Perceptual Cues to Yes/No Question Intonation in Kabardian

Ayla Bozkurt Applebaum

Department of Linguistics, University of California at Santa Barbara, USA

ayla1@umail.ucsb.edu, ayla.a@cox.net

Abstract

This paper reports results of a perception study of yes/no question intonation in Kabardian as spoken by the diaspora community in Turkey. This study argues that stimuli were more likely to be judged questions as the terminal F0 points were lowered. Furthermore, question responses became more numerous as the steepness of the drop in F0 from the stressed syllable to the following word increased. The effect of lowering the terminal F0 values and increasing the slope of the post-accentual F0 fall was cumulative in inducing question judgments.

Index Terms: intonation, perceptual cue, yes/no question, Kabardian

1. Introduction

Kabardian is a Northwest Caucasian language spoken by approximately one million people [1], primarily in Russia and Turkey but also in smaller communities elsewhere, including Syria, Lebanon, Jordan, Germany, and the United States. Kabardian belongs to the Circassian branch of the Northwest Caucasian language family; this family also includes three other languages: Ubykh, an extinct language last spoken in Turkey, and the two very closely related languages/dialects of Abkhaz and Abaza. The Circassian languages, which are mutually intelligible, are commonly divided into two branches: East Circassian, including Kabardian and closely related Besleney, and West Circassian, including Bzhedug, Shapsug, Abadzekh, and Temirgoy [2]. A further distinction is made within Kabardian between West Kabardian, comprising the Kuban and Kuban-Zelenchuk dialects, Central Kabardian, which includes Baksan and Malka, and East Kabardian, including the Terek and Mozdok varieties. The Baksan dialect is the basis for the literary language which was established in the 19th century [3]. The Kabardian sound system is well known for possessing a number of typologically unusual properties, including a small vowel inventory, an extensive number of fricatives, and a series of ejective fricatives. The intonation system of Kabardian, however, has not been subject to systematic instrumental investigation despite the potential for interesting interactions with its extremely complex morphology.

The intonation system of the Kabardian can be analyzed within the autosegmental/metrical framework [4]. Kabardian boundary tones are aligned with the right edge of Intonational Phrases (abbreviated IP) [5]. Statements and yes/no questions each end in with a pitch fall, which can be analyzed as a L% boundary tone [6, 7].

The most common pitch accent in declarative statements is H*, which may be found on any syllable bearing word level stress [6, 7]. Stress in Kabardian is sensitive to the weight of syllables. The word-final syllable is stressed if it contains either a long vowel or a coda consonant. If neither of these conditions is met, stress falls on the penultimate syllable [3, 8, 9, 10]. Certain suffixes fall outside of the stress domain, which implies that stress in certain morphological constructions can fall to the left of the penult syllable [3, 8, 10].

A simple H* pitch accent is observed in statements and wh-words, while a multi tonal H*HL sequence characterizes full NPs in questions and focused NPs in statements [6, 7].

In Kabardian distant past tense, statements and yes/no questions are syntactically and morphologically identical. For example the expression in Example 1 can be read as "They made the baby cry (statement in the distant past)" or as "Did they make the baby cry? (question in the distant past)"

Example 1:

nanəw-r	ja-	ʁa-	ʁa-	t
baby-ABS	they	CAUS	cry	PST

'they made the baby cry' (as a statement in the distant past)

'did they make the baby cry' (as a yes/no question)

In speech, statements and yes/no questions are clearly distinguished by prosody. A pitch contour for the statement reading of Example 1 is shown in Figure 1, and for the question reading is shown in Figure 2.

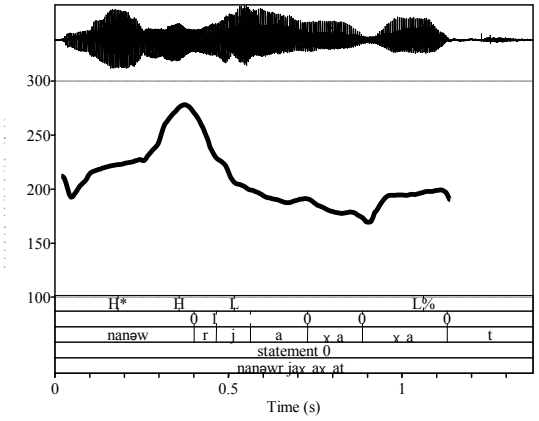

Figure 1: *Statement intonation: /nanəwr jaʁaʁat/ 'they made the baby cry'*

The question intonation pattern has a wider pitch range and higher pitch peak than does the statement intonation pattern. Further, the pitch fall from the peak is steeper in question intonation.

The prosodic distinction between question and statement is localized potentially in two places: at the steep F0 fall which occurs on the stressed syllable of the NP in question on to a following word or at the end of the IP where F0 is further lowered.

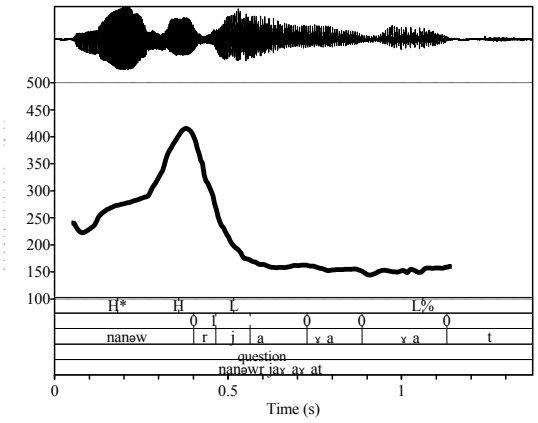

Figure 2: *Question intonation: /nanəwr jaɤaɤat/ 'did they make the baby cry?'*

The main goal of this study is to isolate the perceptual cues which distinguish yes/no questions from declarative statements.

Kabardian constructions in the distant past provide an opportunity to isolate prosodic perceptual cues to sentence type, uncontaminated by syntactic cues as syntax does not distinguish yes/no questions from statements.

A perceptual experiment using a consistent set of speech stimuli created through manipulation of a naturally occurring F0 contour by overlap-add (PSOLA) synthesis in Praat [11] is reported below.

2. Method

A psycho-physical experiment was designed to separately measure effects on perceived utterance type due to pitch changes near the stressed syllable and near the end of utterance. The pitch contour of the statement in Figure 1 was manipulated to more closely resemble the pitch contour of the question in Figure 2. The two regions of interest were varied independently of each other, using pitch synchronous overlap-add (PSOLA) synthesis.

The stimulus utterances were based on the single recording of /nanəwr jaɤaɤat/ 'they made the baby cry' in statement intonation shown in Figure 1.

The pitch of the statement was stylized at 1.5 semitone increments, obtaining eight pitch points, with three near the F0 peak and three in the final pitch declination as shown in Figure 3.

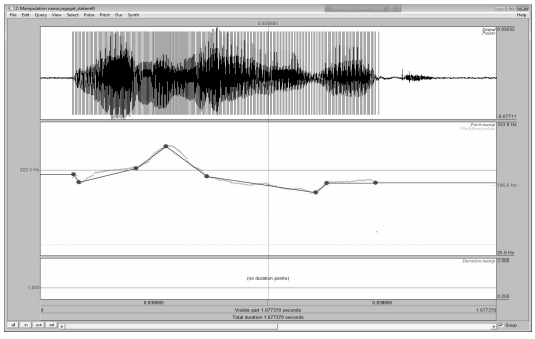

Figure 3: *Stylized pitch contour of statement in Praat*

The corresponding production of /nanəwr yaɤaɤat?/ 'did they make the baby cry?' as a yes/no question has larger pitch range. Stylizing the question at 2 semitone increments resulted in pitch points which roughly corresponded to the location of the pitch points in the statement. The F0 values from the question intonation were used as targets for the statement manipulations.

Two intonation contours were created in the region surrounding the F0 peak: one at the pitch level of the original statement and the other at the pitch observed in the question. Four levels of final pitch were created for the region at the end of utterance. The levels were equally spaced on a log scale, and ranged from the pitch values in the statement down to pitch values a little lower than those found in the question. In combination, a total of 8 token utterances were created.

The pitch contours of the 8 stimuli are shown in the next two figures. The dashed lines show the stylized pitch contour of the question, for comparison. Figure 4 shows the pitch of four stimuli with low (statement-like) pitch at H*. The topmost solid line in Figure 4 is the un-manipulated stylized pitch of the statement. Figure 5 shows the pitch of four stimuli with high (question-like) pitch at H*. Note that the constant F0 values at the left and right edges of the figures lie in unvoiced regions, and do not contribute to the synthesized stimuli.

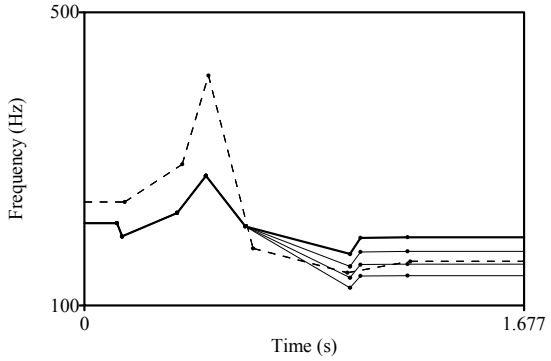

Figure 4: *Modified pitch of statement (low peak)*

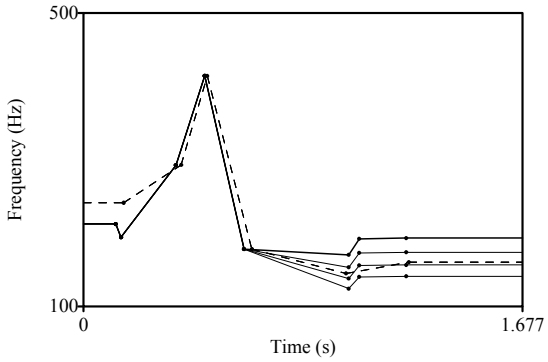

Figure 5: *Modified pitch of statement (high peak)*

The procedure used to generate the stimuli is documented as Praat code in Figure 6 in the Appendix. The initial part of the code executes in the object window to read the statement wave file and produce a manipulation. The next part of the code runs in the manipulation editor to produce the stimulus waveforms and publish them to the object window. The final

part of the code runs in the object window to write the stimulus files to disk.

2.1. Subjects

Fifteen native speakers of Turkish Kabardian, all of whom reported their hearing to be normal, participated in the study.

Subjects were instructed by the author in Turkish and Kabardian. The subjects wore a headphone, and sat facing the author who played the stimuli from a notebook computer. Each subject was presented with 24 test prompts consisting of three repetitions of each of the eight unique stimuli in random order. The subject was asked after each stimulus whether it was a statement or a question. The experimenter recorded the verbally given responses via Praat. Subjects were also asked to rate the naturalness of the stimuli on a five point scale, from 1 (odd) to 5 (natural).

The presentation and data recording were automated as an MFC experiment in Praat, which was implemented by the script in Figure 7 in the Appendix.

3. Results

Peak intonation at pitch points 3 through 5 took on two values, corresponding to statement or question intonation. Final intonation at pitch points 6 through 8 took on four values, where 1 represents statement intonation and 2, 3, 4 are respectively lowered by factors of 0.900, 0.810, and 0.729. Tail intonation level 4 roughly corresponded to the observed intonation in the question.

Table 1 shows results for each of the fifteen subjects. The table shows the number (of three trials) where the subject classified the utterance as "question".

Peak Intonation (points 3,4,5)	**Low F0 at Peak**				**High F0 at Peak**			
Tail Intonation (points 6,7,8)	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
Female 1	0	0	1	2	0	0	1	3
Female 2	0	0	0	0	0	0	0	2
Female 3	0	0	0	1	0	0	0	1
Female 4	0	0	0	1	1	1	0	2
Female 5	0	0	0	1	0	2	2	1
Female 6	0	0	1	1	0	1	2	2
Female 7	0	0	2	2	0	0	2	3
Female 8	0	0	3	3	0	0	0	2
Male 1	0	0	0	0	0	0	0	0
Male 2	0	0	0	1	1	1	3	3
Male 3	0	0	0	0	0	0	1	1
Male 4	0	0	1	3	0	0	3	2
Male 5	0	0	1	2	0	0	1	3
Male 6	0	0	1	3	0	0	0	2
Male 7	0	0	0	2	0	1	3	3
Total Number of Question ratings	0	0	10	22	2	6	18	30

Table 1: *Number of trials in which subjects classified the stimulus as "question".*

The totals are recapitulated in Table 2. The trend is for more trials to be rated as question as the intonation of the final pitch points are lowered. Also more trials were rated as question when the question intonation was applied in the three pitch points surrounding the pitch peak.

Peak Intonation	**Tail Intonation**			
	1 (low)	**2**	**3**	**4 (high)**
High F0	2	6	18	30
Low F0	0	0	10	22

Table 2: *Total trials in which subjects classified the stimulus as "question".*

The histogram of naturalness rating scores is shown in Table 3. Most trials were rated moderately natural (3 or 4). Extreme high or low naturalness ratings were rarely used. The naturalness ratings did not show strong trends between stimuli (Table 4).

Naturalness Rating	**1 (odd)**	**2**	**3**	**4**	**5 (natural)**
Count	5	23	101	224	7

Table 3: *Histogram of naturalness rating counts*

Peak Intonation	**Tail Intonation**			
	1	**2**	**3**	**4**
Low F0	156	160	161	161
High F0	171	166	156	147

Table 4*: Total of naturalness ratings per stimulus type aggregated across listeners*

4. Discussion

Results indicate that stimuli were more likely to be judged questions as the terminal F0 points were lowered, in keeping with the pattern observed in production [6, 7]. Furthermore, question responses became more numerous as the steepness of the drop in F0 from the stressed syllable to the following word increased. The effect of lowering the terminal F0 values and increasing the slope of the post-accentual F0 fall was cumulative in inducing question judgments.

5. Conclusion

A tentative proposal suggested by this experiment is that speakers of standard Kabardian wait for the end of utterance to find the cue as to utterance type (statement versus yes/no question). Although the syntactic cue is absent in the distant past construction, Kabardian speakers continue to look to the intonation of the end of utterance to make the discrimination.

6. Acknowledgements

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7. Appendix: Praat Scripts

The following Praat scripts were referenced in the text above.

```
### Read data from object window
file_name$ = "nanuryagagat_statemt0"
Read from file... 'file_name$'.wav
To Manipulation... 0.01 75 600
Edit

### Create stimuli in Manipulation Editor
editor Manipulation 'file_name$'
Stylize pitch... 1.5 Semitones
Set pitch dragging strategy... Only vertical
Select... 1.0 1.3
factor = 1.0
for ft from 1 to 4
  printline factor 'factor'
  Publish resynthesis
  Multiply pitch frequencies... 0.9
  factor = factor * 0.9
endfor
Multiply pitch frequencies... 1.5241579

Select... 0.3 0.4
Multiply pitch frequencies... 1.2915
Select... 0.4 0.5
Multiply pitch frequencies... 1.4962
Select... 0.5 0.7
Multiply pitch frequencies... 0.8561
Select... 1.0 1.3
factor = 1.0
for ft from 1 to 4
  printline factor 'factor'
  Publish resynthesis
  Multiply pitch frequencies... 0.9
  factor = factor * 0.9
endfor
endeditor

### Write wav files back in object window
select Sound fromManipulationEditor
Rename... ssq_pqt4
Write to WAV file... ssq_pqt4.wav
select Sound fromManipulationEditor
Rename... ssq_pqt3
Write to WAV file... ssq_pqt3.wav
select Sound fromManipulationEditor
Rename... ssq_pqt2
Write to WAV file... ssq_pqt2.wav
select Sound fromManipulationEditor
Rename... ssq_pqt1
Write to WAV file... ssq_pqt1.wav
select Sound fromManipulationEditor
Rename... ssq_pst4
Write to WAV file... ssq_pst4.wav
select Sound fromManipulationEditor
Rename... ssq_pst3
Write to WAV file... ssq_pst3.wav
select Sound fromManipulationEditor
Rename... ssq_pst2
Write to WAV file... ssq_pst2.wav
select Sound fromManipulationEditor
Rename... ssq_pst1
Write to WAV file... ssq_pst1.wav
```

Figure 6: *Praat scripts to generate perceptual test stimuli*

```
"ooTextFile"
"ExperimentMFC 4"
stimuliAreSounds? <yes>
stimulusFileNameHead = ""
stimulusFileNameTail = ".wav"
stimulusCarrierBefore = ""
stimulusCarrierAfter = ""
stimulusInitialSilenceDuration = 0.5 seconds
stimulusMedialSilenceDuration = 0
numberOfDifferentStimuli = 8
"ssq_pst1" ""
"ssq_pst2" ""
"ssq_pst3" ""
"ssq_pst4" ""
"ssq_pqt1" ""
"ssq_pqt2" ""
"ssq_pqt3" ""
"ssq_pqt4" ""
numberOfReplicationsPerStimulus = 3
breakAfterEvery = 8
randomize = <PermuteBalancedNoDoublets>
startText = "Click to start"
runText = "Choose statement or question."
pauseText = "You can have a short break if you
like. Click to resume."
endText = "The experiment is finished."
maximumNumberOfReplays = 1000
replayButton = 0.3 0.7 0.4 0.3 "Press the
spacebar to play the last sound again" " "
okButton = 0 0 0 0 "" ""
oopsButton = 0.05 0.2 0.25 0.15 "Retry" "x"
responsesAreSounds? = <no> "" "" "" "" 0 0
numberOfDifferentResponses = 2
0.3 0.45 0.7 0.8 "statement" "" "s"
0.55 0.7 0.7 0.8 "question" "" "q"
numberOfGoodnessCategories = 5
0.15 0.25 0.5 0.6 "1 (odd)"
0.30 0.40 0.5 0.6 "2"
0.45 0.55 0.5 0.6 "3"
0.60 0.70 0.5 0.6 "4"
0.75 0.85 0.5 0.6 "5 (natural)"
```

Figure 7 *Praat script to conduct perceptual experiment*

8. References

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