# The prosody of yes/no-questions in German first language acquisition

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# Abstract

Even though there are many studies on the acquisition of intonation, it is not clear yet how the acquisitional path of yes/no-questions develops in children learning (YNOs) languages that distinguish interrogatives and declaratives by means of pitch contours. The present study investigates the intonational realisation of information-seeking YNQs and declarative statements (DCLs) by monolingual German children between 2;8 and 4;0. Child productions were analysed for pitch range and phonological pitch patterns. Our findings suggest that, independent of age, DCLs are predominantly marked by falling f0 with a L-% boundary tone. The youngest children produce YNQs with both falling and rising patterns where L-% is the most common boundary tone. In contrast, 3- to 4-year-olds produce YNOs mostly with rising f0 with either L-H% or H-^H%. Thus, although the youngest children may be aware of the prosodic difference, they do not use pitch consistently yet to differentiate YNQs and DCLs. As of age 3;0, German children make conscious and consistent use of boundary tones to mark YNOs and DCLs.

# Introduction

In Germanic languages, YNQs and DCLs can be distinguished by prosody and/or word order. In this paper, we will examine at which age German children make use of different pitch contours in their productions to distinguish YNQs and DCLs. Previous research of adult speech has shown that YNQs are frequently accompanied by a rising pitch contour, ending in a high boundary tone, whereas DCLs are marked by a falling pitch contour, ending in a low boundary tone (e.g. Pruitt & Roelofsen, 2013; Wochner, Schlegel, Dehé, & Braun, 2015). The most common intonation patterns in adult German are H\*L-% for DCLs and L\*H-^H% for YNQs (e.g. Grice, Baumann, & Benzmüller, 2005; Wochner et al., 2015). Michalsky (2014, 2015) states that German distinguishes syntactically and phonologically identical structures as interrogative vs. (continuous) declarative by means of scaling, with questions exhibiting larger nuclear rise excursions than statements. For Dutch, Van Heuven and Haan (2000) report that pitch range is larger in questions with declarative syntax than in DCLs.

Regarding the realisation of pitch contours in early childhood, Snow (2002, 2004) reports that English-learning 1-year-olds do not actively control sentence intonation and that their pitch range is narrower compared to that of pre-schoolers. He furthermore finds that 4year-olds have more difficulties realising an adult-like pitch range in rises than in falls. This is in line with Lieberman's (1967) breathgroup-theory, which assumes that. physiologically, the production of rises requires more effort than the production of falls, which emerge automatically as subglottal pressure decreases. Patel and Grigos (2006) find that English-learning 4-year-olds use a longer final syllable duration to signal interrogativity, whereas 7-year-olds use a combination of rising f0 and longer final syllable duration. 11-year-olds are able to manipulate f0 as a single cue to signal a question. Thus, mastery of adult-like f0movement in YNQs seems to present a challenge even in the early school years. On the other hand, there are also studies suggesting good intonational control in rising pitch contours and large pitch ranges of YNQs by 2- and 3-year-old German and Spanish monolingual children (e.g. Lleó & Rakow, 2011). Given the conflicting findings in the literature, it remains unclear how children manipulate intonation to make a contrast between YNQs and DCLs.

The present study addresses the following questions. First, do German pre-schoolers use rising vs. falling intonation to distinguish YNQs from DCLs? Second, does age affect their realisation of pitch range for questions, i.e. do very young children produce smaller ranges for rises than older children? Third, is the final boundary tone a crucial marker for children to distinguish YNQs and DCLs?

## Method

#### Participants

Twelve monolingual German-learning children between 2;8 and 4;0 (5 female, average = 3;3) participated in the study. According to parental reports, all subjects had normal hearing. An additional 12 children were excluded from the analysis due to tiredness (n = 1), shyness (n = 2), lack of enthusiasm (n = 8) or hoarseness (n = 1).

Participants were divided into three age groups with 4 children each: group 1 (2;8-2;10), group 2 (3;1-3;4) and group 3 (3;10-4;0). All children were rewarded for participation with a small toy and parents were reimbursed for parking fees or bus tickets.

#### Materials

Stimuli consisted of 8 YNQs and 8 DCLs. For each sentence type, there were 4 inflected modal verbs, 3 inflected main verbs and 1 inflected copula verb. Half of the YNQS and half of the DCLs were presented in direct speech and the other half in indirect speech so that participants either had to imitate the utterances, or change the word order and adapt intonation.

Each sentence consisted of 6-10 words including the prompt, e.g., *Bitte sag Max: Hier ist deine Medizin.* ('Please tell Max: Here is your medicine.') or *Bitte frag Max, ob er Schmerzen hat.* ('Please ask Max whether it hurts.')

Children's productions were recorded on a Sony HDR-MV1 stereo video camera recorder.

#### Procedure

We used an elicited production/imitation task. First, each child watched a hand puppet play, which set the scene for the ensuing elicitation phase and helped making children familiar with the puppets. In the elicitation phase, the child was given a doctor's bag with which to examine one of the hand puppets. The experimenter encouraged the child to address the hand puppet with DCLs and YNQs. All children received the same stimuli in a random order depending on the order the child selected the instruments from the doctor's bag.

#### Data treatment and analyses

Videos were converted into audio files (48.0kHz, 16-bit, mono). Amplitude was

normalised to account for differences in overall speech rate using the digital editor Amadeus Pro (version 2.2.2). The audio files were analysed using Praat (version 6.0.18).

Words and syllables were labelled manually. For the phonological analysis, pitch accents and boundary tones were annotated according to the GToBI annotation system (Grice et al., 2005). For the phonetic analysis, f0 minima and f0 maxima were measured in Hz within the range from the final accented syllable to the right boundary tone, except for (L+)H\* L-H%. In this case, the rise was measured only in the final boundary tone. The contour was described as "rise" if the maximum f0 followed the minimum f0 and as "fall" if the maximum f0 preceded the minimum f0. Pitch range was measured between these extremes and calculated in semitones (st). Figure 1 provides an exemplar annotation.<sup>1</sup>



Figure 1. Annotation of a YNQ (f0 is smoothed).

#### Results

On average, each age group produced a total of 22 DCLs (SD = 6.1) and 25 YNQs (SD = 5.3). Across all age groups, children's realisations of DCLs were predominantly marked by a falling pitch contour with a L-% boundary tone. As can be seen in figure 2, the youngest age group was not as consistent in their prosodic realisations as the two older groups. Only 82% of their DCLs were produced with a falling pitch pattern as opposed to 100% in group 2 and 97% in group 3. Furthermore, whereas the older two groups mostly used the adult-like L-% to realise a fall (95% and 97%, respectively), we also found a considerable amount of less steeply falling !H-% patterns (24%) in the productions of the voungest children.

In order to mark an utterance as a YNQ (see figure 3), age group 1 produced both falling

<sup>&</sup>lt;sup>1</sup> Note that due to the relatively small data set we refrained from analysing responses to direct vs. indirect prompts separately. This will be done in future work with a larger data set.

(63%) and rising patterns (37%), with L-% being the most common boundary tone overall. Rising tones were realised as H-% or the adult-like pattern H- $^{H}$ %. In age group 2, 93% of the YNQs were produced with rising intonation. Of these, 48% ended in H- $^{H}$ % and 41% in L-H%. Similar results are found for the oldest group (76% rises<sup>2</sup>), where rises are mostly realised as adult-like H- $^{H}$ % (48%) and less often as H-% (14%) or L-H% (14%).



Figure 2. Realisation of the final boundary tone in DCL targets by age group.



*Figure 3. Realisation of the final boundary tone in YNQ targets by age group.* 

Children's realisation of pitch range (see figure 4) was assessed statistically. For this purpose, *range* was entered as dependent variable into a linear mixed effects regression model with *age group* and *contour* as fixed factors and *participants* and *items* as crossed random factors. The model revealed a significant effect of *contour* (p = .03). The range of rising utterances (average 6.11st) was on average 1.52st larger than that of falls (average 4.59st). There was neither an effect of *age group* (p = .3) nor an interaction between *contour* and *age group* (p = .4).



Figure 4. Pitch range in falling and rising utterances by age group (whiskers represent standard errors).

#### Discussion

In the present study, child productions of DCLs and information-seeking YNQs were analysed with regard to their prosodic realisation in terms of pitch range and final boundary tones. Results suggest that, very generally, children between 2;8 and 4;0 are able to manipulate intonation in order to distinguish YNQs from DCLs. DCLs are predominantly marked by a falling contour and, except for the youngest age group, YNQs are mostly produced with rises. With regard to both consistency of contour direction (rise or fall) and selection of boundary tone, there seems to be a developmental trend, setting the youngest children's productions apart from those of the older ones.

Children in all three age groups were rather consistent in their use of falls for DCL targets, often realising the adult-like L-% boundary tone. In the youngest group, nearly one quarter of the falls was realised with a less steeply falling !H-% pattern. This could be due to the fact that a fall is not used as a consistent cue to mark DCLs vs. YNQs yet. Stronger age effects are found with respect to the production of YNQs. While the older two groups rather reliably mark YNQs by a rising pitch contour, realised as L-H% or H-<sup>A</sup>H%, the youngest children showed a lot of variability between rising and falling intonation with more than half of the utterances produced with falling contours. In those cases where children managed to produce a rise, pitch ranges were as large as those of older children, contradicting predictions emerging from Lieberman's (1967) breath-group-theory. In the study by Patel and Grigos (2006), Englishlearning 4-year-olds failed to use f0 to signal a YNQ-DCL contrast, whereas the children in

<sup>&</sup>lt;sup>2</sup> The relatively high number of falls in this group is due to the productions of a single child who consistently produced falling utterances.

the present study are able to manipulate f0 to realise the contrast.

Our data support the findings reported by Lleó and Rakow (2011). Not only did they find appropriate accent ranges in the YNQ-productions of 2- and 3-year-old Germanlearning children, they also report good intonational control with respect to language-specific tonal patterns. Results of the present study suggest that German children start using native-like phonological intonation patterns rather early. Even in the productions of the youngest age group we find a solid amount of adult-like boundary tones, especially for the falls (L-%), and to a lower degree also for the rises (H-^H%).

Overall, the present study shows that from approximately 3 years of age, German children use rising vs. falling intonation with adult-like boundary tones to distinguish YNQs from DCLs in production. We did not find evidence for the assumption that age affects the realisation of pitch range for rises. The youngest children in our study were able to use the same pitch ranges for question intonation as the older children. Thus, in contrast to suggestions by Lieberman (1967), Snow (2002, 2004) and Patel and Grigos (2006), children do not have problems producing rising intonation per se. Rather, it seems that the voungest participants had problems selecting the appropriate contour for a given sentence type, in particular for YNQs. This can be seen in their occasional use of a rise for DCLs as well as in their relatively frequent selection of a falling contour for a YNQ. Children's difficulty with the mapping of intonation contours to a specific semantic context is reflected in findings from comprehension studies (e.g. Saindon, Trehub, Schellenberg, & Van Lieshout, 2016).

In future research, we will take a closer look at children's use of nuclear tunes in YNQs and DCLs to find out more about how systematic they are in their distinction of the two sentence types. Furthermore, we are currently investigating the comprehension of rising and falling intonation in short sentences. Since in German, both intonation and word order may be used as cues to distinguish YNQs and DCLs, we also focus on how intonation and syntax interact in the acquisition of YNQs.

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