AN EVENT-RELATED POTENTIAL STUDY OF IMPLICIT CAUSALITY AND THE ESTABLISHMENT OF COREFERENCE

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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 (Koornneef & Van Berkum, 2006). Recently, Van Berkum et al. (2006) 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 examined 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 (Ledoux, P.C. Gordon, Camblin, & Swaab, in press; Swaab, Camblin, & P.C. Gordon, 2004). The current experiment 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 examine 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 congruent with the bias of the verb; the same clause of the second sentence is incongruent. For NP1-biased verbs, the repeated name 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 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 <u>Ronald</u> told a very funny joke.
2.) Yesterday evening Ronald amused *Alison* because <u>Alison</u> needed cheering up.

NP2-biased verb:
1.) At the museum Amy thanked *Joe* because <u>Joe</u> had explained the paintings so patiently.
2.) At the museum *Amy* thanked Joe because <u>Amy</u> was trying to practice good manners.
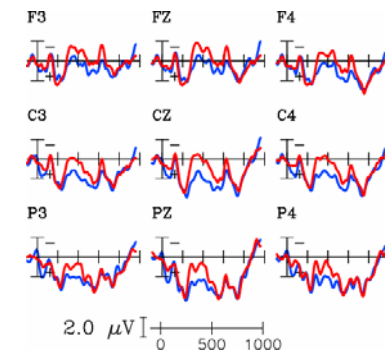
Methods

• Participants were 9 (to date) 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 (300-500ms) to the critical repeated names (see examples). In this time window, there was a main effect of verb congruency: the amplitude of the N400 was reduced to repeated names that were congruent with the bias of the verb, relative to those that were incongruent, $F(1,8) = 17.10$, $p < .01$. The main effect of prominence was not significant in this sample ($F (1,8) = 2.04$, $p = .19$); however, there is a clear difference in the N400 time window that may become significant with an increase in statistical power.

Verb congruency also interacted with verb bias, an effect that we attribute to prominence. For NP1-biased verbs, the amplitude of the N400 did not differ as a function of congruency. For NP2-biased verbs, the amplitude of the N400 was reduced to repeated names that were congruent with the implicit causality bias of the verb (and that corefered with a non-prominent antecedent).

Verb Congruency Effect

Congruent: Yesterday evening *Ronald* amused Alison because Ronald…
             At the museum Amy thanked *Joe* because Joe…
Incongruent: Yesterday evening Ronald amused *Alison* because Alison…
             At the museum *Amy* thanked Joe because Amy…
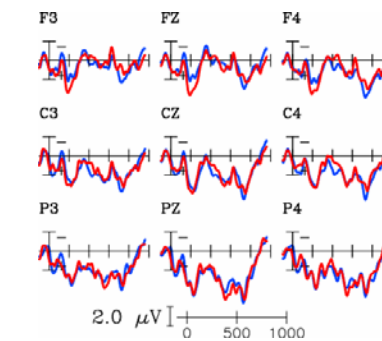
Antecedent prominence effect
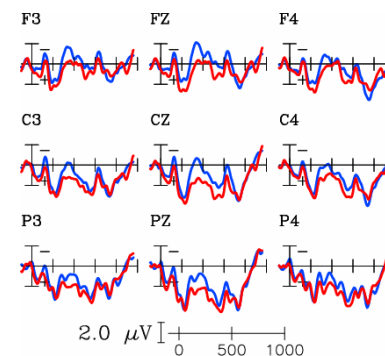
Prominent: Yesterday evening *Ronald* amused Alison because Ronald…
             At the museum *Amy* thanked Joe because Amy…
Nonprom: Yesterday evening Ronald amused *Alison* because Alison…
             At the museum Amy thanked *Joe* because Joe…

NP1 Biased Verbs

Cong/Prom: Yesterday evening *Ronald* amused Alison because Ronald…
Incong/Nonprom: Yesterday evening Ronald amused *Alison* because Alison…

NP2 Biased Verbs
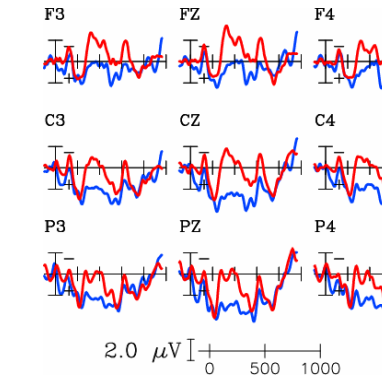
Congruent/Nonprominent: At the museum Amy thanked *Joe* because Joe…
Incongruent/Prominent: At the museum *Amy* thanked Joe because Amy…

DISCUSSION

When coreference was established using repeated names, the effect of the implicit causality of a verb was seen on the N400: a reduction of the N400 was seen to names that were congruent with the implicit causality bias of the verb, relative to names that were incongruent. The locus of the effect (the N400 component) differed from that seen for the implicit causality effect with pronouns (the P600 component). Van Berkum et al. interpreted their result with pronouns as suggesting that readers interpret the incongruent pronoun as a morphosyntactic violation; that is, the pronoun is 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. Our results suggest a similar process for repeated names; in this case, however, because names carry semantic but not syntactic information, the violation is detected as a difference in the amplitude of the N400.

We also observed an effect of the prominence of the antecedent of the repeated name. A reduction of the N400 was observed to names that corefer with a non-prominent antecedent, relative to those that corefer with a prominent antecedent. This result mirrors that of previous behavioral (P. C. Gordon, Hendrick, Ledoux, & Yang, 1999) and electrophysiological (Ledoux, et al., in press; Swaab, et al., 2004) research showing that repeated name coreference is easier with nonprominent antecedents.

The differences in the magnitude of the congruency effect based on the type of implicit causality verb hints at the interplay of congruency and prominence. In the NP1-biased sentences, verb congruence and prominence are necessarily orthogonal; that is, in the congruent sentence condition (in which a reduction of the N400 is anticipated), the antecedent of the repeated name is prominent (in which case an increase in the N400 is anticipated), and vice versa. In this case, the two effects seem to cancel each other out. In the NP2-biased sentences, verb congruence and (non)prominence pattern together, and the amplitude of the N400 seems to reflect an additivity of these two factors. Future research will examine this interaction in greater detail.

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