

# TONAL COMPONENT IN ESTONIAN QUANTITY PERCEPTION AND PRODUCTION



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## BACKGROUND

Estonian is known for its three-way quantity-contrast, which uses a combination of different prosodic means (stress, duration, pitch).

The domain of the quantity contrast is a disyllabic foot.

The main acoustic properties of the three quantities are:

1) Duration ratio of vowels in the first and second syllable (V1/V2 ratio):

	Quantity 1 (Q1)	Quantity (Q2)	Quantity (Q3)
<b>Duration ratio V1/V2</b>	<b>0.7</b>	<b>1.5</b>	<b>2.0</b>
<b>Examples</b>	[vili] (‘com’, sg. nom.) [kala] (‘fish’, sg. nom.)	[vi:li] (‘file’, sg. gen.) [kalla] (‘calla’, sg. nom.)	[vi:li] (‘file’, sg. part.) [kal:la] (‘pour’, sg. imp.)

Table 1. V1/V2 ratios in different quantities and examples

2) Pitch turning point (TP):

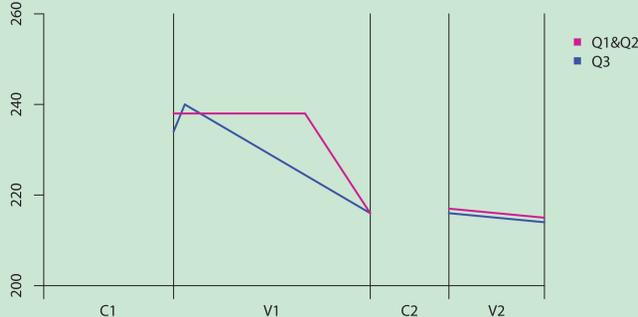


Figure 1. The location of TPs in the three quantities

**RESEARCH GOAL:** to clarify the role of pitch in quantity perception and production.

## RESEARCH MATERIAL AND METHOD

### Stimuli

The duration of the vowels in the first and second syllable (V1, V2) was changed in a natural-spoken word *siidi* (‘silk’, sg. gen.) so that stimuli with three-kinds of V1/V2 ratios were created:

	C(ms)	V1(ms)	C(ms)	V2(ms)	Total duration (ms)	Ratio
<b>Stimulus 1</b>	116	160	70	105	451	1.5
<b>Stimulus 2</b>	116	190	70	75	451	2.5
<b>Stimulus 3</b>	116	175	70	85	446	2.0

Table 2. Modified durations and V1/V2 ratios in stimuli

The pitch was manipulated so that the location of TP varied in 6 steps on V1. In this way altogether 3x6=18 stimuli were created.

These 18 stimuli were embedded in a frame sentence *Ma ostan \_talle* (‘I’ll buy \_him’). The semantic context of the frame sentence allows the test word to be both in Q2 (‘silk’ sg. gen.) and in Q3 (‘silk’, sg. part.).

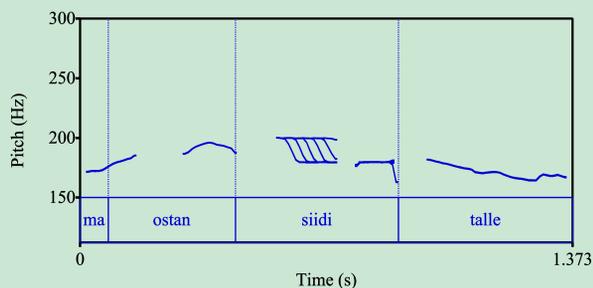


Figure 2. Pitch movement in the 6 stimuli, embedded in a frame sentence ‘I’ll buy \_him’

**Test subjects:** 5 males and 7 females between the ages of 20 and 39.

### Method

Test subjects heard each stimulus 10 times and had to imitate the stimuli with a varying quantity in the word *siidi* (‘silk’). Each subject produced 180 sentences. Altogether 2160 sentences were recorded, of which 2065 were used for the analysis. The imitations were recorded and analysed with Praat (Boersma, Weenink 2010).

## RESULTS

### Perception

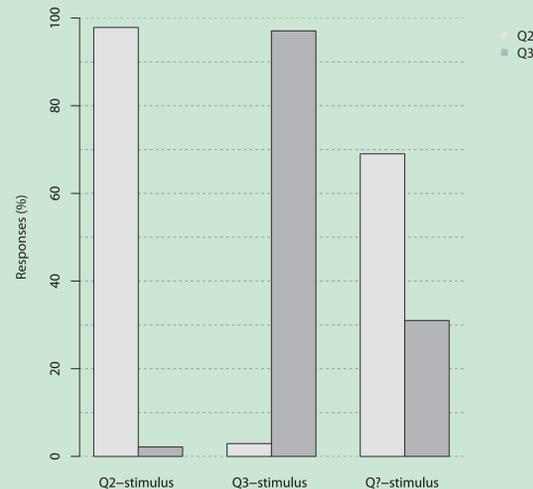


Figure 3. Percents of given Q2- and Q3-responses to the stimuli with different duration ratios

- 98% of the responses to the stimuli with V1/V2 ratio of 1.5 were in Q2.
- 97% of the responses to the stimuli with V1/V2 ratio of 2.5 were in Q3.
- Variation of Q2- and Q3-responses occurred in case of the stimuli with V1/V2 ratio of 2.0, where 69% of responses were in Q2 and 31% of responses in Q3.

The pitch effect in quantity perception was analysed in the stimuli with duration ratio 2.0, because only here variation of Q2- and Q3-responses occurred.

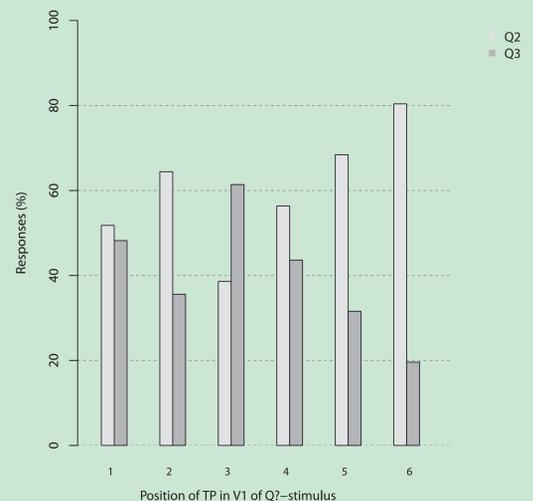


Figure 4. Percent of Q2- and Q3-responses to the stimuli with different locations of TP

- The stimuli with TP at 1/3 in V1 (actually in the middle of V1) were most often (61%) perceived as Q3.
- Q2 was mostly perceived, when the TP was located at 5/6 (68% of responses) or at 6/6 (80% of responses) in V1.
- The variation of Q2- and Q3-responses is most unclear in stimuli with TP at 1/6 in V1.

### Production

Stimulus	Response	Turning point (%)		Range of the fall (Hz)	
		Females	Males	Females	Males
Q2-stimulus	Q2	6.6	24.0	18.3	7.5
	Q3	5.1	12.2	32.0	19.0
Q3-stimulus	Q2	5.4	8.8	24.7	11.3
	Q3	3.5	13.5	25.0	17.9
Q?-stimulus	Q2	6.4	27.2	18.1	8.3
	Q3	8.5	12.6	24.2	13.2

Table 3. Range of pitch fall (Hz) and percent of TPs presented according to V1/V2 ratio of stimuli. Percent of TP calculated with reference to the duration of V1, showing the relative distance between the beginning of V1 and a TP

- There were no differences in pitch realizations of Q2- and Q3- imitations. The TP was always located at the beginning of V1 and the range of the pitch fall correlated with the length of V1.

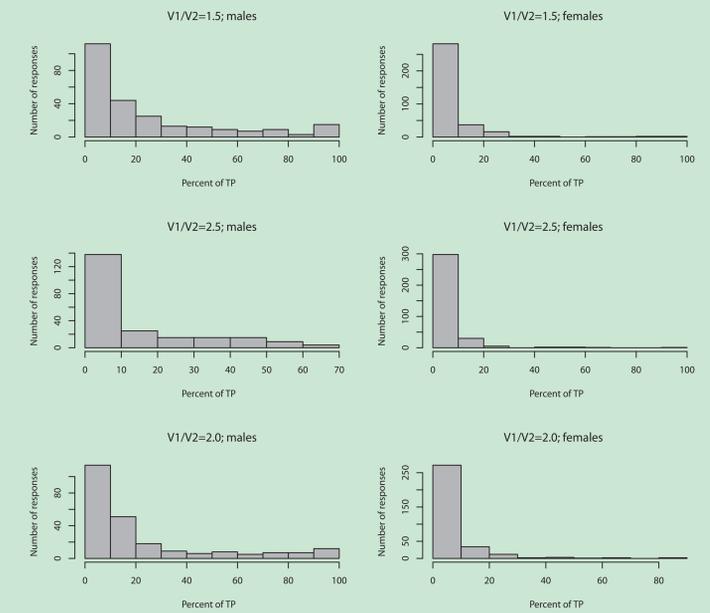


Figure 5. Histograms of the percent of TPs for males (left column) and females (right column) separately

- There emerged no bimodal data distribution in percents of TPs and no categories in pitch production emerged.

## CONCLUSIONS

- The results presented here (Figure 3) indicate that when the duration ratios of the foot are clear enough, then pitch has no influence on quantity perception. When the V1/V2 ratio (ratio of 2.0 for example) is ambiguous, the quantity judgement will depend on test subjects’ perceptual habits (dialectal background) or on additional acoustical property. Pitch is relevant as a secondary acoustic cue for the quantity.
- Two perceptual categories of pitch emerged in the quantity perception (Figure 4), as also earlier reported (Lehiste 1960, Lippus et al. 2009). The TP located before the midpoint or in the middle of V1 contrasts with the TP located in the second half of the V1. When TP is located too close to the beginning of V1, pitch will be perceived as low level and the correct ratio of V1/V2 is needed for successful quantity perception.
- However, no categories in pitch production emerged (Figure 5). This may be due to the nature of the stimuli. The test word *siidi* (‘silk’) was placed in the middle of the frame sentence and this unstressed position might have contributed to the neutralization of the pitch movement in imitations (cf. Eek 1983).

## ACKNOWLEDGMENTS

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## REFERENCES

- Asu et al. 2009 = Asu, Eva Liina, Pärtel Lippus, Pire Teras, Tuuli Tuisk 2009. The realization of Estonian quantity characteristics in spontaneous speech. – Nordic Prosody. Proceedings of the Xth Conference, Helsinki 2008. Frankfurt am Main: Peter Lang Verlag, pp. 49–56.
- Boersma, Paul, David Weenink 2010. Praat: doing phonetics by computer (Version 5.1.30) [Computer program]. Retrieved March 25, 2010, from <http://www.praat.org/>
- Eek, Arvo 1983. Kvantiteet ja rõhk eesti keeles (I). – Keel ja Kirjandus, 9, pp 481–489.
- Krull, Diana 1993. Word-prosodic features in Estonian conversational speech: some preliminary results. – Experiments in Speech processes. PERILUS, 17. Stockholm: Institute of Linguistics, University of Stockholm, pp. 45–54.
- Lehiste, Ilse 1960. Segmental and syllabic quantity in Estonian. – American Studies in Uralic Linguistics. Ed. Thomas A. Sebeok. Uralic and Altaic Series, vol. 1. Bloomington: Indiana University Publications, pp. 21–82.
- Liiv, Georg 1961. Eesti keele kolme vältusastme kestus ja meloodiatüübid. – Keel ja Kirjandus 7 and 8, pp 412–424 and 480–490.
- Lippus et al. 2009 = Lippus, Pärtel, Karl Pajusalu, Jüri Allik 2009. The tonal component of Estonian quantity in native and non-native perception. – Journal of Phonetics, vol 37, pp. 388–396.