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Anticipating information structure: An event-related potentials study of focus assignment via the *it*-cleft

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ABSTRACT

The present study uses event-related potentials to investigate the role of prediction in the processing of information structure, a domain of language that belongs to the level of the discourse. Twenty-three native speakers of English read short contexts including three Noun Phrases (NPs) (e.g., *Either an adviser or an agent can be helpful to a banker*), followed by a *wh*-question that established the discourse role of each referent (*In your opinion, which of the two should a banker hire?*). The NP that the question was about (*banker*) was the Topic, and the two NPs that could fill the slot opened by the *wh*-question (*adviser, agent*) were the Focus NPs. The participants' brain activity was recorded with EEG while they read the responses to the *wh*-questions, which differed along two dimensions: (1) the availability of the *it*-cleft construction (*In my opinion, [it is] an agent…*), a Focus-devoted device that makes Focus assignment predictable in the response; and (2) the discourse role of the target noun (Focus, Topic), which corresponds to the first referent in the response (*In my opinion, [it is] an agent/a banker…*). Crucially, we manipulated the phonological properties of the Focus and Topic nouns such that, if the Topic noun began with a consonant (e.g., *a banker*), both nouns that could fill the slot opened by the *wh*-question began with a vowel (e.g., *an agent, an adviser*) (counterbalanced in the overall design). This allowed us to measure effects of prediction at the prenominal article, before the integration of semantic and discourse information took place. The analyses on prenominal articles revealed an N400 effect for articles that were unexpected based on the phonological properties of the Focus nouns, but only in the conditions with the *it*-cleft. This effect emerged between 250 and 400 ms, with a frontal bias. The analyses on the noun revealed that violations of information structure (i.e., cases where the *it*-cleft was followed by the Topic noun) yielded a broadly distributed P600 effect, relative to appropriately clefted (i.e., focused) nouns. A similar (but numerically less robust) effect emerged for Topic relative to Focus NPs in the conditions without the *it*-cleft, suggesting that, in the absence of a constraining cue, comprehenders still assigned Focus to the first referent in the response. Overall, these results suggest that, when reading answers to *wh*-questions, comprehenders use information structure constraints (i.e., prior context + the *it*-cleft) to anticipate the form that the response should take (i.e., how information should be packaged).

1. Introduction

A central question in psycholinguistic research concerns the types of mechanisms that comprehenders rely on in the course of online processing. One such mechanism is prediction, the ability to anticipate what is likely to come up in the input (e.g., Kutas et al., 2011; Huettig, 2015; Kuperberg and Jaeger, 2016). For example, upon reading the sentence *The day was breezy, so the boy went outside to fly…* most English speakers expect a continuation such as *a kite*, based on offline cloze probability ratings (DeLong et al., 2005). Other continuations, such as *an airplane*, are possible, but unexpected after that particular preamble. The question arises to what extent comprehenders generate similar expectations in real time. Despite claims that language might not be sufficiently constraining to make anticipatory processing a successful (or even useful) strategy (e.g., Jackendoff, 2002), the available evidence suggests that language processing is, at least to some extent, predictive. Anticipatory processing has been attested across most domains of grammar, and both the types of cues that comprehenders use predictively and the types of representations that become activated are myriad (see Kuperberg and Jaeger, 2016 for a review). In light of this evidence, Kutas et al.

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(2011) have pointed out that the relevant question is not whether language processing is predictive (see also Kuperberg and Jaeger, 2016, who open their review with the statement "Language processing is predictive") but rather, under what circumstances language processing is predictive, which cues are used predictively, and which representations are activated. The present study contributes to this debate by investigating prediction at the level of the discourse, a domain of language that remains relatively uncharted (see also Rohde et al., 2011; Rohde and Horton, 2014).

Much of the evidence supporting the view that language processing is predictive comes from studies using event-related potentials (ERPs), which are brain responses that are time-locked to relevant stimuli and that provide high temporal resolution (e.g., Kutas and Hillyard, 1984; Federmeier and Kutas, 1999; Wicha et al., 2004; DeLong et al., 2005; Van Berkum et al., 2005; Otten and Van Berkum, 2007; Van Petten and Luka, 2012; Lau et al., 2013; Wlotko and Federmeier, 2015; Nieuwland, 2016; Ito et al., 2016; Nieuwland, 2019). ERP studies on prediction have typically focused on the N400 component, a negative waveform that typically emerges between 200 and 500 ms in central posterior electrodes of the EEG cap and that is sensitive to both semantic integration and lexical access and retrieval (e.g., Kutas and Hillyard, 1980; see Lau et al., 2008 for a review). Importantly, the amplitude of the N400 for words that are plausible in a sentence has been found to be inversely related to their offline cloze probability (e.g., Kutas and Hillyard, 1984), which has been interpreted as evidence that the N400 is sensitive to violations of lexical expectations. Such an effect, however, does not provide conclusive evidence that the N400 is sensitive to lexical prediction, as it could also reflect the integration costs induced by the target word (see Van Petten and Luka, 2012 and Bornkessel-Schlesewsky & Schlesewsky, 2019 for discussion). Strong N400-based evidence for lexical prediction comes from studies that have manipulated the form of linguistic material (i.e., articles, adjectives) preceding the target lexical items. For example, using highly constraining sentences like *The day was breezy, so the boy went outside to fly…*, DeLong et al. (2005) compared brain responses to expected and unexpected nouns that differed with respect to whether they began with a vowel or a consonant and were thus preceded by different allomorphs of the indefinite article (*a kite vs. an airplane*). In turn, this allowed them to examine effects of prediction at the prenominal article, when the target noun was yet to appear (i.e., before semantic integration took place). Their results revealed N400 effects for both unexpected nouns and articles. Crucially, the fact that an N400 effect emerged in the comparison of expected and unexpected articles, which are function words that do not differ in meaning, provides some of the strongest evidence that comprehenders preactivate properties of the bottom-up input in light of top-down expectations. Comparable effects have been reported in studies using the same rationale (e.g., Martin et al., 2013), including those manipulating other linguistic properties, such as grammatical gender (e.g., Foucart et al., 2014) and definiteness (e.g., Fleur et al., 2019), although the qualitative nature of the brain response shows variability across studies (e.g., Wicha et al., 2004; Van Berkum et al., 2005). Recent reports, however, have argued that predictive processing might not take place with the level of detail assumed in these studies (e.g., Ito et al., 2017a; Nieuwland et al., 2018; see DeLong et al., 2017 for counterarguments; see also Ito et al.'s rebuttal, 2017b).

Another ERP component that has received attention in studies on predictive processing is the Anterior Positivity (e.g., Federmeier et al., 2007; DeLong et al., 2011; Martin et al., 2013; Foucart et al., 2014; see Van Petten and Luka, 2012). This is a positive deflection that emerges between ~500 and 900 ms in frontal electrodes of the EEG cap, and that has been linked to prediction disconfirmation (i.e., the cost of having mispredicted). For example, in DeLong et al.'s studies (2005, 2011), an Anterior Positivity emerged at the noun *airplane*, which represents the point at which the prediction that *kite* would appear in the bottom-up input was proven wrong. Interestingly, the Anterior Positivity has similar latency and polarity to the P600 (e.g., Osterhout and Holcomb, 1992), a component that reflects difficulty at the level of the syntax (e.g., Hagoort et al., 1993; Friederici et al., 1996) which recent accounts link to the violation of top-down expectations (e.g., Kuperberg, 2007; Van de Meerendonk et al., 2010; see Tanner et al., 2017). In fact, some authors have wondered the extent to which the two positivities might be related (e.g., Kutas et al., 2011).

The present study investigates the role of prediction in the processing of information structure, a domain of language that is concerned with how information is organized in a sentence in order to build a coherent discourse representation. More specifically, we examine the assignment of Focus, which represents information that is new or relevant to the discourse (i.e., in the sense that it cannot be inferred solely from context) (e.g., Lambrecht, 1994). We investigate the contribution of prediction to Focus assignment in a design manipulating the phonological properties of focused nouns (where we will examine the N400 and the Anterior Positivity/P600) and their preceding articles (where we will examine the N400). Previous studies have investigated the role of predictive processing at the level of the lexicon or the morphosyntax, but only a few reports have examined anticipatory processing at the level of the discourse. For example, Rohde et al. (2011) provide evidence that implicit causality verbs like *detest* allow comprehenders to anticipate the type of information (i.e., causal) that an upcoming relative clause is likely to provide. Likewise, an eye-tracking study by Rohde and Horton (2014) provides evidence that intrasentential connectives (e.g., such as *so* and *because*, which signal consequence and cause, respectively) and verb class (implicit causality vs. transfer of possession) allow comprehenders to anticipate the coherence relation between a prompt and its upcoming continuation. Our study investigates the role of predictive processing in the establishment of other discourse relations. In the following section, we provide a succinct description of the relevant linguistic properties for our study.

1.1. Linguistic properties

The present study is concerned with two information structure categories, Topic and Focus. Topic corresponds to what a sentence is about (e.g., Reinhart, 1981; Lambrecht, 1994) and Focus corresponds to new or discourse-relevant information (i.e., information that cannot be recovered from context, even if it has been previously mentioned) (Halliday, 1967; Reinhart, 1981; Lambrecht, 1994). Consider, for example, the discourse context in (1):

(1) Who did the paparazzi photograph in Paris?
   a. It was the actor that the paparazzi photographed.
   b. *It was the paparazzi that photographed the actor.

In (1a), the NP *the paparazzi* is the Topic, since the story is about some paparazzi, and the *wh*-question requests additional information about them. In turn, the Noun Phrase (NP) *the actor* has Focus status, since it provides new/relevant information and fills the slot opened by the *wh*-question (see also Rochemont, 1998). In terms of syntactic operations, it is assumed that the *wh*-word *who* introduces a variable that binds the constituent with Focus status in the response (e.g., Declerck, 1988; Erteschik-Shir, 1986).

In this particular example, Focus has been assigned syntactically, via the *it*-cleft construction (e.g., Lambrecht, 1994, 2001; Lambrecht and Polinsky, 1997; Patten, 2012). The *it*-cleft construction is a biclausal structure where the matrix clause, which consists of two function words (*it is*), assigns Focus to *the actor* (e.g., Lambrecht, 2001; Patten, 2012). In

turn, the subordinate clause (i.e., *that the paparazzi photographed*) takes the form of a restrictive relative clause that is predicated of the focused element (e.g., Kiss, 1999; Lambrecht, 2001), although alternative accounts assume that it modifies the pronoun *it* (e.g., Jespersen, 1927; Bolinger, 1972; Patten, 2012).[1]

That the *it*-cleft is a Focus-devoted construction is apparent in (1b). Here, the NP following the cleft (i.e., *the paparazzi*) is not licensed by prior context to be focused (i.e., it cannot be bound by the *wh*-word), which renders the response infelicitous. Although the sentence in (1b) is syntactically correct and semantically congruent, it is not a good answer to the *wh*-question, since it violates information structure (i.e., Focus is assigned to the Topic). What this means is that the presence of an *it*-cleft in the response to a *wh*-question constrains Focus assignment; it signals that the upcoming element must bear Focus. The present study examines whether, when reading answers to *wh*-questions like (1), comprehenders take the *it*-cleft as a cue that the upcoming NP must be one that is licensed by the discourse to be focused. In the next section, we provide a brief (selective) review of previous studies that have used ERP to examine information structure and Focus assignment.

2. Literature review on focus assignment

A few studies have examined how information structure constraints modulate sentence processing in question-answer pairs (Bornkessel et al., 2003; Hruska and Alter, 2004; Magne et al., 2005; Cowles et al., 2007; Reichle, 2008; Wang et al., 2009, 2011). Although these studies did not explicitly examine anticipatory mechanisms, most of them assume that questions (i.e., context) allow the parser to generate predictions regarding how information should be packaged in the upcoming response.

Bornkessel et al.'s reading study (2003) examined German sentences with subject-object and object-subject word order in a design manipulating whether the preceding *wh*-question focused the subject of the response (i.e., an NP with nominative case) or the object (i.e., an NP with accusative case). Their results revealed a positivity for all nouns that could fill the slot opened by the *wh*-word, regardless of sentence position and even case marking. Bornkessel et al. interpret this positivity as a P3b, a component related to information delivery and the resolution of uncertainty, and posit that it reflects the integration of a constituent that comprehenders predicted upon reading the *wh*-question. Importantly, their proposal clearly assumes that Focus assignment is carried out predictively, although they provide no direct evidence for it.

An auditory study by Hruska and Alter (2004) investigated how prior context (i.e., *wh*-questions) influenced the processing of German sentences where either an appropriate or an inappropriate constituent carried Focus accent. The authors found that constituents that filled the slot opened by the *wh*-question but were missing Focus accent yielded an N400–P600 biphasic pattern, whereas background information carrying superfluous Focus accent yielded no effects. Interestingly, when comprehenders listened to the same sentences in isolation (i.e., devoid of a context that would determine which phrase should bear Focus), the ERP results were different and obeyed syntactic (as opposed to discourse) constraints. The authors take these findings as strong evidence that context allows the parser to predict where in the response Focus will be assigned.

Another auditory study by Magne et al. (2005) manipulated contrastive Focus via prosody in French, with a design where the focused constituent could be located in either sentence-medial or sentence-final position. For example, the question *did he give a ring or a bracelet to his fiancée?* generates the expectation that the response will focus on the gift that was offered (i.e., *the ring* or *the bracelet*), as opposed to the gift's recipient (i.e., *the fiancée*) since the question establishes a contrast between two possible gifts, not two possible recipients. Mid-sentence, their results revealed a positivity for NPs that were incorrectly focused via pitch prominence or were incorrectly missing Focus, relative to their felicitous counterparts. The authors interpret this positivity as part of the P3 family (e.g., Donchin, 1981), and account for it as a surprisal effect when the brain encounters incorrectly focused elements or elements missing Focus in light of top-down expectations. When the critical word was in final position, incorrect Focus assignment yielded an N400-like effect relative to their felicitous counterparts, possibly due to sentence wrap-up effects or to the presence of incongruities earlier in the sentence.

Wang et al. (2011) investigated the contribution of information structure to semantic processing in a design that involved *wh*-question and answer pairs in Dutch. Their results revealed that semantic congruency effects (i.e., the N400 size difference between congruent and incongruent words) were larger when the critical word had Focus status (see also Wang et al., 2009; Bredart and Modolo, 1988) or was accentuated, suggesting that both factors encouraged deeper semantic processing and facilitated the detection of the subtle semantic anomalies. Crucially, Focus status and pitch prominence interacted, such that comprehenders were most sensitive to the semantic incongruities (i.e., they yielded the largest N400) when the target word both had Focus status and was accentuated. Although the Wang et al. studies do not report unique brain signatures of Focus assignment, they do provide indirect evidence that information structure modulates the processing of bottom-up input in light of top-down information.

Cowles et al. (2007) are among the first to have examined Focus assignment via the *it*-cleft construction in English (see also Reichle, 2008 for French). Herein, we provide a detailed account of their study, since the present study builds directly upon it. In Cowles et al.'s study, participants first read a sentence introducing three NPs (e.g., *a queen, an advisor, and a banker* in 2 below), followed by a *wh*-question requesting additional information about the first NP (i.e., *the queen*), which was the Topic. The *wh*-question biased the response against the Topic, since only the other two NPs (i.e., *the banker, the advisor*) could fill the slot opened by the *wh*-word (i.e., be focused). These two NPs appeared in contrastive focus after the *wh*-question, thus reinforcing the bias against the Topic (i.e., *the queen*). Participants then read the response to the *wh*-question, which involved the *it*-cleft construction. In the congruous condition (2a), the cleft assigned Focus to one of the licit NPs (i.e., *the banker*). In the incongruous condition (2b), Focus was incorrectly assigned to the Topic (i.e., *the queen*), thus violating information structure.

(2) Set-up 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?

Response:

a. Congruent: It was the banker that the queen silenced.
b. Incongruent: It was the queen that silenced the banker.

Cowles et al. found that clefted nouns (regardless of congruency) yielded a positivity between 200 and 800 ms relative to all other content words in the sentence. Since the position following the cleft is the point when the *wh*-question is answered, the authors interpret this positivity as a P3b, similar to Bornkessel et al. (2003) (see also Nieuwenhuis et al., 2005). An additional finding is that incorrectly focused nouns (i.e.,

[1] There are two main approaches in the syntax literature regarding the treatment of *it*-cleft constructions, the expletive vs. the extraposition approach. The two approaches differ, among other things, with respect to whether the matrix clause is assumed to be semantically empty (i.e., an expletive) (e.g., Kiss, 1998, 1999; Lambrecht, 2001; Rochemont, 1986) or to play an interpretive function (e.g., Bolinger, 1972; Patten, 2012). They also differ with respect to whether the subordinate clause is assumed to be predicated of the focused constituent (e.g., Lambrecht, 2001) or to modify the pronoun *it* (e.g., Han and Hedberg, 2008; Patten, 2012). It is beyond the scope of this article to provide a detailed review of these two approaches or adjudicate between them, but the reader is referred to Patten (2012). Importantly for the purposes of the present study, there is consensus across approaches that the *it*-cleft is a focusing device.

queen in 2b) yielded an N400 effect relative to correctly focused ones (i.e., *banker* in 2a) between 200 and 500 ms in right medial electrodes. The authors interpret this N400 effect as evidence (1) that comprehenders use prior context to determine which NPs can be focused (to answer the *wh*-question) and (2) that the *it*-cleft allows for the prediction that the upcoming word will bear Focus status (see Cowles et al., 2007, p. 239), since the syntactic position after the cleft is reserved for Focus. When this expectation is not met, the result is an N400 effect (e.g., Kutas and Hillyard, 1984; DeLong et al., 2005). Notice, however, that Cowles et al.'s design cannot tease apart effects related to information structure violations from those related to the violation of a prediction, since both processes might have happened concurrently (i.e., upon encountering the word *queen* in 2). In fact, this is true of all the above studies, which did not examine prediction. We address this issue in the present study.

Before moving on to the present study, we briefly summarize the results from previous studies. This literature provides converging evidence that the brain is sensitive to information structure constraints, although the specific brain responses associated with Focus assignment and violations of Focus assignment vary considerably across studies. For example, the reading studies by Bornkessel et al. (2003) and Cowles et al. (2007) both found a P3b-like effect for constituents that could fill the slot opened by the *wh*-question, relative to those that could not (see another reading study by Stolterfoht et al., 2007). With respect to incorrect Focus assignment, there seems to be more variability with respect to the qualitative nature of the brain response. For example, the auditory study by Hruska and Alter (2004) found no effects for incorrectly focused phrases, whereas another auditory study by Magne et al. (2005) found a positivity related to the P3 for incorrectly focused NPs, and Cowles et al. (2007) found an N400 effect.

3. The present study

In the present study, we adapted the paradigm by Cowles et al. (2007) to examine Focus assignment via the *it*-cleft. Our main research question concerns whether, in the process of building a discourse representation, the *it*-cleft allows the parser to predict that the upcoming referent is a candidate for Focus assignment and, crucially, not the Topic. Similar to Cowles et al. (2007), our materials include a set-up context with three NPs (e.g., *an adviser, an agent, a banker* in 3 below), followed by a *wh*-question requesting additional information about one of them (*a banker*), the Topic. In the first two conditions (3a-b), the response involves the *it*-cleft. In (3a), the cleft assigns Focus to an appropriate NP (*an agent*). In (3b), Focus is incorrectly assigned to the Topic (*a banker*), thus violating information structure. One novelty of our design is that, following DeLong et al. (2005), we systematically manipulate the phonological properties of the referents that can and cannot be focused, such that they are preceded by different allomorphs of the English indefinite article (*a* vs. *an*). For example, in (3), the Topic NP (*a banker*) begins with a consonant and is therefore preceded by allomorph *a*. In contrast, the two NPs that can fill the slot opened by the *wh*-question both begin with a vowel and are thus preceded by allomorph *an* (e.g., *an adviser, an agent*). This manipulation, counterbalanced in the overall design, allows us to examine effects of prediction at the article (*a/an*), before the integration of semantic and discourse information takes place.

(3) Set-up context: Either an adviser or an agent can be helpful to a banker. In your opinion, which of the two should a banker hire?
Response including the *it*-cleft
a. Congruent: In my opinion, it is an agent that a banker should hire.
b. Incongruent: In my opinion, it is a banker that should hire an agent.
Response without the *it*-cleft
c. In my opinion, an agent should be hired.
d. In my opinion, a banker should hire an agent.

Notice that, although our design manipulates prenominal articles, it differs from previous ERP studies manipulating prenominal material (e.g., Wicha et al., 2004; DeLong et al., 2005; Martin et al., 2013) in that, by the time comprehenders read the target responses to the *wh*-questions, they have already encountered the expected and unexpected nouns (and articles) in the preceding context. Thus, our design examines reactivation, rather than preactivation, of the target NPs.

Another novelty of our design is that we added two conditions where the response to the *wh*-question did not include the *it*-cleft construction (3c-d). Our rationale was that, if the *it*-cleft makes Focus assignment more constrained and, therefore, more predictable, then Focus assignment should be less predictable when the cleft (i.e., the predictive cue) is not available, even though Focus still needs to be assigned to answer the *wh*-question. Thus, a comparison of (3a-b) and (3c-d) will allow us to evaluate the reliability of the *it*-cleft construction as a predictive cue for Focus assignment. In condition (3c) the first NP mentioned is one that is licensed by the discourse to be focused (*an agent*). In contrast, in (3d) the first NP mentioned is the Topic NP (*a banker*). One possibility is that there will be no preference for either response type, since neither violates information structure (unlike 3b). Alternatively, the order of discourse referents in (3d) might be dispreferred, even though Topic NPs often correspond to grammatical subjects and often occupy the first (i.e., most prominent) position in the sentence. There are two reasons for this. First, as discussed by Lambrecht (1994), once the Topic has been clearly established in the discourse (in the present study, via the *wh*-question), there is no reason why it should either be the subject or occupy the most prominent position in the sentence. This is especially true in a language like English, which shows much flexibility when it comes to assigning discourse roles to specific NPs in a sentence (e.g., Lambrecht, 2001). Second, it is possible that the parser will attempt to bind the variable introduced by the *wh*-expression as soon as possible, similar to the establishment of other *wh*-dependencies in real time (e.g., Stowe, 1986). Since the first noun in (3d) is the Topic, such binding operation would fail.[2]

To our knowledge, this is among the first studies to have examined anticipatory processing at the level of the discourse, where the predictive cue (i.e., the *it is* portion of the cleft construction) is a Focus-devoted structure and the activated representation is not a specific lexical item, but either one of the two nouns that are licensed by context to occupy the position where Focus is assigned. Below we lay out our research questions (RQ) and predictions:

RQ1: *When reading responses to wh-questions, does the presence of an it-cleft (i.e., a Focus-devoted construction) allow comprehenders to anticipate that the upcoming NP must be licensed by prior context to bear Focus?* If so, unexpected articles, that is, articles that are incompatible with the phonological properties of the two nouns that are licensed to have Focus status (i.e., hereinafter, "Focus NPs" or "Focus nouns") should yield a larger N400 than articles that are compatible (i.e., expected articles) (conditions 3b vs. 3a). Such a pattern of results would provide evidence that comprehenders use information structure constraints (the context + the cleft) to predict how information will be packaged in the response to a *wh*-question. This is because the *it*-cleft constrains the information structure category of the clefted constituent (i.e., it must be able to have Focus status, so it cannot be the Topic). In the absence of the *it*-cleft, it is possible that articles that are incompatible with the phonological properties of the Focus NPs will not differ from compatible articles.

We will further evaluate the reliability of the *it*-cleft as a predictive cue for Focus assignment by comparing clefted nouns to their non-clefted counterparts. Recall that Cowles et al. (2007) and Bornkessel

[2] We point out that, in English, the Focus constituent (with or without the *it*-cleft) receives pitch accent (e.g., Lambrecht, 2001). In reading studies, this information is absent (although comprehenders might infer it), which can modulate the nature of the brain's responses (see, for example, Frazier and Gibson, 2015; Stolterfoht et al., 2007).

et al. (2003) found that all NPs with Focus status yielded a positivity, relative to other NPs in the sentence without Focus-status. Here, we reasoned that, if the *it*-cleft structure constrains Focus assignment, clefted nouns overall should yield more positive waveforms than the same nouns in the responses without the cleft (conditions 3a + 3b vs. conditions 3c + 3d).

RQ2: *How does the brain respond to violations of Focus assignment?* The previous literature has shown qualitatively different responses for cases where an unlicensed constituent bears Focus (i.e., no effects, P3-like effects, N400 effects). Based on the study by Cowles et al. (2007), which inspired the present design, we predict that cases where the *it*-cleft incorrectly focuses the Topic NP (i.e, cases where the wrong NP is bound by the *wh*-expression, thus violating information structure; condition 3b) will yield an N400 effect, relative to felicitous Focus assignment (i.e., condition 3a). Predictions for the conditions without the *it*-cleft are less straight-forward, since neither (3c) nor (3d) violates information structure. One possibility is that there will be no difference (in terms of ERPs) between Focus-first and Topic-first responses. Alternatively, if the parser attempts to bind the variable introduced by the *wh*-expression as soon as possible (e.g., Stowe, 1986), an N400 effect (based on Cowles et al.) might emerge for Topic-first (3d) relative to Focus-first responses (3c), since only Focus nouns can be bound by the *wh*-expression. This would also be consistent with Lambrecht's (1994) claim that, if the Topic NP is clear in the discourse, there is no reason why it should either be the subject or occupy the first position in the response.

4. Methods and materials

4.1. Participants

Before the testing began, all experimental procedures were reviewed by the ethics committee at the BCBL (Basque Center on Cognition, Brain and Language), and the study received clearance (no project number was assigned). Twenty-three native speakers of English (14 females) gave their informed written consent to participate in the study (mean age: 30; range: 19–44). They were all right-handed, as determined by the Edinburgh Handedness Inventory (Oldfield, 1971), had normal or corrected-to-normal vision, and they indicated no history of neurological or language disorders. They all completed a background questionnaire where they indicated that English was their native language (English was both of their parents' native language too, although four participants reported a bilingual parent). All participants received their elementary, high school, and college education in English, and the majority of those who had conducted postgraduate studies had done so in English too. Participants received compensation for their time.

Data from five additional participants (one female) were excluded from analysis. Two participants were unable to complete the experiment, and another one had too many drifts in the EEG recording. Finally, two participants showed poor performance in a control grammaticality judgment task testing knowledge of the *a/an* rule (described below). These two participants accepted 5/8 sentences where the *a/an* rule was violated, but rejected all ungrammatical fillers, suggesting that they were attentive to the task but largely disregarded articles. Since sensitivity to the morphophonological rule is crucial, their data were dismissed.

4.2. Materials

The materials comprise 120 set-up contexts following the basic structure in (3) above (introductory sentence + *wh*-question). An additional example is presented in (4) below. Appendix 1 provides all experimental stimuli.

(4) Set-up context: Either a linguist or a translator can be useful to an editor. In your opinion, which of the two should an editor contact?

Response including the *it*-cleft

a. Focus NP as target: In my opinion, it is a linguist that an editor should contact.
b. Topic NP as target: In my opinion, it is an editor that should contact a linguist.

Response without the *it*-cleft

c. Focus NP as target: In my opinion, a linguist should be contacted.
d. Topic NP as target: In my opinion, an editor should contact a linguist.

The set-up context. The purpose of the set-up context was to introduce all three referents in the context and to situate them in a story. The story always followed the same basic pattern. First, it was established that either NP1 (*a linguist*) or NP2 (*a translator*) could work for, cooperate with, help, or include NP3 (*an editor*). Then, the *wh*-question asked comprehenders to form an opinion regarding whether NP3 should contact or would prefer NP1 or NP2 (the range of verbs used in the set-up contexts can be seen in Appendix 1). To ensure that participants formed an opinion, the *wh*-question always began with the phrase *in your opinion*. The *wh*-question made NP1 and NP2 the only candidates for Focus assignment, since only they could fill the slot opened by the *wh*-word and answer the *wh*-question. NP3 was the Topic, since the *wh*-question requested additional information about it. Importantly, similar to Cowles et al. (2007), the contexts were designed such that there would be no bias towards either one of the two NPs that could bear Focus. Both of them provided an appropriate response to the *wh*-question. The only bias was against the Topic NP, which did not answer the question. To create these 120 set-up contexts, we selected 360 nouns (120 Topic Nouns + 240 Focus Nouns), with each noun being used only once. Half of the Topic nouns (60) and half of the Focus nouns (120) began with a consonant and were preceded by allomorph *a*. The remaining 180 nouns began with a vowel and were preceded by allomorph *an*.

Unlike Cowles et al. (2007), the two candidates for Focus assignment (*a linguist, a translator*) did not appear in contrastive focus at the end of the *wh*-question. This was done to ensure that the Focus NP in the response (e.g., *a linguist* in (4a) and (4c) above) was less recent than the Topic NP (*an editor* in (4b) and (4d) above), since N400 amplitude is known to be reduced as a function of recency (e.g., Van Petten et al., 1991). In addition, by not repeating the two Focus NPs, we controlled for the number of expected and unexpected articles in the set-up context (two instances of each allomorph), since repetition is also known to decrease N400 amplitude (Van Petten et al., 1991). That way, if unexpected articles (and nouns) yield an N400 effect relative to expected ones, recency and repetition cannot account for such an effect. The contrastive focus between the two focusable NPs was established via the *either…or* construction at the beginning of the set-up context (e.g., *either a linguist or a translator*). In addition, it was reinforced by using the *wh*-construction *which of the two* in the question (as opposed to, for example, *who* as in Cowles et al.'s study), which forces comprehenders to select one out the two referents.

Another way in which our materials differ from Cowles et al.'s is that none of the stories in the present study were set in the past. By locating the stories in the past, a preference might emerge towards definite NPs. Instead, the contexts herein presented hypothetical scenarios with generic referents. In addition, the *wh*-questions only used modal verbs of advice, suggestion, likelihood, ability, et cetera, which reinforced the non-perfective nature of the stories.

The response. For each set-up context, we created four responses (480 responses in total) that differed along two dimensions: the availability of the predictive cue (presence, absence of the *it*-cleft) and the discourse role of the target NP (Focus, Topic), which was the first referent in the response. The example in (4a-d) above shows all four

conditions in which the response to the *wh*-question could occur. The critical articles and nouns are underlined for clarity. Similar to Cowles et al.'s study (2007), all four responses were syntactically and semantically correct. Condition (4b) is not an appropriate response to the *wh*-question, since it violates information structure (Focus is assigned to the Topic), but the sentence is syntactically and semantically correct. It is, however, pragmatically inappropriate.

In the conditions where a focusable NP was the target (4a, 4c), the critical noun was the first one in the set-up context half of the times. The other half, it was the second NP. The response always began with the phrase *in my opinion*, for consistency with the *wh*-question. This also ensured that the critical article was not the first word in the responses without the cleft. The critical NP was located mid-sentence both in the conditions with and without the cleft, although sentence position was not identical (sixth/seven vs. fourth/fifth).

With these materials, we created four experimental lists following a Latin square design such that, for each set-up context, which remained invariable, participants only saw one of the four response types in (4). This yielded 30 items per condition. Across lists, all set-up contexts could occur with all four types of responses.

4.2.1. Item controls

We used the Corpus of Contemporary American English (COCA) to calculate the mean log frequency of the 240 critical nouns in the study (120 Topic nouns + 120 Focus nouns selected for the response). The Focus and Topic nouns were matched with respect to log frequency (Focus Nouns, mean log frequency: 1.06; SD: 0.56; Topic Nouns: 1.13; SD: 0.57), $t(119)$, -0.784, $p = .43$. Regarding word length, the Focus nouns and the Topic nouns were matched with respect to number of characters (Focus Nouns, mean number of characters: 7.46; SD: 2.41; Topic Nouns: 7.52; SD: 2.09), $t(119)$, -0.217, $p = .83$, and number of syllables (Focus Nouns, mean number of syllables: 2.75; SD: 1.05; Topic Nouns: 2.65; SD: 0.92), $t(119)$, 0.819, $p = .42$. In addition, based on Brysbaert et al.'s concreteness ratings (2014), the Topic and Focus nouns were comparable with respect to concreteness (Focus Nouns, mean concreteness 4.21/5; SD: 0.73; Topic Nouns: 4.29/5; SD: 0.55), $t(112)$, -1.251, $p = .21$).[3] Finally, we used the SUBTLEX-US corpus (Brysbaert and New, 2009) to calculate the orthographic neighborhood of the nouns. The Focus and Topic nouns were also matched with respect to orthographic neighborhood (Focus Nouns, mean number of orthographic neighbors: 2.3; SD: 5.7; Topic Nouns: 1.5; SD: 3.5), $t(112)$, 1.274, $p = .21$).

4.2.2. Control task: grammaticality judgment task (with correction)

The study included a Grammaticality Judgment Task (GJT) with correction testing the participants' offline sensitivity to the *a/an* alternation. The task, which was administered after the participants had completed the EEG task, encompassed 16 sentence pairs manipulating the grammaticality of the *a/an* rule. Half of the sentences included a noun beginning with a vowel, preceded by allomorph *an*. The other half included a noun beginning with a consonant, preceded by allomorph *a*. Examples are provided in (5) and (6).

(5) An/*A actor must know how to imitate accents.
(6) Yesterday a/*an banker spoke about the crisis on TV.

To create these materials, we selected 16 different nouns from the EEG experiment. Each sentence pair included a grammatical and an ungrammatical version of the same sentence (see 5 and 6). Across items, the target nouns were located in different sentence positions (approximately an equal number of times). These materials were assigned to two lists following a Latin Square design, such that each list only included one version of each sentence. Across lists, participants saw all sentences in their grammatical and ungrammatical versions, but each participant only saw one version of each sentence. The task also included six ungrammatical fillers targeting other grammatical rules of English (e.g., agreement, word order, irregular plurals). All participants saw all fillers.

4.3. Procedure

The testing took place in one session that lasted approximately 3 h. After providing their informed consent, participants sat on a comfortable chair facing a computer monitor and received instructions that they would read a series of statements, each accompanied by a question (i.e., the set-up context). Their task was to evaluate each statement and to think about how they would answer the question. They were told that, upon a button press, they would read a suggested response to the question. They received additional instructions to avoid blinks and body movements while reading the responses, and to rest their eyes at the beginning of each context. Participants also learned that, occasionally, a *yes/no* question would appear after a trial, requesting information about the set-up context (the statement or the *wh*-question) or the response. Forty-eight trials (12 per condition) were followed by comprehension questions (40% in total). The questions targeted the Topic NP, either one of the focusable NPs, or the verb in the question an equal number of times.

Before the experiment began, participants completed a practice set including seven trials. None of the questions were *wh*-questions (e.g., *could our government…?*) and none of the responses involved the *it*-cleft. None of the critical nouns from the experimental stimuli appeared in the practice trials, and no indefinite articles were used. Four of the practice trials included a comprehension question. Participants received feedback for two practice trials, to ensure that they understood the task. The experiment began right after the practice. The experiment encompassed six blocks of 20 items, separated by short breaks. Within each block, items from all four experimental conditions were intermixed and randomized. Words were displayed in black text (Courier New font) against a grey background. The last word of each response was marked with a period. The presentation of the stimuli was carried out using *PsychoPy* (Peirce, 2007, 2008; Peirce and MacAskill, 2018).

Each trial began with the set-up context, which remained on the screen until participants were ready to read the response. Upon a button press, there was an interval ranging from 500 to 1000 ms, pseudorandomly varied at 50 ms increments, after which the response began. First, a fixation cross was displayed for 500 ms. Then, the first word of the response appeared on the screen. Words were presented one at a time. Each word remained on the screen for 450 ms, followed by a 300 ms pause. At the end of each response, participants either answered a *yes/no* comprehension question or saw the next trial. The prompts for the comprehension question remained on the screen until the participants provided a response, which they did with the left hand: middle finger for *yes* and index finger for *no*. Participants used their left hand in an attempt to keep the left hemisphere (which is dominant for language and controls the right hand), as unengaged as possible.

After the EEG recording, participants completed a Backwards Digit Span (i.e., a subtest of the Wechsler Adult Intelligence Test WAIS, 2004) and a Letter-Comparison Task (Earles and Salthouse, 1995), the results of which are not reported here. Participants also completed a computerized Grammaticality Judgment Task (GJT) with correction testing knowledge of the *a/an* rule (described in the *Materials* section). Participants read one sentence at a time (presented in whole on the screen) and decided if the sentence was good or bad in English, via a button press. Whenever participants judged a sentence as ungrammatical, a command appeared on the screen showing the rejected sentence and prompting them to correct it (by typing it in a box).

[3] A few of the critical nouns were missing from Brysbaert et al.'s ratings. The *t*-test was therefore conducted without seven pairs of nouns.

4.4. EEG recording and analysis

We recorded EEG signals continuously from 32 sintered Ag/AgCl active electrodes plugged in an elastic headcap (Biosemi, Amsterdam, NL). Electrode placement followed the International 10–20 System (midline: FZ, CZ, PZ, OZ; lateral: FP1/2, AF3/4, F3/4, F7/8, FC1/2, FC5/6, C3/4, T7/8, CP1/2, CP5/6, P3/4, P7/8, PO3/4, O1/2). By default, Biosemi uses a non-standard referencing method via two additional electrodes: CMS (Common Mode Sense, between C3 and Cz) and DRL (Driven Right Leg, between Cz and C4). All recordings were re-referenced offline to the average of two flat electrodes placed on the mastoids. To monitor blinks, two additional flat electrodes were placed above and below the left eye. Horizontal eye movements were measured with two more flat electrodes placed on the left and right outer canthi. The exclusive use of active electrodes ensured that electrode impedances remained very low overall. The recordings were amplified with an ActiveTwo amplifier (Biosemi, Amsterdam, NL), and digitized continuously with a sampling rate of 2048 Hz. The recordings were down-sampled offline to 1024 Hz.

We used the Brain Vision Analyzer 2.1 software (Brain Products, GmbH, Germany) to analyze the EEG data. First, we applied a 0.1 Hz high-pass filter to remove drift. We then segmented the continuous EEG into epochs in the interval between −300 and + 1000 ms relative to the onset of the critical articles, and in the interval between −100 and + 1000 ms relative to the onset of the critical nouns. The epochs for the articles were baseline-corrected relative to the 300 ms pre-stimulus interval. The epochs for the nouns were baseline-corrected relative to a 100 ms pre-stimulus interval. We chose a shorter baseline for the nouns to ensure that any effects that might emerge for unexpected articles would not contaminate the baseline for the noun. Bad electrodes were interpolated by using spherical spline interpolation. Trials with artifacts (e.g. blinks, horizontal eye movements, excessive muscle movement, or excessive alpha waves) were manually rejected before analysis (based on visual inspection). Approximately the same number of trials was preserved per condition (range: 20 to 30 out of 30). For the analyses on the article, the mean number of trials per condition did not differ across conditions, $F(3, 78) = 1.432$, $p > .1$ (i.e., range: 27–28). The same was true for the analyses on the noun, $F(3, 78) = 0.642$, $p > .1$ (i.e., range: 27–28). The remaining trials were included in the analysis, regardless of accuracy in the comprehension question. Epochs were averaged per condition and for each subject. Finally, we applied a 30 Hz low-pass digital filter to the averaged waveforms.

We used a spatiotemporal approach to analyze the EEG data (to avoid statistical power loss). For the analyses on the article, ERPs were quantified via mean amplitudes between 250 and 400 ms, which corresponds to the time window where unexpected articles yielded more negative waveforms than expected ones in Martin et al.'s study (2013). As it was not possible to use the same spatial regions of interest (ROI) as in the Martin et al. study (i.e., we used different EEG systems, with different electrode density and different electrode arrays), we created comparable ones. That is, we divided the cap into three regions as a function of the Anterior-Posterior dimension: Frontal (AF3, F3, FC1, Fz, AF4, F4, FC2), Central (C3, CP1, CP5, Cz, C4, CP2, CP6), and Posterior (P3, PO3, O1, Pz, P4, PO4, O2) (see also Foucart et al., 2014). Based on Martin et al. (2013), the analyses on the article were carried out in the Frontal region, but we also analyzed the Central region, where previous studies have reported effects of prediction on prenominal articles (e.g., DeLong et al., 2005; Foucart et al., 2014).

For the analysis on the noun, we computed mean amplitudes between 200-500 ms and 200–800 ms. The former corresponds to the time window where violations of information structure (i.e., cases where the Topic NP inappropriately followed the *it*-cleft) yielded an N400 effect in Cowles et al.'s study (2007). The latter corresponds to the latency of the positivity found for clefted nouns (relative to other, non-clefted nouns in the sentence) in the same study. These analyses were carried out in the Central and Posterior regions (based on Cowles et al.'s description of the relevant effects, since no specific ROI information is provided in their report).[4] ERPs on the noun were also quantified between 500 and 900 ms, which corresponds to the time window where unexpected nouns yielded an Anterior Positivity relative to expected ones in the Martin et al. (2013) study. The analyses in the 500–900 ms time window were thus restricted to the Frontal region.

For each analysis, mean amplitudes were entered into a repeated-measures ANOVA with Cleft (present, absent) and Expectedness (Focus, Topic) as the repeated measures. In total, we planned two analyses on the article (i.e., 250–400 ms: Frontal, Central) and five on the noun (200–500 ms: Central, Posterior; 200–800 ms: Central, Posterior; 500–900 ms: Frontal). One additional analysis (described below) was carried out upon visual inspection of the waveforms. We applied a false discovery rate correction (Benjamini and Hochberg, 1995) to all follow-up tests, to avoid an inflated Type I error.

5. Results

Mean accuracy with the comprehension questions embedded in the EEG task was 95% (SD: 6%; range: 75–100%), suggesting that participants paid attention to the materials. With respect to the Grammaticality Judgment Task administered after the EEG task, if participants' corrections were unrelated to the *a/an* rule, their score was properly adjusted. For example, one participant incorrectly rejected *It was rainy, so we grabbed an umbrella* and replaced it with *It was raining, so we took an umbrella*. Since this participant's correction preserved the grammatical use of the *a/an* rule, it was not counted as a miss. The same was done when participants correctly rejected an ungrammatical sentence but failed to correct the violation of the *a/an* rule.[5] Mean accuracy with grammatical and ungrammatical sentences in the offline Grammaticality Judgment Task was 100% and 91% (SD: 3%), respectively. Although this difference is significant, $F(1, 22) = 7.93$, $p = .01$; $\eta_p 2 = 0.265$, the high accuracy rates for both grammatical and ungrammatical sentences suggest that participants were, overall, sensitive to the rule.

Figs. 1 and 2 show the ERPs for expected and unexpected articles in the conditions with (4a, 4b) and without the *it*-cleft (4c, 4d), respectively. Visual inspection of the waveforms reveals a different pattern of results as a function of the availability of the *it*-cleft. In the conditions with the cleft (4a, 4b), unexpected articles appear more negative than expected ones between approximately 250-400 ms, an effect that was broadly distributed but with a frontal bias (e.g., Martin et al., 2013). Fig. 3 provides topographic maps of this effect (in addition to topographic maps in the 600–900 ms time window, where articles preceding Topic nouns appear more positive than those preceding Focus nouns in the conditions without the cleft). Fig. 4 plots the negativity for unexpected articles in the conditions with the *it*-cleft, together with a measure of uncertainty (i.e., within-subject standard error of the effect mean).

Figs. 5 and 6 show the ERPs for Focus and Topic nouns (i.e., expected vs. unexpected) in the conditions with and without the *it*-cleft, respectively. In the conditions with the cleft (4a, 4b), Topic nouns (i.e., violations of information structure) appear more positive than Focus nouns

[4] The reader might wonder why we selected the N400 time window (200–500 ms) based on Cowles et al.'s study (2007), as opposed to Martin et al. (2013). Our rationale was that, in both Cowles et al.'s study and our own, unexpected nouns also violated information structure. The same is not true of Martin et al.'s study. Although unexpected nouns in Martin et al.'s study might have carried integration costs, triggered by the parser's attempt to update the semantic representation of the sentence, they did not require a restructuring of how information was packaged in the sentence.

[5] Four participants substituted *found treasure* for *found a treasure*. Since we had no way of determining whether participants had a stylistic preference for the former or considered the latter ungrammatical, we removed this item from the analysis of these participants' data.

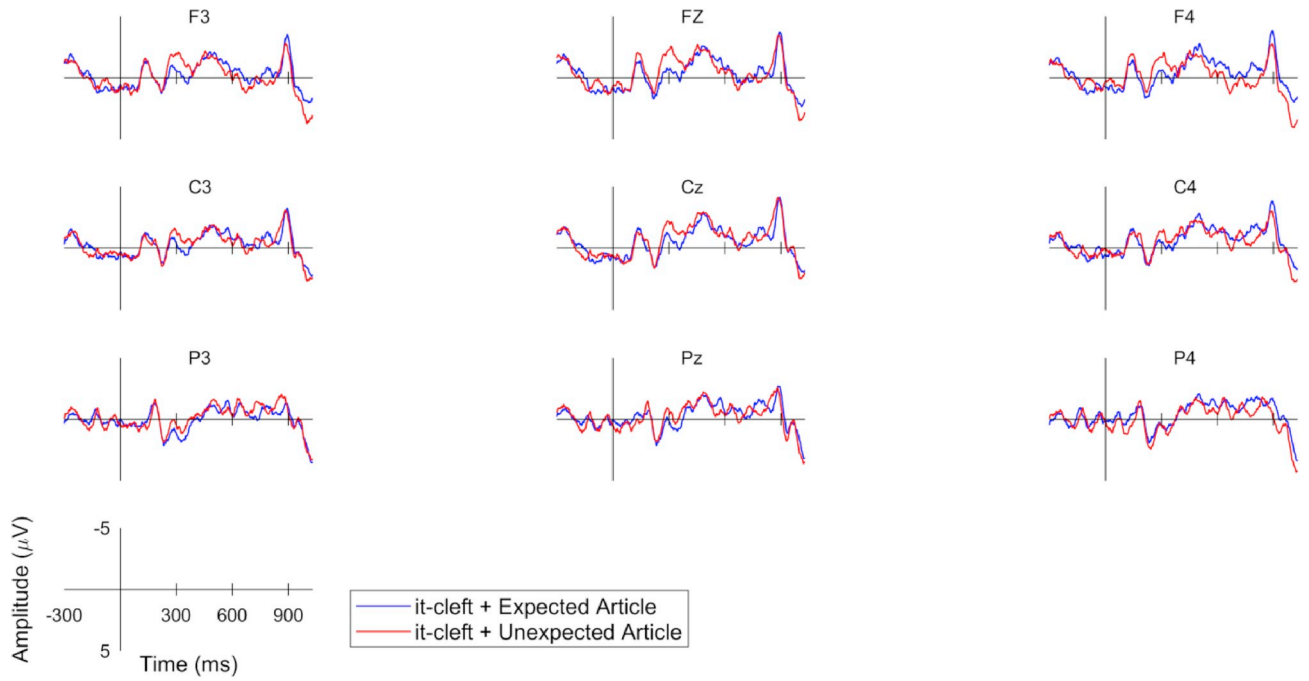

Fig. 1. Grand average ERP waveforms for the articles in the conditions with the *it*-cleft: expected articles, unexpected articles. ERPs are plotted for equidistant representative electrodes.

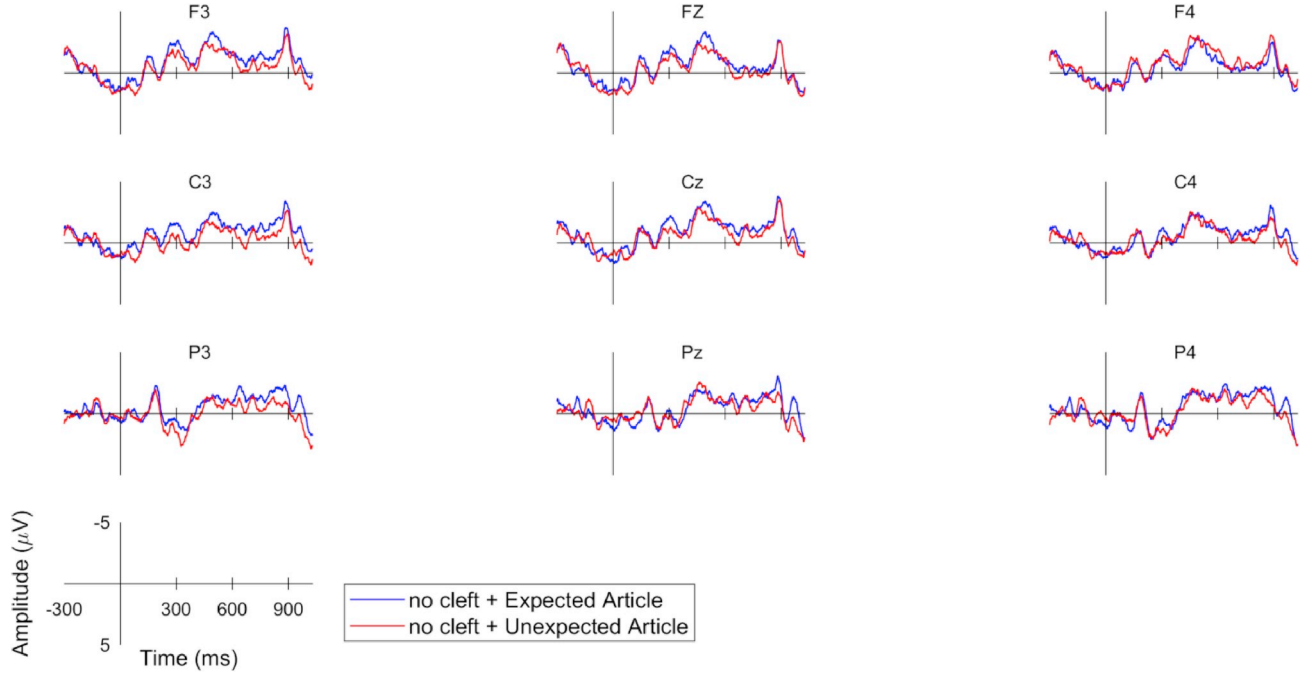

Fig. 2. Grand average ERP waveforms for the articles in the conditions without the *it*-cleft: expected articles, unexpected articles. ERPs are plotted for equidistant representative electrodes.

between approximately 600-900 ms in posterior regions, consistent with the P600. In the conditions without the cleft (4c, 4d), Topic nouns also yielded more positive waveforms than Focus nouns, but the positivity appears considerably less robust. Fig. 7 provides topographic maps of these effects, and Fig. 8 plots the positivity for incorrectly clefted Topics, together with a measure of uncertainty (i.e., within-subject standard error of the effect mean). Finally, clefted nouns overall (4a+4b) appear more positive than the same nouns in the conditions without the cleft (4c+4d) between 200 and 800 ms. This positivity is visible in Fig. 9, which plots clefted vs. non-clefted nouns collapsing across Expectedness.

Since, contra to our predictions, violations of information structure yielded an effect consistent with the P600 (e.g., Reichle, 2008), we also analyzed the 600–900 ms time window in the Posterior region.

5.1. *Effects on the article*

250-400 ms (Frontal and Central regions). In the Frontal region, the

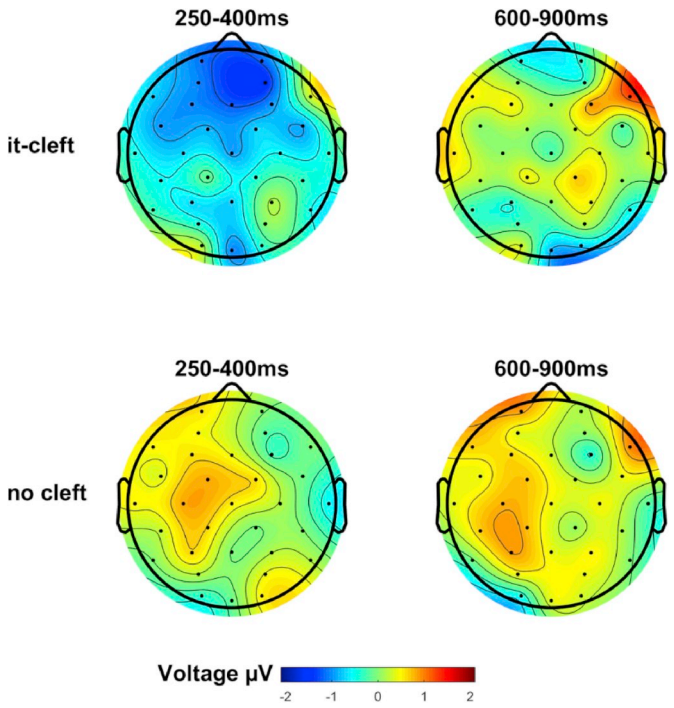

Fig. 3. Topographic plots for the prediction effect at the article in the conditions with the *it*-cleft (upper row) and without the *it*-cleft (lower row) in the 250–400 ms and 600–900 ms time windows. Plots were computed by subtracting the expected condition from the unexpected condition.

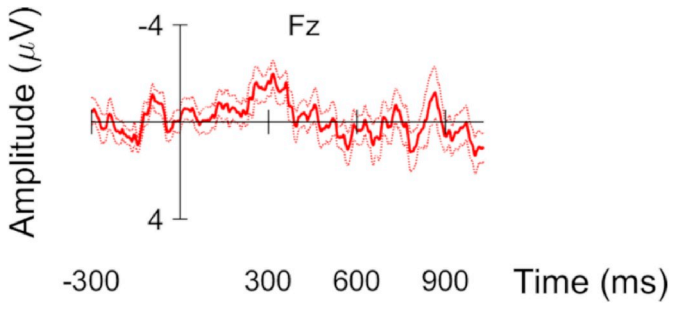

Fig. 4. Negativity for unexpected articles in the conditions with the *it*-cleft (computed by subtracting the expected from the unexpected condition), plotted for representative electrode Fz. The solid line represents the mean effect and the dotted lines represent the within-subject standard error of the mean.

ANOVA revealed a significant Cleft by Expectedness interaction, $F(1, 22) = 6.777$, $p < .05$; $\eta_p2 = 0.235$, driven by the fact that unexpected articles (*M*: −1.27 μV; *SD*: 1.92) yielded more negative waveforms than expected ones (*M*: −0.33 μV; *SD*: 1.94), but only in the conditions with the *it*-cleft, $F(1, 22) = 8.226$, $p < .01$, $q^* = 0.025$; $\eta_p2 = 0.272$. The ANOVA conducted in the Central region revealed no significant effects.[6]

5.2. Effects on the noun

200-500 ms (Central and Posterior regions). The only significant effect revealed by the omnibus ANOVA was a main effect of Cleft in both regions (Central: $F(1, 22) = 5.998$, $p < .05$; $\eta_p2 = 0.214$; Posterior: 5.965, $p < .05$; $\eta_p2 = 0.213$) driven by the fact that clefted nouns elicited more positive waveforms (Central: *M*: 1.82 μV; *SD*: 3.29; Posterior: *M*: 3.20 μV; *SD*: 3.67) than the same nouns in the conditions without the cleft (Central: *M*: 0.95 μV; *SD*: 3.09; Posterior: *M*: 2.18 μV; *SD*: 3.23) (see Fig. 9).

200-800 ms (Central and Posterior regions). The omnibus ANOVA revealed a main effect of Cleft in both regions (Central: $F(1, 22) = 4.943$, $p < .05$; $\eta_p2 = 0.183$; Posterior: 6.358, $p < .05$; $\eta_p2 = 0.224$) driven by the fact that clefted nouns elicited more positive waveforms (Central: *M*: 1.77 μV; *SD*: 2.68; Posterior: *M*: 2.60 μV; *SD*: 2.89) than the same nouns in the conditions without the cleft (Central: *M*: 0.94 μV; *SD*: 2.22; Posterior: *M*: 1.53 μV; *SD*: 2.31) (Fig. 9).

500-900 ms (Frontal region). The omnibus ANOVA revealed no significant effects, although Topic nouns (i.e., unexpected) yielded numerically more positive waveforms than Focus nouns in the conditions with the *it*-cleft.

600-900 ms (Posterior region). Consistent with the analyses above, the ANOVA revealed a significant main effect of Cleft, $F(1, 22) = 5.886$, $p < .05$; $\eta_p2 = 0.211$, with clefted nouns showing more positive waveforms (*M*: 2.03 μV; *SD*: 2.44) than the same nouns in the conditions without the cleft (*M*: 0.83 μV; *SD*: 1.78). Importantly, the ANOVA also revealed a main effect of Expectedness, $F(1, 22) = 4.764$, $p < .05$; $\eta_p2 = 0.178$, which was driven by the fact that Topic nouns yielded more positive waveforms (*M*: 1.85 μV; *SD*: 2.05) than Focus nouns (*M*: 1.01 μV; *SD*: 1.96) overall.[7] Although Cleft and Expectedness did not interact, a comparison of Figs. 5 and 6 (and the topographic plot in Fig. 7) suggests that this effect is mainly driven by incorrectly clefted Topics. We therefore conducted planned comparisons (Topic vs. Focus nouns within each level of Cleft), which confirmed that the positivity was only significant for clefted Topics (*M*: 2.79 μV; *SD*: 2.93) relative to clefted Focus NPs (*M*: 1.28 μV; *SD*: 2.33), $F(1, 22) = 12.11$, $p < .01$, $q^* = 0.025$; $\eta_p2 = 0.355$.

5.3. Summary of effects

To sum up, unexpected articles following an *it*-cleft yielded an N400-like effect relative to expected ones between 250 and 400 ms, in the frontal portion of the scalp (e.g., similar to Martin et al., 2013, although we used a different reference method). Clefted nouns yielded a central-posterior positivity relative to the same nouns in the conditions without the cleft, between 200 and 800 ms, consistent with Cowles et al.'s (2007) findings. Unlike Cowles et al., violations of information structure (i.e., incorrectly clefted Topics) yielded a P600 (as opposed to an N400) relative to felicitous Focus assignment. The main effect of Expectedness (and the lack of an interaction with Cleft) in the analyses of the noun suggests that the P600 also characterizes Topic relative to Focus nouns in the conditions without the cleft (not previously examined), although planned comparisons revealed that the positivity was mainly driven by incorrectly clefted Topics. Finally, we found no evidence for an Anterior Positivity for unexpected compared to expected nouns in the 500–900 ms time window.

6. Discussion

The present study used ERP to investigate the role of prediction in the online processing of information structure, a domain of language dealing with how information is organized in a sentence to form a coherent discourse representation. Drawing on the distinction between Topic and Focus in a discourse context, we examined the extent to which, when reading answers to *wh*-questions, comprehenders interpret the *it*-cleft construction as a cue that the upcoming referent must be one that is licensed by the discourse to be focused (i.e., not the Topic) (e.g.,

[6] Without the cleft (4c, 4d), unexpected articles appear slightly more positive than expected ones between 600 and 900 ms, in the central-posterior portion of the left hemisphere, but post-hoc analyses revealed no effects, so we do not report them here.

[7] In the conditions without the cleft, Topic nouns also appear slightly more negative than Focus nouns between 400 and 600 ms in fronto-central areas of the cap (see Figs. 6 and 7), but post-hoc analyses did not confirm this observation, so they are not reported here.

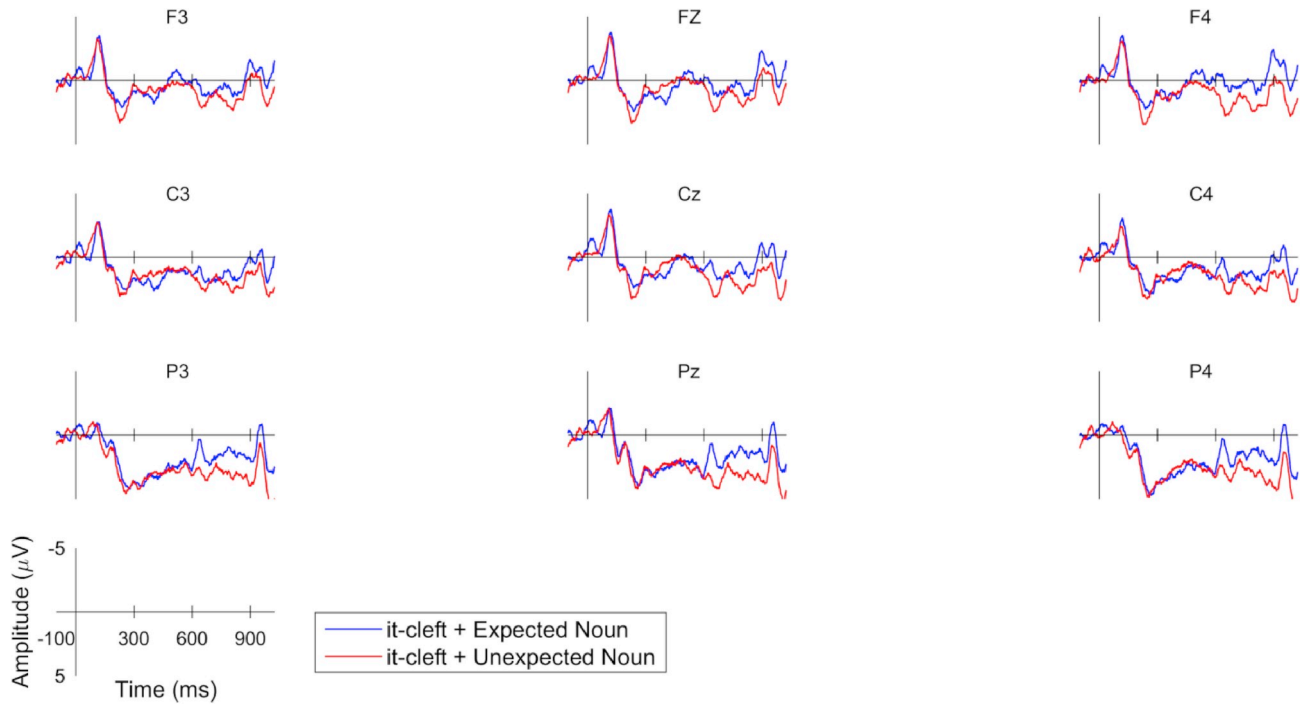

Fig. 5. Grand average ERP waveforms for the nouns in the conditions with the *it*-cleft: expected nouns, unexpected nouns. ERPs are plotted for equidistant representative electrodes.

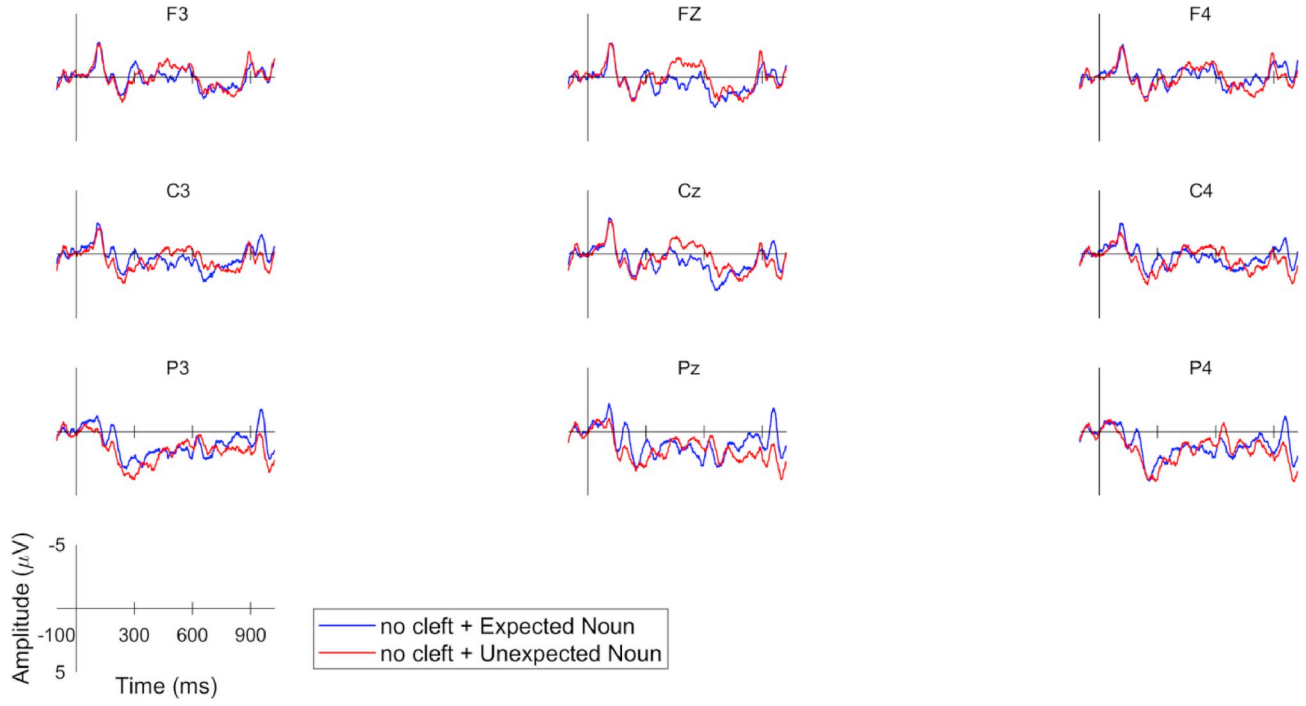

Fig. 6. Grand average ERP waveforms for the nouns in the conditions without the *it*-cleft: expected nouns, unexpected nouns. ERPs are plotted for equidistant representative electrodes.

Lambrecht, 2001).

Twenty-three native speakers of English read short sentences introducing three NPs, followed by a *wh*-question that clearly established the discourse role of each NP: the Topic and two candidates for Focus assignment. Participants then read the response to the *wh*-question while their brain activity was recorded with EEG. The responses varied along two dimensions: the availability of the *it*-cleft construction, which constrains Focus assignment (thus, making it more predictable in the response) and the discourse role of the target noun (Focus, Topic), which was the first referent in the sentence. Crucially, the Topic and Focus nouns in each context differed with respect to whether they were preceded by the *a* or *an* allomorphs of the English indefinite article. For example, if the Topic noun began with a consonant and was preceded by allomorph *a* (e.g., *a banker*), then the two candidates for Focus assignment both began with a vowel and were preceded by allomorph *an* (e.g., *an adviser*, *an agent*) (counterbalanced in the overall design). This allowed us to measure effects of prediction at a point when the target noun in the response was yet to appear (i.e., before lexical integration

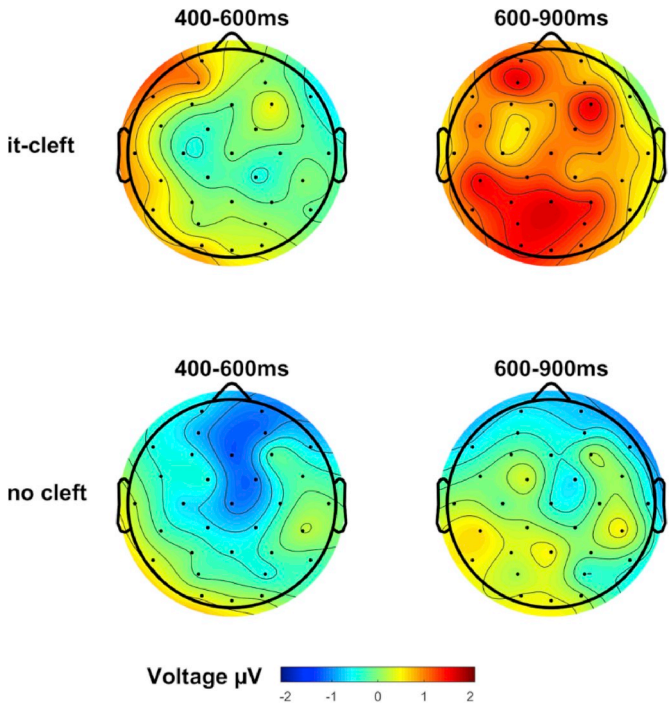

Fig. 7. Topographic plots for the prediction effects at the noun in the conditions with the *it*-cleft (upper row) and without the *it*-cleft (lower row) in the 400–600 ms and 600–900 ms time windows. Plots were computed by subtracting the expected condition from the unexpected condition.

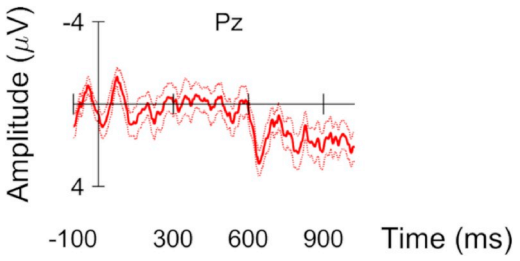

Fig. 8. P600 effect for incorrectly clefted nouns (computed by subtracting the expected from the unexpected condition), plotted for representative electrode Pz. The solid line represents the mean effect and the dotted lines represent the within-subject standard error of the mean.

took place and, at least in the responses with the *it*-cleft, before information structure constraints were checked).

Our results revealed that articles that were unexpected based on the phonological properties of the two Focus nouns in the context yielded a negativity between 250 and 400 ms relative to expected articles, but only in the conditions with the *it*-cleft construction (4b relative to 4a). No reliable effects emerged for articles that were incompatible with the Focus nouns in the responses without the cleft, and this difference was supported by a significant Cleft by Expectedness interaction (in the Frontal region). The presence of the *it*-cleft in the response also modulated the processing of the target nouns, with clefted nouns overall (regardless of their discourse role) showing more positive waveforms than their non-clefted counterparts between 200 and 800 ms (e.g., Cowles et al., 2007). In the 600–900 ms time window, our results revealed that violations of information structure (i.e., cases where the *it*-cleft inappropriately focused the Topic NP) yielded a posteriorly distributed positivity, relative to nouns that were felicitously clefted (4b relative to 4a). This effect also emerged in the conditions without the *it*-cleft (4d relative to 4c), where Topic nouns (i.e., those which did not fill the slot opened by the *wh*-question) also yielded more positive waveforms than Focus nouns, although planned comparisons revealed that this effect was mainly driven by incorrectly clefted Topics. This positivity is consistent with the P600, a component that is sensitive to various structural constraints (e.g., Osterhout and Holcomb, 1992; Hagoort et al., 1993; Kaan et al., 2000; Gouvea et al., 2010) and which recent accounts assume reflects the violation of top-down expectations (e.g., Kuperberg, 2007; Van de Meerendonk et al., 2010; Van Petten and Luka, 2012; Tanner et al., 2017). We discuss these effects below.

6.1. *Effects on the article*

The N400-like effect for articles that were unexpected after the *it*-cleft suggests that this construction cues comprehenders that Focus assignment is imminent, allowing them to anticipate that the upcoming NP must be one that is licensed by prior context to be focused. In addition, knowledge of which specific NPs in the context could bear Focus was established via the *wh*-question, which created a clear division of discourse roles for the three referents (one Topic NP, two Focus NPs). When the parser encounters an article that is unexpected based on these information structure constraints, the result is an enhanced N400, a component that is sensitive to processes of lexical access and retrieval, including violations of lexical predictions (e.g., Kutas and Hillyard, 1984; Federmeier and Kutas, 1999; DeLong et al., 2005; Kutas and Federmeier, 2011; see Kutas et al., 2011 for a review). That an N400 effect emerged on prenominal articles, before the target noun appeared in the response, suggests that comprehenders must have anticipated certain features of (one of) the Focus nouns upon encountering the cleft. Thus, we answer RQ1 (i.e., *When reading responses to wh-questions, does the presence of an it-cleft allow comprehenders to anticipate that the upcoming NP must be licensed by prior context to bear Focus?*) in the affirmative.

As for the conditions without the *it*-cleft, the absence of an N400 effect for incompatible articles is interesting, given that (1) Focus still needed to be assigned in the response in order to answer the *wh*-question; and (2) the division of discourse roles was the same as in the conditions with the *it*-cleft. Thus, although comprehenders must have inferred which NPs could bear Focus from the *wh*-question, the absence of a Focus-devoted cue in the response (e.g., *In my opinion an agent…*) might have not allowed the parser to anticipate at which point in the sentence Focus assignment would take place. Alternatively, it is also possible that, in the absence of a constraining cue, most participants expected the response to continue with the Focus NP (e.g., *an agent should be hired…*), which answered the *wh*-question, but some expected it to continue with the Topic NP (e.g., *a banker should hire an agent*), given that Topics often occupy the first sentence position in English. In turn, this might have reduced the effects of expectedness at the article. In fact, some of our participants expressed these different preferences after they were debriefed about the study. The fact that Topic nouns yielded more positive waveforms than Focus nouns (i.e., similar effect as for incorrectly clefted Topics) suggests that the parser attempted to assign Focus to the first referent in the response.

Our results add to a growing body of literature showing that, at least in certain conditions, comprehenders use different types of information from higher-level representations to anticipate upcoming material before the bottom-up input becomes available. As previously discussed, many studies have provided support for this type of anticipatory processing at the levels of the lexicon (e.g., Kutas and Hillyard, 1984; Altmann and Kamide, 1999; Federmeier and Kutas, 1999) and the morphosyntax (e.g., Garnsey et al., 1997; Wicha et al., 2004; DeLong et al., 2005; Van Berkum et al., 2005; Lau et al., 2006; Staub and Clifton, 2006; Huettig and Janse, 2016). However, fewer studies have shown anticipatory effects at the level of the discourse (e.g., Rohde et al., 2011; Rohde and Horton, 2014), as is the case herein, where the activated representation is not a specific word or structure, but the form that an utterance should take (i.e., how information should be packaged in the response) relative to the mental states of the speaker and the interlocutor (e.g., Lambrecht, 1994). A recent study by Fleur et al. (2019) provides additional evidence that context allows the parser to generate expectations regarding information structure. The authors found that prenominal articles that were

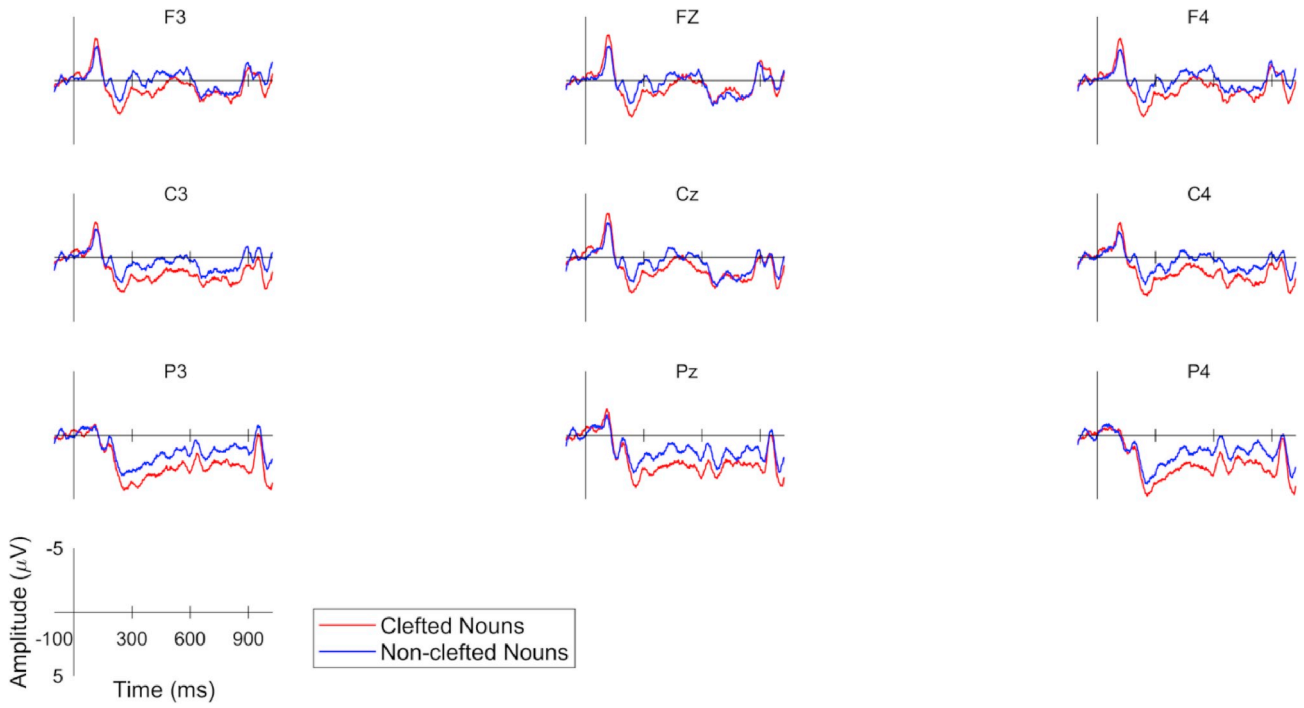

Fig. 9. Grand average ERP waveforms for clefted nouns (averaged across the expected and unexpected conditions) and non-clefted nouns (averaged across the Topic and Focus conditions). ERPs are plotted for equidistant representative electrodes.

unexpectedly definite yielded an enhanced N400 relative to expectedly definite articles. Their interpretation is that encountering a definite article (i.e., preferred for identifiable referents) when the context favors an indefinite referent disrupts the information structure of the discourse, since the parser needs to update the semantic representation of the sentence (see also Kirsten et al., 2014).

Nevertheless, Topic and Focus NPs in our study differed with respect to more than just their phonological properties, and the reader might wonder how this might have affected our results. One anonymous reviewer wondered whether the negativity for unexpected articles following the cleft could be an "uncertainty positivity" for expected articles. Since our contexts encompassed two candidates for Focus assignment but only one Topic referent, it is possible that, upon encountering the expected article, uncertainty arose regarding the identity of the subsequent noun (e.g., *an agent/adviser*). The same is not true of unexpected articles, since only one noun could follow (e.g., *a banker*). The fact that no reliable difference emerged at the article in the conditions without the *it*-cleft suggests that this negativity cannot be explained in terms of an uncertainty positivity for expected articles, since the same uncertainty existed in the conditions without the cleft (e.g., *In my opinion, an agent/adviser*). We can think of no reason why uncertainty with respect to the continuation of the response would only arise in the conditions with the cleft.

Another possibility is that the negativity reflects a misalignment, not of information structure categories (Topic vs. Focus), but of thematic roles. Since the *wh*-question always requested information about the object of the verb, information structure violations (i.e., cases where the subject was clefted) always involved a thematic role misalignment. To us, the absence of the negativity in the conditions without the *it*-cleft (following the same context + *wh*-question) suggests that the negativity cannot simply reflect a thematic role misalignment, since the same misalignment existed in Topic-first responses without the cleft. Since the cleft does not constrain whether the following NP is a subject/agent or an object/theme (i.e., both can be clefted), but the information structure category of the referent (i.e., only a focusable NP can be clefted), our interpretation is that the effect must be mainly driven by information structure constraints. That said, it is possible that thematic constraints did influence the processing of the responses to some extent (we discuss this possibility further in section 6.2.2).

6.1.1. *Topography of the N400 effect for unexpected articles*

The topographical distribution of the N400 effect for unexpected articles in our study deserves some discussion. As Figs. 1 and 3 clearly show, this effect showed a frontal maximum. Although this is not characteristic of the canonical N400, which tends to be largest in centro-parietal electrodes (e.g., DeLong et al., 2005), it is similar to the N400 effect reported by Martin et al. (2013) for unexpected prenominal articles, although the differences in reference method between the two studies preclude strong claims. Ito et al. (2017a) suggest that the frontal distribution of the N400 effect in Martin et al.'s study might be due to the use of a global reference (as opposed to average mastoids). We, however, re-referenced the recordings to average mastoids, suggesting that reference site is not deterministic with respect to the topography of this negativity.[8] It is unclear to us why the negativity is frontally distributed, although recent reports provide some evidence in support of the functional similarity between frontal and centro-parietal N400s (e.g., Voss and Federmeier, 2011; cf. Stróżak et al., 2016).

[8] As an exploratory analysis, we re-referenced the recordings to the average of all 32 scalp electrodes to examine whether the topography of the effect was modulated by reference site. These analyses must be interpreted with caution, given that we used an EEG system with half the scalp density as Martin et al.'s study (e.g., Dien, 1998 recommends no less than 64 electrodes for the use of a global average reference). These analyses revealed a marginal Cleft by Expectedness interaction in the Frontal region, $F(1, 22) = 3.517$, $p = .074$; $\eta_p 2 = 0.14$, driven by the fact that unexpected articles (*M*: −0.80 μV; *SD*: 1.16) were marginally more negative than expected ones (*M*: −0.46 μV; *SD*: 1.13) in the conditions with the cleft, $F(1, 22) = 3.456$, $p = .076$; $\eta_p 2 = 0.14$ (not corrected for multiple comparisons). Thus, although the effects did become less robust with an average reference (relative to average mastoids), the qualitative pattern of effects is similar (negativity for unexpected articles, relative to expected ones, in the Frontal region). These weaker effects that we obtained with a global average reference are consistent with Ito et al.'s concerns that the use of this referencing method can diminish N400 effects (although they could also be due to the lack of electrode density).

Another possibility is that the negativity is a Left Anterior Negativity "LAN", a component with similar latency to the N400 that has been argued to index automatic morphosyntactic processing (e.g., Molinaro et al., 2011). Although there is considerable variability across studies with respect to LAN-elicitation (e.g., Tanner and Van Hell, 2014; Molinaro et al., 2015), this component sometimes emerges for local morphosyntactic errors, including violations of morphophonological rules (e.g., Molinaro et al., 2008). Thus, it is possible that, upon encountering the *it*-cleft, our comprehenders treated articles that were incompatible with the phonological properties of the expected Focus NPs as a violation of the *a/an* rule, which might have yielded a LAN. This account would still suggest that comprehenders expected the NP following the *it*-cleft to be focusable, since there were no actual morphophonological mismatches in the experimental materials. In that sense, our study differs significantly from studies investigating morphophonological violations, where the target word signaled an irreparable violation of the relevant rule (example from Italian taken from Molinaro et al., 2008: *lo scialle/*peperone, il peperone/*scialle* "the shawl/the red pepper").

6.1.2. Comparison with previous studies manipulating prenominal material

As we mentioned in the Introduction, there is variability in the previous literature with respect to the nature of prediction effects on prenominal material, and recent reports have even argued that prediction might not be as detailed as it has been traditionally assumed (e.g., Ito et al., 2017a; Nieuwland et al., 2018). Our results suggest that, at least under certain circumstances, comprehenders can anticipate the phonological or orthographic form of prenominal articles. Although, in principle, this is compatible with previous reports (e.g., Wicha et al., 2004; DeLong et al., 2005; Martin et al., 2013; Foucart et al., 2014; but see Ito et al., 2017a; Nieuwland et al., 2018), we must point out that our design is very different from previous studies on predictive processing that have manipulated prenominal articles. This is because the main purpose of our study was to investigate predictive processing at the level of the discourse and, thus, both the predictive cue and the activated representation are different from those in previous reports. For example, in the studies by Wicha et al. (2004) and DeLong et al. (2005) (see also Martin et al., 2013) the predictive cue was the cloze probability of a word in a given sentence context, and the activated representation was that specific word (i.e., *prediction* the way Van Petten and Luka, 2012 define it). In contrast, in our study, the predictive cue was the matrix clause of the *it*-cleft construction (i.e., *it is…*), which encompasses two function words and assigns Focus. In addition, since we designed the contexts such that there would be no response bias towards either one of the two nouns that could bear Focus, the activated representation in our study was not a specific noun, but any noun that was licensed by the discourse to be focused (to value the *wh*-question) (i.e., what Van Petten & Luka call *expectation*). Another important (related) difference between our study and the studies by Wicha et al. (2004), DeLong et al. (2005), and Martin et al. (2013) concerns the fact that our participants had already encountered both the expected and unexpected nouns in the context, before reading the response. Since our research question concerns whether the parser anticipates discourse properties (i.e., the form of the response to the *wh*-question), we designed our materials such that participants would have to rely on world knowledge as little as possible. In turn, this required providing them with the target lexical items in the context. Thus, the effects reported herein provide evidence for reactivation, rather than preactivation, of the target NPs. Future studies investigating predictive processing in the domain of information structure should explore alternative paradigms where the contexts do not provide the target words (i.e., relying instead on world knowledge).

Other aspects of our design might account for why unexpected articles yielded an N400 effect in the conditions with the *it*-cleft. In their review of the role of prediction in language comprehension, Kuperberg and Jaeger (2016) discuss how comprehenders' goals (which are determined by the nature of the experimental task, at least to a certain extent) can modulate anticipatory processing. The authors point out that deeper sentence processing is more likely to encourage the use of higher-level representations to preactivate lower-level properties of upcoming words. In the present study, participants received instructions to carefully evaluate the contexts and consider how they would answer the *wh*-questions. Since answering the *wh*-questions corresponds to Focus assignment, this is likely to have encouraged participants to use information structure constraints predictively when reading the responses. In fact, the studies by Wang et al. (2009, 2011) provide evidence that Focus structures themselves encourage deeper processing. Recall that their studies showed that comprehenders were better able to detect subtle semantic anomalies (i.e., semantic illusions) when the incongruent word had Focus status. The fact that prediction effects on prenominal articles only emerged in the conditions with the *it*-cleft still suggests that the phonological form of prenominal articles is only anticipated upon the availability of a sufficiently constraining cue.

Another aspect of our design that might have contributed to the emergence of an N400 effect for unexpected articles concerns the rate at which the responses to the *wh*-questions were displayed (450/300 ms). Previous studies have provided evidence that comprehenders are more likely to exploit predictive mechanisms when the bottom-up input is presented at a slower rate (e.g., DeLong, 2009; Dambacher et al., 2012; Wlotko and Federmeier, 2015; Ito et al., 2016, 2017a; see also Kuperberg and Jaeger, 2016) or when sufficient time is available for prediction generation (e.g., Chow et al., 2018). For example, Wlotko and Federmeier (2015) found evidence for pre-activation of semantic features when sentences were presented with a 500 ms Stimulus Onset Asynchrony (SOA) (replicating Federmeier and Kutas, 1999), but not with a 250 ms SOA, suggesting that processing pressure might cause comprehenders to abandon prediction as a strategy. Likewise, Ito et al. (2017a) found a larger N400 effect and a larger Anterior Positivity for unexpected, relative to expected, nouns with a 700 ms SOA, compared to a 500 ms SOA. Although our study does not manipulate SOA, we used a relatively comfortable 750 ms SOA (450 ms per word + 300 ms pause) (comparable to Martin et al., 2013 and Ito et al., 2017a) in an attempt not to overwhelm comprehenders, who had to integrate multiple sources of information from the context and the response. In turn, this might have facilitated the use of anticipatory strategies. Thus, it remains an open question whether comprehenders would employ similar predictive mechanisms in situations that more closely resemble natural reading.

6.2. Effects on the noun

6.2.1. Psycholinguistic validity of the it-cleft as a focusing-device

Before we discuss how the parser processed violations of Focus assignment (i.e., cases where the *it*-cleft assigned Focus to the Topic), we evaluate the psycholinguistic validity of the *it*-cleft as a focusing device. The more positive waveforms for clefted nouns (i.e., regardless of their information structure category) relative to the same nouns in the conditions without the *it*-cleft in the 200–800 ms time window could be reminiscent of the positivity reported by both Bornkessel et al. (2003) and Cowles et al. (2007) for focused phrases. Recall that Bornkessel et al. (2003) found a positivity for all new discourse referents that could fill the slot opened by a *wh*-question, even when the *wh*-word and the new discourse referent carried irreconcilable case information. Likewise, Cowles et al. (2007) found that clefted nouns overall (i.e., regardless of congruency), yielded more positive waveforms than all other content words in the response. Both Bornkessel et al. and Cowles et al. interpreted this positivity as a P3b, a component related to information delivery and resolution of uncertainty. Their proposal is that the positivity reflects the integration of the information requested in the *wh*-question. In the present study, the positivity that we found for clefted nouns relative to their non-clefted counterparts fits well with the possibility that the parser could more easily focus the NPs in the sentence (regardless of congruency) right after encountering the *it*-cleft, which constrained the location of the constituent bearing Focus.

We mentioned earlier that, although both clefted and non-clefted

nouns were the first referent in the response (e.g., *In my opinion, it is a linguist*… vs. *In my opinion, a linguist*…), they occupied different positions in the sentence (seventh vs. fifth, respectively) (a similar issue arose in the study by Cowles et al., 2007). Thus, the reader might rightfully wonder to what extent these differences in sentence position, which have been shown to modulate processing (e.g., Van Petten et al., 1991), might be responsible for the positivity. To address this question, we performed additional analyses to compare clefted vs. non-clefted prenominal articles (which also differ with respect to sentence position: sixth vs. fourth), in the same time window (200–800 ms) and regions (Central, Posterior) where the positivity emerged for clefted nouns. These analyses revealed no main effect of Cleft in either region (Central: $F(1, 22) = 0.001$, $p > .1$; $\eta_p2 = 0.000$; Posterior: $F(1, 22) = 0.839$, $p > .1$; $\eta_p2 = 0.037$). To us, this suggests two things. First, at this point in the response (i.e., at the article) Focus was yet to be assigned (i.e., even if certain properties of the Focus NP had been anticipated or reactivated in the conditions with the *it*-cleft). Second, the more positive waveforms that we found for clefted nouns (relative to their non-clefted counterparts) are unlikely to be epiphenomenal.

6.2.2. Effects of information structure category (topic vs. focus)

An interesting finding in our study is that incorrectly focused nouns (i.e., clefted Topics) yielded a P600 (~600–900 ms) relative to appropriately focused nouns. As previously discussed, the P600 has been argued to index general difficulty at the level of the syntax, as it is reliably found for outright syntactic violations (e.g., phrase structure errors, Friederici et al., 1996), garden-path sentences (e.g., Osterhout and Holcomb, 1992; Gouvea et al., 2010), and the integration of dislocated material (e.g., Kaan et al., 2000; Fiebach et al., 2002). In addition, recent proposals have linked the P600 to the violation of top-down expectations (e.g., Kuperberg, 2007; van de Mereendonk et al., 2010; Tanner et al., 2017). Therefore, one possibility is that the participants in the present study processed the information structure violations as structural errors, based on top-down expectations. Since the syntactic position following the *it*-cleft must be occupied by a noun that is licensed by prior context to be focused, it is possible that, upon encountering an "unlicensed" noun, one that could not be bound by the *wh*-expression (i.e., the Topic NP), the parser struggled with its integration. In fact, this is one of the scenarios that Cowles et al. (2007) contemplated in their discussion of how the parser might react to information structure violations, although this prediction was not borne out in their study (i.e., violations elicited an N400). Another possibility (also laid out by Cowles et al., 2007) is that a P600 emerged due to the reversal of thematic relations in the response. Since the *wh*-question requested information about the object of the verb (e.g., [*which of the two*]$_i$ *should a banker hire* t_i*?*), the *it*-cleft must have generated the expectation that the object of the verb would be focused, since it provided the answer to the question (i.e., it had Focus status). Upon encountering the subject instead, the result is a P600, consistent with a growing body of literature showing that the P600 is sensitive to combinatorial difficulty triggered by semantic-thematic constraints (e.g., Kolk et al., 2003; Bornkessel-Schlesewsky and Schlesewsky, 2008; see an extensive discussion in Kuperberg, 2007). With the present design, we cannot adjudicate between these two possibilities, since violations of information structure always involved an unexpected thematic role.[9] It should be pointed out, however, that the *it*-cleft does not constrain the thematic role of the clefted constituent (i.e., both subjects and objects can be felicitously clefted) but its information structure category (i.e., only focusable constituents can be successfully clefted). Thus, if we interpret the P600 for clefted Topics as evidence that the parser struggled with their integration, it seems more likely that this was due to a Focus assignment error.

Thus, the answer to RQ2 (i.e., *How does the brain respond to violations of Focus assignment?*) is less conclusive. It is possible that the brain treats violations of information structure as the violation of a structural constraint. However, in our study, it is also possible that the brain treated them as a thematic role misalignment, since the P600 is sensitive to both factors. It is also unclear to us why information structure violations in the present study yielded a qualitatively different component than in Cowles et al.'s study (i.e., P600 vs. N400), although similar variability has been attested in studies manipulating Focus accent (e.g., Hruska and Alter, 2004; Magne et al., 2005). There are differences between the two studies that might account for this divergence, the most obvious one being the prenominal articles. In Cowles et al.'s study, the articles preceding the clefted nouns were identical in the congruent and incongruent conditions. In our study, however, we systematically manipulated prenominal articles, and participants were sensitive to them, as suggested by the N400 effect for unexpected articles. Although we can only speculate, it is possible that the unexpected articles cued participants that the upcoming syntactic position, which is reserved for Focus, had been usurped by the Topic, which might have encouraged more structural processing. The reader might also wonder to what extent the P600 for incorrectly clefted nouns in our study might be an artifact driven by the negativity on the preceding article. Since we applied a baseline-correction procedure to the waveforms (as is standard; see Luck, 2014), the negativity for unexpected (i.e., Topic) articles might have caused the positivity on the subsequent Topic noun to become amplified, an issue that is unlikely to have arisen in Cowles et al.'s study, since they did not manipulate prenominal articles. In our study, however, the negativity for unexpected articles ends at approximately 450 ms, which corresponds to the end of the presentation of the article. Then, the following pause (before presentation of the noun) lasted for 300 ms. Since we used the last 100 ms of this pause for baseline correction, it is unlikely that the negativity contaminated the noun's baseline (i.e., the negativity ends 200 ms before). As Fig. 1 shows, the baselines for expected and unexpected articles appear comparable before the display of the noun.

We now turn to the conditions without the *it*-cleft. Here, responses where the Topic NP was the first referent in the sentence (e.g., *In my opinion, a banker*…) also yielded more positive waveforms than Focus-first responses (e.g., *In my opinion, an agent*…) between 600 and 900 ms. Although planned comparisons suggested that this difference was not significant, the lack of a Cleft by Expectedness interaction precludes strong claims restricting the P600 to incorrectly clefted Topics. One possible explanation for this positivity is that, in the absence of a strong cue constraining the location of the Topic and Focus NPs in the response, the parser attempted to bind the variable opened by the *wh*-expression as soon as possible, similar to the resolution of other *wh*-dependencies (e.g., Stowe, 1986). Consequently, when the first referent in the response was the Topic NP, this binding operation failed, yielding a P600-like effect. If we assume such a strategy, it is also possible that the misalignment between the expected argument (i.e., object) and the encountered one (i.e., subject) contributed to the positivity. Notice that both interpretations are consistent with Lambrecht's (1994) claim that, if the Topic is clear in the discourse, the Focus NP can occupy the first position in the sentence without the structure becoming syntactically marked. Both interpretations also fit well with the P600. However, the fact that neither response type violated information structure means that we cannot rule out the possibility that this effect might actually be a late negativity for Focus relative to Topic NPs. Under this account, the parser might have predicted a passive construction upon encountering the Focus NP first (i.e., the object of the verb), thus incurring higher

[9] It is unclear to us whether this confound can be avoided, since violations of information structure (at least, via syntactic constructions like the *it*-cleft) involve assigning categories like Focus to the "wrong" NP. In fact, even if we had designed our materials such that half of the *wh*-questions requested information about the subject, (e.g., *Either an agent or an adviser might need a banker. Which of the two should contact a banker? In my opinion, it is an agent/*a banker*…) violations of information structure would have still involved a thematic role misalignment.

processing costs. It is also possible that, in the absence of the cleft, comprehenders showed qualitative differences in the processing of the responses, which might explain both the more negative waveforms for Topic relative to Focus nouns between 400 and 600 ms and the positivity for Topic nouns between 600 and 900 ms (neither of which was reliable, according to planned comparisons). Future studies should attempt to adjudicate between these possibilities.

7. Conclusion and future directions

The present study found that, when reading answers to *wh*-questions, comprehenders use information structure constraints (i.e., prior context and a Focus-devoted construction, the *it*-cleft) to anticipate the form that the response should take. By manipulating the phonological properties of the nouns that could and could not bear Focus in light of such discourse constraints, we were able to examine effects of prediction on prenominal articles, at a point when the target nouns were yet to appear, before the integration of semantic/discourse information occurred. That an N400 effect emerged only for prenominal articles that were unexpected after the *it*-cleft provides evidence that, when the response is sufficiently constraining, comprehenders are able to anticipate where in the response Focus will be assigned. That said, our study does not shed light on whether comprehenders preactivate the phonological form of prenominal articles (e.g., DeLong et al., 2005), since our participants had already seen the critical NPs in the discourse contexts leading to the responses where ERPs were calculated. Thus, our results are consistent with the possibility that comprehenders reactivate prenominal articles upon availability of a constraining cue. Future studies investigating predictive processing in the domain of information structure should explore alternative paradigms where the contexts do not provide the target words (i.e., relying instead on world knowledge), as in (7) below:

(7)

Set-up context: Which fruit did some Disney character bite that caused her to fall asleep?
Response including the *it*-cleft:

a. Focus NP as target: It was an apple that a princess called Snow White bit.
b. Topic NP as target: It was a princess called Snow White that bit an apple.

Another advantage of the design in (7) is that any uncertainty concerning the identity of the noun following expected and unexpected articles would be controlled for, since neither *apple* nor *Snow White* appears in the discourse context leading to the response.

Additional evidence for the psycholinguistic validity of the *it*-cleft as a mechanism to assign Focus comes from the finding that clefted nouns overall yielded a positivity (related to information delivery), relative to the same nouns in the conditions without the cleft. Finally, our results suggest that the parser treats information structure errors (i.e., clefted Topics) as violations of structural constraints determined by top-down expectations, although we cannot rule out the possibility that thematic constraints also impacted the processing of the responses (even though clefts do not constrain thematic role, but information structure category), since violations of information structure always involved a misalignment of thematic roles. Future studies should attempt to dissociate the role of information structure constraints from that of thematic constraints.

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Appendix A. Supplementary data

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