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Violations of information structure: An electrophysiological study of answers to wh-questions

H.W. Cowles [a,*], Robert Kluender [b], Marta Kutas [b], Maria Polinsky [b]

[a] University of Florida, Linguistics, P.O. Box 115454, Gainesville, FL 32611, United States
[b] UC San Diego, United States

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Abstract

This study investigates brain responses to violations of information structure in *wh*-question–answer pairs, with particular emphasis on violations of focus assignment in *it*-clefts (*It was the queen that silenced the banker*). Two types of ERP responses in answers to *wh*-questions were found. First, all words in the focus-marking (cleft) position elicited a large positivity (P3b) characteristic of sentence-final constituents, as did the final words of these sentences, which suggests that focused elements may trigger integration effects like those seen at sentence end. Second, the focusing of an inappropriate referent elicited a smaller, N400-like effect. The results show that comprehenders actively use structural focus cues and discourse-level restrictions during online sentence processing. These results, based on visual stimuli, were different from the brain response to auditory focus violations indicated by pitch-accent [Hruska, C., Steinhauer, K., Alter, K., & Steube, A. (2000). ERP effects of sentence accents and violations of the information structure. In *Poster presented at the 13th annual CUNY conference on human sentence processing, San Diego, CA*.], but similar to brain responses to newly introduced discourse referents [Bornkessel, I., Schlesewsky, M., & Friederici, A. (2003). Contextual information modulated initial processes of syntactic integration: the role of inter- versus intrasentential predictions. *Journal of Experimental Psychology: Learning, Memory and Cognition, 29*, 871–882.].

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1. Introduction

This study examines the contribution of information structure to sentence processing by investigating what kinds of ERP responses are elicited when focus is incorrectly assigned via syntactic structure. The answers that speakers give to *wh*-questions like (1) are constrained not only in terms of their propositional content, but also in terms of *how* that content is packaged. (1a) is an acceptable (if somewhat verbose) answer to the question while (1b) is not, in spite of the fact that both answers provide the same information, namely that the agent of lettuce-eating was the rabbits.

(1) What ate the lettuce in your garden, the deer or the rabbits?
a. It was the rabbits that ate the lettuce.
b. #It was the lettuce that the rabbits ate.

The crucial difference, then, lies not in the content but in the form of the answer.

This simple example shows that answers to *wh*-questions are constrained by information structure, namely the division of content into topic and focus. The informative part of an answer to a *wh*-question must present new or newly activated information, and thus have focus status. Cleft constructions in particular (1a,b) provide a way to identify the element in the clefted position as focus (e.g. Lambrecht, 2001; Rochemont, 1986); this is indicated in the example by means of underlining.

Knowing the nature of the brain's response to information structure violations can give us a better understanding

* Corresponding author. Fax: +1 352 392 0639.
E-mail address: cowles@ufl.edu (H.W. Cowles).

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of the processes that underlie the comprehension of information structure categories like focus; it can also provide insight into the functional significance of the brain response that is elicited. For example, if the answers to *wh*-questions that violate focus constraints were to elicit an increase in N400 amplitude (Kutas & Hillyard, 1980), this would provide evidence that the N400 is sensitive not only to lexico-semantic, morpho-syntactic, pragmatic, and world knowledge information (e.g. Bornkessel, McElree, Schlesewsky, & Friederici, 2004; Federmeier & Kutas, 1999; Frisch & Schlesewsky, 2001, 2005; Hagoort, Hald, Bastiaansen, & Petersson, 2004; Hopf, Bayer, Bader, & Meng, 1998; van Berkum, Hagoort, & Brown, 1999), but also to focus distinctions encoded in the information packaging of an utterance.

2. Linguistic background

Focus is usually defined as that part of an utterance that introduces new or newly activated information into the current discourse. Since the status of information as "new" is often vague and open to question, focus can be defined operationally as a well-formed answer to a *wh*-(or information) question (e.g. Lambrecht, 1994; Rochemont, 1998; Selkirk, 1996). The *wh*-phrase introduces an open variable that binds the focus portion of the felicitous answer; more informally, the *wh*-phrase opens up an empty slot in the discourse representation built by the listener, and this slot is then filled by the focus portion of the answer. For example, in (1b), *lettuce* cannot have focus status because it cannot be bound by the *wh*-phrase. In other words, the question in (1) asks for the agent of the lettuce-eating event, and it is apparent that the lettuce did not eat itself. On the contrary, rabbits, deer, or even previously unmentioned entities like gophers could have focus status in the answer to the extent that they can be construed as lettuce-eaters.

Focus is realized in different, language-specific ways, and it is common to have more than one way of encoding focus in a language (Kiss, 1998; Lambrecht, 1994; Lambrecht & Polinsky, 1997). In English, focus can be marked via prosodic contour, as shown in (2), where the pitch accent (indicated by capital letters) on *rabbits* creates a felicitous answer in (2a), while the placement of a pitch accent on *lettuce* in (2b) does not.

(2) What ate the lettuce in your garden, the deer or the rabbits?
a. The RABBITS ate the lettuce.
b. #The rabbits ate the LETTUCE.

Focus in English can also be expressed syntactically; one such syntactic construction in English for encoding focus is a so-called "*it*-cleft" (Ross, 1986, pp. 233–234), shown in (1).

This study addresses the processing of focus as embodied in *it*-clefts, for example (1a), *It was the rabbits that ate the lettuce*. Note that *the rabbits* may elicit particular processing effects, as it is at this point that a comprehender can first integrate the new information pertaining to the referent of this NP into a larger discourse model of who did what to whom (or, more exactly in this case, what did what to what). These cleft constructions are known to be most felicitous in cases where the focus is contrastive, that is, when the focus picks out one entity to the exclusion of other possibilities (e.g. it was the rabbits and not the deer—or the gophers or any other animal—that ate the lettuce). In this paper, therefore, we will be dealing with contrastive focus in particular.

3. Mapping processing effects onto possible brain responses

Let us consider what the nature of these processing effects might be, and how they might be reflected in brain responses. Given that questions such as (1) are typically asked to elicit information that is previously unknown, it seems safe to assume that cases in which the exact answer is already expected (based on prior discourse) are relatively rare. Under more common circumstances, when comprehenders are unlikely to have clear expectations about the nature of the focused referent, they should nonetheless have clear expectations about where in the answer such information will be provided—namely in a syntactically licensed focus position—and what the focus of the answer *cannot* be (1b).

Abstracting away from language-specific issues for a moment, expectations such as these about general information delivery parameters were among the earliest explanations given (Sutton, Braren, Zubin, & John, 1965) for the P300 or P3b component, a centroparietal positivity with a latency of roughly 250–800 ms post-stimulus onset. A broader view of information processing not limited to language contexts would thus suggest that the delivery of information of this sort, i.e. focus status in the answer to a *wh*-question, might be indexed by a P300 or P3b component.

This prediction is supported by the results of a study investigating the influence of a preceding *wh*-question on preferred (subject–object–verb [SOV]) vs. non-preferred (object–subject–verb [OSV]) word order options in German (Bornkessel, Schlesewsky, & Friederici, 2003). Following a wide variety of *wh*-question contexts (in which case marking and word order were manipulated relative to both SOV and OSV target sentences), Bornkessel et al. consistently observed positivity between 280 and 480 ms in response to the introduction of any new discourse referent that could fill the open slot introduced by the *wh*-phrase of the preceding question, and thereby serve as the focus of the answer. This was true regardless of whether or not the focused referent matched the preceding *wh*-phrase in case-marking features (e.g. 'who' vs. 'whom'), and therefore in thematic role assignment and grammatical function. Bornkessel et al. tentatively interpreted this positive response as a P3b, although they were troubled by the fact that the same