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Processing focus structure and implicit prosody during reading: Differential ERP effects ☆

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Abstract

Several recent studies have shown that focus structural representations influence syntactic processing during reading, while other studies have shown that implicit prosody plays an important role in the understanding of written language. Up until now, the relationship between these two processes has been mostly disregarded. The present study disentangles the roles of focus structure and accent placement in reading by reporting event-related brain potential (ERP) data on the processing of contrastive ellipses. The results reveal a positive-going waveform (350–1300 ms) that correlates with focus structural processing and a negativity (450–650 ms) interpreted as the correlate of implicit prosodic processing. The results suggest that the assignment of focus as well as accent placement are obligatory processes during reading.

Keywords: ERPs; Focus structure; Implicit prosody; Ellipsis

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1. Introduction

Understanding a sentence requires identifying the *focus* of the sentence, roughly speaking the most important and emphasized constituent of a sentence. In spoken language, the focus structure of a sentence is strongly connected to its prosodic structure. Typically, focus is signalled prosodically by a prominent pitch accent. In contrast to spoken language, written text does not explicitly encode prosodic information such as pitch accents. Nevertheless, almost every reader is familiar with the phenomenon of inner speech. To explain this phenomenon, researchers have claimed that stress and intonation patterns are imposed on written language during silent reading (e.g., Ashby & Clifton, 2005; Fodor, 1998; Rayner & Pollatsek, 1989). However, the question of how this implicit prosodic representation is connected to the focus structural properties of a sentence has been mostly disregarded up until now. The present study investigates the processing of focus structure and of (implicit) prosodic structure and their interrelation during reading. A distinction regarding the processing of these two aspects is important, as linguistic theory assumes different types of representations for focus structural and prosodic properties of sentences. If evidence for distinct types of processes can be obtained, then this would confirm assumptions in linguistic theory as well as lead to a more fine-grained understanding of the processes involved in reading. Before turning to our study, theoretical assumptions and experimental findings with regard to focus and prosodic structure in auditory and written language will be discussed.

2. Focus structure and prosodic structure in auditory language

The focus structure of a sentence can be described in pragmatic or *information structural* terms. The information structure of a sentence represents its division into *focus* and *background* (Rochemont, 1986; Selkirk, 1984, 1995; von Stechow, 1991). While *background* refers to information that is already given by a specific context, *focus* refers to the part of the sentence that represents new or contrastive information. In languages like English and German, the focus of a sentence is typically signalled prosodically by pitch accents, i.e., shifts in the pitch of the voice in addition to other changes (e.g., loudness and duration) that increase the prominence of the focused element. As illustrated in (1a), the constituent which is asked for by the wh-element is the focus of the answer ($[\ldots]_F$ indicates the focus structure, and pitch accents are indicated by all-capitals). The rest of the sentence is given by the context and is therefore background information.

(1) What did Johnny buy yesterday?
 a. Johnny bought [a PREsent]$_F$.
 b. #Johnny [BOUGHT]$_F$ a present.

The examples in (1) also illustrate that recovering the focus structure of a sentence is an obligatory process for sentence comprehension. For a sentence like (1b), one immediately detects the ill-formedness of this sentence as an answer to the question in (1). This would not occur if we did not compute focus structure as part of the obligatory processing of a sentence. Psycholinguistic evidence clearly indicates that perceivers' attention is immediately directed to focused material. Cutler and Fodor (1979) have shown that focusing by pitch accents leads to faster responses in phoneme monitoring, and, in addition, perceivers interpret pitch accents in information structural terms. Pitch accents are taken as indicators of new information (Birch & Clifton, 1995, 2000; Dahan, Tanenhaus, & Chambers, 2002). It can also be shown that syntactic processing, e.g., syntactic ambiguity resolution, can be affected by focal pitch accents (Carlson, 2001, 2002; Schafer, Carter, Clifton, & Frazier, 1996; Schafer, Carlson, Clifton, & Frazier, 2000).

However, the close relationship between pitch accents and the focus of a sentence is not that straightforward. For example, what is accented is not always focused. A sentence like (2a) with the same prosodic structure as in (1a) is also an appropriate answer to the question in (2).

(2) What did Johnny do yesterday?
 a. Johnny [bought a PREsent]$_F$
 b. #Johnny [BOUGHT a present]$_F$
(3) What happened yesterday?
 a. [Johnny bought a PREsent]$_F$
 b. #[Johnny BOUGHT a present]$_F$

In this case, the accent can project focus to another constituent, e.g., a single accent on the noun *present* allows focusing of the entire verb phrase (VP) as in (2a) and the entire sentence as in (3a). In these cases, the sentence has a *wide focus*. But this is only possible for an accent on a specific constituent. A pitch accent on the verb *bought* in (2b) and (3b) does not license focus projection to the entire VP or sentence. For this sentence, only *narrow focus* is available.

In linguistic theory, these facts are captured by principles that characterize the accent–focus relationship by referring to the syntactic structure of a sentence (see, e.g., Cinque, 1993; Gussenhoven, 1983, 1992; Haider & Rosengren, 2003; Reinhart, 1995; Selkirk, 1984, 1995). It is assumed that syntactic constituents in the surface syntactic structure of a sentence are *F(ocus)-marked*, and that F-marking plays a role in the meaning of a sentence (for an overview of the literature on the relationship between focus structure and semantic interpretation, see, e.g., Bosch & van der Sandt, 1999; Kadmon, 2000) as well as in the prosodic structure (e.g., Selkirk, 1984, 1995). For cases in which the whole sentence is F-marked as in example (3), it is assumed that this is only possible if the constituent carrying the nuclear accent (the noun *present* in (3a)) is in its syntactic base position (in contrast to positions in the syntactic tree occupied by moved constituents) and in the sister position of the verbal head of VP (the verb *bought* in (3a)). According to Cinque (1993), a phrase's main accent is assigned to its most deeply embedded constituent. If there are no further information structural constraints given by a specific context, the focus projects to wide focus. If the phrasal accent falls on a constituent higher in the structure, the focus does not project, and the sentence receives a narrow focus reading (see Haider, 1993, 2000).

Experimental evidence demonstrates that an accented sister constituent to the verbal head can indeed project focus to the entire VP (Gussenhoven, 1983; Birch & Clifton, 1995). Birch and Clifton (1995) had participants listen to dialogs like those in (4) that started with a question that required a wide VP focus in the answer.

(4) Why is Gretchen so sad?
  a. She's MOVING to IOWA.
  b. She's MOVING to Iowa.
  c. She's moving to IOWA.

Participants were asked to rate the appropriateness of the second sentence in the dialog. They rated sentences such as those in (4c) nearly as highly as those in (4a), and participants comprehended such sentences equally well and equally quickly. Sentences like (4b), in contrast, were judged to be less acceptable and harder to comprehend than (4a) and (4c)[1].

To sum up the preceding discussion, we can see that focus structure signalled by pitch accents plays an important role in auditory language processing. Given the close relationship between pitch accents and a sentence's focus structure, the question arises whether focus structure is also processed in the absence of explicit prosodic information, that is, in written language.

3. Focus structure and prosodic structure in reading

Focus structural properties of a sentence in written language can be manipulated in different ways. One possibility is the use of it-clefts in English (see example in (5)).

(5) It was [the KING]$_F$ who led the troops.

Focusing by means of it-clefts in English increases the salience of the focused constituent (Birch, Albrecht, & Myers, 2000) and leads to more careful encoding by the reader (Birch & Rayner, 1997).

Another possibility for a focus structural manipulation is the use of focus particles. In the sentence in (6), the focus particle *only* assigns narrow focus and nuclear stress to its right-adjacent constituent. This is assumed to be a typical pattern for sentences with focus particles in English and German (see e.g. Büring & Hartmann, 2001).

(6) Only [BUSInessmen]$_F$ loaned money at low interest were told to record their expenses.

[1] Whereas focus projection is possible with accented arguments of the verb, Birch and Clifton (2000) demonstrated that focus projection is not possible with accented verbal adjuncts.

Some studies using focus particles for the manipulation of focus structure showed that a sentence-initial particle reduces reading times for reduced relative clauses in sentences like (6) (Ni, Crain, & Shankweiler, 1996; Sedivy, 2002). However, with identical sentence materials as in the Ni et al. study, Clifton, Bock, and Radó (2000) failed to replicate this effect. In an eye movement study, Paterson, Liversedge, and Underwood (1999) demonstrated that focus particles do not influence first-pass parsing, but facilitate the reanalysis of the syntactic structure, suggesting that this type of manipulation affects the parser in a late processing stage. The reading studies that did find reduced reading times interpret their findings in terms of focus structural processing. This, however, is problematic, as the materials used to study the processing of focus structure are confounded with prosodic characteristics. The focus of a given sentence always coincides with the position of pitch accent.

There is empirical evidence that phonological and prosodic representations are built up while reading a sentence. This process is called *phonological coding* (see e.g., Pollatsek, Rayner, & Lee, 2000; Rayner & Pollatsek, 1989). As proposed by Slowiaczek and Clifton (1980), phonological coding in reading compensates for the lack of prosodic information in written language, since prosody is needed for successful understanding. This idea is also formulated in the *implicit prosody hypothesis* which assumes that the imposed prosodic contour influences syntactic processing (Fodor, 1998, 2002; see also Bader, 1998 for a similar claim). Empirical evidence for this hypothesis comes from a number of recent studies demonstrating that prosodic representations constructed during reading influence the processing of syntactic ambiguities (e.g., Fodor, 2002; Steinhauer, 2003; Steinhauer & Friederici, 2001). These studies investigated effects of intonational phrasing during reading. To our knowledge, there is only one study that has investigated accent placement during reading (Bader, 1998). The study used locally ambiguous sentences and manipulated the presence or absence of a focus particle in the ambiguous region (see the example in (7)).

(7) …dass man <u>(sogar) ihr Geld</u> anvertraut/beschlagnahmt hat.
… that one (even) her money entrusted/confiscated has.
"… that someone entrusted money to her/confiscated her money."

The pronoun *ihr* (*her*) can be either the dative object of a ditransitive verb like *anvertraut* (*entrusted*) or a possessive pronoun as part of the accusative object of a transitive verb like *beschlagnahmt* (*confiscated*). In the absence of a focus particle, no reading time differences at the point of disambiguation were found for the different verbs. For the sentences including a focus particle *sogar* (*even*), longer reading times were observed for the direct object disambiguation. Bader (1998) explains this result in prosodic terms. The focus particle *sogar* (*even*) can assign focus either to the pronoun or the noun. The preferred prosodic pattern for the fragment in (7) is the one with a pitch accent on the content word *Geld* (*money*), as function words like *ihr* (*her*) are prosodically less prominent and tend to be phonetically reduced in spoken language (Selkirk, 1984, 1995). However, in the sentences in (7), there is not only a prosodic difference between the two readings, but also a focus structural one. Evidence against a focus structural explanation comes from a further experiment by

Bader (1998) in which the preferred prosodic pattern was shown to be sensitive to rhythmic alternations. This serves as evidence for a pure prosodic preference and supports the assumption that implicit prosody in terms of accent placement plays a crucial role in sentence reading. Nevertheless, the focus particle assigns both accent and focus to one of the following constituents, and, therefore, either prosodic and/or focus structural processes might be at work.

Given the problem of confounding prosodic and focus structural properties by using focus particles in several studies, the question arises whether there is evidence for pure focus structural effects in processing. Bader and Meng (1999) showed that focus structural characteristics affect the reanalysis of syntactically ambiguous sentences. In a behavioral study, the authors investigated word order variations in German which, in contrast to English, has a relatively free word order. The subject of a sentence can either precede the object as in (8a) for the *canonical* word order, or the subject can follow the object as in (8b) for the *non-canonical* word order. Along with the syntactic difference between canonical and non-canonical word order is a difference regarding the focus structural representation. Without any contextual constraints, a complement clause with canonical word order as in (8a) has a wide focus reading, whereas (8b) requires narrow focus on the second noun phrase or the second noun phrase and the verb (see e.g., Abraham, 1992; Lenerz, 1977; Steube, 2000).

(8a) …, dass [die neue Lehrerin$_{subject}$ einige der Kollegen$_{object}$ angerufen hat]$_F$
… that the new teacher some the colleagues phoned has
"… that the new teacher phoned some of the colleagues."

(8b) …, dass die neue Lehrerin$_{object}$ [einige der Kollegen$_{subject}$ angerufen haben]$_F$
… that the new teacher some the colleagues phoned have
"The director said that some of the colleagues phoned the new teacher."

Bader and Meng (1999) used a grammaticality judgment task and found the well-known difficulties with non-canonical sentences with ambiguously case-marked NPs; this was argued to reflect syntactic reanalysis of the preferred canonical order. The authors also reported even more difficulty with non-canonical sentences that require an additional *focus structural revision* than with non-canonical sentences for which no focus structural revision was required (sentences with pronouns). At the point of disambiguation (the auxiliary *haben*) in sentences like (8b), the focus structural representation has to be changed from wide focus to narrow focus.

These data provide experimental evidence that the assignment of focus structure is an obligatory process in sentence comprehension. Without any preceding contextual information, the whole sentence is interpreted as new information and, therefore, a wide focus reading is computed. If this wide focus assignment turns out to be incompatible with the syntactic structure of the sentence, a focus structural revision takes place. With regard to the prosodic structure of different word orders, it is assumed that the sentence accent is on the noun preceding the verb for both word orders (whether this is the right assumption will be discussed in the next section). Therefore, no additional implicit prosodic processing should be at work. But again, no experimental evidence is at hand that show that focus structure alone plays a role in the processing of word order variations.

To sum up, the studies described above suggest that focus structural representations as well as prosodic representations in terms of accent placement are computed during reading and influence syntactic reanalysis. But given that focus structure and implicit prosodic structure are highly interconnected and mostly confounded, no experimental evidence is available to date that allows for a clear differentiation of these two types of processes. Furthermore, all reading studies discussed above investigated effects of focus structure and implicit prosody on the processing of syntactic ambiguities. The question arises whether focus structural and implicit prosodic processes can be observed without being mediated by syntactic processing difficulties.

4. ERP correlates of processing focus structure and prosodic structure

The present study was designed to investigate focus structural and implicit prosodic processing during online sentence comprehension in the absence of syntactic ambiguity resolution. Event-related brain potentials (ERPs) were chosen as the dependent variable. ERPs are a fine-grained, online measurement with high temporal resolution that allows for the differentiation of distinct processes in a multi-dimensional fashion. Each ERP effect comes with three signatures: the polarity (negativity N, or positivity P), the latency (in milliseconds after a critical stimulus is presented), and the topography (scalp distribution). There is a rich ERP literature addressing semantic and syntactic processing and well-established components such as the N400, a negativity around 400 ms that correlates with semantic processing (see e.g., Kutas & Hillyard, 1980) and the P600, a positivity around 600 ms that is a signature of syntactic processing (see e.g., Osterhout & Holcomb, 1992). In contrast, there are only a few ERP studies that have investigated effects of focus structure and accent placement on language processing. Two of these studies were conducted in the auditory domain and three were reading studies. Before turning to our study, we provide a short overview of these studies.

4.1. Auditory studies

Johnson, Clifton, Breen, and Morris (2003) investigated the processing of auditorily presented English question-answer pairs (see examples in (9) and (10)). The wh-questions in (9) asked for one constituent in the following answers. The answer either matched (see 9a) or did not match (see 9b) the information structural expectations with respect to the prosodic structure.

appropriate context
(9a) Rhonda kissed Jason. Who else was kissed by Rhonda?
inappropriate context
(9b) Evelyn kissed Jeremy. Who else was Jeremy kissed by?
target
(10) JERemy was kissed by Rhonda, too.

The results showed that focus and prosodic pitch accenting are associated with different ERP effects. The processing of focused (new) constituents compared to non-focused (given) material evoked a widely distributed late positivity (500–700 ms) irrespective of prosody. The processing of prosodic information in terms of a missing pitch accent, in contrast, elicited an early anteriorly distributed negativity (100–500 ms). Hruska, Alter, Steinhauer, and Steube (2000) and Hruska (2004) presented question-answer pairs in German and found a similar positivity at parietal electrode sites for focused constituents, but only for prosodically matching question-answer pairs. A negativity (200–600 ms) with a centro-parietal distribution was reported for a missing pitch accent in the answer.

Therefore, both studies showed that focus structural processing in auditory language comprehension elicits a late positivity, whereas prosodic information in terms of a missing pitch accent evokes an earlier negativity. The two studies described above were able to differentiate between effects of focus structure and those of prosody. Both presented their sentence material auditorily, so it was possible to create mismatches between a predicted focus structure and the prosodic structure actually heard. This does not apply to the three reading studies using ERPs.

4.2. Reading studies

Cowles (2003) investigated sentence reading in short contexts in English. The first sentence of the context introduced three referents (*A queen, an advisor and a banker were arguing over taxes)*. The second (and last) context sentence was a wh-question asking for a decision between two of the referents (*Who did the queen silence, the advisor or the banker?*). In the matching condition, the following sentence picked up one of the referents by an it-cleft which assigns narrow focus, but also an accent to the noun (*It was the <u>advisor</u> that …*). The it-cleft in the mismatch condition picked up an entity which was mentioned already, but was not included in the alternative set given by the question (*It was the <u>queen</u> that …*). The results measured on the noun in the it-cleft showed a right lateralized negativity (200–500 ms) for the mismatch condition compared to the matching condition. The author interpreted this negativity as a "kind of N400" (p. 135) due to a mismatch between the actual referent in the it-cleft and the participants' expectations built upon the prior context.

Bornkessel, Schlesewsky, and Friederici (2003) investigated question–answer pairs in German. In answers in which one argument is asked for by the wh-question, the focused (and accented) constituents elicited a parietal positivity (280–480 ms). The authors interpreted this effect as a correlate of focus structural processing.

Stolterfoht and Bader (2004) and Stolterfoht (2005) investigated word order variations in German. The authors used sentences similar to the examples in (8) previously discussed. According to Bader and Meng (1999), the non-canonical word order in (8b) not only requires a syntactic reanalysis at the point of disambiguation, but also a focus structural revision process. For these type of sentences, Stolterfoht and Bader indeed found a positivity, and, moreover, a right central negativity (500–600 ms) for the sentences with non-canonical word order at the disambiguating auxiliary. The positivity was taken to reflect the predicted syntactic reanalysis, and the negativity was interpreted to reflect the focus structural revision process. However, it was argued that the negativity might not only be the correlate of focus structural processing, but may also reflect an implicit prosodic revision. As previously mentioned, both focus structural as well as implicit prosodic structure are constructed during reading.

In sum, the results of the reading ERP studies have shown rather inconsistent results when compared to the auditory ERP studies. Negativities as well as a positivity were found for focus structural processing. Possible reasons for this inconsistency might be the differences in the design of the experiments (sentences with or without contexts), the different structures (it-clefts vs. complement clauses) and the exact processes at work (mismatch detection and focus structural expectations triggered by the context in contrast to revision processes). Another prominent reason for the inconsistent results may be the confound of focus structure and prosodic structure in the stimulus material previously discussed. The focused sentence constituents in the ERP studies always coincided with the position of the nuclear accent. The present ERP study aims to disentangle focus structural and prosodic processes during online sentence reading.

5. The experiment

In addition to wh-questions, it-clefts, or focus particles, contrastive ellipsis is a useful structure in the investigation of focus structural and prosodic characteristics. To differentiate between focus structural revision and accent replacement, we used elliptic constructions, namely *replacives.* Examples of the various structures are outlined in (12) and (13) (the term replacive is adopted from Carlson, 2002 who refers to Drubig, 1994). Replacives leave one narrowly focused element behind. This constituent contrasts with one narrowly focused constituent in the related clause, the *correlate* [the object in (12a) and (13a) and the subject in (12b) and (13b)].

As far as we know, the literature on elliptic constructions does not include a syntactic analysis for these German sentence types. Nevertheless, we assume that there is no difference with regard to syntactic complexity between the sentences with an object replacive in (12a) and (13a) and the sentences with a subject replacive in (12b) and (13b)[2] even though other types of ellipses such as gapping show clear complexity effects in processing (for an overview of ellipsis processing, see Frazier & Clifton, 2001). Carlson (2002) investigated replacives in English and the data seem to support the assumption that subject and object replacives do not differ in complexity. In addition, several behavioral studies (Carlson, 2001, 2002) have shown that lexical, focus structural, and prosodic parallelism between the correlate and the replacive influences the processing of ambiguous ellipsis. Therefore, the processing of ellipses may be able to tell us about focus structural and implicit prosodic effects during sentence processing.

[2] Syntactic analyses of replacives in English do not assume syntactic complexity differences between subject and object replacives (see Drubig, 1994; Winkler, 2003).

Default focus structure and prosodic structure

(11) [Am Dienstag hat der Direktor den SCHÜler getadelt]$_F$
On Tuesday has the principal$_{nom}$ *the pupil*$_{acc}$ *criticized*
"On Tuesday, the principal criticized the pupil."

Object replacive with no focus particle (ON): ***focus structural revision***

(12a) Am Dienstag hat der Direktor [den SCHÜler]$_F$ getadelt,
und nicht [den LEHrer]$_F$
On Tuesday has the principal$_{nom}$ *the pupil*$_{acc}$ *criticized,*
and not the teacher$_{acc}$
"On Tuesday, the principal criticized the pupil,
and the prinicipal did not criticize the teacher."

Subject replacive with no focus particle (SN): ***focus structural*** **&** ***prosodic revision***

(12b) Am Dienstag hat [der DiREKtor]$_F$ den Schüler getadelt,
und nicht [der LEHrer]$_F$
On Tuesday has the principal$_{nom}$ *the pupil*$_{acc}$ *criticized,*
and not the teacher$_{nom}$
"On Tuesday, the principal criticized the pupil,
and the teacher did not criticize the pupil."

Object replacive with focus particle (OF): ***no revision***

(13a) Am Dienstag hat der Direktor nur [den SCHÜler]$_F$ getadelt,
und nicht [den LEHrer]$_F$
On Tuesday has the principal$_{nom}$ *only the pupil*$_{acc}$ *criticized,*
and not the teacher$_{acc}$
"On Tuesday, the principal criticized only the pupil,
and the prinicipal did not criticize the teacher."

Subject replacive with focus particle (SF): ***no revision***

(13b) Am Dienstag hat nur [der DiREKtor]$_F$ den Schüler getadelt,
und nicht [der LEHrer]$_F$
On Tuesday has only the principal$_{nom}$ *the pupil*$_{acc}$ *criticized,*
and not the teacher$_{nom}$
"On Tuesday, only the principal criticized the pupil,
and the teacher did not criticize the pupil."

In the present experiment, sentences as in (12) and (13) were used. The sentence in (11) illustrates the default assignment of focus and accent for the first conjunct of the sentences in (12). Given the experimental evidence for focus projection in English (Birch & Clifton, 1995) and for a preference for the wide focus reading for sentences without a preceding context in German (Bader & Meng, 1999; Stolterfoht & Bader, 2004), we assume that the first conjunct has a wide focus reading. The whole clause is new information. According to Cinque (1993), the nuclear accent lies on the most deeply embedded phrase, the accusative object (*den Schüler*), and projects focus to the entire sentence. During online sentence comprehension, the language processor assigns this *default* prosodic and focus structure illustrated in (11) to sentences as in (12) until the replacive is encountered.

If the sentence is continued by an object replacive that assigns narrow focus and accent to the object of the related clause as in (12a), there is a focus structural difference between the default assignment illustrated in (11) and the representation in (12a). The processing system has to revise the focus structural representation (*focus structural revision*: wide focus → narrow focus). If the sentence in (11) is continued by a subject replacive which assigns narrow focus and accent to the subject of the related clause as in (12b), a focus structural revision has to be made as well (*focus structural revision*: wide focus → narrow focus). In addition, the nuclear accent has to be reassigned to the subject, i.e. an additional prosodic revision has to take place (*prosodic revision*: nuclear accent object → nuclear accent subject). In contrast, the control sentences in (13) require no prosodic or focus structural revision. The focus particle *nur* (*only*) assigns narrow focus and accent independently of its adjacent constituent in the first conjunct, i.e. the default assignment cannot apply.

Thus, we predict two different kinds of revision processes. We expect an ERP correlate of focus structural revision and a correlate of prosodic revision. Both of these revision processes are expected to show up at the replacive, i.e. the noun phrase in the second conjunct in the examples in (12), when the processing system is forced to change the default focus and prosodic structure illustrated in (11). Based on the results from the auditory ERP studies, we expect a negative-going waveform as a correlate of prosodic revision and a positive-going waveform as a correlate of focus structural revision. However, there might be modality-related differences with regard to the time course of the ERP effects. In auditory language processing, prosodic information might be in the foreground, whereas focus structural information might be more highlighted in reading. Therefore, we predict an earlier onset for the positivity correlated to focus structural processes and a later onset for the negativity correlated with prosodic processes. The specific hypotheses for our study with respect to the ERP effects (HI–HIII) and with respect to the behavioral effects (HIV) are formulated below.

5.1. Hypotheses

(HI) If we compare the replacives of (12a) and (13a), **ON vs. OF**, a focus structural revision has to be made for (12a) only, the sentence without a focus particle. We should see the correlate of ***focus structural revision*** for sentence (12a): *wide focus → narrow focus.* According to the auditory studies, which were able to differentiate between focus structural and prosodic processing, this might be a positivity.

(HII) If we compare the replacives of (12a) and (12b), **ON vs. SN,** a focus structural revision is necessary for both sentences. Only for sentence (12b) is an additional prosodic revision necessary. The accent has to be shifted to the subject. Therefore, we should see the correlate of ***prosodic revision*** for sentence (12b):

nuclear accent object → nuclear accent subject. According to the auditory studies, this might be a negativity.

(HIII) If we compare the replacives of (12b) and (13b), **SN vs. SF**, a focus structural and prosodic revision is necessary for (12b), the sentence without the focus particle. We should see the correlate of ***focus structural and prosodic revision*** for this comparison: *wide focus → narrow focus* and *nuclear accent object → nuclear accent subject*. In principle, we should find a positivity and a negativity. These effects, however, may overlap in time and may not be as clear as in the single revision comparisons.

(HIV) For the behavioral data (error rates and reaction times for answering comprehension questions), we predict higher error rates and reaction times for sentences requiring focus structural and/or prosodic revisions (sentences without focus particles) than for sentences for which no revision processes are necessary (sentences with focus particles), i.e., for **ON** and **SN** vs. **OF** and **SF.**

5.2. Method

5.2.1. Participants

Twenty students of the University of Leipzig (mean age 24.0, age range 20–30, 10 female) participated in the experiment. All participants were right-handed native speakers of German and had normal or corrected-to-normal vision.

5.2.2. Materials

The experimental sentences were constructed on the basis of a verb list consisting of 100 transitive verbs. The participles of the verbs were combined with two masculine nouns (unambiguously nominative and accusative) to form the VP. The first position in the sentences (*Vorfeld*, position in front of the finite verb) was filled by a temporal adverbial. Together with the VP and the finite verb (auxiliary) in V2-position, the first conjunct of the sentence (correlate) results in an unmarked argument order in German: *temporal adverbial > auxiliary > subject > object > lexical verb*. The second clause of the sentence (replacive) consists of a negation particle *nicht* (*not*) and another masculine noun which was either marked for nominative or accusative case. This results in two versions of each sentence. Two further versions were constructed by the insertion of the focus particle *nur* (*only*) either before the subject or the object of the first clause. For a comparison of the sentences with focus particles (OF vs. SF), no difference in the ERP effects should occur because no revision processes are necessary. This comparison can also serve as an indicator of whether comparisons involving morphologically identical constituents as those involving morphologically different constituents differ at all. If different case marking (nominative vs. accusative) plays a role, we should find similar effects for the comparison of constituents with different case marking, both in sentences without focus particles (ON–SN) and in sentences with focus particles (OF–SF). The four sentence versions corresponded to the full crossing of the factor *Contrast* (subject vs. object) and *Focus Particle* (containing a focus particle vs. no particle; see examples in (12) and (13)).

The final set of experimental sentences presented to participants consisted of 50 sentences for each of the four critical conditions, resulting in a total of 200 sentences per participant. Each participant saw two versions of one quadruple. The two versions differed with regard to the presence of a focus particle and the type of replacive. Each participant saw 150 filler sentences as well. To avoid strategies of contrastive accent placement in the first part of the sentences, the filler sentences contained no contrastive ellipsis. In 100 of the filler sentences, a focus particle appeared in front of the first noun phrase in one half and in front of the second noun phrase in the other half. The remaining 50 filler sentences contained no particle (see Table 1).

After the presentation of each critical sentence, participants were required to answer a comprehension question. The questions asked for the relation of agent and patient of the sentences. The comprehension task required the answer YES equally as often as the answer NO. To keep the length of the experiment acceptable for the participants, only 80 of the filler sentences were followed by a question. The sentences were presented in 10 blocks with 63 trials (sentences + questions). The frequency of questions, fillers, and critical sentences was the same in each block. The sentences were pseudo-randomized with the following constraints: (1) trials of one quadruple were separated by at least one block; (2) trials with and without focus particles and sentences with subject or object contrast were not presented in more than three consecutive trials; (3) no more than three experimental or filler trials were presented in succession; and (4) questions that required the same answer or trials without a question were not presented in more than three successive trials. In addition, we ensured that each condition occurred approximately equally often in each block. From the stimuli, we created two experimental lists which were pseudo-randomized in parallel two times. The resulting four experimental lists were presented five times across the twenty participants.

5.2.3. Procedure

The sentences were presented word by word except for the noun phrases and prepositional phrases: determiner/preposition and noun were presented as a whole. The

Table 1
Different versions of filler sentences

Without focus particle
Am Montag hat die Mutter die Kinder beschäftigt.
On Monday has the mother the children occupied
"On Monday, the mother occupied the children."
Focus particle in front of the second DP
Am Montag hat die Tante nur die Nichten begrüßt.
On Monday has the aunt only the nieces welcomed
"On Monday, the aunt welcomed the nieces only."
Focus particle in front of the first DP
Am Dienstag hat nur die Sängerin die Zuschauer beschimpft.
On Tuesday has only the singer the audience insulted
"On Tuesday, only the singer insulted the audience."

words and phrases were presented in the center of a computer screen. The presentation of a sentence was preceded by a fixation point, which appeared for 550 ms followed by a pause of 100 ms. Words were presented for 450 ms. Determiner and noun were presented together for 550 ms. The inter-stimulus interval was 100 ms. The presentation of a sentence was followed by a 1500 ms pause, after which a question mark was presented for 450 ms to signal the beginning of the comprehension question. Then, the whole comprehension question appeared on the screen for 2000 ms. After a pause of 200 ms, YES and NO appeared on the screen to signal the value assignment of the two hand-held push-buttons. Participants were given a maximum of 2500 ms to press one button. When an answer had been given or after 2500 ms, the fixation cross for the next trial appeared after a pause of 1000 ms. Participants were asked to avoid blinks and other movements during the presentation of the sentences and to restrict blinks and movements to the presentation and answering of the comprehension question. The assignment of the values YES and NO to the left and right push-buttons was crossed over participants. Prior to the experimental session, 25 practice trials were presented. The whole experiment lasted approximately 1.25 h. Including electrode preparation, an entire session lasted no longer than 2.5 h.

5.2.4. EEG recording

The EEG was recorded with 26 AgAgCL-electrodes, which were fixed at the scalp by means of an elastic cap (Electro Cap International) and placed in the following electrode sites labeled according to the nomenclature proposed by the American Encephalographic Society (Sharbrough et al., 1991): FP1, FPZ, FP2, F7, F3, FZ, F4, F8, FT7, FC3, FC4, FT8, T7, C3, CZ, C4, T8, CP5, CP6, P7, P3, PZ, P4, P8, O1, O2. The ground electrode was positioned above the sternum. The recordings were referenced against the left mastoid. The activity over the right mastoid was actively recorded and did not reveal any condition-specific variations. All recordings were re-referenced to linked mastoids offline. The vertical electrooculogram (EOGV) was recorded bipolar from electrodes placed above and below the right eye. The horizontal EOG (EOGH) was recorded bipolar from positions of the outer canthus of each eye. Electrode impedances were kept below 5 kΩ. All EEG and EOG channels were amplified using a Twente Medical System DC amplifier and recorded continuously with a bandpass between DC and 70 Hz and digitized at a rate of 250 Hz. The ERPs were filtered off-line with 8 Hz low pass for the plots, but all statistical analyses were computed on non-filtered data.

5.2.5. Data analysis

For the behavioral data, error rates and reaction times for the comprehension questions were analyzed. Incorrectly answered trials were excluded from the reaction time analysis. Reaction times and error percentages per condition and subject were used as data entries in repeated measures analyses of variance (ANOVAs), with the factors Contrast and Focus Particle.

For the ERP data, only trials that were responded to correctly entered the analysis. Trials containing occular, amplifier-saturation, or other artifacts were also excluded (EOG rejection above 40 μV). On average, less than eleven trials per condition were excluded from the averaging procedure. These were equally distributed over conditions: ON, 10.1; SN, 10.9; OF, 10.0; SF, 10.5.

The EEG data per participant and condition were averaged from the onset of the noun phrase [determiner + noun, underlined constituents in examples (12) and (13)] in the second conjunct to 1500 ms post-onset, before grand averages were computed over all participants. The averages were aligned to a 200 ms pre-stimulus baseline.

For the statistical analyses of the ERP data, ANOVAs were calculated for mean amplitude values per time window per condition. Time windows were chosen on the basis of previous studies and visual inspection of the data. To allow for a quantification of hemispheric differences, the three midline electrodes and the lateral positions were analyzed separately. For the midline electrodes, the analysis included the variables Contrast (object vs. subject), Focus Particle (containing a focus particle vs. no particle) and Electrode (FZ, CZ, PZ). Instead of the variable Electrode, the analyses for the lateral electrodes included two topographical variables: Region (anterior vs. central vs. posterior) and Hemisphere (left vs. right).

Crossing the two factors for the lateral electrodes resulted in the following six Regions of Interest (ROIs): left anterior (F7, F3, FT7); right anterior (F8, F4, FT8); left central (T7, C3, CP5); right central (T8, C4, CP6); left posterior (P7, P3, O1); and right posterior (P8, P4, O2). The statistical analysis was carried out in a hierarchical manner, i.e. significant interactions ($p < .05$) were resolved. In the presence of significant interactions, one-way ANOVAs were performed, with P values adjusted by means of a modified Bonferroni procedure (Jaccard & Wan, 1996). For interactions with one or both of the topographical factors, further analyses were conducted for each ROI. No main effects of, or interactions between, topographical factors alone are reported. In order to avoid excessive type one errors due to violations of sphericity, we applied the Huynh and Feldt (1970) correction when the analysis involved factors with more than one degree of freedom in the numerator.

5.3. Results

5.3.1. Behavioral data

With regard to error rates, a repeated measures ANOVA revealed a highly significant effect of Focus Particle ($F(1,19) = 14.39$, $p = .001$). Error rates were higher for sentences without focus particles (ON, SN) than for sentences with focus particles (OF, SF) (see Table 2).

The analysis of the reaction times revealed no significant effects (all Fs < 1).

Table 2
Error rates and reaction times for all four conditions

	ON	OF	SN	SF
Error rates (%)	7.2	6.4	7.3	4.3
Reaction times (ms)	373	372	371	368

5.3.2. ERP data

ERPs were measured from the onset of the noun phrase in the second conjunct (the replacive) to 1500 ms post-stimulus onset. Analyses of words preceding the noun phrase in the second conjunct *und nicht* (*and not*) revealed no significant effects.

Fig. 1 shows the grand averages for the sentences with object contrast (12a) and (13a), i.e., with and without focus particle (OF vs. ON). The sentences without a focus particle (ON) show a widely distributed positivity (350–1300 ms). Hypothesis HI relates to these results. Fig. 2 shows the grand averages for the sentences without focus particles (12a) and (12b), i.e., object and subject contrast (ON vs. SN). Here, the sentences without a focus particle (SN) show a widely distributed negativity (450–650 ms). Hypothesis HII relates to these data.

Last, Fig. 3 shows the grand averages for the sentences with subject contrast (12b) and (13b), i.e., with and without a focus particle (SN vs. SF). For the sentences

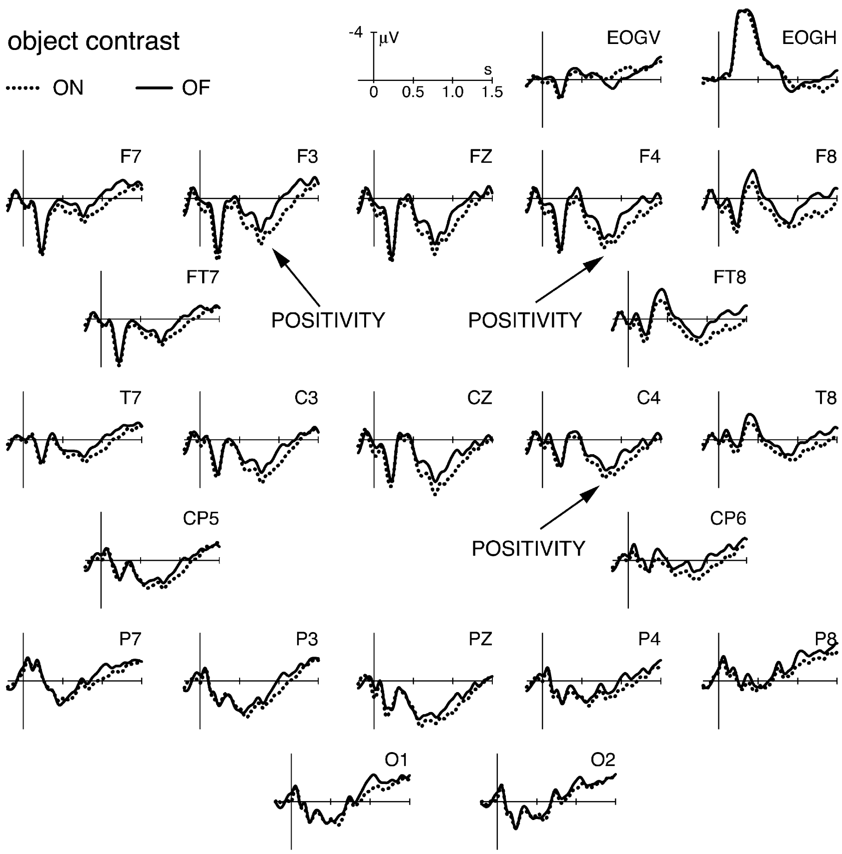

Fig. 1. Grand average ERPs elicited by the noun phrase in the replacive (onset at the vertical line) for the sentences with object contrast. Sentences with (OF) and without (ON) a focus particle are compared. Negativity is plotted upwards.

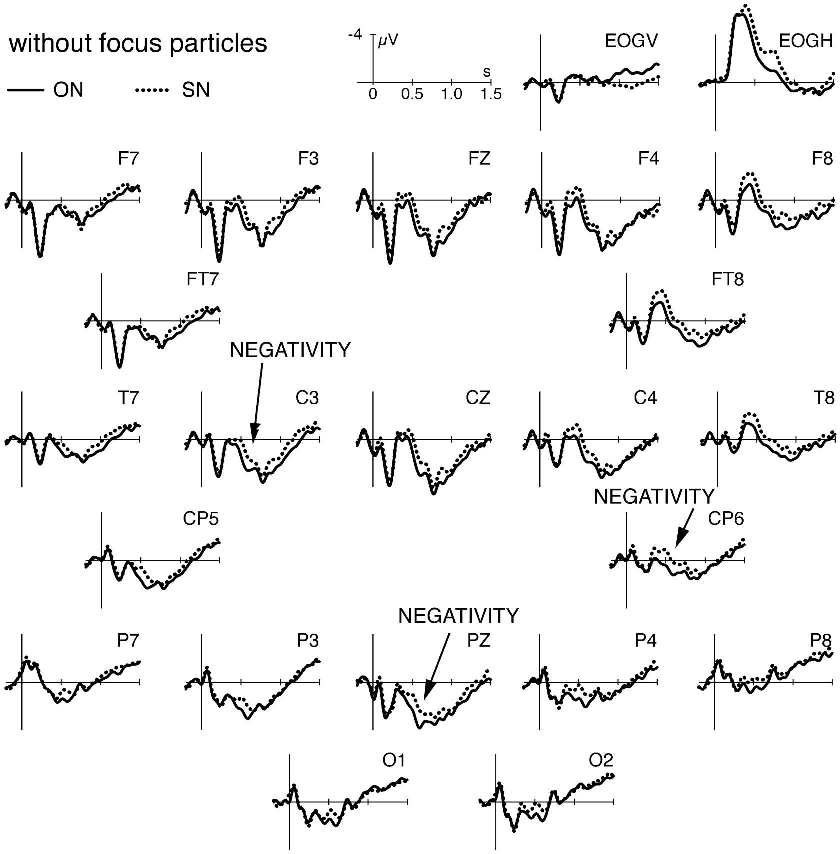

Fig. 2. Grand average ERPs elicited by the noun phrase in the replacive for the sentences without focus particles. Sentences with an object contrast (ON) are compared to sentences with a subject contrast (SN).

without a focus particle, we found a right-central negativity (450–650 ms). Hypothesis HIII relates to these data.

The grand average waveforms for the sentences with focus particles (13a) and (13b), i.e., subject and object contrasts (SF vs. OF), did not reveal any significant effects in the relevant time windows, and are therefore, not displayed separately. For the statistical analysis of the effects seen in the grand averages, two different time windows were chosen: 350–1300 ms post-noun phrase onset for the positivity and a 450-650 time window for the negativities.

5.3.2.1. 350–1300 ms. The global analysis of the lateral electrodes (see Table 3a) revealed no significant main effects, but a significant interaction between Focus Particle and Contrast ($F(1,19) = 4.27$, $p = .05$). In step-down analyses (see Table 3b), the comparison of sentences with object contrast, with and without a focus particle (ON vs. OF) showed a significant effect of Focus Particle after modified Bonferroni

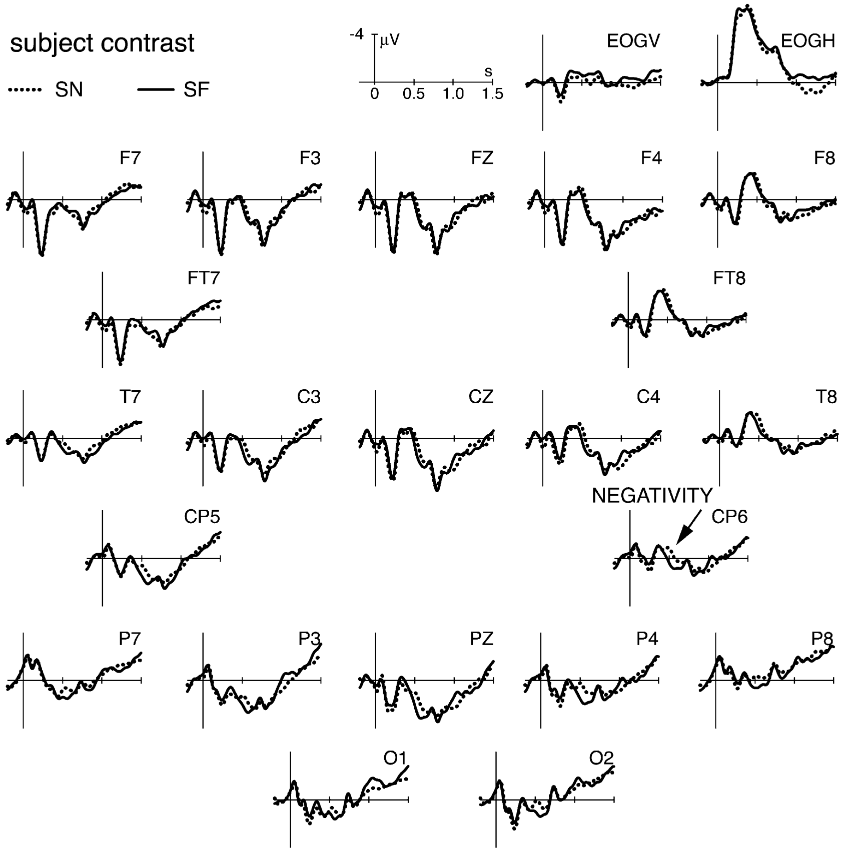

Fig. 3. Grand average ERPs elicited by the noun phrase in the replacive for the sentences with subject contrast. Sentences with (SF) and without (SN) a focus particle are compared.

correction ($F(1,19) = 9.93$, $p = .005$). The waveform was more positive-going for sentences without a focus particle (ON).

The global analysis of the midline electrodes (see Table 3c) revealed no significant main effects or interactions. In sum, the results of the first analysis covering a long time range demonstrated a highly reliable, widely distributed positivity for the sentences with object contrast and without a focus particle (ON) in comparison to sentences with object contrast and a focus particle (OF; see Fig. 1). This is the comparison for which we predicted a correlate of focus structural revision.

5.3.2.2. 450–650 ms. The global analysis of the lateral electrodes (see Table 4a) revealed a significant main effect of Contrast ($F(1,19) = 6.52$, $p = .02$) and a significant interaction of Focus Particle × Contrast ($F(1,19) = 6.65$, $p = .02$). In step-down analyses performed to dissolve the interaction between Focus Particle and Contrast (see Table 4b), the comparison of sentences without a focus particle, subject and object

Table 3a
Global analysis of the lateral electrodes, 350–1300 ms

Lateral electrodes, global analysis (350–1300 ms)	DF	*F*	*p*
Focus Particle	1,19	2.78	.11
Contrast	1,19	.31	.58
Focus Particle × Contrast	1,19	**4.27**	**.05**
Focus Particle × Region	2,38	1.21	.30
Contrast × Region	2,38	.28	.76
Focus × Hemisphere	1,19	.01	.94
Contrast × Hemisphere	1,19	.22	.65
Focus × Contrast × Region	2,38	.97	.37
Focus × Contrast × Hemisphere	1,19	.12	.73
Focus × Region × Hemisphere	2,38	.83	.41
Contrast × Region × Hemisphere	2,38	.06	.52
Foc × Contr × Reg × Hemi	2,38	.29	.69

Table 3b
Single comparisons resolving the interaction Focus Particle × Contrast for lateral electrodes, 350–1300 ms

Lateral electrodes, single comparisons (350–1300 ms)	DF	*F*	*p*
ON vs. OF	1,19	**9.93**	**.005**
ON vs. SN	1,19	2.43	.13
SN vs. SF	1,19	.07	.79
OF vs. SF	1,19	1.99	.17

Table 3c
Global analysis of the midline electrodes, 350–1300 ms

Midline electrodes, global analysis (350–1300 ms)	DF	*F*	*p*
Focus Particle	1,19	.99	.33
Contrast	1,19	1.54	.23
Focus Particle × Contrast	1,19	1.99	.17
Focus Particle × Electrode	2,38	.50	.61
Contrast × Electrode	2,38	.21	.75
Focus × Contrast × Electrode	2,38	.35	.70

contrast (ON vs. SN) revealed a significant effect of Contrast after Bonferroni correction ($F(1,19) = 8.71$, $p = .008$). The sentences with subject contrast, with and without focus particle (SN vs. SF) showed a marginally significant effect of Focus Particle ($F(1,19) = 2.83$, $p = .10$). Visual inspection of the data in this comparison showed a negativity similar to the negativity found by Stolterfoht and Bader (2004). Despite the fact that the three-way interactions between Focus Particle, Contrast, and one of the topographical factors did not reach significance, we analyzed each ROI separately to compare these two negativities (see Table 4c). We found that the effect only reached significance in one ROI: right central ($F(1,19) = 5.03$, $p = .04$).

The global analysis of the midline electrodes (see Table 4d) revealed a highly significant effect of Contrast ($F(1,19) = 8.55$, $p = .009$) and a significant interaction between Focus Particle and Contrast ($F(1,19) = 4.10$, $p = .05$). In step-down analyses (see Table 4e), a significant main effect of Contrast ($F(1,19) = 7.49$, $p = .01$) after

Table 4a
Global analysis of the lateral electrodes, 450–650 ms

Lateral electrodes, global analysis (450–650 ms)	DF	*F*	*p*
Focus Particle	1,19	.02	.90
Contrast	1,19	**6.52**	**.02**
Focus Particle × Contrast	1,19	**6.69**	**.02**
Focus Particle × Region	2,38	3.29	.08
Contrast × Region	2,38	.32	.64
Focus × Hemisphere	1,19	.08	.78
Contrast × Hemisphere	1,19	.28	.60
Focus × Contrast × Region	2,38	.16	.78
Focus × Contrast × Hemisphere	1,19	.61	.44
Focus × Region × Hemisphere	2,38	.45	.57
Contrast × Region × Hemisphere	2,38	1.41	.26
Foc × Contr × Reg × Hemi	2,38	.10	.84

Table 4b
Single comparisons resolving the interaction Focus particle × Contrast for lateral electrodes, 450–650 ms

Lateral electrodes, single comparisons (450–650 ms)	DF	*F*	*p*
ON vs. OF	1,19	5.02	.04
ON vs. SN	1,19	**8.71**	**.008**
SN vs. SF	1,19	2.83	.10
OF vs. SF	1,19	.06	.81

Table 4c
Planned comparison of SN vs. SF for each ROI for lateral electrodes, 450–650 ms

Planned comparison of SN vs. SF for each ROI (450–650 ms)	DF	*F*	*p*
Anterior, left	1,19	.00	.95
Anterior, right	1,19	.53	.47
Central, left	1,19	2.74	.11
Central, right	1,19	**5.03**	**.04**
Posterior, left	1,19	1.56	.23
Posterior, right	1,19	4.02	.06

Table 4d
Global analysis of the lateral electrodes, 450–650 ms

Midline electrodes, global analysis (450–650 ms)	DF	*F*	*p*
Focus Particle	1,19	.03	.87
Contrast	1,19	**8.55**	**.009**
Focus Particle × Contrast	1,19	**4.10**	**.05**
Focus Particle × Electrode	2,38	1.80	.19
Contrast × Electrode	2,38	.42	.61
Focus × Contrast × Electrode	2,38	.41	.63

Bonferroni correction was found only for the comparison of sentences without a focus particle, subject and object contrast (SN vs. ON).

In sum, the results for the time window between 450 and 650 ms revealed a widely distributed negativity for the sentences with subject contrast and without a focus par-

Table 4e
Single comparisons resolving the interaction Focus particle × Contrast for, midline electrodes, 450–650 ms

Midline electrodes, single comparisons (450–650 ms)	DF	*F*	*p*
ON vs. SN	1,19	**7.49**	**.01**
OF vs. SF	1,19	.01	.92
ON vs. OF	1,19	1.80	.20
SN vs. SF	1,19	1.81	.19

ticle (SN) compared to sentences with object contrast and without a focus particle (ON; see Fig. 2). For this comparison, a prosodic revision process was hypothesized. When sentences with subject contrast and without a focus particle were compared to sentences with subject contrast and with a focus particle (SN vs. SF), a marginally significant negativity that reached significance only in the right central region (Fig. 3) was observed. Here, we predicted processes of both focus structural and prosodic revision. In both time windows, we found no significant effects for the comparison between sentences with focus particles, subject and object contrast (SN vs. SF).

6. Discussion

The behavioral data show that the presence of a focus particle affected processing, and therefore, confirm our hypothesis (HIV) in which we predicted higher error rates for sentences requiring focus structural and/or prosodic revisions. As expected, error rates were significantly higher for sentences without focus particles, as for these sentences, focus structural and prosodic revision processes were predicted. These revision processes were assumed not to be necessary if focus particles assigning the prosodic structure and focus structure of the sentence are present. The reaction times revealed no significant effects, though the reaction time data may not be particularly meaningful as participants were not asked to make a speeded decision.

The ERP data show that for the comparison of the sentences with focus particles, no significant effects were found. This result confirms our assumption that revision processes were not necessary for these sentences. This result also indicates that the morphological difference between nominative and accusative case marking, and the different syntactic functions, respectively, do not play an important role in the processing of contrastive ellipses.

According to our hypotheses, we predicted two different ERP correlates on the basis of previous auditory studies: a positivity for focus structural revision (HI) and a negativity for implicit prosodic revision (HII). Overall, the ERP results confirm our hypotheses. We found a bilateral sustained positivity (350–1100 ms) as a correlate of focus structural revision. A widely distributed negativity (450–650 ms) was observed for the revision of the implicit prosodic representation. Our results fit well with the results of the auditory studies previously discussed (Hruska, 2004; Hruska et al., 2000; Johnson et al., 2003) as a negativity was found for prosodic processing, whereas a positive deflection was found for focus structural processing.

Though the polarity of the effects are comparable to those previously reported in the auditory domain, we also observed differences between auditory language comprehension and reading. The onset of the negativity appeared much earlier in the auditory studies than in the present study, and the positivity in auditory studies clearly appeared later than the positivity we observed. This is most likely an effect of modality. In auditory language comprehension, prosodic information is likely to be in the foreground, while in reading, focus structure is more salient. The explicit acoustic information realized as a missing pitch accent available in the auditory stimulus is presumably more salient than a missing accent in an implicit prosodic representation, so prosodic processes can begin earlier in response to auditory stimuli. Another difference between the two modalities seems to be the feasibility of revision processes. We argued that the effects observed in the present study reflect revision processes, i.e. changes in the prosodic and focus structural representations built up during sentence comprehension. It seems to be unlikely that the effects found in the auditory domain, where explicit focus structural and prosodic information are present, are correlates of revision processes. But what are the arguments for interpreting our results as correlates of revision processes?

With respect to the positivity, we consider a neurocognitive model of sentence processing developed by Friederici (1999, 2002), which assumes different independent stages during language processing. In this model, late positivities between ~500 and 1000 ms are correlated with the last stage of the comprehension process, during which syntactic reanalysis and the mapping of different types of linguistic information take place. This interpretation of positive ERP effects fits well with our interpretation of the positivity found in the current study. As discussed above, it is widely accepted within linguistic theory that focus-marking is part of the surface syntactic structure, and therefore it is not surprising that the correlate of focus structural revision resembles the correlate of syntactic reanalysis. The earlier onset and the slightly different distribution of the positivity in the current study (350 ms, bilateral) in comparison to the "classical" P600 (around 500 ms, parietal) is not unusual. Several studies have reported positivities for syntactic processing with an earlier onset (Mecklinger, Schriefers, Steinhauer, & Friederici, 1995; Friederici, Mecklinger, Spencer, Steinhauer, & Donchin, 2001) and different distribution (Kaan, Harris, Gibson, & Holcomb, 2000; Friederici, Hahne, & Saddy, 2002). The latency of positivities has been attributed to the relative ease of detection and the necessity of reanalysis.

However, in the light of recent findings that semantic and plausibility violations can also elicit a P600 (see van Herten, Kolk, & Chwilla, 2005; van Herten, Kolk, Chwilla, & Vissers, 2004), a one-to-one correspondence between the P600 and syntactic processing has been questioned. Rather than reflecting syntactic processing, the positivity found in the present study could be related to the mapping of different types of linguistic information (see Friederici, 1999, 2002). Under the assumption that focus-marking is not part of the syntactic structure, but has a representational level of its own (see e.g., Lambrecht, 1994; Erteschik-Shir, 1997), the positivity might reflect difficulties with the mapping of the focus structural representation with syntactic structure and semantic interpretation.

Regarding the negativity found in our study, also two possible explanations are available. In parallel to the auditory studies, the negativity might reflect integration problems due to a mismatch between the expectation of an object replacive driven by the default accent on the object and the actual subject replacive requiring an accent placed on the subject. However, evidence against this explanation comes from a study by Stolterfoht, Friederici, Alter, and Steube (2004) who presented contrastive ellipses auditorily and did not observe a negativity. Instead, a late posterior positivity was reported for sentences with a contrastive accent on the object continued by a subject replacive. The positivity was interpreted as a reflection of integration difficulties of the prosodic information given and the syntactic function of the replacive. The alternative explanation, i.e., that the negativity is a correlate of a revision process, gets support from studies by Hopf, Bayer, Bader, and Meng (1998) Bornkessel, McElree, Schlesewsky, and Friederici (2004), in which negativities for the reanalysis of garden-path sentences are reported.

In the comparison for which we predicted correlates of both prosodic and focus structural revision in (HIII), we found only a small locally restricted right-central negativity (450–650 ms). This may be the result of overlap of the ERP components. The correlates of focus structural and prosodic processing are reverse in their polarity and overlap temporally. Another reason for this finding might be an interaction between focus structural and implicit prosodic processing. Further experiments will have to be performed to explore the precise relationship between implicit prosodic and focus structural processing. The right-central negativity we report resembles the negative component (500–600 ms) that was found by Stolterfoht and Bader (2004) for the processing of non-canonical word order. This seems to support the speculation by Stolterfoht (2005) that for the processing of scrambled sentences, both focus structure and accent placement have to be revised.

With regard to the other two reading studies using ERPs, the difference in the design of the experiments might explain why the results in those studies differ from the present results. Cowles (2003), who found a negativity, interpreted this effect as a “kind of N400” (p. 135) and argues that prior context causes the participants to form expectations about which of the referents can appear in the contrastively focusing it-cleft. No comparable semantic mismatch between the contextually driven expectation and the phrases in focused position was at hand in the present study and the study by Bornkessel et al. (2003) who found a positivity at phrases focused (and accented) by preceding wh-questions. Further research can hopefully shed light on the ERP correlates of focus structural and prosodic processes driven by contextual information and the same processes during the revision of a default structure.

In conclusion, we were able to show that the highly interconnected processes of accent placement and focus marking clearly have different neurophysiological correlates. The present study questions the interpretation of results obtained in earlier reading studies in terms of focus structure only. We also suggest that more precision in future research on information structural processing can tell us more about how focus structure and prosodic processes are related in processing. In addition to the assignment of focus during reading, accent placement is an obligatory process and plays an important role in the comprehension of written language.

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