Event-Related Potentials and Scalar Implicatures

Bronwen Evans, Kirsten Goldman and Marie Landis
School of Cognitive Sciences
Hampshire College

Abstract

This ERP study examined pragmatic errors, specifically scalar implicatures, and attempted to elicit the N400 component previously found by Noveck and Posada (2003). By testing many different sentence types, both felicitous and infelicitous, this study sought to narrow down the specific instances when the N400 could occur in order to more narrowly define pragmatic error.

Background

It is likely that much of our everyday inferences involve working out speakers' intended meanings. The first systematic attempt to explain how listeners derive these inferences was made by Grice (1975). In his paper he proposes that speakers obey a set of rules, cooperating to communicate and understand intended meanings. One of these rules is that a speaker makes his contribution as informative as is required but no more so. By Grice's account the statement, "Some elephants have trunks" is in violation of the Quantity Maxim, since 'some' is too weak a term from the possible range of terms appropriate to the utterance. Adults are typically divided in their interpretation of the statement, some respond to it pragmatically, as if 'some' implied 'some but not all', while others respond logically, recognizing that 'some' is logically consistent with 'all'. Researchers in the field agree about rates of responding to scalar implicatures but disagree on the degree of automaticity.

A Neo-Gricean approach would predict that the pragmatic interpretation is the default interpretation in communicative situations, and that logical responding is a result of the implicature being undone by context. If this were the case, logical responding should show longer reaction times.

Relevance theory describes the implicature as being an effortful decision-making process in which the listener/responder arrives at the implicature while searching for a relevant interpretation of the utterance. By this view, pragmatic responding should take longer than logical responding.

The N400 has historically been thought to be an indicator of semantic integration. If truth judgments do not affect the N400, and the N400 for underinformative sentences is small relative to the control and felicitous sentences, it is likely that the N400 in this case is representative of associativity or expectedness of words. Additionally, this would indicate that the implicature of 'some but not all' is not automatic, but more likely a product of a post-semantic decision-making processes.

Methods

In all, there were seven sentence types presented to the participants, randomized among 200 sentences. These sentences were shown in four blocks of 50 sentences each, with a brief rest period between blocks. Sentences were counter-balanced for felicitous and infelicitous versions of the same semantic content: these sentences were separated into two counterbalanced experiments, A or B, which were run a roughly equal number of times. Each participant was run in only one of these experiments.

After each sentence was shown, the participant was asked to make a judgment:

"Could this sentence be true? Yes / No"

Participants

• Participants were 16 undergraduate students at Hampshire College (7 female, 9 male), all predominantly right-handed, with no diagnosed learning disabilities or neurological disorders.

• Participants were recruited through local advertisements (emails and posters), and all were compensated for their participation.

Methods

Shorter sentences (control, scalar sentences) were displayed one word at a time on the computer screen to the participant. For longer sentences, the first clause was shown at once (ex: "Mike opened the trunk-"), then each word thereafter was shown individually, as in Fig. 1.

After each sentence, subjects were asked to make a judgment as to the truth value of the sentence. They were told that there was no right or wrong answer and that they were to make a personal judgment. Our aims were to have the subjects think critically about the sentences, beyond the sometimes awkward grammatical construction.

Sentence Types
• Control (ex: "Donald did his dishes.")
• Felicitous Scalar Implicature (ex: "Some people have hats.")
• Infelicitous Scalar (ex: "Some birds have feet.")
• Felicitous presupposition (ex: "Mike opened the trunk swiftly when he opened the trunk.")
• Infelicitous presupposition (ex: "Helen passed the store when she passed the store.")
• Felicitous repetition (ex: "The man left the station when his train arrived.")
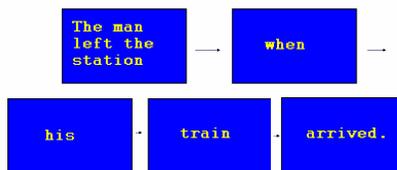• Infelicitous repetition (ex: "The boy lost his tie when he misplaced his tie.")
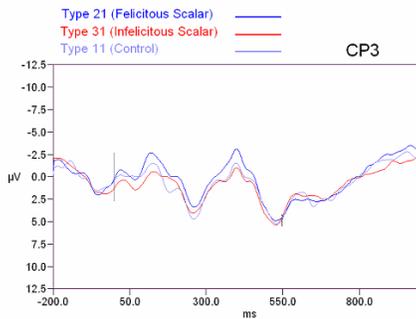

Figure 1

Results

Behavioral
• Participants made judgments that disagreed with the researchers' felicitous/infelicitous designation significantly more on infelicitous sentences than felicitous sentences: $t(18) = 11.57$ $p < .001$

N400
• Significant difference between felicitous scalar and infelicitous scalar at electrode CP3: $t(27) = -2.17$ $p = .039$
• Maximal at CP3: 3 (electrode (F3, C3, CP3)) x 3 (condition) MANOVA $f(2,44) = 4.94$ $p = .012$

Figure 2

Results

Semantic anomalies are historically indicated by an N400 in the central parietal area about 400 ms after an inappropriate word. Greater N400s in that area were seen in felicitous sentences, indicating a greater degree of semantic integration than shown in the underinformative 'some' statements. This occurred regardless of which way the participant responded to the question. This indicates that implicatures are part of a late-arriving effort-demanding decision process.

These trends support the Relevance Theory view of forming implicatures as a late arriving and effortful decision-making process. Additionally the view that the N400s elicited are representative of semantic relatedness of the final word to the subject of the sentence is supported.

Further research into the pragmatic implications of the issue of scalar implicatures would do well to look for a late, controlled decision-making process rather than an automatic inference. Context and speaker meaning have been shown to have significant effects on sensitivity to scalar implicatures, and future research on the subject would do well to focus on implicature sensitivity in relation to contextual features present in real world interactions.

Discussion

• During analysis, the felicitous and infelicitous scalar implicature sentences were compared with control sentences.

• A negative component occurred at approximately 400 ms after these types of sentences were shown (see Fig. 2). Judging from the data, the N400 was generally strongest after felicitous scalar sentences and weakest after infelicitous scalar sentences. However, statistical analysis showed significance only for the CP3 electrode and slight trends for some others. A larger study with more participants will probably show greater significance.

• One possible limitation of this experiment was that the question asked after every sentence: "Could this sentence be true?" should have elicited a logical rather than grammatical response. However, some participants provided the same answer for every question, indicating that they were not thinking about the questions logically (or at least not with the same logic as the experimenters) or became bored with the question. Future studies should change the wording of the question, alter the question itself, or pose different questions for different sentence types to ensure the question posed does not influence differences seen in the N400.

References

Carston, Robyn. (2002). Linguistic Meaning, Cognitive Meaning and Communicative Linguistics. *Mind & Language*, 17(1,2), 127–148.

Feeney, Aidan et. al. (2004). The Story of *Some*: Everyday Pragmatic Inference by Children and Adults. *Canadian Journal of Experimental Psychology*, 58(2), 121-132.

Grice, P (1975). Logic and conversation. In P. Cole & J. L. Morgan (Eds.), *Studies in syntax: Vol 3: Speech acts*. New York: Academic Press.

Noveck, Ira A. and Andres Posada. (2003). Characterizing the time course of an implicature: An evoked potentials study. *Brain and Language* 85, 203–210.

yay for geeks!