENCE OF IMPLICIT CAUSALITY ON THE ESTABLISHMENT OF COREFERENCE: AN EVENT-RELATED POTENTIAL STUDY OF READING

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INTRODUCTION

Implicit causality is a feature of certain interpersonal verbs by which information about the cause of events described by a verb is conveyed implicitly as part of the verb's meaning. Verb implicit causality has been demonstrated to have immediate effects during reading, as measured by word-by-word self-paced reading and eye tracking (Koorneef & Van Berkum, 2006). Recently, Van Berkum et al. (2007) measured the effect of violating a verb's implicit causality bias using event-related potentials (ERPs). When readers encountered a pronoun that was inconsistent with the bias of the verb (*Linda apologized to David because he...*), a P600 effect was observed (relative to consistent pronouns).

The current experiment used a similar experimental design, but included an examination of the ERP response to coreferential repeated names. Repeated name coreference has been shown previously to depend on the prominence of the antecedent (a structural factor of a sentence): names that corefer with a prominent antecedent are more difficult to process than names that corefer with a non-prominent antecedent (Camblin, et al., 2007; Ledoux, et al., 2007; Swaab, et al., 2004). We examined the extent to which implicit causality acts as a focusing mechanism in reading, and whether that mechanism would override the focusing mechanism of structural prominence. In doing so, we examined the interplay of semantic and structural factors during discourse processing.

EXPERIMENT

Materials

A sample stimulus set is shown below. The second clause of the first sentence shown for each type of verb is consistent with the bias of the verb; the same clause of the second sentence is inconsistent. For NP1-biased verbs, the repeated name or pronoun corefers with a prominent antecedent in the first sentence, and with a non-prominent antecedent in the second sentence. For NP2-biased verbs, the repeated name or pronoun corefers with a non-prominent antecedent in the first sentence, and with a prominent antecedent in the second.

NP1-biased verb:

- 1.) Yesterday evening *Ronald* amused Alison because he/Ronald told a very funny joke.
- 2.) Yesterday evening Ronald amused *Alison* because she/Alison needed cheering up.

NP2-biased verb:

- 1.) At the museum Amy thanked *Joe* because he/Joe had explained the paintings so patiently.
- 2.) At the museum Amy thanked Joe because she/Amy was trying to practice good manners.

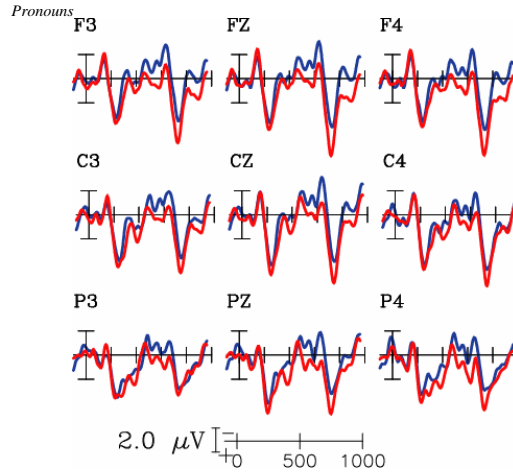
Methods

- Twelve participants were tested in the pronoun conditions; 14 were tested on the repeated names. All were right handed native speakers of English.
- Participants read 160 experimental sentences (mixed with 90 fillers). Items were counterbalanced across conditions, and were not repeated within participants.
- Sentences were presented with RSVP at a rate of one word every 500 ms (ISI=200ms).
- EEG was recorded from 29 electrodes, referenced to the left mastoid. Vertical and horizontal eye movements were monitored via sub- and supra-orbital electrodes, and left and right external canthus montages, respectively.

RESULTS

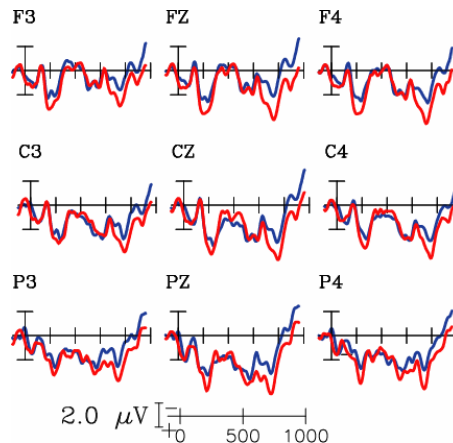
ANOVAs were done on the mean amplitude of the N400 (250-450ms) and the P600 (500-900ms) to the critical repeated names and pronouns (see examples). For pronouns, there was a main effect of verb congruency in the later time window: the amplitude of the P600 was greater to pronouns that were inconsistent with the bias of the verb, relative to those that were consistent, $F(1,11) = 6.69, p = .03$.

For repeated names, there was an interaction of consistency and prominence in both time windows. When the antecedent was not prominent, the amplitude of the P600 was greater to repeated names that were inconsistent with the bias of the verb, $F(1,13) = 5.35, p = .04$. When the antecedent was prominent, the effect of consistency was significant in the N400 time window: the amplitude of the N400 was reduced to repeated names that were consistent with the bias of the verb, relative to those that were inconsistent, $F(1,13) = 5.39, p = .04$.



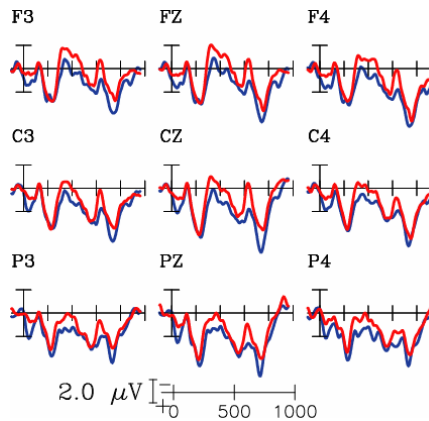
Consistent: Yesterday evening *Ronald* amused Alison because he...
At the museum Amy thanked Joe because he...
Inconsistent: Yesterday evening Ronald amused *Alison* because she...
At the museum Amy thanked Joe because she...

Repeated names – non-prominent antecedent



Consistent: At the museum Amy thanked *Joe* because Joe...
Inconsistent: Yesterday evening Ronald amused *Alison* because Alison...

Repeated names – prominent antecedent



Consistent: Yesterday evening *Ronald* amused Alison because Ronald...
Inconsistent: At the museum Amy thanked Joe because Amy...

DISCUSSION

When coreference was established using pronouns, the effect of the implicit causality of a verb was seen on the P600: a greater positivity was seen to pronouns that were inconsistent with the implicit causality bias of the verb (relative to pronouns that were consistent), regardless of the prominence of the antecedent. Our results are thus similar to those observed by Van Berkum, et al. (2007).

The locus of the effect of implicit causality for sentences containing repeated name coreference depended on the prominence of the antecedent. When the antecedent of the repeated name was not prominent in the discourse representation (a situation in which repeated name coreference has been shown to be felicitous; P.C. Gordon, et al., 1999), we observed an effect of implicit causality that was similar to that seen for pronouns: the amplitude of the P600 was larger to names that were inconsistent with the bias of the verb. When the antecedent of the repeated name was prominent in the discourse representation, and repeated name coreference was expected to be infelicitous, we observed an effect of verb implicit causality instead on the N400, the amplitude of which was reduced to names that were consistent with the bias of the verb.

Van Berkum et al. (2007) interpreted their result with pronouns as suggesting that readers viewed the incongruent pronoun as a morphosyntactic violation; that is, the pronoun was seen to be of the wrong gender based on the foregrounding of one antecedent relative to the other by the implicit causality of the verb. This explanation seems unlikely to account for the P600 effect we observed for repeated names, as repeated names do not carry morphosyntactic information. Instead, the P600 effects that we observe in the current experiment seem similar to those observed recently by several groups (see Kolk & Chwilla, 2007 and Kuperberg, 2007 for review and discussion), in which strong semantic expectations exert an influence over syntactic processing. In the present experiment, this is observed in cases in which semantic integration can proceed without hindrance, that is, cases in which the pronoun or repeated name is used felicitously. The infelicitous use of a repeated name to corefer with a prominent antecedent resulted in a disruption of semantic integration processing (similar to that observed previously as a repeated name penalty; Camblin, et al., 2007; Ledoux, et al., 2007; Swaab, et al., 2004), the magnitude of which was influenced by verb consistency.

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