

# Prosody and Scope in German Inverse Linking Constructions

*Uli Sauerland & Oliver Bott*

Seminar für Sprachwissenschaft  
Universität Tübingen, Germany

uli@alum.mit.edu, oliver.bott@student.uni-tuebingen.de

## Abstract

In German, prosody interacts with quantifier scope. We investigate this interaction in inverse linking constructions. We present evidence from elicited production of linguistically naive speakers supporting the following two claims: 1) There are two kinds of inverse linking constructions of which only the prepositional type requires a marked intonation contour for inverse scope. 2) In the prepositional construction, a double focus contour is employed with inverse scope rather than a topic-focus (rise-fall) contour as previously assumed (Krifka 1998).

## 1. Introduction

Sentences with two quantificational expressions like (1) often exhibit scopal ambiguities ([9] and others).

- (1) A guard is standing on top of every building.

On the *linear scope construal* of (1), scopal order corresponds to the linear order of quantifiers. The linear scope construal of (1) can be paraphrased as: ‘There is a single guard who’s standing on every building.’ On the *inverse scope construal*, the scopal order of quantifiers is the reverse of their linear order. For (1), a paraphrase of the inverse scope construal is: ‘For every building, there’s a (potentially different) guard standing on top of it.’ In German, the availability of inverse scope is in many cases dependent upon a specific intonation contour ([4], [10]). Because the semantics of scope is well understood, this interaction is well suited to investigate the semantic effects of intonation.

Previous work on the interaction between scope and intonation has exclusively considered the QArg-Neg and QArg-QArg constructions. In QArg-Neg constructions, the scope between a nominal quantifier and negation is inverted ([2], [6]), while QArg-QArg cases concern inverse scope of two quantifiers that are both arguments of the verb ([7], [6], [10]).

Consider first QArg-Neg cases: In examples like (2), inverse scope requires the hat intonation contour (also called *I-topic accent*, *bridge accent*, and *topic-focus accent*).

- (2) ALle Politiker sind NICht korrupt.  
all politicians are not corrupt

This contour is characterized by a pitch rise on *alle* and a corresponding fall on *nicht*. The contour is described phonetically in [3] where it’s called the hat-contour 1.

Now consider QArg-QArg cases. For these, it’s important whether the arguments occur in their canonical subject-object order as in (3a), or in the non-canonical object-subject order as in (3b). It’s generally accepted that (3a) with canonical argument order only allows inverse scope when pronounced with a special intonation contour. (3b), however, with a non-canonical

order of argument inverse scope allows both linear and inverse scope with any intonation ([4] and others).

- (3) a. Ein Junge hat mit jedem Mädchen getanzt.  
one boy has with every girl danced  
b. Mit jedem Mädchen hat ein Junge getanzt.  
with every girl has a boy danced

However, the phonetic characterization of the intonation contour required to bring about inverse scope in examples like (3a) remains unclear. [7] claims that it is the same contour in (2) and (3a). Both [6] and [1], however, claim that the pitch contour for inverse scope in (3a) differs from the hat contour required in (2). Namely, [6] claims that the contour involves a small fall followed by a rise, while [1] claims that a double focus contour is sufficient for inverse scope in (3a).

We set out to determine empirically what intonation contour is used with inverse scope of two quantifiers in German by looking at the production of linguistically naive subjects. A natural experimental design for this question is an evoked production experiment where quantifier scope is controlled for by context. However, in both of the QArg-Neg and the QArg-QArg constructions, the inverse scope construal is difficult to access (cf. [8] for English), and therefore difficult to use in production experiments with linguistically naive subjects. Therefore, we chose to look instead at inverse linking constructions which haven’t been investigated before.

The term *inverse linking construction* refers to structures like (4) where one quantifier contains another quantifier ([9]).

- (4) [One resident of [every town]<sub>DP</sub> ]<sub>DP</sub> complained.

Inverse linking constructions offer the following two advantages: 1) the inverse scope construal is very easy to access even for linguistically naive subjects. For example in (4), the pragmatically most salient interpretation is the inverse scope construal. A paraphrase of this interpretation is: ‘Every town has one resident that complained.’ The linear scope construal ‘A person who resided in all towns complained’ is only marginally available in (4). 2) In German, there are two inverse linking constructions, only one of which seems to require a special intonation for inverse scope. Hence, it’s easy to create minimal pairs for an experimental design. The two constructions are illustrated in (5). For our purposes, we call (5a) a *prepositional* inverse linking construction and (5b) a *genitival* inverse linking construction.

- (5) a. ein Bewohner von jedem Ort  
one resident of every town<sub>DAT</sub>  
b. ein Bewohner jedes Ortes  
one resident every town’s<sub>GEN</sub>

Both (5a) and (5b) allow inverse scope easily and, as in (4), a linear scope construal is marginal. However, only the prepositional example (5a) seems to require a certain intonation pattern for the inverse linking construal. This difference is expected if the genitival (5b) is syntactically derived by overt movement from a structure with a prenominal genitive similar to *every town's resident* (e.g. [12]).

The structure of this paper is the following: Sections 2 and 3 of this paper report the results of two experiments on the intonation of inverse linking constructions in German. In 2, we present a study that looked at the intonation of the second quantifier in prepositional and genitival inverse linking. The data confirms the hypotheses that a) prepositional inverse linking requires intonational marking on the second quantifier, while genitival inverse doesn't, and b) that the type of accent used on the second quantifier is a rising accent. The experiment in section 3 is a control study, looking at items where the second quantifier of the inverse linking items is replaced by a non-quantificational determiner. If the effect found in experiment 1 is due to inverse scope, we expect to find no corresponding effect in this control study. Section 4 presents our conclusions.

## 2. Experiment 1

In this experiment, we tested two hypotheses concerning the intonation of inverse linking constructions in German. The first hypothesis is that there is no intonational difference between prepositional and genitival inverse linking items. The second hypothesis is that the prepositional inverse linking must be produced with a hat contour.

To falsify these hypotheses, we investigated the pronunciation of inverse linking constructions by linguistically naive speakers. We designed four items with two conditions each. All target sentences were designed to intuitively allow on the inverse scope interpretation. Moreover the corresponding contexts were to be only consistent with inverse scope. Each item, hence, consisted of a disambiguating context, and a two sentence dialog of which the second line was the target sentence. (6) is the English translation of one context we used.

- (6) Context: Two friends are talking about last night. One of them had visited Peter last night, who's crazy about jazz. On that occasion, Peter played a record of Miles Davis, a record of John Coltrane, and a record of Fred Frith.

The target sentences were presented as part of a two sentence dialogue. The dialog in (7) illustrates the kind of dialogue used in the prepositional conditions.

- (7) A: Was hat Peter denn von Miles Davis, John  
What has Peter then of Miles Davis John  
Coltrane und Fred Frith aufgelegt?  
Coltrane and Fred Frith play  
B: Peter hat eine Platte von jedem Musiker  
Peter has a record of every musician  
aufgelegt.  
played

The genitival condition was identical to the corresponding prepositional condition except for two differences: We used a genitival inverse linking construction in the second sentence of the dialogue. Furthermore, different proper names were used throughout in the two conditions to avoid possible effects of

memorization.

- (8) B: Peter hat eine Platte jedes Musikers aufgelegt.  
Peter has a record every musician's played

The collected data were then analyzed by two methods to test our hypotheses. Method one relied on the intuitive judgement of a trained experimenter whether an accent marking was present on the second quantifier in the target sentence. This technique has been successfully applied in [5]. Method two consisted of a phonetic analysis of the F0 contour on the second quantifier in the target sentence. Specifically, we computed the F0 difference between the onset and offset of the stressed syllable of the second quantifier.

Our expectation based on hypothesis 1 was that there would be significant difference between conditions visible in the pitch difference.

Consider now hypothesis 2. We contrast our claim that both quantifiers are focussed, with the claim that a hat contour is used for scope inversion ([7]). The predictions for the F0 contour of our items the two assumptions make are schematically shown in (9).

- (9) a. rise ... fall (hat-contour)  
L\*H ... H\*L  
Q1 ... Q2  
b. rise ... rise (focus-focus-contour)  
H\*L ... H\*L  
Q1 ... Q2

As (9) shows, the F0 contour on the second quantifier is predicted to differ depending on the phonological accent associated with the first quantifier ([3]). Namely, if an L\*H accent was associated with the first quantifier, a rise-fall contour with the fall on the second quantifier is expected. However, if the first quantifier were to bear an H\*L accent as we claim, a rise on the first quantifier with a subsequent fall, and another rise on the second quantifier are predicted. Hence, our hypothesis predicts that the measured F0 difference would be significantly greater than 0, while the competing hypothesis ([7]) predicts that the measured F0 differences should be negative.

### 2.1. Method

#### 2.1.1. Participants

5 women and 7 men, all native speakers of German participated in this study for payment. The participants were university students and researchers without any special knowledge of linguistics.

#### 2.1.2. Procedure

The experimental block consisted of eight experimental items and twenty filler sentences. The items were presented in a randomized order in a print-out with two items per each sheet. Before the experiment the subjects read a written instruction, and two test recordings per subject were performed. Subjects took between 40 and 60 minutes to complete the experiment.

All items consisted of a context paragraph and a two sentence dialogue as discussed above. Subjects were instructed to process one item at a time in the following manner: First, subjects were to read the entire context paragraph and both sentences of the dialogue until they had fully understood it. Secondly, they indicated to the experimenter that the recording can begin. After the experimenter had started recording, the sub-

ject read the dialogue aloud. Recording was done with head-mounted microphone (manufacturer: Shure) on a fan-less Apple iMac computer. After the recording, subjects had to listen to the recorded dialogue. Finally, they had to rate the appropriateness of their production (naturalness of intonation) on a scale from 0 to 100. The ratings had two objectives: 1) to make sure that the subjects were reading attentively and 2) to ensure that the subjects were using natural intonation. The items were presented in a randomized order for each subject.

The gathered data were phonetically analyzed using the *Pitchworks* (Scicon R&D, Los Angeles, Calif.) software running on an Apple Macintosh computer. Pitch extraction was performed with the *Autocorrelation* algorithm of *Pitchworks*, where the F0 calculation range was adjusted individually for each subject to take individual differences in F0 range into account. Pitch extraction and measurements were performed by trained linguistics students, and the measured values manually entered into a computer. The statistical analysis was performed using the *STAT* data analysis package (Gary Pearlman, ACM). The analysis was performed on raw frequency data following [11] and others.

## 2.2. Results

The productions were analyzed with respect to two different kinds of measures: intuitive evaluation by a trained experimenter as used in [5], and a statistical analysis of selected points of the measured F0 contours.

First we looked for perceptive evidence of focus on *jeder* or *jedes* ('every'). A phonetically trained experimenter listened to each production of a target sentence and judged whether a focus was present on the target sentence. To decide whether focus is present the experimenter judged whether the target sentence would be an appropriate answer to a question requiring narrow focus on *jeder*.

The results confirmed our hypothesis one, that there is a difference between the two conditions. In the prepositional condition, 25 items (52%) were judged to clearly have focus on the relevant quantifier, while only 12 items (25%) were judged to have a clear focus in the genitival condition.

Secondly we examined the F0-contour acoustically: Using the pitchtracking software, we measured the F0-onset and F0-offset of the stressed syllable of the relevant quantifier. We then computed the difference between offset and onset. Four data points were missing because the F0 could not be measured. These missing points were replaced with the average of the obtained measurements for the particular subject.

The results again corroborated our first hypothesis: ANOVA showed a significant effect of the conditions both by subject ( $F(1,3)=10.941, p<.05$ ) and by items ( $F(1,11)=14.796, p<.005$ ).

To test our second hypothesis, we computed the average F0 difference across the prepositional inverse linking items and the average across the genitival inverse linking items. We found an average rise of 29.3 Hz (SD: 31.7 Hz) in the prepositional condition, and an average rise of 13.8 Hz (SD: 23.5 Hz) in the genitival condition. In a simple t-test, the rise found proves significantly greater than 0 in both the prepositional condition ( $t(42)=6.0449, p<.0001$ ) and the genitival condition ( $t(42)=3.847, p<.0005$ ). Because the prepositional condition differed significantly from the genitival condition in the ANOVA analysis, our result would be unexpected if the contour used for inverse scope was the rise-fall contour.

We therefore conclude that prepositional inverse linking

constructions are typically produced as illustrated in figure 1 (recording obtained in the experiment), where both quantifiers bear a H\*L accent.

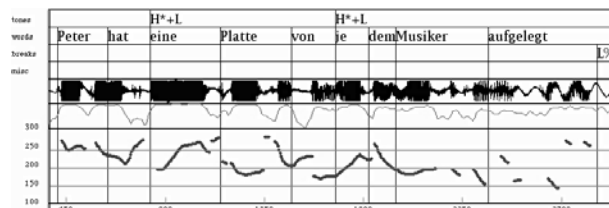


Figure 1: typical production, prepositional inverse linking

Further, we conclude that genitival inverse linking constructions don't require a focus on the second quantifier. They are typically produced without intonational marking as illustrated in the production example shown in figure 2.

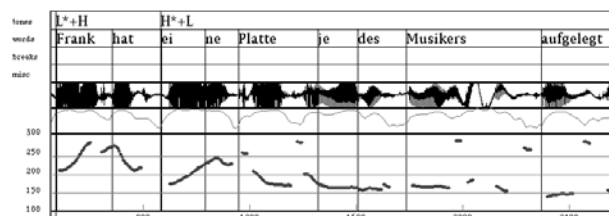


Figure 2: typical production, genitival inverse linking

## 2.3. Discussion

Our data show that the intonation of prepositional inverse linking constructions differs from that of genitival inverse linking constructions, and that the pitch contour required with prepositional inverse linking involves a rise on the second quantifier. However, since we didn't include a comparison with linear scope in our experiments, we cannot conclusively say that the observed intonation with inverse linking is the effect of inverse scope. Since linear scope is marginal the inverse linking constructions with *jedem* ('every'), we investigated this question with slightly different items in a control experiment.

## 3. Experiment 2 (Control)

In Experiment 2 we sought to control for a possible intonational difference between the prepositional and the genitival inverse linking construction which is not the effect of inverse scope. Therefore we investigated constructions similar to the inverse linking constructions but with only one quantifier. In such items, scope is not an issue and therefore no effect of inverse scope on intonation is expected. These were intended to be phonetically as similar as possible to the items of experiment 1. Our hypothesis was that using the same experimental paradigm as with experiment 1, we would find no significant difference between the prepositional and genitival control items.

The target sentences of the items were derived from those of experiment 1 by replacing the universal quantifier *jedem/jedes* ('every') with the non-quantificational determiner *jenem/jenes* ('that'). The first sentence of the dialogue pairs and the contexts were slightly changed from experiment 1 to achieve coherence. Two of the items used are illustrated in (10) and (11).

- (10) A: Was hat Hans denn für Musik aufgelegt?  
What kind has Hans then of music played  
B: Er hat eine Platte von jenem Musiker aufgelegt.  
He has one record of that musician played
- (11) A: Was hat Hans denn für Musik aufgelegt?  
What kind has Hans then of music played  
B: Er hat eine Platte jenes Musikers aufgelegt.  
He has one record that musician's played

The entity referred to by *jenem* was thereby mentioned before in the preceding context.

To ensure that a relevant comparison between the results of experiment 1 and experiment 2, we used the same method for the evaluation. Moreover, the same experimenters as in experiment 1 were used.

### 3.1. Method

#### 3.1.1. Participants

Seven women and five men, all native speakers of German participated in this experiment for payment. The participants were university students and researchers without any special knowledge of linguistics, and they were different from the participants of experiment 1.

#### 3.1.2. Procedure

The experiment contained 50 items. Eight of them were experimental items (four prepositional constructions like (10) and four equivalent genitival constructions like (11)). All the other items were fillers containing one or more quantifiers. The procedure was identical to that in Experiment 1.

### 3.2. Results

We again evaluated the data using two methods: the intuitions of trained experimenters and the acoustic measurements. By both methods, we did not find any significant difference between the two conditions.

According to the intuitive judgement evaluation, a focus was clearly present on *jenem* in the prepositional condition in 16 cases (33%). In the genitival condition, a focus was present in 13 cases (27%). The corresponding values in experiment 1 were 25 (52%) vs. 12 (25%) cases with focus.

We also performed again an acoustic analysis of the F0 using the same method and pitchtracking software. In the resulting table of differences between F0-onset and F0-offset one data point was missing, because of a mispronunciation at the relevant syllable. We substituted again with the average difference of the measured data points.

The two conditions were not a significant factor in the ANOVA of the acoustic measurements ( $F(1,3)=3.987$ ,  $p=.140$  both by subjects,  $F(1,11)=2.406$ ,  $p=.149$  by items). The significance levels in experiment 1 were  $p<.05$  by subjects and  $p<.005$  by items. A typical pronunciation of a prepositional item is shown in figure 3 and that of a genitival item in figure 4.

## 4. Discussion and Conclusions

We obtained two experimental results concerning the intonation of German inverse linking structures: Our first result is that prepositional inverse linking constructions require a different

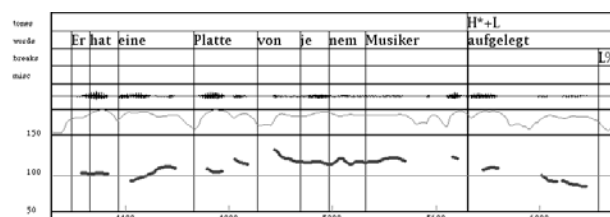


Figure 3: typical production, prepositional control item

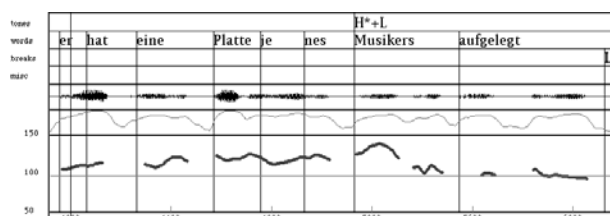


Figure 4: typical production, genitival control item

intonational marking from genitival inverse linking constructions. Secondly, we showed that inverse scope doesn't always require a fall on the second quantifier (contra [7]). Furthermore, the comparison between experiments 1 and 2 suggests that inverse scope in the prepositional inverse linking construction forces the presence of intonational marking.

Our result indicates that inverse scope in German may require either a rise-fall or a rise-rise (double focus) contour. In a next step, we plan a direct comparison between inverse scope and linear scope using inverse linking.

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