

# WHAT CAUSES THE ACTIVATION OF CONTRASTIVE ALTERNATIVES, THE SIZE OF FOCUS DOMAIN OR PITCH ACCENT TYPE?

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Theories of information structure argue that focus involves alternative sets; experimental studies have also shown that narrowly focused constituents lead to the activation of alternatives. However, narrow focus can be realized with different accent types, indicating the information status of the referent and it is unclear whether it is focus domain or accent type that conditions the activation of alternatives. In two visual-world eye-tracking experiments in German, we compared narrow focus conditions (Exp1: L+H\*, Exp2: H+L\*; narrow focus realized on the subject constituent) to a broad focus condition. We analysed participants' fixations to words that are contrastively related to the accented word while they processed the utterance.

Results showed that contrastive associates were not generally fixated more in narrow focus conditions, but only when the narrow focus is realized with an L+H\* accent, suggesting that accent type plays a stronger role than focus domain in the activation of contrastive associates.

**Keywords:** information structure, intonational meaning, focus, contrast, eye-tracking, German

## 1. INTRODUCTION

What many researchers agree on is that each utterance contains an information-structural focus, which may include single words (narrow focus, NF) or larger phrases (broad focus, BF), cf. [12, 18, 19]. In the semantic literature, focus is defined in terms of the presence of alternatives that are relevant for interpretation [17, 23]. According to [23], the "focus semantic value of a sentence is a set of alternatives from which the ordinary semantic value is drawn, or a set of propositions which potentially contrast with the ordinary semantic value" (p. 76). Clearly, this set of alternatives is smaller and more homogenous for narrow focus than for broad focus constituents.

It is an open question, however, whether the type of pitch accents of the narrow focus constituent is relevant for establishing alternative sets, too. Accentual realizations are expected to play a role, considering that accent types contribute to a referents' information status [10, 22, 24]. Clear cases are nuclear L+H\*, which supposedly signals

new/contrastive information and H+L\*, which indicates that the referent is discourse-old and inferable [2, 16, 26].

There are some psycholinguistic studies that claim that alternatives play a role in the processing of narrow focus constituents [5, 14] and in processing focus particles [8, 9]. [5] for instance, conducted a cross-modal priming experiment in Dutch to test the activation of alternatives to utterance-final words in narrow focus and in broad focus utterances. Listeners performed lexical decision tasks to visually presented target words (e.g., *pelican*) after they heard sentences in which the final word was related or unrelated to the targets (e.g., *flamingo* or *celebrity*). The prime words were either produced as narrow focus (nuclear H\*+L accent according to ToDI cf. [11]) or as focus exponent of a broad focus realization (nuclear !H+L\*). Results showed that lexical decision times were modulated by focus structure: there was a priming effect (faster reactions to visual targets after related than unrelated primes), but only when the primes were produced as narrow focus (and not when they were produced as part of a broad focus). These reaction time analyses suggest that the activation of contrastive alternatives is possible, but only for narrow focus constituents. Note that this effect of focus condition was not observed when the visual targets had a non-contrastive, associative relation to the auditory primes (e.g., *flamingo-pink*). This further suggests that the priming effect for contrastive associates is very specific and most likely caused by the semantic contribution of the respective pitch accent types (contrastive vs. non-contrastive). Similar results were found in an experiment on English, in which the prime words also occurred in phrase-final position [14].

These results suggest that listeners decode focus structure from prosodic realization and that alternatives to words in narrow focus become salient but they do not allow us to conclude that narrow focus generally leads to the activation of alternatives: First, since the prosodic realization of the entire utterances differed (prior to the prime and the prime itself), we do not know whether the results from phrase-final primes generalize to different

positions in the phrase. Second, since focus structure (narrow vs. broad) was co-varied with pitch accent type, it is unclear which factor contributed to the priming effect.

To tease apart the contribution of focus domain and pitch accent type, we designed two visual world eye-tracking experiments with printed words in German [21, 25]. To exclude prosodic effects prior to the target words, we tested narrow focus accents in phrase-initial position (Exp. 1: L+H\*, Exp. 2: H+L\*), realized on the subject-noun. The processing of these narrow focus realizations was compared to a control condition produced as a broad focus (with a default non-contrastive rising accent on the subject constituent). We monitored participants' fixations to contrastive associates (e.g., *dancer* upon hearing *gymnast*) while they processed the utterance.

If narrow focus leads to the activation of alternatives, we should see more fixations to contrastive associates in both narrow focus conditions compared to the control condition, already while the subject constituent is processed. If participants are sensitive not only to the focus structure but also to the semantic contribution of the pitch accent type (new/contrastive in Experiment 1 and given/inferable in Experiment 2) we expect differences in fixation patterns only in Experiment 1.

## 2. EXPERIMENT 1

In Experiment 1 we compared the processing of subject nouns with a contrastive narrow focus accent (nuclear L+H\* according to GToBI [10]) to those with a non-contrastive accent (prenuclear L+H\*), recorded as a broad focus. Note that GToBI assigns the same label to both realizations, although the L+H\* nuclear accent has an earlier peak, a larger f<sub>0</sub>-excursion, a longer duration and a steeper fall than the prenuclear L+H\* accent (cf. Figures 1 and 2).

### 2.1. Methods

#### 2.1.1. Participants

Forty native speakers of German between 18 and 29 years (av. 21.5 years, 32 female) participated for a small fee. They were unaware of the purpose of the experiment. All reported to have normal hearing and normal or corrected-to-normal vision.

#### 2.1.2. Materials

The experiment comprised 48 trials, 24 experimental and 24 filler trials. All utterances started with a subject-constituent, followed by a disyllabic

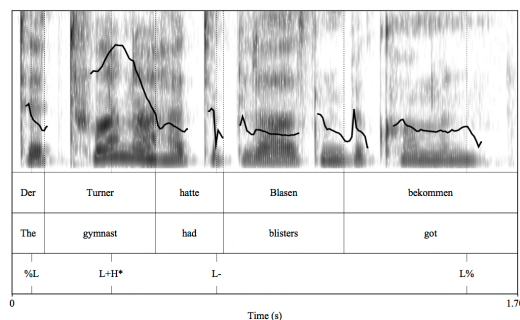
auxiliary (e.g., *wollte* 'wanted to'), an object noun and a non-finite verb (e.g., *Der Turner hatte Blasen bekommen* 'The gymnast had gotten blisters'). All of the subject-constituents carried penultimate stress and consisted of two to four syllables.

The words for the visual display in experimental trials were compiled as follows. For each of the subject nouns, we selected two nouns, one that was contrastively related to the subject and one that was non-contrastively related. They were gathered in two web experiments (free association task and continuation task). In the former, participants typed in the first word that came to their mind after seeing the subject noun, in the latter, they completed a fragment like 'Not the gymnast had gotten blisters but the...'. We chose the most frequent responses as contrastive and non-contrastive associates, respectively, if they differed from each other, were no onset competitors and had similar word lengths and lexical frequencies [factors that are known to affect fixation behaviour, cf. 6, 15]. When the most frequently named associates were too different in lexical frequency or number of characters, we chose a less frequently named associate as visual target.

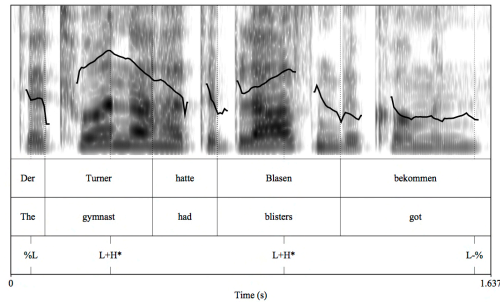
Each trial contained four visually presented words: the experimental trials showed the contrastive and non-contrastive associate, the grammatical object that had to be clicked as well as an unrelated distractor. Filler trials displayed the contrastive associate, the grammatical object that had to be clicked, a word that was non-contrastively related to the object and an unrelated distractor. The four words in any given trial differed in onset letters, but had comparable lengths and lexical frequencies.

The utterances were recorded by a phonetically trained female speaker of German in a sound-attenuated cabin (44.1 kHz, 16 Bit). She recorded all experimental sentences as pairs, once with the contrastive narrow focus accent (NF) and subsequent deaccentuation (nuclear L+H\* L- see Fig. 1) and once realized as broad focus (BF, see Fig. 2).

**Figure 1:** Example realization with a narrow focus (NF) accent on the subject constituent (f<sub>0</sub> is shown between 100 and 300 Hz in all figures).



**Figure 2:** Example realization of the broad focus control condition (BF).



The filler trials were all recorded as broad focus utterances. All sentences in the experiment were preceded by the prelude ‘Ich habe gehört’ (*I have heard*), to naturally increase the preview time for the words [13].

### 2.1.3. Procedure

Participants were tested individually in a sound attenuated room at the University of Konstanz. They were instructed to listen to the utterances and to click on the object that was mentioned therein as quickly as possible.

Participants sat at a distance of approximately 70 cm from a 20 inch LCD screen, so that they could freely move the computer mouse. Their dominant eye was calibrated with an SMI Eyelink 1000 Plus system (sampling rate: 250 Hz). Auditory stimuli were presented via headphones (Beyerdynamic DT-990 Pro) at a comfortable loudness.

Intonation condition was manipulated according to a Latin-Square Design (12 trials for each intonation condition for each participant, realized on different items). Across the experiment, the position of each of the different types of printed words on screen was balanced (upper left and right, lower left and right). Two basic experimental lists with 48 trials were constructed. They were pseudo-randomized four times with the restriction of at most three experimental trials in a row (but at most two of the same intonation condition). After each block of five trials, an automatic drift correction was initiated. In total, we had eight experimental lists, to which participants were randomly assigned (five participants per list).

Every trial started with a fixation cross in the middle of the screen, which was shown until participants clicked on it. In all trials, the same token of the prelude (with a duration of 897ms) was used. This was followed by a 1000ms silence after which the target sentence was auditorily presented. After participants had clicked on the object mentioned in the target sentence, there was a 1000ms inter-trial

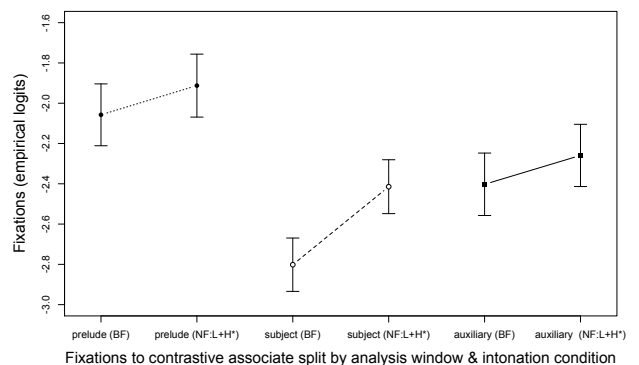
interval. Eye-movement data (fixations, blinks, saccades) were recorded throughout the experiment.

## 2.2. Results

The eye-tracking data were extracted in 4ms steps. Fixations were automatically coded as pertaining to a given word if they fell within a square of 100 x 100 pixels, centred on the middle of that word. We analysed participants’ fixations in three lexically determined analysis windows: while they processed the prelude, the subject noun and the auxiliary. The start and end of each analysis window was calculated for each item individually, based on manual annotations of the respective acoustic landmarks (start and end of the subject-NP as well as the end of the auxiliary). A delay of 150ms was added to each acoustic landmark to reflect the time it takes to plan a saccade following auditory input [20].

The statistical analyses followed the proposal in [1]. We calculated the empirical logits of fixations to the contrastive and non-contrastive associate for each of the three analysis windows (dividing fixations to that word by fixations that were directed elsewhere and taking the logarithm). Empirical logits were then analysed using linear mixed effects regression models with intonation condition as fixed factor and random intercepts and slopes for participants and items [1]. Non-significant terms were removed. To ensure the validity of the model, data points with residuals beyond 2.5sd of the mean were removed and the model was refitted. P-values were calculated using the Satterthwaite approximation in the R-package lmerTest.

**Figure 3:** Average empirical logits of fixations directed towards the contrastive associate in Experiment 1. Whiskers show +/- 1 standard error.



While participants processed the subject noun, there was a significant effect of intonation condition ( $\beta = 0.40$ , 95%CI: [0.03;0.77], SE = 0.18,  $t = 2.2$ ,  $p < 0.05$ , see middle line of Fig. 3). Participants fixated the contrastive associate more when the

subject was produced as narrow focus (nuclear L+H\*) than as part of a broad focus (prenuclear L+H\*). There was no effect of condition during the processing of the prelude and the auxiliary (both p-values > 0.5), see left and right lines of Figure 3. No differences were found for non-contrastive associates (all p-values > 0.5; not shown).

### 2.3. Discussion

The eye-tracking data showed clear differences between focus conditions in participants' fixation behaviour to the contrastive associate, while they processed the subject. In the narrow focus condition (with a contrastive nuclear L+H\* accent on the subject), participants fixated more on the contrastive associate than in the broad focus condition. The results hence extend earlier findings, showing that narrow focus constituents with an L+H\* accent result in the activation of alternatives, irrespective of utterance position. These results moreover show that listeners quickly distinguish prenuclear and nuclear L+H\* in online processing.

## 3. EXPERIMENT 2

In Experiment 2, we compared the processing of subject nouns, in which the narrow focus was realized as non-contrastive nuclear H+L\* to the broad focus realization of Experiment 1. The procedure and analysis were identical to Experiment 1.

### 3.1 Methods

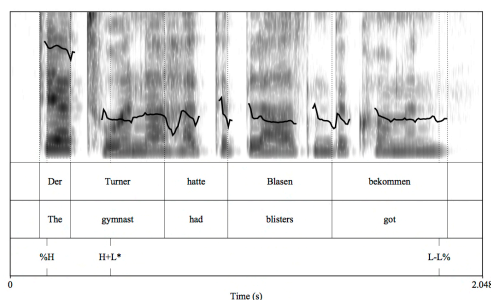
#### 3.1.1. Participants

Another set of 40 participants, aged between 19 and 33 years (av. 25.7 years, 28 female) participated for a small fee.

#### 3.1.2. Materials

The sentences were recorded anew by the same speaker, this time with an H+L\* accent on the subject (see example realization in Figure 4).

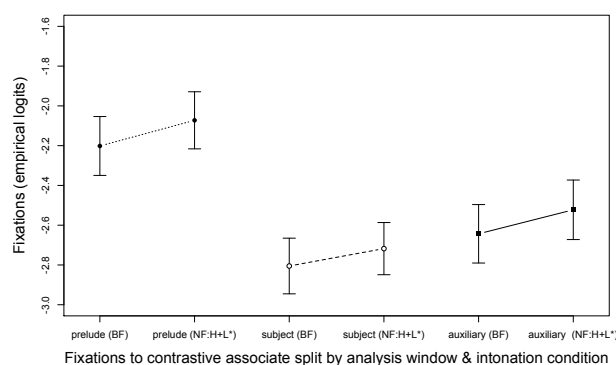
**Figure 4:** Example realization of the NF H+L\* condition.



## 3.2 Results

There was no effect of intonation condition, in none of the analysis windows (see Figure 5). Combining the data, there was a significant interaction between *Experiment* and *Condition* (narrow vs. broad focus) while participants processed the subject constituent ( $\beta = 0.51$ ,  $SE = 0.26$ ,  $t = 1.95$ ,  $p = 0.05$ ).

**Figure 5:** Empirical logits of fixations directed towards the contrastive associate in Experiment 2.



### 3.3 Discussion

The fixation pattern of Experiment 2 showed no effect of intonation condition on the fixations to the contrastive associates. The interaction between experiment and focus condition corroborates that subject nouns with an H+L\* narrow focus accent do not lead to the activation of contrastive alternatives.

## 4. GENERAL DISCUSSION

Our results replicate and extend earlier findings on the activation of alternatives in different focus conditions. While [5, 14] showed that alternatives to utterance-final narrow focus constituents in Dutch and English are activated, we show that this result also holds for German and, more importantly, for utterance-initial constituents. Moreover, participants activate alternatives to narrowly focused constituents only when they are produced with a nuclear L+H\* accent (signalling new/contrastive information) and not when they are produced with an H+L\* accent (signalling given/inferable information). In sum, our results show that not all narrow focus constituents are processed in the same way, at least not with respect to the activation of alternatives. This poses interesting challenges for the semantic formalization of information structure categories, such as focus. In future studies, we plan to use this paradigm to investigate the processing of meaning differences that are signalled less categorically [3, 4, 7].

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