

# Focus particles and prosody processing in Dutch: Evidence from ERPs

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## Abstract

The present ERP study investigated the effect of focus particles on Dutch sentence processing. Focus particles such as *only* are claimed to indicate focus constituents and can thus affect the interpretation of pitch accents during speech comprehension [1]. Our results show that contrastive pitch accents are unexpected in sentences *without* a focus particle and triggered a fronto-central positivity, most likely a P300. For sentences *with* a focus particle, however, there was no processing difference between accented and unaccented elements at the object noun phrase (NP) right adjacent to the focus particle. However, in a later position in the sentence, a contrastive pitch accent on the preposition NP triggered positivities resembling either P300- or P600-effects. We interpret the results as evidence that focus particles generate strong expectations for an accented focus constituent, which then 'neutralizes' the processing of an upcoming pitch accent that would normally be unexpected. The late positivity that is present at the preposition NP presumably indicates re-interpretation of the focus structure and the scope of the particle needed for the accommodation of the pitch accent.

## 1. Introduction

In Germanic languages, prosody is assumed to function as a marker of information structure. That is, the most informative elements (i.e., focus) in an utterance are prosodically most prominent whereas less informative elements are prosodically unmarked. Generally, the information structure of an utterance is determined by the preceding discourse context and is reflected in prosody. The expectation of such focus-accent correspondence is well established in speech comprehension in Dutch [2]. Moreover, recent production studies on Dutch have examined that the acoustic characteristics of pitch accents differ with respect to the focus domain they denote [3]. While broad focus accents have the most neutral shape, the high prosodic prominence of contrastive pitch accents is achieved phonetically by a hyperarticulation of the falling gesture of the H\*L accent (i.e., a deeper valley) [3]. Dutch listeners have also been shown to be sensitive to the special status of contrastive pitch accents: They are perceived as prosodically most prominent and allow a reconstruction of the preceding discourse [4].

In some cases, however, there is no contextual information that can indicate the information structure of an utterance. Such out-of-the-blue sentences have a neutral focus structure in which each element is equally informative. Theoretically, the final element has been assumed to represent the default focus that 'projects' over the whole sentence. However, empirical studies have questioned the default focus and shown that there is no final-focus bias for focus identification in isolated sentences [5]. Listeners have been found to rely on phonetic cues for focus identification.

The difficulties with focus structure assignment in isolated sentences may arise due to the lack of contextual expectations (but see [5] for general focus identification difficulties in the context). Hence, if isolated sentences contain focus particles such as *only*, focus expectations may be elicited even if a context is lacking. The position and distance of the focus particle and the focus element can vary (cf. 1a-c). As a result, it is unclear how listeners' expectations about the focus particle's scope are shaped. Note that for the Dutch particle *only*, various combinations are possible [6] such as an adjacent (1c) as well as an extrapolated focus element (1d).

- (1a) Only the WINNER received a bonus.
- (1b) The WINNER only received a bonus.
- (1c) The winner only RECEIVED a bonus.
- (1d) The winner only received a BONUS.

Very little is known about the processing of focus particles in spoken language. The current study addresses the question whether focus particles modify the processing of isolated sentences by creating narrow focus expectations.

## 2. Processing focus particles and prosody

Recent behavioral experiments have shown that sentences with focus particles such as *only* demand a higher semantic processing demands than sentences without focus particles [7]. The interpretation difficulties of sentences with focus particles have been attributed to the additional costs necessary for the establishment of sets of alternatives that is triggered by the contrastive semantics of *only* [7]. Moreover, it has been suggested that adult English speakers activate a set of alternatives in the case of *only* whereas children do not [7].

Neuro-imaging studies on the processing of focus particles are scarce. In an ERP experiment on German [1], focus particles have been shown to elicit an expectation for a pitch accent on a directly adjacent element. Incongruous prosodic realization in sentences with a focus particle arises when both elements, right- and left-adjacent to a focus particle, receive an identical prosodic marking (i.e., both are accented or both are unaccented, cf. *Peter PROMISED only ANNA* vs. *Peter promised only anna*). Such incongruous accents were shown to trigger positive fluctuations in the ERP. However, it remains unclear whether the processing of the prosodic mismatches tested in that study can be directly related to the processing of the focus particle. It is possible that the accentual over- and underspecification in the experimental stimuli is incongruous even in the absence of a focus particle.

Yet another ERP experiment on German [8] provides insights into the processing of contrastive pitch accents in isolated sentences as compared to contrastive pitch accents in a discourse context. The behavioral results of the study show that listeners (by 92%) consider a contrastive accent in an isolated sentence inappropriate. Furthermore, the authors

suggest that the processing of contrastive accents in isolated sentences does not resemble the processing of pitch accents in context. Pitch accents in isolated sentences do not elicit early negative components related to the processing of expected (congruous) pitch accents in the context. In other words, listeners expect a neutral prosody in isolated sentences. However, no specific ERP effect has been found as a correlate of inappropriate contrastive accents in isolated sentences. In our current experiment, we investigate the neural correlates of contrastive prosody processing in isolated sentences with and without the focus particle *only*.

### 3. The Experiment

#### 3.1. Participants

Thirty-five right-handed Dutch participants (9 male, age 18-29, mean 20.5) were paid to participate in the EEG experiment after signing an informed written consent. None of them reported any neurological, psychiatric, hearing or language impairment. Five participants were excluded due to a significant data loss (more than 40% on any given electrode). We report results from the remaining thirty participants.

#### 3.2. Stimuli

Experimental materials were 120 items that were recorded in all four conditions (480 sentences in total, see Table 1). Each participant received a list of 120 items with 30 instances of each condition. None of the participants listened to more than one version of each sentence, and every participant listened to all experimental stimuli in a pseudo-randomized order.

Stimuli were recorded by a female speaker in an acoustically shielded studio at the University of Groningen. Sentences *without* a focus particle were recorded as an answer to a wh-question in lieu of the stimulus' naturalness and cut out of the dialogue. Sentences *with* a focus particle were recorded in isolation. Experimental sentences were pronounced as a single intonational phrase without any disruptions such as hesitations. Stimuli were normalized in loudness and were presented as single isolated sentences.

Table 1: *Experimental conditions. Contrastive pitch accents are displayed in capitals.*

		Focus Particle (1/ 2)
Accent on (a/ b)	<b>1. no focus particle</b>	
	1a Object NP	They gave a BONUS to the player.
	1b Preposition NP	They gave a bonus to the PLAYER.
	<b>2. with a focus particle</b>	
	2a Object NP	They gave <i>only</i> a BONUS to the player.
	2b Preposition NP	They gave <i>only</i> a bonus to the PLAYER.

In each list, half of the sentences (n=60) did not contain a focus particle (1) while the other half of the sentences had the focus particle *only* (2). For each of these subgroups, either the object noun phrase (NP) (i.e., *bonus*, n=30) or the preposition NP (i.e., *player*, n=30) was pronounced with a contrastive pitch accent. The position of *only* was always prior to the direct object (see Table 1), which is grammatical in (2a) and acceptable in (2b).

All sentences were matched for length, sentence plausibility, sentence structure and average word frequency for target NPs (CELEX corpus [9]). All target NPs had a lexical stress on the first syllable. This allowed us to time-lock the ERP waveforms to the target word's onset. Note that sentences

with a focus particle were always one word longer (i.e., by the particle *only*) than the corresponding sentences without a focus particle.

#### 3.3. Acoustic analysis

We measured the duration and maximum and minimum fundamental frequency (f0) for accented and unaccented object NPs and for *only*. We compared the acoustic data for sentences with and without focus particles.

Table 2: *Acoustic data for direct objects.*

	duration (ms)	f0 min (Hz)	f0 max (Hz)
<b>1. Object NP in sentences without a focus particle</b>			
(1a) accented	359	165	253
(1b) unaccented	272	184	212
<b>2. Object NP in sentences with a focus particle</b>			
(2a) accented	399	186	273
(2b) unaccented	314	191	223
<b>Focus particle <i>only</i></b>			
(2a) accented	218	215	247
(2b) unaccented	213	201	220

As Table 2 shows, accented object NPs have a longer mean duration and a higher fundamental frequency than unaccented ones. Contrastive pitch accents had an H\*L contour, which is typical for Dutch focus accents [3].

#### 3.4. Procedure

Once the electrodes were applied, participants completed a trial session and then performed the actual experiment (divided in two blocks with 60 sentences each). To minimize the awareness with the experimental conditions, participants first listened to a block of sentences without focus particles (1a-b). In the second block, all sentences with focus particles (2a-b) were presented. During the auditory stimulus presentation (via loudspeakers), participants were instructed to fixate a cross on the screen in order to minimize blinking and movement. The fixation cross was displayed at the beginning of each trial and lasted until the end of the trial. After a delay of 100 ms, a single sentence was presented for 2 seconds on average and followed by 1500 ms silence. Then, in some of the trials a word was displayed on the screen and participants were asked to judge its semantic relatedness to the presented sentence. Correct and incorrect trials were counterbalanced. After a response given by a button press, a blinking period of 2000 ms was initiated. The purpose of this comprehension task was to guarantee participants' attention to the meaning of the stimuli.

#### 3.5. EEG recording and analysis

The EEG was recorded from an elastic cap with 64 Ag/AgCl electrodes according to the International 10-20 system (Electro Cap International). Electrodes were referenced online to the average of all electrodes and re-referenced offline to the algebraic average of left and right mastoid electrodes. Impedances were kept below 5  $\Omega$ . The EEG was digitalized online with a sampling frequency of 250 Hz and filtered offline with a band-pass filter of 0.01 – 30 Hz. After data inspection, trials containing movement artifacts, ocular artifacts or electrode drifts were rejected. If data loss for one or more analyzed electrodes in at least one condition exceeded 40%, the data from this participant were discarded. On the basis of the exclusion criteria, five participants were discarded.

We time-locked ERP waveforms to the onset of the object and preposition NP in each sentence. Word onset was identical to the onset of the lexically stressed and accented syllable. Sentences with *only* differed from sentences without *only* even before the onset of the direct object (e.g., a focus particle was present vs. absent). In order to account for differences emerging prior to the onset of the target word, we performed a baseline correction relative to a 0 to 100 ms stimulus baseline *within* the target word. We computed average voltages from 0 to 1300 ms post-stimulus onset.

### 3.6. Results

The determination of time-windows for statistical analysis was achieved by visual inspection of the data and by analysis of 26 subsequent 50-ms-bins performed for each segment's duration (ranging from 0 to 1300 ms). The analyses showed differences between the conditions in an early (200-350 ms) and a late (500-700 ms) time window. All further analyses were performed for both time windows and for object NPs (*bonus*) and preposition NPs (*player*).

We computed repeated measures ANOVAs for both identified time windows and separately for lateral and midline electrodes. For lateral electrodes, ANOVAs were calculated with four within-subject factors *Accent* (accented vs. unaccented element), *Focus Particle* (with focus particle vs. without focus particle), *Topography* (frontal vs. central vs. parietal regions), and *Lateralization* (left vs. right sites). For ANOVAs on midline electrodes, all factors were included except for *Lateralization*. All reported *p* values are adjusted with the Huynh-Feldt correction for nonsphericity. Single electrodes were grouped in Regions of Interests (ROIs): frontal, central, and parietal, which were also divided in left and right for the lateral electrodes. All statistical tests were performed on mean voltage values.

#### 3.6.1. Results in the 200 – 350 ms time window

**Object NP.** We found a main effect of focus ( $F(1,29)=13.744$ ,  $p=.001$ ) which showed that sentences with a focus particle were more positive than sentences without a focus particle. Moreover, there was a three-way interaction between *Focus Particle*, *Accent*, and *Lateralization* for lateral electrodes ( $F(1,29)=4.996$ ,  $p<.05$ ). Follow-up analyses showed an interaction between *Accent* and *Lateralization* only for the no-particle condition ( $F(1,29)=19.411$ ,  $p<.001$ ) but not for the particle condition ( $p=.193$ ). Post-hoc tests revealed that the effect of *Accent* was significant on right sites ( $F(1,29)=13.740$ ,  $p=.001$ ) but not on left sites ( $p=.365$ ). Hence, accented object NPs elicited positive ERP waveforms on right sites in sentences without a focus particle. By contrast, there was no effect of *Accent* for sentences with a focus particle: Accented objects were not processed differently than unaccented ones. For midline electrodes, in addition to the abovementioned main effect of *Focus Particle* ( $p<.01$ ), there was a main effect of *Accent* ( $F(1,29)=5.162$ ,  $p<.05$ ), indicating that accented elements elicit more positive waveforms than unaccented ones.

**Preposition NP.** There was only a marginal main effect of *Focus Particle* ( $p=.073$ ) and no interactions where both factors *Focus Particle* and *Accent* were involved. We observed an interaction between *Accent* x *Lateralization* for lateral electrodes ( $F(1,29)=14.529$ ,  $p=.001$ ). Post-hoc tests showed a significant effect of *Accent* for both left sites ( $F(1,29)=11.850$ ,  $p<.01$ ) and right sites ( $F(1,29)=26.358$ ,  $p<.001$ ).

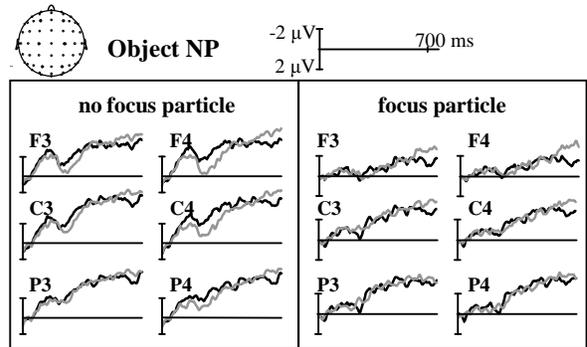


Figure 1: Effect of Accent for object NPs in sentences without 'only' (left) and with 'only' (right). Accented (grey line) versus unaccented object NPs (black line).

Accented preposition NPs triggered more positive waveforms than unaccented preposition NPs on both left and right regions and irrespective of the presence of a focus particle in the sentence. Moreover, an interaction between *Accent* and *Topography* ( $F(2,58)=13.866$ ,  $p<.001$ ) indicated that the effect of *Accent* was significant only on frontal ( $F(1,29)=31.153$ ,  $p<.001$ ) and central regions ( $F(1,29)=25.106$ ,  $p<.001$ ), but not on parietal regions ( $F(1,29)=2.766$ ,  $p=.107$ ). For midline electrodes, there was an interaction *Accent* x *Topography* ( $F(2,58)=15.538$ ,  $p<.001$ ) which revealed that accented prepositional objects were more positive than unaccented ones on frontal ( $F(1,29)=36.634$ ,  $p<.001$ ) and central sites ( $F(1,29)=27.828$ ,  $p<.001$ ) and marginally significant on parietal sites ( $p=.066$ ). The interaction between *Focus Particle* x *Topography* ( $F(2,58)=5.702$ ,  $p<.05$ ) revealed that sentences with focus particles triggered more negative waves on frontal sites ( $p<.01$ ) while no effect was found for central and parietal regions ( $p>.05$ ). The effects are displayed in Figures 1 and 2.

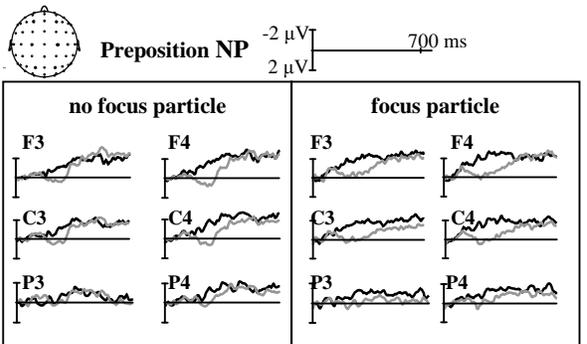


Figure 2: Effect of Accent for preposition NPs in sentences without 'only' (left) and with 'only' (right). Accented (grey line) vs. unaccented object NPs (black line).

#### 3.6.2. Results in the 500 – 700 ms time window

**Object NP.** We found a main effect of *Focus Particle* ( $F(1,29)=11.946$ ,  $p<.01$ ) indicating that sentences with a focus particle were more positive than sentences without a focus particle. There were no interactions between *Focus Particle* x *Accent*. We observed only a two-way interaction between *Focus Particle* x *Topography* ( $F(2,58)=3.928$ ,  $p<.05$ ) which revealed that sentences with a focus particle triggered more positive ERP fluctuations on frontal ( $F(1,29)=6.766$ ,  $p<.05$ ) and central sites ( $F(1,29)=19.159$ ,  $p<.001$ ), but not on parietal sites ( $p=.148$ ). The analysis of midline electrodes revealed the same results.

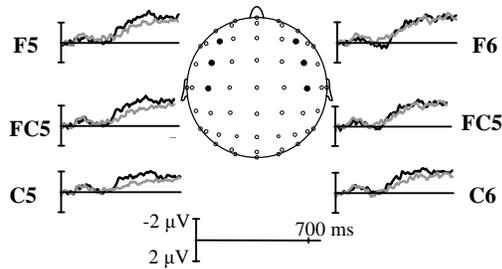


Figure 3: Effect of Focus for accented preposition NPs in sentences with focus particles (grey line) as compared to sentences without particles (black line).

**Proposition NP.** We found a four-way interaction between *Focus Particle*, *Accent*, *Topography* and *Lateralization* ( $F(2,58)=3.855$ ,  $p<.05$ ) which was caused by an interaction of *Focus Particle*, *Topography* and *Lateralization* only for accented preposition NPs ( $F(2,58)=4.555$ ,  $p<.05$ ) but not for unaccented preposition NPs ( $p=.412$ ). Follow-up analyses showed a marginal interaction of *Focus Particle* x *Lateralization* for frontal regions ( $p=.076$ ) and no interaction for central ( $p=.434$ ) or parietal ( $p=.358$ ) regions. Post-hoc tests performed on frontal ROIs in the accented condition revealed that there was a trend for left lateralization ( $p=.122$ ) for the observed effect. Thus, only in case of accented preposition NPs, sentences with focus particles gave rise to frontal positivities as compared to sentences without focus particles (Figure 3). No effects were significant for midline electrodes.

#### 4. Discussion

The current experiment investigated whether focus particles such as *only* generate expectations of upcoming pitch accents in isolated sentences. Moreover, we tested whether listeners process sentences without focus particles based on their expectations of default accentuation in neutral focus sentences.

Our results show that, in sentences without a focus particle, listeners do not accept contrastive pitch accents on either object NPs or preposition NPs. That is, in both positions a fronto-central P300 is elicited (200-350 ms) for the processing of accented elements relative to unaccented ones. Previous studies [10] have suggested that prosody-related P300 effects arise as a surprise due to the incongruous accentuation in the context. We relate the fronto-central topography of the P300 to the processing of (prosodically) unexpected events: Contrastive accents are not expected in isolated sentences because no context is available to support the interpretation of their strong prominence which may involve the computation of a contrastive set of alternatives.

Importantly, in sentences with a focus particle, no such difference between accented and unaccented direct objects was found. Such a result supports the assumption that contrastive focus particles trigger on-line expectations of upcoming contrastive pitch accents. Thus, after *only*, a contrastive pitch accent on the object NP is expected and no P300 is elicited. However, one would have predicted a surprise effect for the *lack* of a contrastive accent after *only*, but we did not observe any difference for the processing of the missing accent. We will address this issue after considering the preposition NP.

In sentences *with* focus particles, accented preposition NPs triggered P300 effects similar to preposition NPs in sentences without focus particles. Moreover, accented preposition NPs elicited a late frontal positivity (500-700 ms) in sentences with *only* as compared to unaccented preposition

NPs. This late positivity may belong to the P600 family that indicates processes of re-interpretation or re-analysis. As mentioned earlier, an accent on the preposition NP may require additional processing due to the re-analysis of the preferred focus structure (adjacent particle and focus) to a less preferred one (extrapolated particle and focus).

There may, however, exist an alternative explanation for finding this rather unexpected late positivity. Since there is no effect for the missing accent on direct objects after *only* (*They gave only a bonus to the PLAYER*), we suggest that listeners may 'fill in' a prosodic prominence after the focus particle (i.e., on *bonus*) even though they do not perceive any. Alternatively, the focus marker *only* may be sufficient for the appropriate contrastive interpretation of the upcoming object regardless of the presence of a contrastive pitch accent on it. Later in the sentence, the prosodic mismatch (missing accent on object NP) might become obvious to the listeners once they perceive the high prosodic prominence on the preposition NP. In this case, a re-analysis of the 'filled-in' prosodic prominence and focus particle's scope is elicited.

In sum, the current experiment provided evidence that the presence of contrastive pitch accents in isolated sentences violates listeners' expectations for neutral accentuation (eliciting a fronto-central P300). However, if a focus particle is present, it immediately generates expectations and interpretations of upcoming elements as contrastive (no P300 for adjacent accented and unaccented objects). Finally, even in sentences with *only*, contrastive pitch accents on prepositional objects remain infelicitous and elicit additional re-analysis processes (P600), presumably reflecting re-interpretation of the particle's scope and the focus structure of the sentence.

#### 5. References

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