Neutralization of Word-Final Voicing in Russian

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Introduction

Background

- Almost all Russian obstruents have voicing contrast
- The Russian voicing opposition is said to be neutralized in word-final positions. For instance, both /d/ and /t/ become /t/ word finally.

  - *kod* 'code' and *kot* 'cat' are both pronounced as [kot]
  - similar to German *Bund* 'group' and *bunt* 'colorful'

  Trubetzkoy (1967), Jakobson, Fant and Halle (1952)

- Acoustic experiments have demonstrated that final neutralization is incomplete in German and Polish.

Polish: Slowiaczek & Dinnsen (1985) found a difference in consonant duration due to underlying voiced obstruents. The duration of the vowel preceding the final obstruent was 10% longer before an underlying voiced voiceless.

German: Port & O'Dell (1985), Port & Crawford (1989) measured five variables in different pragmatic situations:

1) vowel duration
2) stop duration
3) burst duration
4) nasal duration
5) closure pulses

- Production experiment demonstrated that the duration of the burst release was significantly different between the voiced/voiceless stops.

Additionally, Discriminant analysis distinguished the voiced from the voiceless tokens 64% across all five pragmatic conditions

- Perception experiment showed that listeners had 69% of correct identification of voiceless/voiced pairs. Discriminant analysis showed similar percentage, hence the assumption would be that discriminant analysis could be regarded as a weak model of human perception.

- Pye (1986) in a production experiment measured Russian
  1) vowel duration,
  2) obstruent duration
  3) the duration of voicing into the obstruent.

The results showed differences in vowel duration between underlying voiced and voiceless obstruents that varied according to the place of articulation. The least difference was found between final coronal stops /t/ and /d/. Example of difference found in Context *a*:

- **Table 1: Differences between Voiced and Voiceless Final Obstruents (Pye, 1986)**

	Vowel Duration	Consonant Duration
b/p	**36%**	**– 15%**
g/k	**17%**	**– 10%**
d/t	**9%**	**– 2%**

Current Study

Examines:

- The neutralization effect in Russian coronal stops t/d.
- In case an incomplete neutralization is found, we try to determine:
- What variables contribute to the incomplete neutralization.

The Experiment

Production Experiment

- Three subjects
- List of words with final coronal stops /t/ - /d/, randomly distributed among distractors.
- Read in 3 repetitions.

Methods

Corpus

A list included eight target pairs + 16 distractors

Target Pairs:

Voiced		Voiceless	
kod	‘code’	**kot**	‘cat’
l’od	‘ice’	**l’ot**	‘flight’
l’ud	‘people’	**l’ut**	‘fierce’
mod	‘fashions (gen)’	**mot**	‘squanderer’
obéd	‘dinner’	**obét**	‘vow’
pod	‘under’	**pot**	‘sweat’
rod	‘origin’	**rot**	‘mouth’
vod	‘waters (gen)’	**vot**	‘here’

The total analyzed target corpus = 144: 16 words x 3 repetitions x 3 speakers.

Subjects

- Three female graduate students, native speakers of Russian
- Age: between 23 and 35
- All three speakers of CSR: two from Moscow, one from St. Petersburg.

Procedure

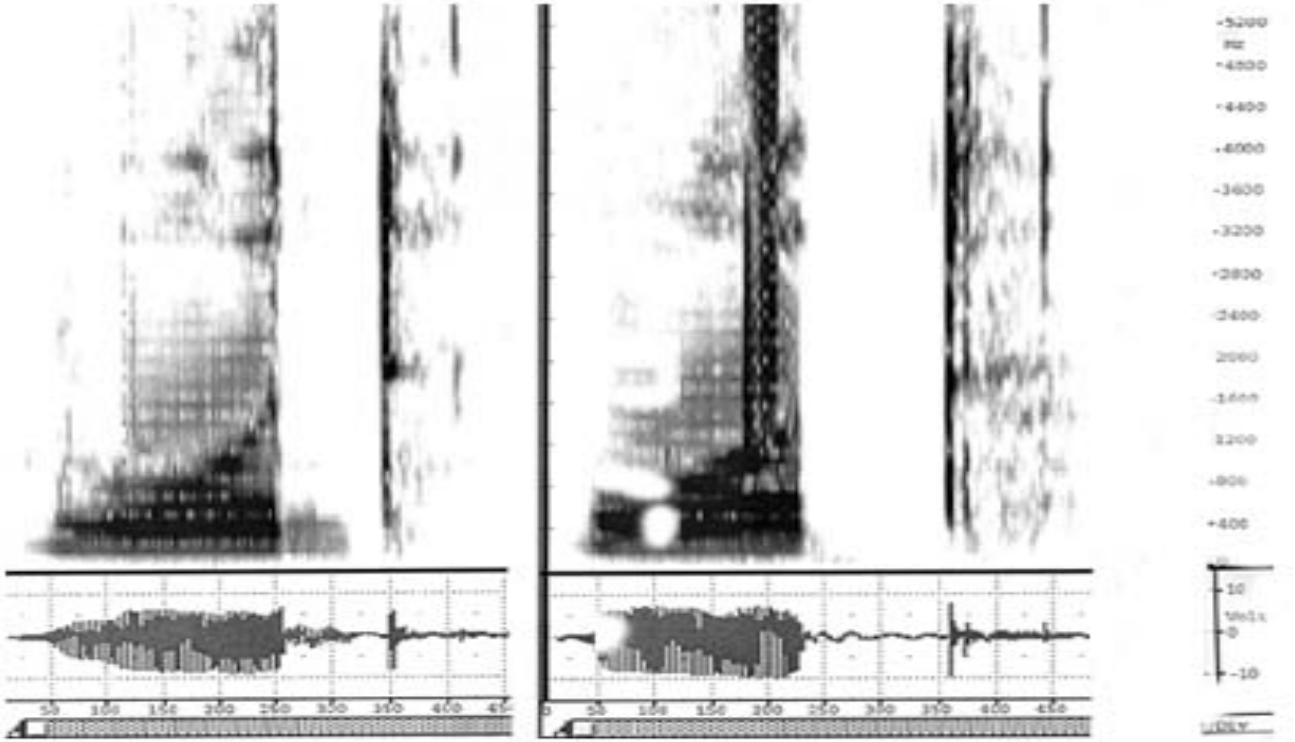
- Subjects recorded individually on different days in the recording laboratory of the Indiana University Linguistics department.
- Recorded onto a DAT tape.
- Measurements taken by hand with SoundScope on Mac.
- Four measurements were taken (wave form and spectrogram); each measurement = variable:

1. **duration of vowel preceding the target obstruent (DV)**
2. **duration of final obstruent (DC)**
3. **duration of voicing into the consonant closure as seen both in the wave form and in the wideband spectrogram (VC) glottal pulses after the vowel offset**
4. **burst duration of the final stop (BD)**

- 5th variable added. Total Closure: consonant duration + voicing into the consonant closure = total consonant (TC).

A Spectrogram and a Wave Form of the Target Pair: *vod* - *vot*

vod vot



Results

Results were analyzed by two types of statistical analysis: variable analysis and Discriminant analysis. Discriminant analysis was used as a means of measuring the degree of contrast by combining several variables, as in the experiment of Port *et al* (1989).

Group Statistics.

A. Variable Means According to Final VoicingFeature

(Mean results (in ms.) of an SPSS T-Test and Anova test for the two groups

Variable Means				Anova Results	
Varbl	FV	Mean(ms)	Std.Dev	F(1,142)	P-Value
VD	1	172	47	.176	.6752
	0	169	51		
CD	1	94	42	.111	.7395
	0	96	41		
VC	1	37	18	.152	.6969
	0	36	21		
BD	1	58	28	25.77	.0001
	0	80	24		
TC	1	131	34	.045	.8324
	0	133	29		

Table 1. Two groups: (1) = underlying voiced, (0) = underlying voiceless
Five variables: VD = Vowel duration, CD = Consonant duration, VC = Voicing into the consonant, BD = Burst duration, TC = Total consonant duration

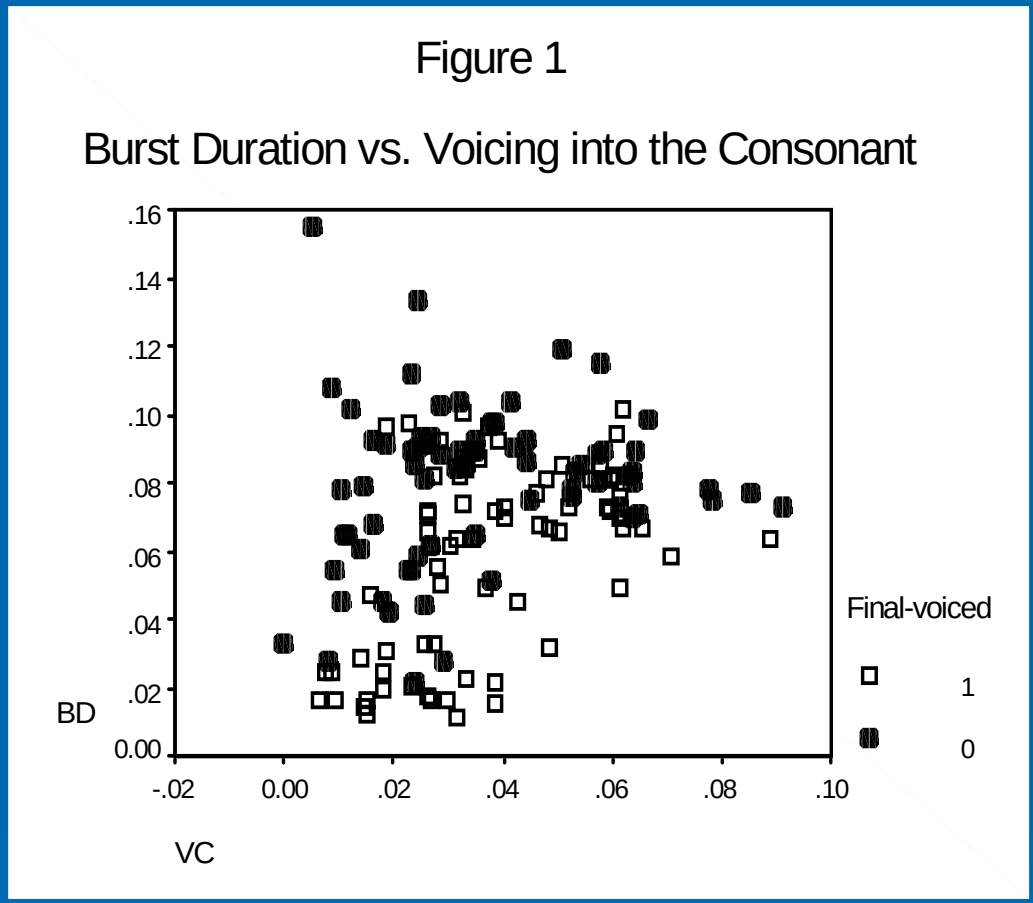


Figure1: Scatter plot

- The overlapping is not complete. Longer burst is associated with voiceless stops.

Descriminant analysis

Data was pooled across all five variables to find the best linear combination of the input variables for distinguishing between the two groups (+/- voice).

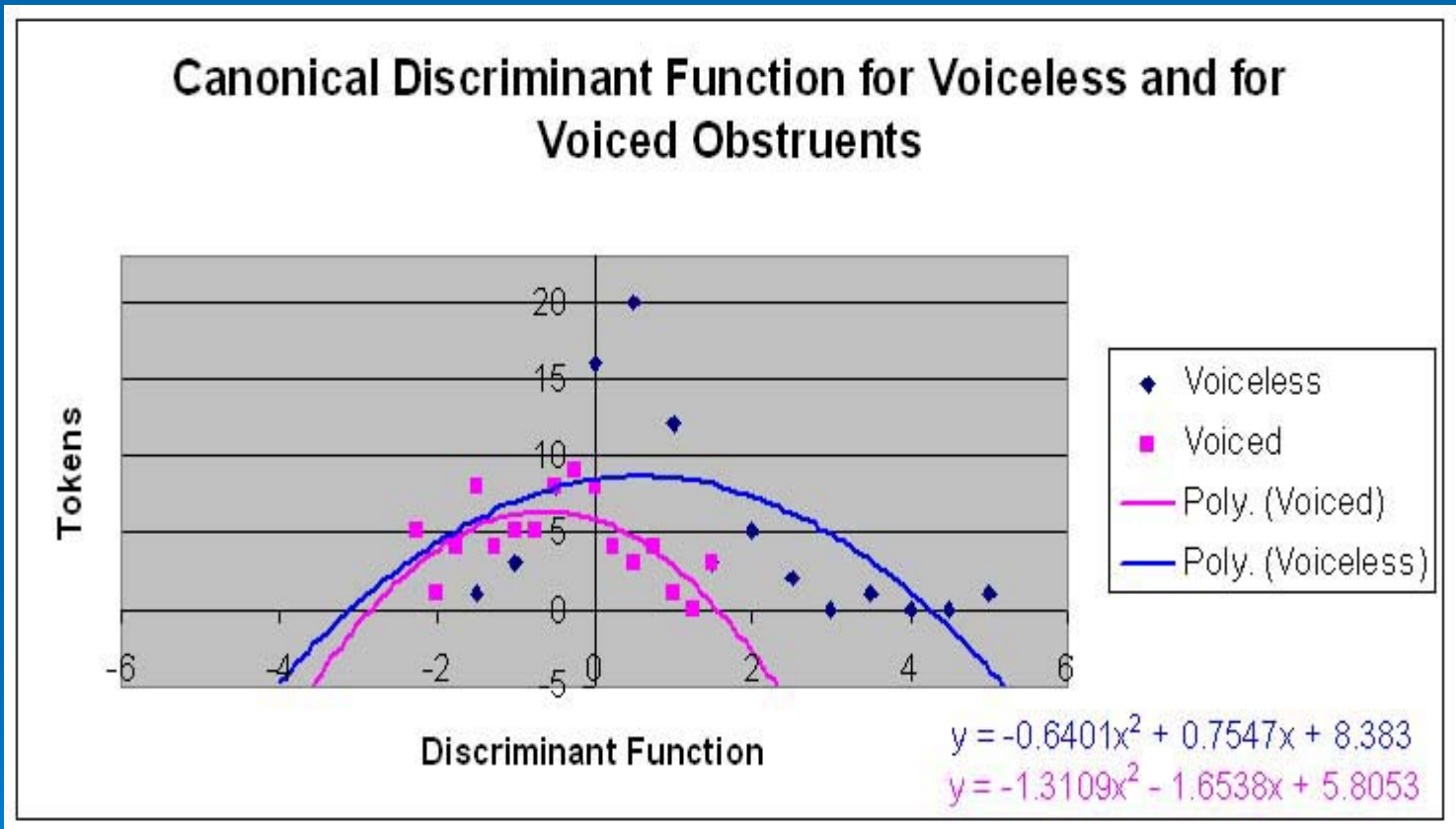
Table 2. Classification Results

	FV	Predicted Group Membership		Total
		0	1	
Original Count	0	50	22	72
	1	16	56	72
Percent (%)	0	69	31	100
	1	22	78	100

- 73.6% of original grouped cases were correctly classified.
  Voiced = 1 Voiceless = 0

- Taking into account the variable analysis described above, we assume that the most **salient factor** in the classification of the voiced tokens was the shorter **burst duration**.

Difference in distribution between the two groups: voiceless (0) and voiced (1)



Conclusion and Discussion

- There is a distinction in Russian between underlying voiced and voiceless coronal stops t/d in word-final position.
- The distinction is seen in the different burst duration of the target obstruents.
- In word final position longer burst duration acts as a cue for voiceless stops.

- Why?

- Airflow mechanism. When the vocal folds are open, and the lungs are contracting, the air passes to the mouth. As a result, a lot of air pressure is built up immediately behind the closure in the mouth. This affects the intensity and the duration of the burst at the release. Since ***longer burst*** duration is a ***result*** of a *openess* of the *vocal folds*, it may be perceived as a cue for ***voiceless obstruents***, both in production and in perception processes.

- Speakers can signify an underlying voicing not only by voicing, but also by controlling other parameters as well (for example, by burst duration).

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