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Focus projection revisited: pitch accent perception in German

1 Introduction

One of the important insights of the recent intensive study of information structure is that for intonation languages like English and German, there is a close relation between focus and prosodic prominence. More specifically, it is now widely accepted as a fact that in such languages focus is signaled by pitch accents. But one issue that is still much discussed is the nature of pitch accent placement in the focussed part of an utterance: is it determined by syntactic, pragmatic, or purely metrical factors or a combination of these? One line of research has established that there are syntactic rules that determine accent placement in focus structures, with the F-marking approach of Selkirk (1995) and the SAAR (Sentence Accent Assignment Rule) of Gussenhoven (1983) serving as prominent foundations. One prediction of these approaches is that certain accent patterns are ambiguous with respect to the possible focus domain: a pitch accent in a certain position can signal focus just on one word (narrow focus) or on a larger constituent (broad focus). The empirical question that arises from this claim is: is there any evidence that these accent patterns are really perceived as ambiguous between different focus interpretations by listeners?

In this chapter, we report on a perception experiment for German in which we tested whether listeners judge certain accent patterns as equally acceptable in different focus structure contexts. The results of the study will give an indication whether listeners perceive pitch accents in certain positions as ambiguous with respect to the possible information structuring of an utterance.

2 Focus projection and previous experimental results

Focus as part of the information structure has been characterized in a variety of ways as the 'most important' information of an utterance (cf. Krifka, 2008) and can be defined to be the part of an answer that corresponds to the *wh*-part of a

question.[1] As a simple example, the question–answer pairs in (1) illustrate different possible focus structures for a single sentence.

(1) a. What did John rent? John rented [a BICYCLE]$_F$ (narrow, NP focus)
     b. What did John do? John [rented a BICYCLE]$_F$ (broad, VP focus)
     c. What happened yesterday? [John rented a BICYCLE]$_F$ (broad, S focus)

The answers in (1) provide the element asked for, the focus in brackets. The word *bicycle* is always shown in small caps to indicate that it contains a syllable bearing a nuclear pitch accent. In all three sentences, the focused material thus is marked by a single pitch accent: in (1a), the pitch accent on the noun *bicycle* signals narrow NP focus on the object NP, in (1b) it signals broad VP focus on the VP *rented a bicycle*, and in (1c), the single accent signals broad focus of the entire sentence. A single pitch accent on a noun in object position thus seems to be ambiguous with respect to the focus domain it can occur in: it can signal narrow NP focus, broad VP focus or even broad sentence focus. This relation between pitch accent placement and focus interpretation as illustrated in (1) is referred to as *focus projection* when the relation is assumed to be mediated by syntax, and a number of lexical and syntactic conditions have been formulated in the literature to define when focus can project in this way (e.g., Gussenhoven, 1983; Selkirk, 1995; von Stechow & Uhmann, 1986; Jacobs, 1993). One much-discussed approach spelling out such syntactic conditions for accent placement is the focus projection rules formulated in Selkirk (1995), which determines the focus projection potential of a pitch accent depending on the syntactic structure of an utterance:

(2) F-marking:
        An accented word is F-marked.
        Vertical Focus Projection:
            F-marking of head of phrase licenses F-marking of phrase.
        Horizontal Focus Projection:
            F-marking of internal argument licenses F-marking of head.

This approach assumes that an accented word is syntactically F-marked. The horizontal focus projection rule determines under which conditions F-marking of one daughter in a phrase can license F-marking of another daughter, while the vertical focus projection rule determines when F-marking can be passed onto the

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1 We only use the term focus in this formal pragmatic sense to avoid confusion with the prosodic notion, which we only refer to as focus exponent or pitch accent.

mother of a phrase. The resulting F-Structure for the example (1c) is illustrated in (3), where starting from the F-marked noun *bicycle*, F-marking projects via the NP and VP up to the entire sentence. Additional focus interpretation rules then ensure that the highest node that is not dominated by another F-marked node in the structure is interpreted as the focus of the utterance, which in our example (3) is the entire sentence.

(3) What happened yesterday? [John$_F$ [rented$_F$ [a$_F$ BICYCLEF]$_F$]$_F$]$_F$]

To explore whether there is empirical evidence for the prediction that certain accent patterns are ambiguous with respect to the possible focus domain they can occur in, several experimental studies have been conducted in which the perception of accent patterns in broad and narrow focus structures has been studied. These studies mostly investigate whether there is really only one single accent in the broad focus cases or whether additional accents on the verb improve the acceptability of the broad focus structure. Gussenhoven (1983) investigated the hypothesis that a single accent on an argument is sufficient for a VP to be focused. The experiment thus directly addresses the empirical grounding of a particular subcase of focus projection: whether and when focus projection over an unaccented verbal head is possible.

 The perception experiment conducted by Gussenhoven to test his hypothesis is a context-retrievability experiment: participants in the experiment judge whether a question and an answer are from the same dialogue or whether the answer was given in response to another question. The experiment included two types of questions and two types of answers as illustrated in (4) and (5):

(4) a. What do you do?   (broad, VP focus)
     b. What do you teach?   (narrow, NP focus)

(5) a. I TEACH LINGUISTICS.   (accents on verb and NP)
     b. I teach LINGUISTICS.   (accent on NP only)

Gussenhoven hypothesizes that in a sentence with an accent on the argument such as (5b) the entire VP can be the focus, just like for (5a) where both words in the VP are marked by an accent. For the experiment, he thus predicts that listeners should not be able to tell any difference between the answers in (5a) and (5b) to the broad focus question in (4a).

 This prediction was confirmed by the results of the experiment: listeners performed no better than chance in judging whether questions asking for wide or narrow focus and answers with a single accent on the argument were matched.

This finding supports the existence of focus projection: to focus the VP, it is sufficient to accent the object NP.

Birch and Clifton (1995) revisited the issues of Gussenhoven (1983) and also investigated broad focus structures with two accent patterns, one condition with only a single accent on the object NP, and one with an additional accent on the verb. They employed two experimental tasks: a *make-sense judgment task* asking about the appropriateness of a dialogue in which the time to make a yes/no judgment is measured, and a *linguistic judgment task* in which subjects rate prosodic appropriateness on a five-point scale. The examples in (4) show the types of question and answers used in dialogues in the experiments:

(6)   Isn't Kerry pretty smart?
    a. Yes, she TEACHES MATH.   (accents on V and NP)
    b. Yes, she teaches MATH.   (accent on NP only)

For the make-sense judgment task, Birch and Clifton report the same reaction times for answers with accents on both V and NP (6a) as for answers in which only the NP is accented (6b). This would support the hypothesis that focus can project from a pitch accented argument. For the linguistic judgment task, however, subjects showed a small but significant preference for answers with accents on both V and NP over an accent only on the NP which contradicts the results of the first task.

In a more recent study, Breen et al. (2010) investigate accent placement in narrow versus broad focus structures in a combined production and perception study. In the production study, speakers produced answers to given questions with broad and narrow focus structures. In the perception study, participants had to choose a matching question to the produced answer. The experimental setup included seven types of questions with varying broad and narrow focus structures, among them a broad focus question as in (7a) and a narrow focus question as in (7b).

(7) a. What happened this morning?   (broad focus)
    b. What did Damon fry this morning?   (narrow, NP focus)

(8)   Damon fried an OMELET this morning.

The results of their perception study show that for simple subject–verb–object sentences with a single accent on the object NP, as in (8), listeners correctly identified (noncontrastive) narrow object focus 57% of the time, interpreting it as wide focus only 13% of the time. Breen et al. (2010) interpret this as showing that a

single accent on an object NP is not ambiguous between narrow and broad focus in English and conclude that this result is incompatible with an approach to focus projection like the one of Selkirk (1995).

In one of the few perception experiments for German, Féry (1993) tests the hypothesis that the same early nuclear pitch accent can signal narrow focus or broad focus. Minimal pairs of intransitive sentences with a pitch accent on the subject were recorded, as in (10), once as the answer to a question inducing narrow focus as in (9a) and one as the answer to a question inducing broad focus as in (9b).

(9) a. Wer   ist   verhaftet   worden?   (narrow, object NP focus)
        who   has   arrested   been
        'Who has been arrested?'

    b. Hast Du   heute die Nachrichten gehört?   (broad focus)
        have you today the news   heard
        'Did you hear today's news?'

(10)   GORBATSCHOV   ist   verhaftet   worden.
         Gorbachev   has   arrested   been
         'Gorbachev has been arrested.'

The two recorded questions then were randomly paired with the realizations of the answer and the participants in the experiment had to judge whether a question and an answer were from the same or a different dialogue. Féry (1993) reports that listeners decided at random whether the realization of the answer was an answer to the question inducing narrow focus or to the one inducing broad focus. She thus concludes that there is no difference in tonal realization between a narrow and a wide focus answer, that is, the same pitch accent on the subject signals broad or narrow focus.

In another study related to focus projection in German, Féry and Stoel (2006) investigated the hypothesis that there is something like an unmarked prosodic structure, which is not only adequate in broad focus contexts, but also in other, narrow focus inducing contexts. They recorded transitive sentences in a topic-focus inducing context, that served as the unmarked prosodic structure with a rising pitch accent on the subject and a falling pitch accent on the object NP as in (11a).[2]

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2 Féry and Stoel (2006) assume that this intonation contour with a rising accent on the subject and a falling accent on the focused word is the same as would be produced in a true broad focus

As a narrow focus structure they recorded sentences in a context inducing narrow corrective focus on the object NP as illustrated in (11b).

(11) a. My neighbor often throws big parties, and therefore she also gets lots of presents.
Movie directors give her movies, writers give her books, and ...

MALER	bringen	immer	BILDER	mit.	(topic focus)
painters	bring	always	pictures	along	

'Painters always bring pictures.'

b. It is said that painters always bring books to our neighbor. But this is not true:

Maler	bringen	immer	BILDER	mit.	(narrow focus)

'Painters always bring pictures.'

For the perception experiment, the sentences were cross-spliced and the participants were asked to judge the acceptability of the intonation of the target sentences occurring either in the matching context or in the nonmatching context. The results showed that the topic–focus intonation contour as in (11a) was judged almost as acceptable in the nonmatching narrow focus context as in the matching broad focus context, whereas the narrow focus sentences were judged as less acceptable in the nonmatching broad focus context. Féry and Stoel interpret this as supporting their hypothesis that there is an unmarked prosodic structure in German that is acceptable independent of a particular information structuring of the utterance. This result also partially supports a focus projection account like the one of Selkirk, since the pitch accent on the object NP in examples as in (11a) seems to be ambiguous between a narrow focus and a broad focus realization. The acceptability results obtained for a pitch accent produced on an object NP in a narrow focus context as in (11b), however, do not support a focus projection account, since such a pitch accent cannot ambiguously occur in a narrow or a broad focus setting.

In a recent study investigating the contours of nuclear falling accents in German, Kügler and Gollrad (2015) conducted a perception experiment investigating whether listeners can distinguish pitch accents on objects produced as a contrastive focus (12a) from accents produced in a broad focus sentence (12b).

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inducing context. They are thus confident that this pattern would get similar high acceptability ratings in a broad focus context.

(12) a. Hat Martin den Frosch gesehen?   (contrastive focus)
          'Has Martin seen the frog?'
          Nein, Martin hat den Wal gesehen.
          'No, Martin has seen the whale.'

    b. Erzähl mir bitte, was passiert ist?   (broad focus)
          'Did you hear today's news?'
          Martin hat den Wal gesehen.
          'Martin has seen the whale.'

The perception experiment consisted of question–answer pairs, in which the intonation of the answer either matched (contrastive focus question and answer, broad focus question and answer) or did not match (contrastive focus question and broad focus answer and vice versa) the focus of the question. Participants of the experiment were asked to evaluate the intonation of the answer sentence as congruent or incongruent with respect to the question. The results revealed that listeners rated the matching question–answer pairs significantly more often as congruent compared to the nonmatching question–answer pairs. This result indicates that there is a difference in the tonal realization of a pitch accent produced in a contrastive environment and one produced in a broad focus environment that listeners are aware of. Since both studies on German comparing broad versus narrow focus on the object NP used contrastive focus, the interesting question arises whether listeners will also distinguish pitch accents produced in noncontrastive narrow focus contexts from those produced in broad focus contexts. Such a result would give a first indication that a pitch accent on an object NP is not necessarily perceived as ambiguous between narrow and broad focus.

3 An experimental study on German

The reported studies revealed rather mixed results. Some of the studies found that an utterance with a single pitch accent on the object NP was accepted as an answer to a broad focus question, as predicted under a focus projection approach. Other studies found that utterances produced in a narrow focus inducing context with a single accent on the object NP were much less acceptable in broad focus contexts. It thus remains an open issue whether a single accent on an object NP is really ambiguous between a narrow focus on the object NP and a wide VP focus as is predicted by the focus projection rules of Selkirk (1995) or the SAAR of Gussenhoven (1983). In particular, the question whether an utterance produced in the context of a wide focus question is ambiguous between a wide and narrow focus

on the direct object has not been investigated so far. We therefore conducted a perception experiment in which listeners were asked to judge the acceptability of question–answer pairs.

3.1 The experiment

Our study investigates whether an utterance produced in a narrow object NP context is also acceptable in a wide VP context and, vice versa, whether an utterance produced in a wide VP context is also acceptable in a narrow object NP context. In contrast to the studies exploring accent patterns in German described above, we used sentences in which all verbal arguments remain in the middle field and exhibit the assumed base order for German, SOV (Subject > Object > Verb).

Question–answer pairs like the examples in (13) and (14) were used.

(13) a. Wen hat der Stier verletzt?   (narrow, object NP focus)
          who has the bull injured
          'Who did the bull injure?'

      b. Maria hat verkündet, dass der Stier [den HÄNDler]$_F$ verletzt hat.
          Maria has announced that the bull the trader   injured has
          'Maria announced that the bull injured the trader.'

(14) a. Was hat der Stier gemacht?   (broad, VP focus)
          what has the bull done
          'What did the bull do?'

      b. Maria hat verkündet, dass der Stier [den HÄNDler verletzt hat]$_F$.
          Maria has announced that the bull the trader   injured has
          'Maria announced that the bull injured the trader.'

We used these question–answer pairs as the two matching conditions and interchanged the questions and answers to create the two mismatching conditions.

Given the mixed results in previous studies, we can derive three competing predictions for our acceptability rating study:

Hypothesis 1
If a single accent on the object is ambiguous, and therefore can project focus independent of the context in which it was produced, ratings should not differ between match and mismatch conditions.

Hypothesis 2
If a single accent on the object produced in a broad VP focus or a narrow object focus context can be differentiated by listeners, significant rating differences between match and mismatch conditions should be found.

Hypothesis 3
If a single accent on the object produced in a broad VP focus is ambiguous, and one produced in a narrow object focus context is not ambiguous, a significant rating difference between match and mismatch conditions should only be found for answers produced in a narrow object focus context.

3.1.1 Method

3.1.1.1 Participants
Thirty-six undergraduate students of the University of Tübingen paid for their participation. All were native speakers of German.

3.1.1.2 Materials
Two female speakers read 40 question–answer pairs like the examples in (13) and (14). Thirty-six of them were used in the Experiment. We used the recorded question–answer pairs as the two matching conditions and interchanged the questions and answers to create the two mismatching conditions. Furthermore, we included two control conditions. As the match condition, we used the question–answer pair in (15), with a narrow focus on the subject NP. The mismatch condition was created by pairing the answer in (15) with a narrow object question as in (13).

(15) a. Wer hat den Händler verletzt?   (narrow, subject NP focus)
          who has the trader   injured
          'Who did injure the trader?'

      b. Maria hat verkündet, dass [der STIER]$_F$ den Händler verletzt hat.
          Maria has announced   that the bull   the trader   injured   has
          'Maria announced that the bull injured the trader.'

Thus, the independent variables were QUESTION TYPE (match vs. mismatch) and ANSWER TYPE [broad (VP) vs. narrow (object NP) vs. narrow (subject NP)].

All our question–answer pairs contained transitive verbs like 'verletzen' (to injure) and the answer sentences were produced as embedded clauses always exhibiting the word order subject–object–verb with a pitch accent on the object NP.

We analyzed the $F0$ values of the acoustic stimuli for the two critical answer sentences [broad (VP) vs. narrow(object NP)) as well as participants' ratings (see Figure 1). For the acoustic analyses, PRAAT (Boersma & Weenink, 2001) and ProsodyPro (Xu, 2006) were used. The mean $F0$ values for each word were submitted to an ANOVA with an error term that was based on item variability. The analyses revealed highly significant differences with regard to $F0$ values from the beginning of the embedded sentence until the object, with higher $F0$ values for broad (VP) up to the object determiner, and higher $F0$ values for narrow (NP) on the object NP. $F0$ values on the participle and auxiliary showed no significant differences: matrix subject [$F(1,39) = 15.68$, $p = .003$]; matrix auxiliary [$F(1,39) = 15.68$, $p < .001$]; matrix verb [$F(1,39) = 9.58$, $p = .004$]; complementizer [$F(1,39) = 31.52$, $p < .001$]; determiner [$F(1,39) = 5.38$, $p = .03$]; subject NP [$F(1,39) = 9.14$, $p = .004$]; determiner [$F(1,39) = 9.86$, $p = .003$]; object NP [$F(1,39) = 46.34$, $p < .001$]; verb [$F(1,39) = .05$, $p = .83$]; auxiliary [$F(1,39) = 1.63$, $p = .21$].
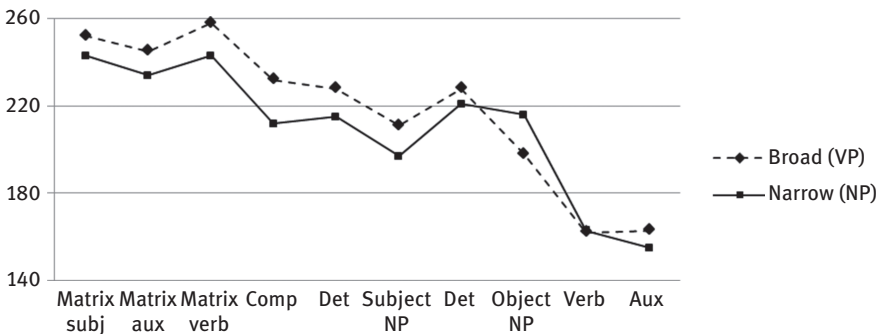
Figure 1: Mean $F0$ values (in Hz) for the two critical target sentences: broad (VP) and narrow (object NP) focus.

3.1.1.3 Procedure

The experiment was run on two PCs using E-Prime software (Psychology Software Tools, Inc.). Participants were seated in front of a computer screen and listened to the question–answer pairs via headphones. After listening, participants were asked to rate the question–answer pairs. The following question appeared on the screen: *Wie gut passt die Antwort zur Frage?* ('How does the answer match the question?'), together with a five-point scale (5 = very good, 1 = very bad). Participants answered by pressing the corresponding numbers on the keyboard in front of them.

3.1.1.4 Data analysis

Participants' ratings were submitted to two separate ANOVAs – one with an error term that was based on participant variability ($F1$) and one with an error term that was based on item variability ($F2$). The ANOVAs we conducted were 2 [match (=congruent question–answer pairs) vs. mismatch (=incongruent question–answer pairs)] × 3 [broad (VP) vs. narrow (object NP) vs. narrow (subject NP)] ANOVAs with repeated measurement on the two factors in both the participant analysis and the item analysis.

3.2 Results

3.2.1 Rating data

Analyses of the rating data (Figure 2) revealed highly significant main effects of QUESTION TYPE [$F_1 (1,35) = 105.20$, $p_1 < .001$; $F_2 (1,35) = 326.02$, $p_2 < .001$] with lower ratings for the mismatch conditions compared to the match conditions (3.7 vs. 4.6), ANSWER TYPE [$F_1 (2,70) = 93.29$, $p_1 < .001$; $F_2 (2,70) = 169.38$, $p_2 < .001$] with lower rating for narrow (subject NP) compared to the other two conditions, narrow (object NP) and broad (VP) (3.6 vs. 4.5 and 4.5), and a highly significant interaction of the two factors [$F_1 (2,70) = 65.15.20$, $p_1 < .001$; $F_2 (2,70) = 235.05$, $p_2 < .001$].
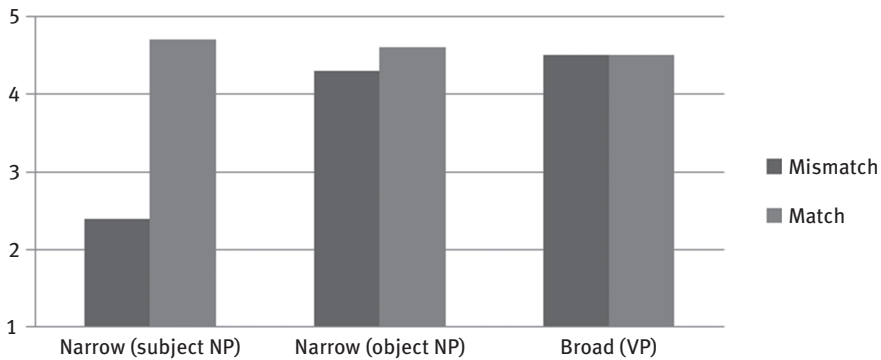
Figure 2: Mean acceptability ratings (scale 5-1) for the six experimental question–answer pairs.

Single comparisons (*match* vs. *mismatch*) for the three answer types showed decreased acceptability ratings for the control conditions with a narrow subject (NP) focus [$F_1 = (1,35) = 102.09$, $p_1 < .001$; $F_2 (1,35) = 496.31$; $p_2 < .001$] as well as for narrow object (NP) focus [$F_1 (1,35) = 10.77$, $p_1 = .002$; $F_2 (1,35) = 22.30$, $p_2 < .001$]. No significant acceptability difference was found for the broad (VP) focus [$F_1 = (1,35) = .31$, $p_1 = .58$; $F_2 (1,35) = .51$, $p_2 = .48$].

3.3 Discussion

The two main effects show decreased ratings for the mismatch conditions as well as for the control conditions with narrow focus (subject NP). More interestingly, we found a highly significant interaction of the two factors, driven by the different behaviors of the mismatch conditions for the three answer types. As expected, we see very low ratings for the control condition with narrow (subject NP) focus, significantly lower ratings for narrow (object NP) focus, but no decrease in ratings for broad (VP) focus. This pattern of results reveals evidence for Hypothesis 3. A single accent on the object produced in a broad VP focus seems to be ambiguous, whereas the one produced in a narrow object focus is not, shown by a significant difference between match and mismatch conditions only for answers produced in a narrow object focus context.

4 General discussion

All in all, our results show that an utterance produced in a narrow NP context paired with a wide VP context decreases acceptability. This result questions the assumption that a pitch accent, independent of the prosodic properties of the utterance as a whole, is ambiguous between narrow and wide focus. On the other hand, according to our results, an utterance produced in a wide VP context is also acceptable in a narrow NP context. Interestingly, there is cross-linguistic evidence that also in other language families that mark focus prosodically the accent pattern produced in a broad focus context is less marked than that produced on a narrow focus context: in a study on prosodic focus in Vietnamese, Jannedy (2007) conducted a perception experiment testing whether utterances produced as answers to certain wh-focus questions could be matched back to that question, which was presented as one of five possible question types. The results of the perception experiment showed that overall prosody in Vietnamese helped to disambiguate the context: for example listeners matched an utterance produced in a narrow NP context with the narrow focus question in 52.22% of the cases. For utterances produced in a broad VP context, however, the results were less clear: listeners matched the VP focus utterance with the corresponding VP question only in 25.56% of the cases, while matching it with an NP focus question in 18.89% of the cases and matching it with a broad sentence focus question in 32.78% of the cases. These data again show that a pitch accent on an object NP is not always ambiguous between a narrow and a broad focus as would be predicted by several syntactic focus projection accounts.

Based on the findings for different Germanic languages that focus generally boosts accents (Eady et al., 1986; Baumann et al., 2006) it has been observed that for German a narrow focus raises the *F*0 value of a pitch accent independent of the syntactic position in which the focused constituent occurs (cf. Féry & Kügler 2008). The results of our experiment give a first indication that this is not only a production phenomenon, but that this raising of pitch accents in certain focus structures is actually perceived by listeners: the raised pitch accent on the narrow focus is more or less only acceptable in that narrow focus structure and is less acceptable in a broad focus context. The intonation pattern used in a broad focus structure including a pitch accent on the NP object is less specific and is thus also acceptable in a narrow focus context. Our results also fit well with an observation by Hartmann (this volume) that for copular clauses in a null context wide focus is less marked than narrow focus. It is thus not generally the case that a single pitch accent on an object NP is ambiguous between a narrow focus and a broad VP focus.

As the acoustic analysis of our stimuli showed, the sentences produced with a narrow object NP focus and a broad VP focus differ not only with regard to the accent on the object NP, but also on the constituents preceding the object. In a follow-up study with cross-spliced materials, we will further investigate what are the exact properties of the intonation pattern that the listeners in our study perceived as (non-)ambiguous between narrow and broad focus.

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