Intonation of polar questions produced by German 2.5- to 4-year-olds

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### Background

**Polar questions and statements in German adult speech**

<table>
<thead>
<tr>
<th></th>
<th>Polar questions (YNQs)</th>
<th>Declarative statements (DCLs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pitch contour</strong></td>
<td>mostly rising</td>
<td>mostly falling</td>
</tr>
<tr>
<td><strong>pitch range</strong></td>
<td>large</td>
<td>small</td>
</tr>
<tr>
<td><strong>word order</strong></td>
<td>VSO(V)</td>
<td>SVO(V)</td>
</tr>
<tr>
<td><strong>answer</strong></td>
<td>required</td>
<td>not required</td>
</tr>
<tr>
<td><strong>example</strong></td>
<td>L* H^-H%</td>
<td>H* L-%</td>
</tr>
<tr>
<td></td>
<td>Trinkt Peter Kaffee?</td>
<td>Peter trinkt Kaffee.</td>
</tr>
<tr>
<td></td>
<td>‘drink-3SG. Peter coffee’</td>
<td>‘Peter drink-3SG. coffee’</td>
</tr>
<tr>
<td></td>
<td>‘Does Peter drink coffee?’</td>
<td>‘Peter drinks coffee.’</td>
</tr>
</tbody>
</table>

(e.g. Grice et al. 2005, Van Heuven & Haan 2000, Wochner et al. 2015)
Background

Production of pitch contours in first language acquisition

- English 1-year-olds do not actively control sentence intonation.
- English 1-year-olds’ pitch range is narrower compared to that of pre-schoolers.
- English 4-year-olds have more difficulties realising an adult-like accent range in rises than in falls.

Patel & Grigos (2006)
- English 4-year-olds use a longer final syllable duration to signal interrogativity.
- English 7-year-olds use a combination of rising f0 and longer final syllable duration.
- Only English 11-year-olds can manipulate f0 as a single cue to signal a question.

Lleó & Rakow (2011)
- German and Spanish 2- and 3-year-olds show good intonational control in rising pitch contours and large pitch ranges of YNQs.
Background

Summary of the literature:
- different findings for children’s realisation of pitch contours and pitch ranges in German and English (Snow 2002, 2004, Patel & Grigos 2006, Lleó & Rakow 2011)

Research questions:
In the period between 2.5 and 4 years of age,
- do children use rising vs. falling contours to distinguish YNQs from DCLs?
- does age affect their realisation of pitch range for YNQs?

Hypotheses:
H1: German children use rising vs. falling contours to distinguish YNQs and DCLs from an early age on.
H2: Pitch range increases as a function of age.
H3: Rises are produced with a larger pitch range than falls from an early age on.
Experiment

Participants:
12 monolingual German-learning children between 2.5 and 4 years of age (5 female)

The subjects were divided into the following age groups (4 children per age group):
- **age group 1** (age range = 2;8 – 2;10, mean age = 2;9)
- **age group 2** (age range = 3;1 – 3;4, mean age = 3;2)
- **age group 3** (age range = 3;10 – 4;0, mean age = 3;10)
Experiment

Set-up

- 2 hand puppets
- 1 doctor’s bag
- 1 camcorder
Experiment

Procedure

Familiarization phase
hand puppet play

Test phase
elicited production/imitation task
(Crain & Nakayama 1987)
Experiment

Procedure: Familiarization phase
Experiment

Procedure

Familiarization phase
hand puppet play

Test phase
elicited production/imitation task
(Crain & Nakayama 1987)
Experiment

Procedure: Test phase

**Elicited production/imitation task** (Crain & Nakayama 1987):

- The child examined one of the hand puppets with instruments of the doctor’s bag.
- The experimenter encouraged the child to address the hand puppet with DCLs and YNQs.
Experiment

Materials: Test phase

Stimuli:
16 target sentences (8 YNQs, 8 DCLs), direct/indirect speech, main/modal/copula verb in present tense, random order

(1) Target sentences for DCLs:
   a. “Bitte sag Max: Wir müssen das Bein verbinden.”
      Please tell Max: We have to bandage the leg.
   b. “Bitte sag Max, dass er bald wieder gesund ist.”
      Please tell Max that he will recover soon.

(2) Target sentences for YNQs:
   a. “Bitte frag Max: Tut das weh?”
      Please ask Max: Does it hurt?
   b. “Bitte frag Max, ob er den Mund aufmachen kann.”
      Please ask Max whether he can open the mouth.
Experiment

Procedure: Test phase

Lars (3;10)
Experiment

Data analysis

Hast du Schmerzen

\[%L \quad L^* \quad L^* \quad H^-H\%

\begin{array}{ccc}
\%L & L^* & L^* & H^-H\% \\
\hline
\text{min} & \text{max} & \text{Time (s)} & 2.033
\end{array}

Lars (3;10)

‘Are you in pain?’
Tier 4: $f_0$ between the final accented syllable and the right boundary tone

- For pitch contour (rise/fall): $f_0$ minima & $f_0$ maxima were measured in Hz.
- For pitch range: The range was measured in semitones (st).
**Experiment**

**Data analysis**

<table>
<thead>
<tr>
<th>Falling contour</th>
<th>Rising contour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Willi (3;10)</td>
<td>Lars (3;10)</td>
</tr>
<tr>
<td>Das machst du gut. ‘You are doing well.’</td>
<td>Hast du Schmerzen? ‘Are you in pain?’</td>
</tr>
</tbody>
</table>
Results: pitch contour

**DCLs:** predominantly falling contour, independent of age

**YNQs:** rising contour more reliably in 3- to 4-year-olds

General linear mixed effect model (Jaeger 2008): DV: contour; IV = age group

glmer(contour ~ age group + (1 | subject) + (1 + age group | item), data = data set, family = “binomial”)

- significant differences of contour use between the youngest and the two older age groups in YNQs (1 vs. 2: p = 0.01, 1 vs. 3: p = 0.04)
- no significant difference between the two oldest age groups in YNQs (p = 0.2)
Results: pitch range

Linear mixed effect model (Baayen 2008): DV: range; IVs = contour, age group
`lmer(range ~ contour * age group + (1 + contour | subject) + (1 + age group | item), data = data set)`
- significant effect of contour \( p = 0.03 \) ➞ range in rises higher than in falls
- no significant effect of age group \( p = 0.7 \)
- no significant interaction between contour and age group \( p = 0.4 \)

Whiskers represent standard errors.

Mean of rising range: 6.11st
Mean of falling range: 4.59st
Discussion: pitch contour

- DCLs are predominantly marked by a falling contour, independent of age.
- YNQs are marked by a rising contour more reliably in the two older age groups than in the youngest age group.

Aspects that may play a role:
- Perhaps, age group 1 is still uncertain about which intonational pattern to use.
- Perhaps, the production of rises requires more effort than the production of falls (see Lieberman 1967).
- Perhaps, age group 1 is able to produce a rising contour for YNQs, but cannot do that consistently.
Discussion: pitch range

- All children produced a higher pitch range for rises than for falls.
- The youngest age group was able to produce the same pitch ranges for YNQ intonation as the older children.

**H2:** Pitch range increases as a function of age. ✗

→ No evidence that age affects the realisation of pitch range for rises

**H3:** Rises are produced with a larger pitch range than falls from an early age on. ✓

→ Evidence that rises are produced with a larger pitch range than falls from an early age on
## General Discussion

<table>
<thead>
<tr>
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<td>fall</td>
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<td>age group 1</td>
<td>fall and rise</td>
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<td></td>
<td>age group 2</td>
<td>rise</td>
<td></td>
</tr>
<tr>
<td></td>
<td>age group 3</td>
<td>rise</td>
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### H1:

- German children use rising vs. falling contours to distinguish YNQs and DCLs from an early age on.
- German children start using native-like intonation patterns fairly early.
- Children do not have problems producing rises *per se*. Rather, the youngest participants had problems selecting the appropriate contour for YNQs.

### Future studies

Future studies will address...
- how intonation and syntax interact in the acquisition of YNQs.
- the comprehension of rising and falling intonation in short sentences.
Thank you.
Questions or comments?

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References

Summary

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**H1:** German children use rising vs. falling contours to distinguish YNQs and DCLs from an early age on.

→ German children start using native-like intonation patterns fairly early.

→ Children do not have problems producing rises *per se.*

  Rather, the youngest participants had problems selecting the appropriate contour for YNQs.

**H2:** Pitch range increases as a function of age. ✗

**H3:** Rises are produced with a larger pitch range than falls from an early age on. ✓
Experiment

Test phase: Stimuli

Thermometer:
1. Bitte frag Max: Hast du Fieber?
2. Bitte frag Max: Kannst du den Mund aufmachen?

Hammer:
4. Bitte frag Max: Darf ich auf das Knie klopfen?
5. Bitte sag Max, dass er ruhig liegen muss.
6. Bitte frag Max: Tut das weh?

Injection:
7. Bitte sag Max, dass er jetzt eine Spritze bekommt.
8. Bitte frag Max, ob er Schmerzen hat.

Bandage:
12. Bitte frag Max, ob er sich besser fühlt.

Medicine:
15. Bitte sag Max: Du darfst nicht mehr so schnell laufen.
16. Bitte sag Max, dass er bald wieder gesund ist.
(1) Target sentences for DCLs:
   a. “Bitte sag Max: Wir müssen das Bein verbinden.”
      Please tell Max: We have to bandage the leg.
   b. “Bitte sag Max, dass er bald wieder gesund ist.”
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(2) Target sentences for YNQs:
   a. “Bitte frag Max: Tut das weh?”
      Please ask Max: Does it hurt?
   b. “Bitte frag Max, ob er den Mund aufmachen kann.”
      Please ask Max whether he can open the mouth.
Experiment

Data analysis

DCL: falling contour

Willi (3;10)

Das machst du gut.
‘You are doing well.’
**Experiment**

**Data analysis**

**YNQ: rising contour**

![Spectrogram of a YNQ: rising contour](image)

**Lars (3;10)**

Hast du Schmerzen?
‘Are you in pain?’

![Spectrogram showing frequency (Hz) and time (s)](image)
Results: pitch range

Linear mixed effect model (Baayen 2008): DV: range; IVs = contour, age group
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Intonation of polar questions produced by German 2.5- to 4-year-olds
Results: final boundary tones

DCLs

YNQs

age groups

occurrence

final boundary tones

DCLs

YNQs

age groups

occurrence

final boundary tones
Results: nuclear tunes

DCLs

YNQs

nuclear tunes:
- IH*L−%
- H*L−%
- L+H*L−%
- others
Results: word order

Polar questions (YNQs):
(3) „Bitte frag Max: Darf ich auf das Knie klopfen?“
   a. du Knie klopfen ich
   b. Darf ich auf das Knie klopfen
(4) „Bitte frag Max, ob er Schmerzen hat.“
   a. du Schmerzen noch
   b. Hast du Schmerzen

Statements (DCLs):
(5) „Bitte sag Max: Du darfst nicht mehr so schnell laufen.“
   a. nicht mehr so schnell laufen
   b. Du darfst nicht mehr so schnell laufen
(6) „Bitte sag Max, dass er bald wieder gesund bist.“
   a. bald ‘sund du
   b. Du bist bald wieder gesund