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

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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 <u>rabbits</u> that ate the lettuce.
 b. #It was the <u>lettuce</u> 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

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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 response was elicited by the sentence-final verb of target sentences in which a new focus (corresponding to the *wh*-phrase of the preceding question) had been introduced. This was considered problematic, because the lexical content of the verb was already provided by the preceding *wh*-question, and therefore could not be considered newly focused information in the same way as the newly introduced discourse referent.

Superimposed on a general information processing view of linguistic focus-marking are the additional processing demands associated with violations of focus assignment. Example (1b) is perfectly grammatical and presents pragmatically plausible information about what was eaten; it is only infelicitous as an answer to the particular *wh*-question in (1) seeking information about who did the eating. The unacceptability of sentences like (1b) could thus arise from linguistic relations gone awry in various ways: (a) from focus being marked inappropriately on the wrong referent, (b) from incongruence between focus assignment and prior context, (c) from a disruption of thematic role assignment, (d) from the misalignment of syntactic positions reserved for focused constituents with elements that do not bear focus, or (e) from a reversal of pragmatic plausibility relations. We discuss each of these possibilities in turn below.

4. Inappropriate focus-marking: no ERP effects?

With regard to possibility (a), singling out the wrong referent for focus assignment, Hruska, Steinhauer, Alter, and Steube (2000) suggested on the basis of an ERP study of spoken German that such inappropriate focus-marking is not responsible for disruptions in on-line sentence processing. In their study, focus was incorrectly assigned by means of pitch accent in answers to *wh*-questions (e.g. 2a,b). Examples of Hruska's et al. stimuli are given in Table 1; words carrying pitch accents are shown in capital letters.

Table 1
Hruska et al. (2000) example stimuli

Condition	Stimuli
NP-focus:	Wem verspricht Peter zu arbeiten? Peter verspricht ANNA zu arbeiten
Match	Whom does Peter promise to work? Peter promises ANNA to work ...
NP-focus:	Wem verspricht Peter zu arbeiten? Peter verspricht Anna zu ARBEITEN
Mismatch	Whom does Peter promise to work? Peter promises **Anna** to <u>WORK</u> ...
VP-focus:	Was verspricht Peter Anna zu tun? Peter verspricht Anna zu ARBEITEN
Match	What does Peter promise Anna to do? Peter promises Anna to WORK ...
VP-focus:	Was verspricht Peter Anna zu tun? Peter verspricht ANNA zu arbeiten
Mismatch	What does Peter promise Anna to do? Peter promises <u>ANNA</u> to **work** ...

When participants encountered phrases that *should* have received prosodic focus-marking but did not (boldface in Table 1), the ERP response was a large posterior negativity followed by a long posterior positivity. Conversely, when participants first encountered pitch-accented phrases that were *not* expected to be in focus based on prior context (underlined in Table 1), there was no reliable ERP effect. It thus appears that while incorrectly marking something as focus elicits no observable ERP change at the scalp, the absence of focus-marking where it is expected causes a robust ERP effect.

Applying these ERP results to infelicitous *it*-cleft constructions (1b), the syntactic structure incorrectly marks focus on something that should not have focus status (*lettuce*). However, since the referent that should have received syntactic focus-marking (and the informative part of the answer in relation to the question, namely *that the rabbits ate*) is not yet available, there may be no significant processing disruption at *lettuce*. In other words, if (1b) is unacceptable because it lacks syntactic focus-marking on the appropriate referent (*rabbits*) and not because the wrong referent (*lettuce*) is so marked, Hruska's et al. results predict that there should be no noticeable difference in the ERP record when *lettuce* is read, but that there should be an ERP difference when *rabbits* is encountered.

5. Incongruence between focus assignment and prior context: N400 effects?

The second possible source of unacceptability in (1b) is the incongruence between focus assignment and prior context. Extra-sentential context effects on sentence processing are well documented; several ERP studies have shown that language-sensitive components like the N400 and left anterior negativity (LAN) can be modulated by prior discourse (e.g. van Berkum et al., 1999). The N400 is characterized by a relative negativity that is generally posterior, with a slightly right or bilateral distribution, beginning around 200 ms post-stimulus onset with a peak at 350–400 ms. It is believed to be an index of processes underlying lexical access and contextual integration (Brown & Hagoort, 1993; Kutas & Federmeier, 2000). Its amplitude is sensitive to a number of factors, including those related to contextual constraint and the relationship of a given word to what is most likely or expected in off-line cloze procedures (Kutas & Federmeier, 2000; Kutas & Hillyard, 1984; see Kutas & Van Petten, 1994; for a review). In a discourse context, sentences that would be sensible in isolation have nonetheless been found to elicit larger N400 responses when occurring in larger discourse contexts in which they were less expected or anomalous (e.g. Federmeier & Kutas, 1999; van Berkum, Zwitserlood, Hagoort, & Brown, 2003). There is thus good reason to expect that the presence of a prior *wh*-question could similarly constrain the processing of an otherwise grammatical *it*-cleft to render it unacceptable in context, thereby eliciting an N400 induced not by familiar semantic constraints, but by information structure-based constraints reflecting the dependency between a *wh*-question and its answer.

However, the expectations generated by semantic constraints are not necessarily the same as those motivated by information structural considerations. Semantic context incrementally restricts the range of possible expectations for upcoming words in a sentence (Kutas & Hillyard, 1984; Van Petten & Kutas, 1990) or discourse (Federmeier & Kutas, 1999; van Berkum et al., 2003) to the extent that under certain circumstances, only a single candidate word remains under consideration. N400 amplitude has thus been found to correlate inversely with the degree to which a particular word is expected on the basis of prior semantic context. Information structural considerations, on the other hand, generate almost the exact opposite type of expectation: that a particular word will *not* occur in a particular sentence position on the basis of prior context. In (1), the context of the *wh*-question sets up the expectation that *lettuce* will not appear in the clefted focus position. Note that even entities that have not been previously mentioned in the discourse, and are therefore unexpected in the established context (e.g. *gophers*), are not nearly as anomalous as previously mentioned entities not expected to be in focus position (such as *lettuce* in (1b)). In short, the constraints imposed by prior semantic context and by information structure have similar but not identical effects in generating expectations about the identity of an upcoming word.

One can therefore make the following predictions based on these considerations. If the context provided by a preceding *wh*-question is treated by the human comprehension system as similar in a general way to any other type of prior constraining semantic context, then one might reasonably expect an N400 response when any such contextual expectation is violated. If on the other hand the human comprehension system differentiates in some fundamental way between the expectation for a particular word in a given context (based on prior semantic context) and the expectation for a particular word *not* to occur in a given context (based on information structure), predictions cannot be as definitive. An information structure violation due to an unexpected referent in focus position could elicit a previously undocumented ERP component, some other ERP component known to vary during language processing such as the LAN or the P600, or an N400 modulated in amplitude, latency, morphology, or scalp distribution.

6. Disruption of thematic role assignment: N400 effects?

A further, related possibility is that an information structure violation like (1b) could specifically interfere with the processing of thematic information, i.e. the assignment of appropriate thematic (semantic) roles to the noun phrases encoding the various discourse referents. Previous research in German has indicated that ambiguity of thematic role assignment in on-line sentence processing also elicits an N400 response. An N400 is elicited when noun phrases are ambiguously case-marked, such that thematic role assignment cannot take place until sentence end in verb-final clauses (Bornkessel et al., 2004; Hopf et al., 1998), and an N400 + P600 complex is elicited when two animate noun phrases in the same clause illicitly receive the same case marking, such that thematic role assignment becomes impossible (Frisch & Schlesewsky, 2001, 2005).

It could thus be the case that the comprehension system has specific difficulty in assigning an appropriate thematic role to the noun phrase in the clefted focus position of (1b). *Deer*, *rabbits*, or other as yet unnamed, animate, plausible agents of lettuce-eating are expected to appear in this position, but *lettuce* does not qualify, and is explicitly designated in the context provided by the preceding *wh*-question as the undergoer of the eating event. When a noun phrase (like *lettuce*) that has been assigned the thematic role of undergoer in the previous discourse context appears in a syntactic position to which that same context has led the comprehension system to expect that it can assign the thematic role of agent, multiple simultaneous sources of difficulty in thematic role assignment result: the prior assignment of the undergoer role to *lettuce* is called into question, the agent role cannot be discharged fully or immediately at the expected syntactic position, and must therefore continue to be held in working memory pending resolution, and the agent of the eating event remains unidentified both in the current sentence as well as in the overall discourse representation. The first two of these difficulties applied *ceteris paribus* to the German studies that used ambiguous case marking to render thematic relations opaque (Bornkessel et al., 2004; Hopf et al., 1998), and all three applied to the German studies that used illicit duplicate case marking to impede successful thematic role assignment (Frisch & Schlesewsky, 2001, 2005). It is thus reasonable to expect that the same three difficulties of thematic processing will conspire to elicit an N400 response in English, even though English rarely (e.g. pronouns) overtly case-marks its noun phrases.

7. Misalignment of syntactic focus position with an unfocused element: P600 effects?

Instead of reacting to a focused element, it could be that the parser reacts to the appearance of non-focus-bearing sentence elements in a syntactic position reserved for focused constituents. When focus is marked grammatically, via the use of specific syntactic constructions (1), a particular syntactic position is reserved for the focused constituent, and the parser expects this position to host the focus of the sentence. When this expectation is not met, the parser may react to the appearance of a non-focus-bearing element in the syntactic focus position as a structural violation. For example, in answer to the question in (1), the cleft position of the answer is expected to provide new and heretofore unknown information about the lettuce eater. When it instead provides already given information about what was eaten, the parser may be thrown off by the fact that the syntactic focus position hosts an element that should not be in focus.

In this case, the cognitive processes associated with focus status, namely, updating information about who the lettuce-eater is in a mental model of the discourse (Erteschik-Shir, 1997, Chap. 1), could be disrupted when the focus-marked constituent is incompatible with the focus status. This is especially relevant for the cleft constructions in our experiment, because the right edge of the syntactic focus constituent (*it is X*) is the first point where relevant information (i.e. the answer to the question) is given. If comprehenders attempt to integrate this information with the question at this point, this process could be disrupted when the focus-marked element cannot be interpreted as focus, and thus cannot be sensibly integrated with the question (i.e. the lettuce cannot eat itself).

If such is the case, one might predict that the brain response to information structure violations of this type would be a P600, a late positivity with a centro-parietal scalp distribution and a latency of about 500–800 ms post-stimulus onset (though P600s have also been known to onset as early as 200 ms), known to be sensitive to violations of phrase structure (Hagoort, Brown, & Groothusen, 1993; Neville, Nicol, Barss, Forster, & Garrett, 1991; Osterhout & Holcomb, 1992), to syntactic integration difficulty (Fiebach, Schlesewsky, & Friederici, 2002; Kaan, Harris, Gibson, & Holcomb, 2000), and to any kind of linguistic parsing difficulty, whether induced by morphosyntactic, semantic, or even orthographic violations (Münte, Heinze, Matzke, Wieringa, & Johannes, 1998).

8. Reversal of pragmatic plausibility relations: P600 effects?

A number of recent studies have raised the possibility that the P600 may be sensitive not only to parsing difficulties, but also to what have been characterized as reversals of pragmatic plausibility relations. This is based on the fact that *eat* in *For breakfast the* [*eggs*/*boys*] *would only eat* ... elicits a P600 when the subject of the sentence is *eggs*, relative to when it is *boys* (Kuperberg, Sitnikova, Caplan, & Holcomb, 2003). This effect was originally attributed to a violation either of thematic relations (the verb *eat* requires an agent subject), or to selectional restrictions on the verb (*eat* requires an animate subject; Hoeks, Stowe, & Doedens, 2004; Kuperberg et al., 2003). However, Kolk, Chwilla, van Herten, and Oor (2003) reported a P600 effect in response to Dutch sentences that reversed expected pragmatic plausibility relations rather than thematic or animacy relations (*The fox that hunted the poachers stalked through the woods*). Kim and Osterhout (2005) further demonstrated that inanimate subject nouns do not elicit a P600 when associated with verbs that fail to encourage a pragmatically plausible combined interpretation (*The hungry tabletops were devouring*...); van Herten, Kolk, and Chwilla (2005) provided evidence that the P600 was not due to the conflict between the expected and actual inflectional ending on the verb.

In light of these results, it may also be the case that in (1b) the parser is thrown off by a reversal of pragmatic plausibility relations. The *it*-cleft syntactic frame sets up the expectation that the cleft position will be dedicated to the agent of the eating event (*rabbits* or *deer*), as requested in the preceding *wh*-question (1), but instead this position contains an inanimate noun phrase that is implausible as the agent of eating (*lettuce*), and plausible only as the undergoer of the action, confounding our expectation. In the particular illustrative example (1) we have been using, pragmatic plausibility and animacy are confounded. However, the actual stimuli used in the experiment (Table 2) contained no such confound: the set-up context for the

Table 2
Experimental stimuli examples

Setup context	A queen, an advisor, and a banker were arguing over taxes. Who did the queen silence with a word, the banker or the advisor?
Congruent target sentence	It was the banker that the queen silenced.
Incongruent target sentence	It was the queen that silenced the banker.
Setup context	A dressmaker, a client, and a manager were looking at the gown. Who did the dressmaker want to flatter, the client or the manager?
Congruent target sentence	It was the client that the dressmaker flattered.
Incongruent target sentence	It was the dressmaker that flattered the client.
Setup context	A priest, a farmer, and a laborer were sitting outside the church. Who did the priest pray for, the farmer or the laborer?
Congruent target sentence	It was the farmer that the priest prayed for.
Incongruent target sentence	It was the priest that prayed for the farmer.
Setup context	A turtle, a parakeet, and a chinchilla were locked in a cage together. What did the turtle snap at, the parakeet or the chinchilla?
Congruent target sentence	It was the parakeet that the turtle snapped at.
Incongruent target sentence	It was the turtle that snapped at the parakeet.

experimental stimuli always contained discourse referents that had the same high animacy feature, and the *wh*-question always indicated one of these as the agent of the action involved, and the other two as potential undergoers of the action. The verb used in the *wh*-question preceding the target sentence was also chosen to be pragmatically consistent with only one of these three discourse referents, namely the one indicated in the question as the agent of the action. Thus the appearance of this agentive discourse referent in the designated object slot of the *it*-cleft could be taken as a violation of the pragmatic context established in the set-up sentence. If this is the case, the brain response could also be a P600 for this reason.

9. Methods

To test the possibilities outlined in the introduction, three-sentence paragraphs like the one shown in Table 2 were used.

The first sentence of each passage began with the introduction of three discourse participants, all occurring in subject position. The primary purpose of this sentence was to introduce these participants and provide a setup context that would make the rest of the passage as natural as possible. The second sentence was a *wh*-question that made one participant the agent of an event, and asked which of the other two participants was also involved in the event as the undergoer. These two sentences together formed the setup context for the target sentence. The third, final sentence was the target sentence and was constructed as an *it*-cleft. As has already been discussed, the clefted element in an *it*-cleft is marked for focus, typically interpreted as contrastive focus. The *wh*-question in the setup was designed to cause participants to expect that one or the other of the two queried discourse participants was going to be placed in the cleft, and thus also that the other non-queried participant would *not* be.

9.1. Participants

Twenty-two UCSD students (half women) were paid or given course credit for their participation. All had normal or corrected-to-normal vision and were right-handed (two reported left-handed family members). All were native English speakers with no history of neurological disorders. Their ages ranged from 18 to 28 (with a mean of 21).

9.2. Design and materials

100 three-sentence passages were constructed. In the congruent condition, one of the two previously presented discourse participants was given in the focus-marked cleft. In the incongruent condition, the agent of the event in the question (e.g. *queen*) was given. It is important to note two things in particular about the stimuli. First, while the information structure of the sentences was violated, the semantics were not. All of the materials were semantically appropriate, once a full reading was available. Thus, participants had no reason to expect that the answer would be semantically inappropriate. Second, the questions were designed not to bias the answer. Thus, while participants were expecting one of the two potential undergoers to be in focus, and in cleft position, they were critically not expecting the agent of the question. The average lexical frequency of the agent and the two possible undergoers was matched as closely as possible (Kucera & Francis, 1967). The agent was always the first participant mentioned in the setup, while the answer to the question was the second participant half of the time and the third participant the other half. The filler items for this experiment consisted of 110 items from another, unrelated experiment that used different question–answer contexts. In these filler items, a five-sentence discourse introduced three discourse referents and ended in either a yes/no- or *which*-N′ question (e.g. *Which one tasted the soup?*). The target answers were always felicitous and did not use a cleft construction.

9.3. Procedure

Participants were seated in front of a computer monitor in a comfortable chair that provided head support. They held a response button in each hand. Participants were asked to remain as still as possible during the trials and were shown their ongoing EEG before the experiment began in order to demonstrate the effects of muscle movement/tension on the EEG signal. Stimuli were presented in 10 alternating blocks of 20 and 21 items, which were presented in different orders between participants. Participants were given opportunities to take short breaks between blocks. For each item, the setup context was presented all at once as a paragraph on the screen. Participants read the context silently and pressed the right response button to indicate when they were finished. At 300 ms after the button press, a red fixation crosshair appeared in the center of the screen for a random amount of time ranging from 500 to 1200 ms. At 500 ms after the offset of the crosshair, the first word of the target sentence appeared in the center of the screen. The entire target sentence was presented in RSVP format, appearing on the screen for 200 ms with a stimulus onset asynchrony of 500 ms between each word. After some of the trials (approximately 3 per block), a true/false statement would appear and participants would press the right button to respond "true" and the left button to respond "false".

9.4. EEG recording and analysis

During each block of trials, event-related brain potentials were recorded from 26 geodesically spaced electrodes embedded in an elastic cap and referenced to an electrode placed at the left mastoid. Electrodes were also placed at the right mastoid, the outer canthi, and under the right eye. Bipolar horizontal EOG was recorded from the outer canthi to monitor for saccadic eye movement, while the signal from the right eye electrode was used to monitor for blinks. The recorded data were additionally re-referenced offline to the average of both mastoids. All impedances were kept below 5 kΩ. The signals were amplified within a bandpass of 0.01 and 100 Hz, and were recorded continuously, digitized at 250 Hz.

One word epochs extended from a 100 ms pre-stimulus baseline to 920 ms post-stimulus onset while whole sentence epochs extended from a 500 ms pre-stimulus baseline to 4500 ms post-stimulus onset. Trials with blocked channels, excessive muscle activity, eye blinks or movements were rejected off-line before averaging. This screening procedure resulted in 10% of the trials being rejected. Results were submitted to an overall ANOVA with repeated measures of condition (congruent vs. incongruent), hemisphere (left vs. right), laterality (lateral vs. medial) and anteriority (4 levels). The Huynh and Feldt (1976) correction was applied when the use of repeated measures could violate sphericity in the ANOVA and corrected *p*-values are reported.

10. Predictions

The design of the experiment was such that our interest focused sharply on what happens when participants encounter the clefted noun (e.g. *queen* or *banker*). One way of examining this would be to compare the ERP to the word in the clefted position with that to words in other positions. The nature of ERPs to words within a sentence are remarkably similar, although initial words differ in generally having larger components overall, and final words are often characterized by a late positivity, presumably reflecting sentence wrap-up processes. Typically, all words, especially open-class words, elicit some N400 activity which is reduced as semantic constraints accrue across the course of a sentence (Van Petten & Kutas, 1991). Closed-class items by contrast tend to elicit smaller posterior N400 activity but do show a frontal (negative) slow potential (N400-700) (Neville, Mills, & Lawson, 1992; Van Petten & Kutas, 1991). A comparison of the individual words in this structure can reveal if there are any differences when participants encounter the clefted noun. If the clefted construction is processed like a typical sentence, we would expect to see initial words with the largest ERPs and the greatest negative amplitude between 300 and 500 ms post-word onset, final words with the greatest positive amplitude in this latency range, and the response to intermediate words between the two. Any deviation from this, in particular at the clefted noun, could indicate a focus-related structural change from the processing of simple declarative subject–verb–object sentences.

In addition, as outlined above, the materials were designed to contrast the possibly differential neural activity at the clefted position as a function of focus congruency. Taking the congruent condition (e.g. *banker*) as a baseline of processing, if participants develop expectations about the identity of upcoming words based on information structure interpretation in a way that is similar to the expectations generated by constraining semantic context, then N400 amplitude should be somewhat larger for the incongruent relative to the congruent condition at the clefted noun (e.g. *queen*). Likewise, if participants experience difficulty in thematic role assignment when the discourse referent singled out as the agent of the action (*queen*) by the preceding context appears in the clefted position where the undergoer of the action (either *banker* or *advisor*) is expected to appear, this could also result in greater N400 activity in the incongruent than the congruent condition. On the other hand, if the incongruence is caused by the appearance of a non-focus-bearing element in a syntactic position reserved for focused constituents, or to a reversal of pragmatic plausibility relations, then a P600 might be elicited instead. Alternatively, if the syntactic focus-marking on *queen* in the incongruent condition is processed in the same way as the superfluous prosodic focus-marking in Hruska et al. (2000), then there may be no ERP processing difference whatsoever observed at the clefted noun.

11. Results

Averaged responses to word positions across the sentence at midline electrodes are shown in Fig. 1. Of particular interest are the solid lines that represent the cleft noun (thin) and the final word (thick): a visual comparison of the clefted noun and the final word shows a prominent overall positive shift for the cleft noun in comparison to the other words in the sentence (including the following word, "that"). This shift is similar to that elicited by the final word of the sentence.

These figures show a remarkable similarity in brain response between the clefted noun position and the final word, especially compared to words occurring both before and after the clefted noun: both cleft noun and final word positions elicit large positivity. Such positive shifts for final words are well known, and it is interesting to see a similar shift here for the clefted noun, but not for the *that* which syntactically marks the end of the cleft phrase, nor for the other non-final open-class word in the target sentence (in our example this is *queen* in the congruent condition and *silenced* in the incongruent condition). This pattern can be also be seen in Fig. 2, which plots the average amplitude between 200 and 800 ms across all midline electrodes, collapsed across condition.

A statistical comparison between these positions in a latency window of 200–800 ms supports these observations: there was a significant difference between the cleft noun and the following *that* ($F[1,21] = 24.94$, $p < .0001$) and between the cleft noun and the other non-final open-class word ($F[1,21] = 35.00$, $p < .00001$). There was also a significant difference between *that* and the final word ($F[1,21] = 25.92$, $p < .00001$) as well as between the other non-final open class word and the final word ($F[1,21] = 27.15$, $p < .00001$). However, there was only a marginal difference between the cleft noun and the final word ($F[1,21] = 3.45$, $p < .08$).

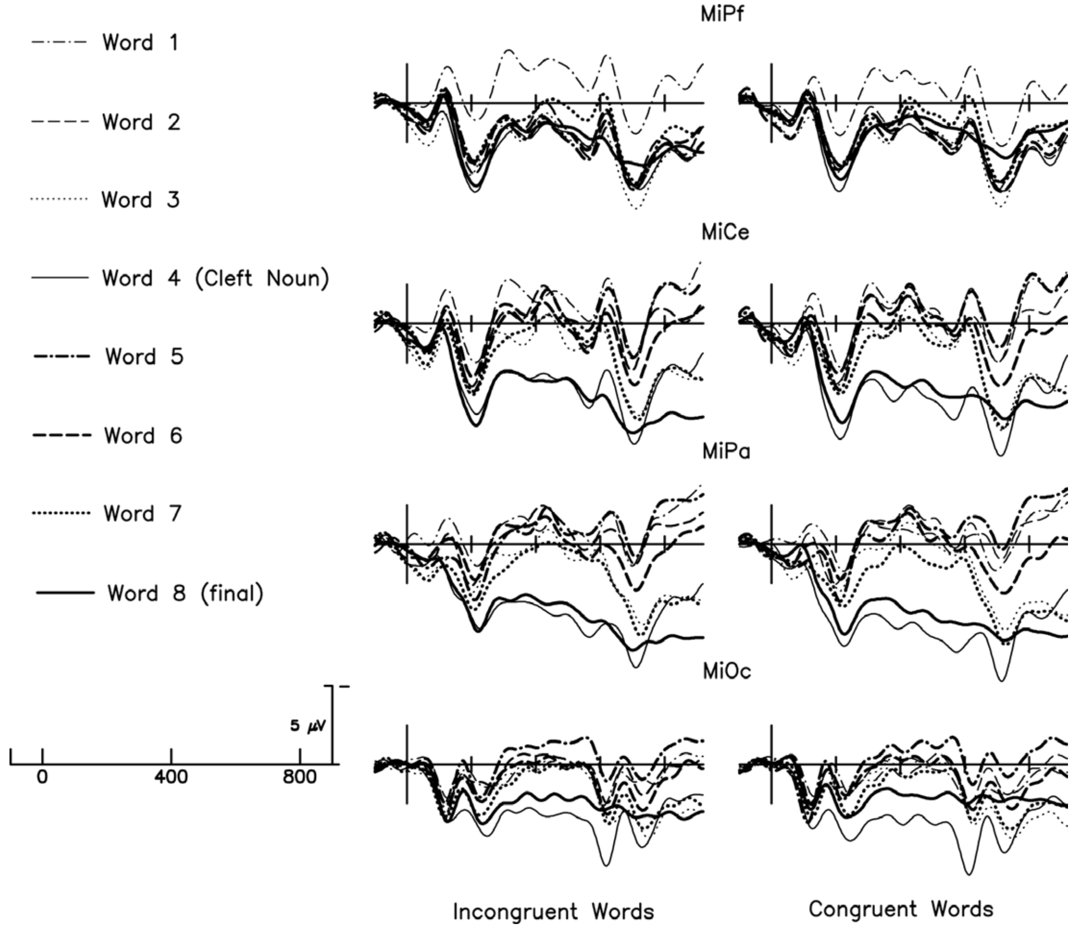

Fig. 1. Comparison of grand average ($N = 22$) ERPs for all words at midline electrodes (MiPf, prefrontal; MiCe, central; MiPa, parietal; MiOc, occipital), shown for congruent and incongruent conditions. Negative amplitude in this and all following figures is plotted up.

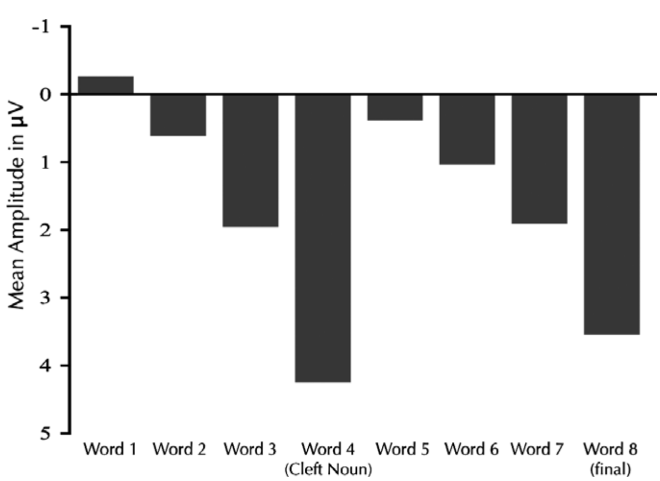

Fig. 2. Chart comparing average amplitude for each word across all midline electrodes between 200 and 800 ms.

To further examine these results,[1] whole-sentence averages were created with a latency window of 0–4500 ms from the beginning of the sentence and a pre-stimulus baseline of 500 ms. Visual inspection of the whole sentence data shows a steady positive shift over the course of the sentence (see Fig. 3). Two analyses were conducted: one in which no additional filtering was applied and another in which a .3 high-pass filter was applied. The results of this filter are also shown in Fig. 3. Both analyses revealed a pattern of results similar to the one-word analyses above, however in the high-pass filter analysis the clefted noun and final word were this time found to be significantly different in the same 200–800 time window as above ($F[1,21] = 33.61$, $p < .00001$), with the clefted noun showing greater positivity than the final word. This suggests that when the steady positive shift across the sentence is controlled for, the positivity seen to the clefted noun is not only similar to that elicited by the final word, but is in fact somewhat larger.

Visual inspection of the waveform in Fig. 4 shows that the brain response to the clefted noun in both conditions is similar for the first 200 ms; both the N1 and P2 peaks are largely aligned and of the same magnitude. However, starting around 200 ms, an increased negativity (or less positivity) for the incongruent condition is observed. This negativity appears largest over right medial electrodes toward the back of the scalp and extends roughly throughout the epoch.

These visual impressions were confirmed by measurements subjected to statistical analysis. The negativity to

[1] An anonymous reviewer noted that positive drift over the course of the sentence could influence our word position analyses and so to investigate this possibility we undertook this additional analysis at the sentence level.

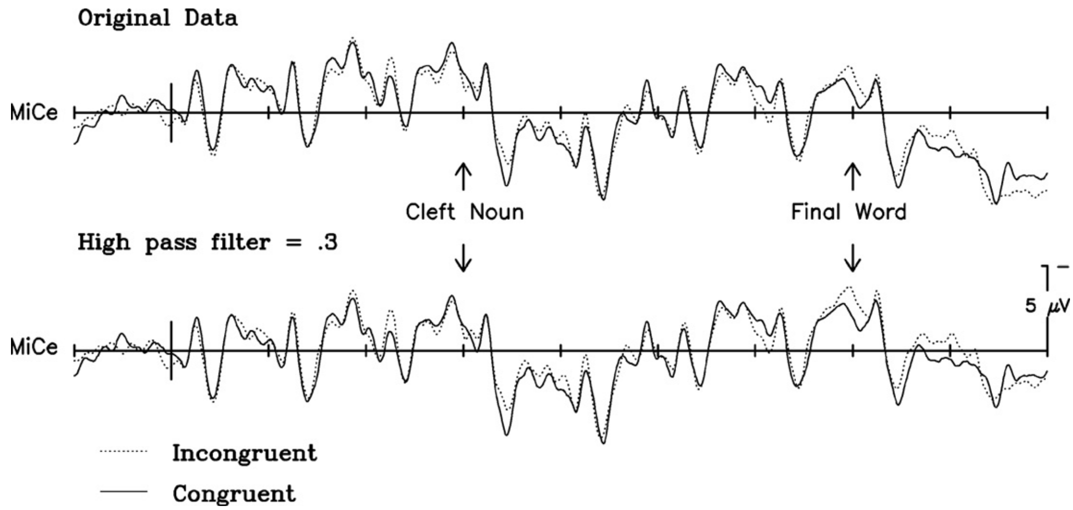

Fig. 3. Comparison of grand average ERPs for across-the-sentence averages, with original and high-pass filtered data.

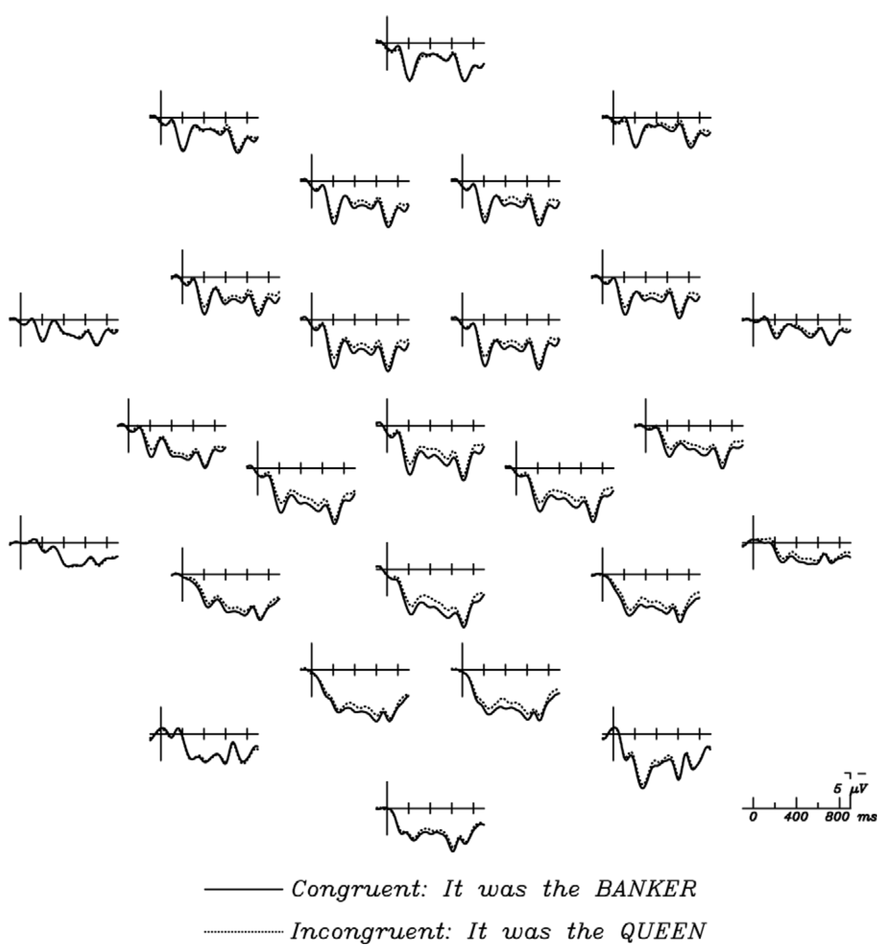

Fig. 4. Comparison of grand average ERPs at the clefted noun for congruent and incongruent conditions for all electrodes.

the unexpected condition was marginal as a main effect between 200 and 800 ms ($F[1,21] = 3.69$, $p < .068$). Within the same time window, there was a significant interaction between condition and laterality ($F[1,21] = 6.11$, $p < .022$). When this interaction was broken down into pair-wise comparisons within laterality, a significant effect of condition was found for medial channels ($F[1,21] = 5.3$, $p < .032$) but not for lateral channels ($F[1,21] = 1$, n.s.), showing that the effect was largest over medial sites. We next examined this same negativity in separate 300-ms time windows, between 200–500 ms and again between 500–800 ms, in order to better fix its temporal locus. Between 200 and 500 ms, the negativity in response to the incongruent condition was once again marginal as a main effect ($F[1,21] = 3.11$, $p < .092$). Within this earlier time window, there was again a significant interaction between condition and laterality ($F[1,21] = 5.94$, $p < .024$) which when broken down into pair-wise comparisons within laterality showed a marginal effect of condition in medial channels ($F[1,21] = 4.182$, $p < .054$) but not in lateral channels ($F[1,21] < 1$), showing that the effect was larger over medial sites. There was also a marginal interaction between condition, hemisphere and laterality ($F[1,21] = 3.96$, $p < .06$). A breakdown of this interaction by hemisphere within laterality showed no reliable effect of condition at either left or right lateral sites (left lateral, $F[1,21] < 1$, right lateral, $F[1,21] = 2$, n.s.) but a marginal effect at left medial sites ($F[1,21] = 3.81$, $p < .06$) and a significant effect at right medial sites ($F[1,21] = 6.72$, $p < .047$), showing that the increase in negativity was largest over right medial electrodes. Finally, there was also a marginal four-way interaction between condition, hemisphere, laterality and anteriority ($F[1,21] = 2.32$, $p < .085$). There were no other significant results (all Fs < 1, except condition × hemisphere × anteriority, $F = 1.20$). In the later time window of 500–800 ms, there was a marginal continuing interaction between condition and laterality ($F[1,21] = 3.74$, $p < .06$), with no other significant effects (all Fs < 2 except condition ($F = 2.89$, $p < .104$)). This difference between 200 and 800 ms after the cleft noun can be seen more closely in Fig. 5, as marked by arrow 1.

The word following the clefted noun (*that*) in all items and conditions was also examined, along with the final word of the target sentence. Fig. 5 shows the grand average ERP at midline electrodes for the clefted noun, the following word *that* and the final word, with numbered arrows marking the effects. Visual inspection of the waveform in response to *that* suggests a brief increase in negative amplitude between 300 and 400 ms after the onset of *that* for the incongruent condition (arrow 2). Statistical analyses revealed that this difference marginally interacted with laterality ($F[1,21] = 4.27$, $p < .051$), with the largest amplitude difference over medial electrodes (although a statistical comparison of condition broken down by laterality showed no significant difference by condition in either lateral ($F[1,21] = .256$) or medial channels ($F[1,21] = 2.58$, n.s.)) No other effects, including a main effect of condition, were reliable, with all Fs < 2 except for an interaction with hemisphere and laterality ($F[3,63] = 2.12$, $p <$ n.s.).

The final word was also examined, although the differences between conditions at this point make such a direct comparison less than ideal. Despite the difference in the preceding context and in word class between the two conditions (i.e., a verb in the congruent condition and a noun

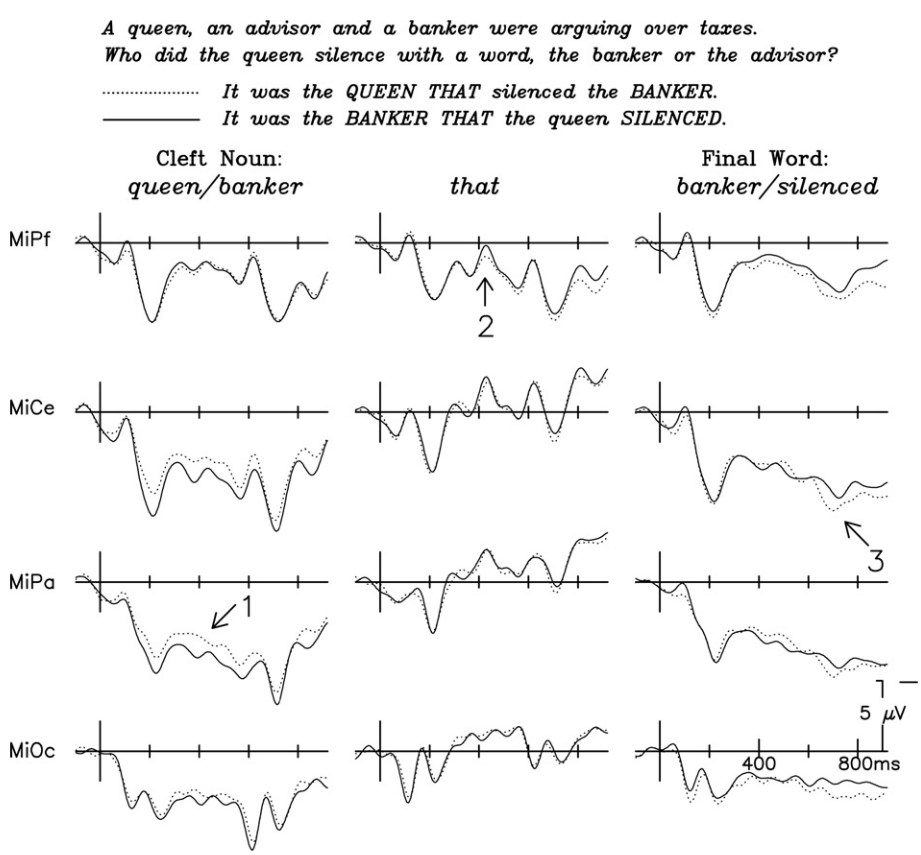

Fig. 5. Comparison of grand average ERPs at midline electrodes for the clefted noun, the following word "that", and the final word.

in the incongruent condition), the response to the final word was largely similar across the two conditions. Visual inspection of the waveform suggests an increase in negative amplitude for the incongruent condition between 400 and 600 ms, but this was not supported by statistical analyses of the data (all Fs < 1, except interactions between condition and hemisphere ($F = 2.29$, $p < .15$) and hemisphere, laterality and anteriority ($F = 1.44$, $p < .24$)). A later shift in positive amplitude, with the incongruent condition becoming more positive than the congruent condition between 700 and 900 ms, with the largest difference over posterior, right medial electrodes is also seen (arrow 3). Statistical analyses showed a marginal four-way interaction between condition, hemisphere, laterality and anteriority in this time window ($F[3,63] = 2.52$, $p < .067$) with no other reliable or marginal effects (all Fs < 1, except for condition ($F = 2.6$, $p < .12$) and an interaction of condition and laterality, ($F = 1.83$, $p < .19$)). A statistical examination of the breakdown of this interaction by condition within each level hemisphere, laterality and anteriority showed a marginal difference by condition in right, lateral, posterior (level 4) channels ($F[1,21] = 4.15$, $p < .054$) and a significant difference in right, medial posterior (level 4) channels ($F[1,21] = 4.79$, $p < .04$), with no other significant or marginal effects (all Fs > 2 except left medial posterior (level 4) channels ($F[1,21] = 2.96$, n.s.) and right medial anterior (level 2) channels ($F[1,21] = 2.5$, n.s.)).

12. Discussion

Our results clearly indicate that misassignment of focus evokes a brain response: an inappropriate word occurring in the focus position of an answer to a *wh*-question does indeed modulate scalp ERP amplitude between 200 and 500 ms post-word onset. Specifically, the amplitude of the potential in this latency range is more negative (or less positive) than that to a focus-appropriate word.

This contrasts directly with what might have been expected from the results of the auditory ERP study by Hruska et al. (2000), in which phrases that should have been prosodically marked as focus (but were not) elicited a large posterior negativity followed by a long posterior positivity, while phrases that were prosodically marked even though not in focus showed no reliable ERP effects at all. This underscores the importance of modality and the specific instantiation of abstract categories like focus status: while focus status can be marked by both prosodic and structural cues, it appears that these cues might have different impacts on real-time language processing as reflected in ERPs. One reason why structural cues like clefting might cause immediate brain responses is that there is little possible ambiguity—once a comprehender realizes that there is a cleft construction, then focus status must be assigned to the clefted word. By contrast, prosodic cues at any given point in a sentence are more ambiguous: an apparent focus-marking pitch accent (Pierrehumbert, 1980) may be superseded by a subsequent change in the prosodic contour of the sentence. Thus, when faced with an apparently incongruous focus status as indicated by prosody, the processing system may behave as if a future, congruous focus assignment may still rescue the interpretation. This would explain why, with prosodic focus-marking, it is not until the constituent that should be marked as focus is encountered that processing difficulty is indicated. It follows from such an interpretation, if correct, that treating certain abstract categories as the same for purposes of processing should be done with caution, especially when they are instantiated by different means available within a language.

The nature of the negative response elicited by the misassignment of focus in our incongruent condition is similar in certain ways to the N400 modulation in response to lexically semantically improbable or anomalous words: it has about the same latency, and its slight right medial distribution is in keeping with other reported N400 effects (e.g. Kutas & Federmeier, 2000; Kutas & Van Petten, 1994). However, the negativity reported here lacks the strong peak that many studies have previously reported; this can be seen not only in the grand average across all participants, but in most cases in the individual participant averages as well.

Despite this morphological dissimilarity, we are inclined to interpret this effect as a kind of N400. First, as we have previously discussed, there are a number of other factors known to modulate ERP amplitude within the traditional N400 time window that are not strictly semantic or pragmatic, including word frequency, repetition, orthography, phonology, and word morphology (c.f. Kutas & Federmeier, 2000). Thus it is reasonable to posit that amplitude in this same time window might be sensitive to certain aspects of information structure as well. If this explanation is on the right track, it would seem premature to posit the existence of a new and separate component specifically sensitive to the effects of information structure. Moreover, other N400-like effects with a similar morphology (i.e. without a sharp peak) have been reported in the literature, particularly in comparisons of closed-class words with varying degrees of lexical semantic content (Kluender & Kutas, 1993; McKinnon & Osterhout, 1996). The N400 activity elicited by closed-class words is in general smaller than that elicited by open-class words anyway, and the N400 effect seen in comparisons of closed-class items based on their lexical semantic content is therefore more subtle and diffuse than in equivalent comparisons of open-class words. While the comparisons in our study were between open-class words, it may be the case that the manipulation of focus assignment is of a similarly subtle nature. As we have emphasized throughout, the violations of information structure included in our study do not violate the basic semantic content of the proposition, but only the way in which that propositional semantic content is arranged and presented.

In the introduction, we discussed two alternative ways in which an N400 effect might be elicited by our materials.

The nature of the response we elicited suggests that, comprehenders use constraints based on prior context to form expectations about the information statuses of discourse referents in the answer. When combined with a dedicated focus construction like clefting, these expectations about what should or should not be focus-marked lead to concomitant expectations as to what should or should not occur in cleft position. Most generally, then, the nature of the violation is consistent with a semantic interpretation of the focus-inappropriate word as incongruous in this clefted focus position. However, an alternative way of viewing the violation is as a disruption of thematic role assignment. In the materials used here, the context provided by the immediately preceding *wh*-question led participants to expect the undergoer of a previously established event to appear in cleft position, and this undergoer role was moreover expected to be associated with one of two particular discourse referents (i.e., either *banker* or *advisor*). Both of these expectations were violated when the agent of the event (i.e., *queen*), which could not felicitously be assigned focus in this context, appeared in the cleft position instead. As a result, neither the agent nor the undergoer roles associated with the thematic grid of the predicate could be unambiguously assigned to the cleft noun, resulting in a temporary disruption of thematic processing.

On the basis of the materials we used, we are not in a position to distinguish between these two alternative interpretations of the N400-like effect as either perceived incongruence between focus assignment and prior context, or as a disruption of thematic processing. Yet it is important to note that both characterizations are rooted in semantic considerations, and thus either interpretation is perfectly compatible with an N400-like effect, and both may in fact have played a role its elicitation. Beyond this, it must be left to future research to tease apart the relative contributions of each of these two semantic factors to the observed N400-like effect.

If we take the effect at the clefted noun as an example of N400 amplitude modulation, our results have implications for our understanding of the N400 component, and in particular, the understanding of information to which the N400 is sensitive. It appears that in addition to word frequency, word repetition, semantic association, and abstractness, information–structural considerations also influence ERP amplitude in the region of the N400, with referents expected as focus and bearing predictable thematic roles (based on prior context) eliciting smaller N400 activity than those that are not expected to bear focus or particular thematic roles. If effects of this nature are replicated in future research, there may be further implications for the status of information structure as a primarily syntactic or primarily semantic level of linguistic analysis.

An even more striking aspect of our findings, however, is the presence of a large late positivity in response to the noun in the clefted position of both conditions, i.e. regardless of whether it was focus appropriate or inappropriate. A similar positivity was seen in response to the final word, but not to any of the intervening words. The fact that the response to the cleft noun of the congruent condition was slightly more positive than the response to the cleft noun of the incongruent condition makes it difficult to interpret this response as a P600 on any current view of its functional significance. In violation paradigms, either syntactic (Hagoort et al., 1993; Neville et al., 1991; Osterhout & Holcomb, 1992) or pragmatic (Hoeks et al., 2004; Kim & Osterhout, 2005; Kolk et al., 2003; Kuperberg et al., 2003; van Herten et al., 2005) in nature, it is invariably the anomalous condition that elicits a sizable, robust P600 effect; in manipulations of syntactic integration (Fiebach et al., 2002; Kaan et al., 2000), it is typically the more complex and difficult-to-process condition that yields a larger P600 response. In this study, it was the non-anomalous, less complex and easier-to-process condition that elicited a slightly larger positive response.

Let us then consider why there might be an increase in positive amplitude for both conditions at this location in the sentence. As already discussed, the cleft construction in these materials provides the focus of the answer to the preceding question. This is an important point in terms of information delivery and resolution of uncertainty; both of these notions have been applied to the P3b component of the ERP (cf. Nieuwenhuis, Aston-Jones, & Cohen, 2005 for a review). Thus the positivity seen here may be a P3b in a sentential context, reflecting the delivery of crucial information.

From a linguistic point of view, the information provided at the clefted position means that the rest of the sentence, expressed as a relative clause, carries background information that is less crucial for interpreting the answer with respect to the question. This is consistent with our additional finding that the positivity at the cleft noun may in fact be larger than that elicited at the sentence-final word. At the cleft noun, comprehenders engage in the type of processing that is akin to clause- or sentence-final integration processes (as generally reflected in a relatively large, late positivity). Comprehenders thus appear to be immediately associating the information provided in the cleft clause with the information sought in the question. Comprehenders apparently feel the need to fill the informational gap that the question introduces without waiting for any further clarifying information provided by the rest of the sentence in the relative clause. Instead, as with other cases where there is a dependency relationship, the processing system seeks to resolve the dependency as soon as possible (e.g. Frazier & Clifton, 1989). In better studied cases, the dependency relationship that is resolved as soon as possible has been within a single sentence, but in our experiment, this dependency spans the question and the answer. We therefore propose that the same anticipatory strategy applies in this less straightforward, cross-sentential dependency as is found in intra-sentential dependencies.

These particular results both confirm and complement the conclusions of Bornkessel et al. (2003) with regard to their ERP study of *wh*-question–answer pairs in German. Bornkessel et al. marked focus not by means of cleft constructions, but by manipulating the order of subject and object (SOV vs. OSV) in both the preceding *wh*-question context and the target sentence itself. They found that any new discourse referent introduced in the target sentence capable of filling the discourse representation slot opened by the *wh*-phrase in the preceding question—regardless of its case properties—elicited a positivity between 280 and 480 ms post-word-onset. Bornkessel et al. independently suggested that the positive component they elicited was a P3b. They also observed the same P3b-like response at the sentence-final verb of target sentences in which any such new discourse referent was introduced.

By means of comparison, the English materials used in our study elicited a P3b-like component at the clefted noun position—regardless of whether the discourse referent appearing there was focus-appropriate or not—and also at the final word of the sentence. Abstracting away for a moment from the differences between Bornkessel et al. and the results presented here, in these two studies in different languages the common finding appears to be this: reliable indicators of focus elicit a P3b response in sentence contexts, both at the focus position itself and at the final word of the sentence.

Bornkessel et al. (2003) were troubled by the fact that the final word of their target sentences, which because of the basic SOV order of German was always a verb, appeared to be eliciting the same ERP component as the newly introduced focus: the same verb occurred in the preceding *wh*-question, and therefore could not also be part of the informational focus of the answer. We believe that this perceived predicament is elucidated and resolved by the brain responses to the final words in our English-language materials. Note that while the final word of the congruent condition was a verb (*It was the banker that the queen silenced*), the final word of the incongruent condition was a noun (*It was the queen that silenced the banker*) that comprised the informational focus of the answer (providing the actual information solicited in the preceding *wh*-question). However, regardless of these differences, the final words of our target sentences always elicited a late positivity that we have characterized as a P3b. This means that, in our materials, a P3b was elicited by the contrastive focus in cleft position, by the informational focus in sentence-final position of the incongruent condition, and by given and therefore non-focused information (the verb) in sentence-final position of the congruent condition. We would suggest, in keeping with suggestions made by Bornkessel et al. (2003), that the appearance of a P3b in these contexts indexes the integration of focused constituents, both at the introduction of the focused element itself and again at sentence end. This seems perfectly in keeping with the generally accepted view of the P3b as a domain-general response to information delivery and resolution of uncertainty.

This interpretation of the positivity elicited by the cleft position in our materials also allows us to cast the N400 difference between the congruent and incongruent conditions in a new light. On one hand, perhaps the reason that the waveforms elicited at this position lack the characteristic peak often found with increases in N400 amplitude is because this component is superimposed on this larger positivity. On the other hand, however, perhaps the difference is not actually an increase in N400 amplitude for the incongruent condition, but rather a decrease in positive amplitude in the 200–500 ms time window: the incongruent condition elicits less of a positivity related to information wrap-up at the clefted noun compared to the congruent condition, as the information needed to answer the question that comprehenders expected based on the sentence structure is not in fact provided. Encountering an inappropriate word in the focus position could thus limit the amount of integration processing that can occur at this point in the sentence. If this is the case, then one would predict differences between the conditions at the final word, which is only partially borne out, with a small, marginal difference in late positive amplitude. However, at the cleft noun itself, it appears that differences between the congruent and incongruent conditions extend, at least marginally, beyond the 200–500 ms time frame. Thus we cannot entirely rule out this alternate possibility.

Under either interpretation of the N400 effect, our results indicate that participants do have an immediate response to violations of expectation based primarily on information structure and to the status of discourse referents. Information processing is guided in part by information structure (instantiated syntactically in our materials, via cleft constructions), and is disrupted when a word whose referent cannot be assigned focus is placed in a focus-marking position.

13. Conclusions

In this paper we have examined the processing consequences of violating information–structural constraints in *wh*-question and answer pairs, and in particular the ERP response elicited by visually presented clefted sentences when the head noun of the clefted phrase was incompatible with a focus interpretation. Based on previous work, several possible brain responses could be predicted: (a) an increased late positive response at the clefted head noun for both incongruent (focus-incompatible) and congruent (focus-compatible) conditions, (b) no immediate difference at the clefted head noun between congruent and incongruent conditions, (c) a larger N400 response for the incongruent noun compared to a congruent noun, and (d) an increase in P600/late positive amplitude for the incongruent noun compared to the congruent.

Our results showed two responses: an increased positivity between 200 and 800 ms at the clefted head noun for both conditions that was similar to the positivity seen at the sentence-final word, and not found in any other words in the sentence, and a greater negativity between 200 and 500 ms after the onset of an incongruent head noun relative to a congruent one. These results suggest that comprehenders use information–structural constraints (along with other previously discussed constraints) during online processing in two ways. First, the positivity suggests that the focus status encoded by the head noun of the cleft phrase (*it was the X*) allows comprehenders to integrate new information in a way that may be similar to integration that occurs during sentence-final processing. These results fit nicely with Bornkessel et al.'s (2003) findings of an increase in positive amplitude in response to noun phrases that could fill the role opened by a previous *wh*-question. Second, the N400 effect suggests that focus status may influence comprehenders' expectations about the identity of upcoming words. Previous work (Hruska et al., 2000) did not observe such an effect when focus was marked prosodically (rather than structurally), which suggests that dedicated focus-marking via clefting may be an important factor influencing processing. Further, this result demonstrates that caution is needed when considering different instantiations of abstract categories like focus: not all kinds of focus elicit the same processing response, even in very similar language environments.

It is not entirely clear from our results whether this increase in negative amplitude is truly an N400 effect superimposed on a positivity elicited by a focus-marked element, or is in fact a modulation of a late positivity (e.g., P3b) itself. Finding an increase in N400 amplitude under these conditions would suggest that lexical processing is sensitive not only to well-established constraints based on semantic context, but also to information structural constraints like focus status. This is consistent with other recent results (DeLong, Urbach, & Kutas, 2005) that show activity during the N400 time window to be sensitive to non-semantically based formal factors like determiner type. Further work is needed to establish precisely how focus constraints interact with the other factors that modulate N400 activity and the concomitant neural processes reflected at the scalp. In any case, the fact that a word in the clefted position in these structures, whether focus appropriate or inappropriate, elicited a response indicates that comprehenders do indeed process sentences at an information structural level: the large positivity in the ERP to both clefted nouns shows us that readers focused their attention on this word position because they expected it to be an informative one—i.e., to deliver the answer to the question just asked.

Acknowledgments

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