

Voicing in Russian Stops: Cross-linguistic implications*

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Abstract

This paper presents the results of an investigation of voicing in utterance-initial and intervocalic stops in monolingual Russian speakers. Prevoicing was found in over 97% of the lenis stops; over 97% of the intervocalic stops were fully voiced. Utterance-initial fortis stops were pronounced as voiceless unaspirated and had short positive VOT. Intervocalic fortis stops were completely voiceless except for a short voicing tail into closure. These results are relevant for typological studies of voicing. Some studies of languages with a two way contrast between initial stops with prevoicing and short lag VOT have reported that prevoicing is less robust than what might be expected. These findings have been attributed to influence from another language without prevoicing. Our results with monolingual speakers of Russian support these claims. Our results are also relevant for the debate about the laryngeal feature in aspirating languages, which often have some voicing of intervocalic lenis stops. Such voicing has been attributed to passive voicing, in contrast with active voicing that occurs in true voice languages such as Russian. We found that the voicing in Russian is much more robust than the intervocalic voicing in aspirating languages. This difference is explained if the features of contrast are different in the two types of languages: [voice] in the case of Russian, [spread glottis] in the case of aspirating languages.

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1. Introduction

In this paper we present the results of our investigation of voicing in Russian word-initial and intervocalic stops, and discuss how our results bear on various theoretical issues.¹ Russian has a two-way laryngeal contrast. It is classified as a *true voice language* like Dutch, French, Spanish and Hungarian. In true voice languages, the contrast in utterance-initial position is usually between voiceless unaspirated stops and prevoiced stops (voicing begins before the stop closure is released). In a recent study of Dutch, van Alphen & Smits (2004) found that only 75% of word-initial “voiced” stops produced by their subjects when reading a wordlist had voicing during closure. This is a surprising result for a language which is supposed to contrast prevoiced stops with voiceless unaspirated stops; it means that 25% of the word-initial² “voiced” stops in Dutch are actually voiceless unaspirated stops. Hence, there is an overlap between the two stop categories with respect to voicing. Similar results³ are reported by Ringen & Suomi (2010, to appear) for Fennno-Swedish, a language which also contrasts prevoiced stops with voiceless unaspirated stops: 87% of the Fennno-Swedish utterance-initial lenis obstruents had prevoicing. Caramazza & Yeni-Komshian (1974) observed even more overlap between the VOT distributions of lenis and fortis stops in Canadian French: 58% of the lenis tokens were produced without prevoicing; all fortis stops were produced without aspiration.⁴ In all these cases, the

¹ We do not consider word-final stops or stops in clusters; for discussion, see Dmitrieva et al. (2010) and Kulikov (2012).

² The word-initial stops discussed in this paper, including those from van Alphen & Smits (2004), are also utterance-initial since subjects read wordlists.

³ In the studies of Dutch, Fennno-Swedish and Canadian English, subjects read word lists so the word-initial stops were also utterance-initial.

⁴ One confusing aspect of descriptions of various languages is that stops in true voice languages and in aspirating languages are often referred to simply as “voiced” and “voiceless,” despite the differences in the pronunciation. This means that it is often difficult or impossible to determine what the exact phonetic nature of the stops in question is because sometimes the series that is referred to as “voiced” has prevoicing in utterance-initial position and sometimes it does not. Sometimes the series that is described as voiceless is aspirated (as in German), whereas

authors suggest that the explanation for the overlap between the fortis and lenis stops is that there is influence from another language with a different type of laryngeal contrast: But this suggestion means that without such influence we would expect little or no overlap. Hence, one motivation for our study was to determine whether speakers of Russian who are not influenced by a language with a different laryngeal contrast also exhibit overlap in lenis and fortis stops in initial position.

German is a language with a two-way laryngeal contrast, but, as is well-known, it is an *aspirating language* (Jessen 1998). In utterance-initial position in aspirating languages, the contrast is between voiceless unaspirated stops and voiceless aspirated stops.⁵ In spite of the lack of voicing in utterance-initial stops in aspirating languages, it has seemed reasonable (to some, e.g. Keating 1984, Kingston & Diehl 1994, Wetzels & Mascaró 2001, among others), to assume that the feature of contrast for both aspirating languages and true voice languages is [voice]. This is because voiced stops *do* occur in (some) aspirating languages in intervocalic (or intersonorant) position and they contrast with voiceless aspirated or voiceless unaspirated stops. However, the intervocalic (or intersonorant) voiced stops in aspirating languages like German are not always fully voiced (Jessen 1998, Jessen & Ringen 2002). Jessen & Ringen suggest that the German variable voicing is due to a phonetic process, not to a [voice] specification on the stops. This means that the intervocalic (or intersonorant) voicing in German is different from the intervocalic voicing in a true voice language where there is no question that the lenis stops are specified with [voice]. In a study of German, Beckman et al. (2010) report that only 62.5% of intervocalic (or intersonorant) lenis stop tokens had voicing of over 90% of the closure. Without

sometimes it is not (as in Russian). We will use the terms *fortis* and *lenis* to refer to the two types of stops without implying what the phonological or phonetic nature of the stop contrast is.

⁵ We do not mean to imply that utterance initial position is the only position in which aspiration occurs in aspirating languages.

data about intervocalic voicing in true voice languages, we cannot determine whether the German variable intersonorant voicing is different from voicing of intervocalic stops in a true voice language.⁶ Hence, a second motivation for our study was to determine whether Russian speakers have full voicing in intervocalic lenis stops.

2. Background

2.1. Voice onset time

Lisker & Abramson (1964) studied Voice Onset Time of stops in utterance-initial position in eleven languages. Voice Onset Time, or VOT, refers to the timing of the beginning of voicing (usually in the following vowel) relative to the release of a stop closure, where release of the stop closure is considered to be time 0. Lisker and Abramson found two types of languages with two-way laryngeal contrasts:⁷ In one type of language with a two-way laryngeal contrast, they found that in one of the stop series voicing begins *during the stop closure*; this means that VOT is a negative number because voicing begins *before* the stop is released. Stops with negative VOT are known as “prevoiced stops” or as stops with voicing lead. In the other stop series in these languages, the VOT is a (relatively) small positive number. Such stops are referred to as having short-lag VOT or as voiceless unaspirated stops. Dutch and Hungarian are two of the languages in which Lisker & Abramson found one series of stops with negative VOT and the other with short-lag VOT. Hungarian and Dutch are both true voice languages. The VOTs reported by

⁶ Keating, Linker & Huffman (1983) survey voiced and voiceless stops in 51 languages. As they note, most of the claims in their sources are based on impressionistic transcriptions, not acoustic analysis. They report that in intervocalic (medial) position, the trend in the true voice languages is no voicing of the voiceless set or variation in the voiced set, whereas in aspirating languages, the voiceless unaspirated stops are *sometimes* voiced.

⁷ Helgason & Ringen (2008) show that Swedish has a type of two-way contrast not discussed by Lisker & Abramson: Swedish contrasts prevoiced stops with aspirated stops.

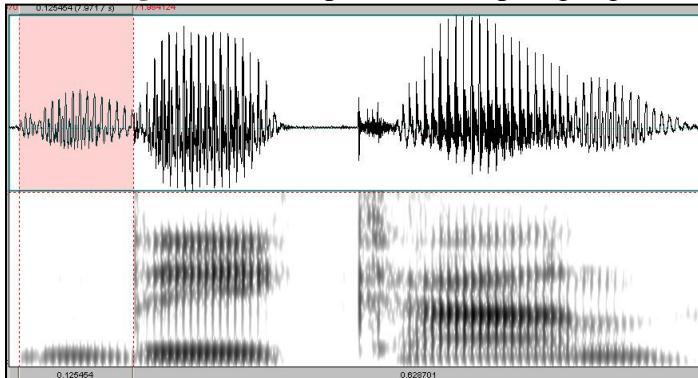
Lisker & Abramson (1964) for initial stops in words produced in isolation in these languages are given in (1):

(1) Mean VOTs (in ms.) for Dutch (1 speaker) and Hungarian (2 speakers)

	Dutch ⁸	Hungarian
/b/	-85	-90
/d/	-80	-87
/g/		-58
/p/	10	10
/t/	15	16
/k/	25	29

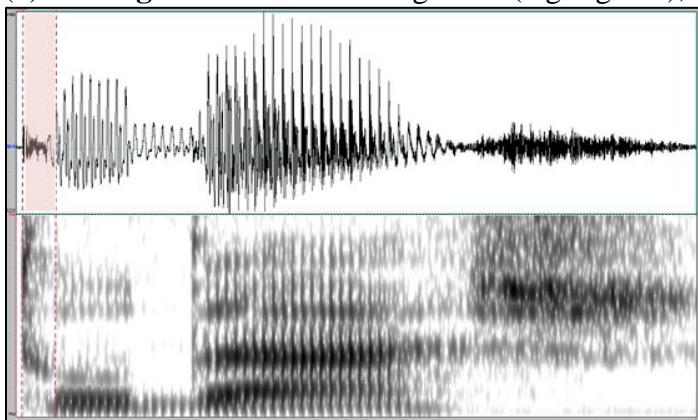
An example of a Hungarian prevoiced stop in initial position is given in (2).

(2) **Hungarian**⁹ initial prevoiced stop (highlighted), *dékán* ‘dean’



An example of a Hungarian stop with short-lag VOT in initial position is given in (3).

(3) **Hungarian** initial short-lag VOT (highlighted), *tudás* ‘knowledge’



⁸ Dutch has no laryngeal contrast in velar stops.

⁹ Hungarian spectrograms from Gósy & Ringen (2009).

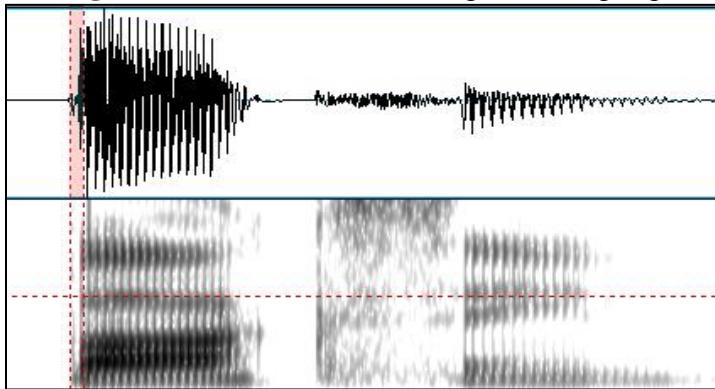
In the second type of language with a two-way laryngeal contrast studied by Lisker & Abramson, in one series of stops, voicing begins a (relatively) long time after the stop closure is released; hence VOT is a (relatively) large positive number for stops in this series. Such stops are known as *long-lag VOT* or (voiceless) *aspirated stops*. The other stop series has short-lag VOT (voiceless unaspirated stops). English and Cantonese are the languages in which Lisker & Abramson found one series of stops with long-lag VOT and the other with short-lag VOT. English & Cantonese are both aspirating languages.

Mean VOTs (in ms.) for Cantonese (1 speaker) and English (4 speakers) from Lisker & Abramson (1964) are given in (4):

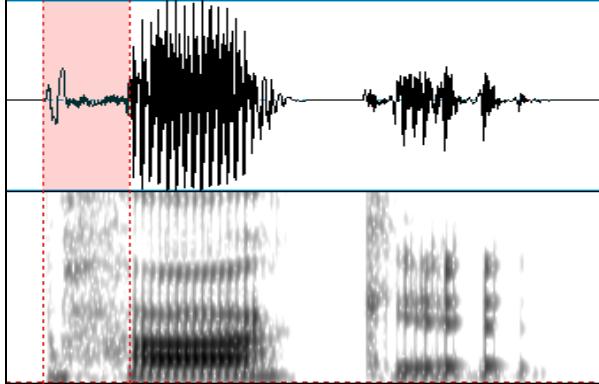
(4)	Cantonese	English ¹⁰
/p/	9	1
/t/	14	5
/k/	34	21
/p ^h /	77	58
/t ^h /	75	70
/k ^h /	87	80

An example of an English stop with short-lag VOT is given in (5) and an example of a English stop with long-lag VOT (aspirated) is given in (6).

(5) English utterance-initial short lag VOT (highlighted) *boxing* (male)



¹⁰ Some English speakers produce prevoiced stops (Lisker & Abramson, 1964). One speaker was responsible for 95% of the stops produced with voicing lead. Lisker & Abramson list the phonemes for Cantonese as /p/, /t/, /k/ and /p^h/, /t^h/, /k^h/, but for English as /b/, /d/, /g/ and /p/, /t/, /k/. We list them both the same as /p/, /t/, /k/ and /p^h/, /t^h/, /k^h/.

(6) English utterance-initial long lag VOT (highlighted) *pocket* (male)

To summarize: Lisker and Abramson studied two types of languages with two-way laryngeal contrasts:

(7) True voice languages

negative VOT in initial position (prevoiced or voicing lead)
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short-lag VOT in initial position (voiceless unaspirated stops)

Aspirating languages

long-lag VOT in initial position (voiceless aspirated stops)
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short-lag VOT in initial position (voiceless unaspirated stops)

2.2. [voice] vs. [spread glottis]

The traditional view, represented by Keating (1984), Kingston & Diehl (1994), among many others, is that the feature of laryngeal contrast in stops in both aspirating and true voice languages is [voice]. Recently, many phonologists have questioned this traditional view, suggesting that in aspirating languages the feature of contrast for stops is [spread glottis], not [voice] (Anderson & Ewen 1987, Beckman et al. 2011, Harris 1994, Honeybone 2005, Iverson &

Salmons 1995, Jessen 1998, Jessen & Ringen 2002.¹¹ Honeybone (2005) presents diachronic evidence for this position from the histories of English and German and Iverson & Salmons (1995) provide both diachronic and synchronic evidence for this position as well. Jessen (1998) presents experimental evidence that the feature of contrast in German is not [voice] and Beckman et al. (2011) argue that experimental results with English VOT can be understood if the feature of contrast is [spread glottis], but not if it is [voice].

Jessen & Ringen (2002) found that there was variation in their German subjects' voicing in intersonorant lenis stops. Such variable voicing in intersonorant lenis stops in German has been documented elsewhere (see Jessen 1998:57f. for additional literature.) Jessen & Ringen argue that the variable intersonorant voicing of German lenis stops, especially in a context where voicing should be easiest to maintain, is the hallmark of a phonetic process (see Cohn 1993, Keating 1996, among others), not the result of a phonological [voice] specification on these stops. They suggest that the variable intervocalic voicing of the lenis stops in aspirating languages is *passive* and that in true voice languages the voicing in intervocalic lenis stops is *active*. *Passive voicing* is voicing that occurs because stops are in a voiced environment, and does not reflect any active voicing gesture on the part of speakers. *Active voicing*, in contrast, is voicing that is the result of active voicing gestures (such as lowering of the larynx or active adduction of vocal folds) on the part of speakers.

2.3 Sensitivity of VOT

There is evidence that speakers are very sensitive to the VOTs that they are exposed to. For example, Nielsen (2006) found that speakers of American English produced significantly longer

¹¹ Some have used different names for the feature, for example, [tense] or [aspirated]. See Honeybone (2005) for an excellent overview of the various positions.

VOTs in aspirated bilabial stops after they were asked to imitate speech with lengthened VOTs in aspirated bilabial stops. Not only did speakers generalize the increased aspiration to aspirated bilabials in new words, they also generalized the increased aspiration to velar stops. In another study, Sancier & Fowler (1997) found that positive VOTs in the short-lag stops in the speech of a speaker of Brazilian Portuguese were longer after an extended stay in the United States and shorter after an extended stay in Brazil. The authors explain these results as the influence of the English stops with long-lag VOT on the amount of positive VOT in the speaker's native Brazilian Portuguese, a true voice language. Similarly, Chang (in press) found that the stops of English speakers learning Korean showed influence from Korean VOT in as little as one week.

3. Study

We recorded 14 speakers of Russian at St. Petersburg State University. Our subjects were monolingual speakers of Standard Russian, 8 males and 6 females, who had grown up and resided in St. Petersburg. None of the subjects had had training in phonetics nor were they English or German language majors.¹² The mean age of the subjects was 19.1 years.

The speakers read a list of words and short phrases twice; the order of presentation was the same for both readings. Mean word duration was 672 ms (SD=191). The list (see Appendix) contained 20 utterance-initial fortis stops (bilabial=10, dental=5, velar=5), 23 utterance-initial lenis stops (bilabial=7, dental=12, velar=4), 13 intervocalic fortis stops (bilabial=6, dental=4, velar=3) and 26 intervocalic lenis stops (bilabial=7, dental=8, velar=11), as well as 15 fillers. Hence the total number of tokens used for analysis was 2296 (82 x 2 x 14). We did not control for co-occurrence of fortis and lenis stops in the same word. Stimuli were presented in Cyrillic

¹² We did not record speakers who were English or German language majors because, as noted earlier, it has been found that exposure to a language with different laryngeal contrasts affects speakers' VOTs in their native language.

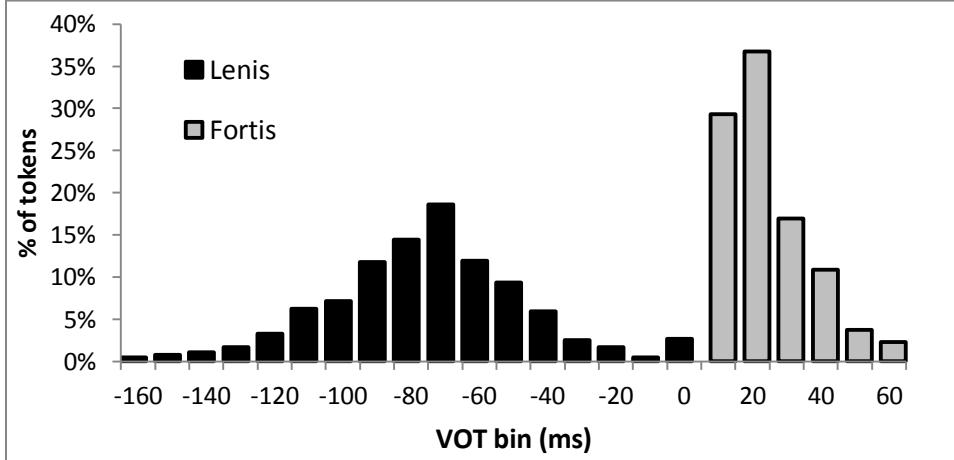
on paper. Subjects read the list from a paper mounted in the recording booth. They were instructed to pause between words (or phrases). If they did not leave a pause between words they were asked to repeat the word/phrase. Subjects were not given any information about the objective of the experiment.

4. Results

4.1. Initial position

The distribution of VOT values for the utterance-initial stops is given in (8).

(8) Distribution of VOT values for initial fortis and lenis stops (ms)



The mean VOTs and standard deviations for initial fortis and lenis stops are shown in (9).

(9)

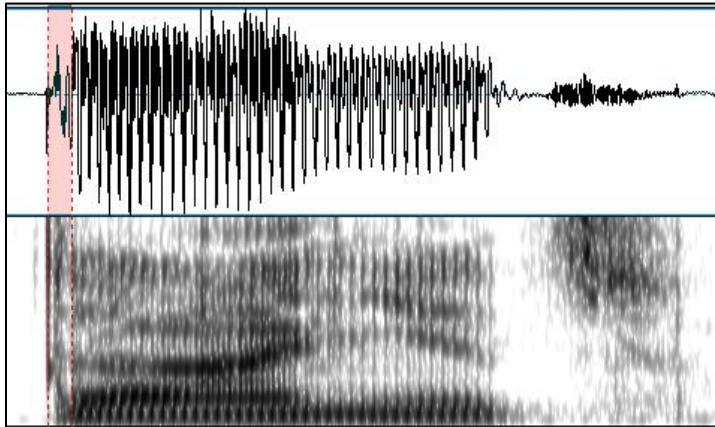
	Bilabial (ms)	Dental (ms)	Velar (ms)
Fortis	18 (8)	20 (6)	38 (12)
Lenis	-70 (29)	-75 (29)	-78 (26)

The statistical analysis of VOT measures (repeated measures ANOVA with voicing (lenis, fortis) and gender (males, females) as factors) found a significant main effect of voicing ($F(1,12)=760.5$, $p<0.001$), no effect of gender ($F<1$), and no interaction ($F<1$). As expected, fortis stops were pronounced as voiceless unaspirated and had short positive VOT. The lenis

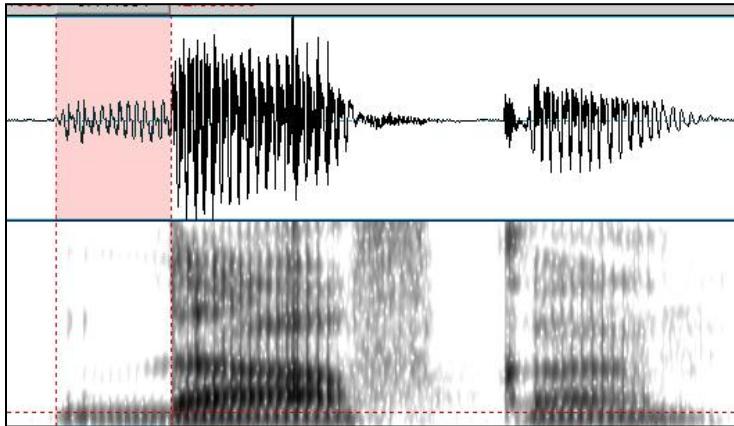
stops were pronounced with robust prevoicing. Male and female speakers did not exhibit differences in VOT in fortis and lenis stops.

These results are consistent with the pattern of contrast between prevoiced and voiceless unaspirated stops reported in Lisker & Abramson (1964). Importantly, 97.4% of the Russian initial lenis stops were prevoiced.¹³ Examples of typical fortis and lenis stops are given in (10).

(10a) Russian utterance-initial short-lag VOT (highlighted), *tanec* ‘dance’ (female)



(10b) Russian utterance-initial prevoiced stop (highlighted), *davka* ‘a crush’ (female)



4.2. Intervocalic position

The results for intervocalic stops are shown in (11). The analysis of duration of voicing during closure (repeated measures ANOVA with voicing (lenis, fortis) and gender (males, females) as

¹³ Those initial lenis stops that were produced as voiceless, unaspirated were due to two male speakers (S5 and S6), who pronounced 12% and 26 % of the initial lenis stops without prevoicing, respectively.

factors) found a main effect of voicing ($F(1,12)=462.5$, $p<0.001$), a main effect of gender ($F(1,12)=10.5$, $p<0.01$), and no interaction ($F(1,12)=1.01$, $p=0.328$). The majority of intervocalic lenis stops (97.5%) were produced with voicing during the entire closure. Production of lenis stops with incomplete voicing was due to six speakers: three males (S7, S9, S13) and three females (S2, S3, S8). Most of these stops (83%) were velars. Female speakers produced longer voicing in lenis stops than male speakers (Female: $M=49$ ms, $SD=4$; Male: $M=43$ ms, $SD=2$).

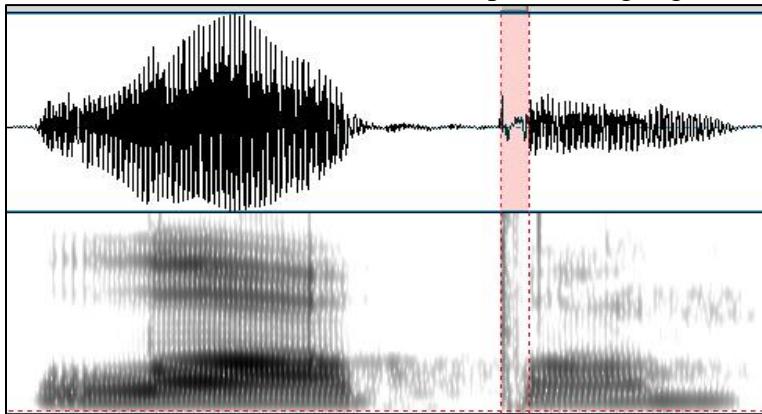
Except for a short voicing tail into closure ($M=22.5$ ms, $SD=11.1$), the intervocalic fortis stops were completely voiceless. Fortis stops were pronounced with a short lag VOT. No gender differences were observed in VOT ($F<1$).

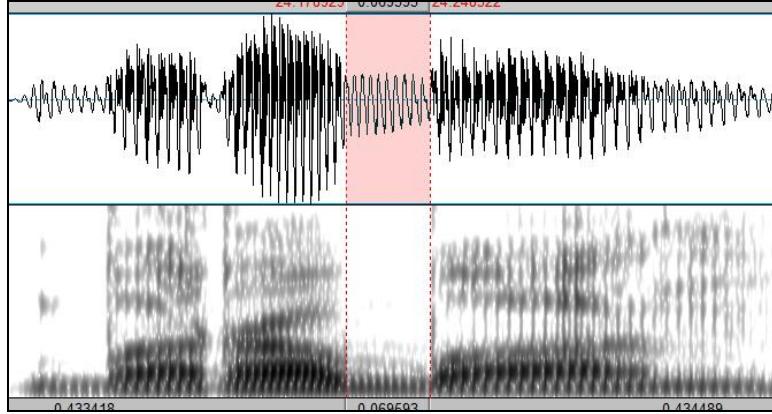
(11) Mean VOT values and closure duration (ms) with standard deviations (in parentheses) of intervocalic fortis and lenis stops

	Fortis			Lenis		
	Closure	VOT	Voice	Closure	Voice	% voiced
Bilabial	103 (21)	18 (7)	22 (10)	78 (13)	78 (13)	99.5%
Dental	96 (22)	18 (6)	23 (12)	62 (13)	62 (13)	99.1%
Velar	92 (20)	35 (10)	23 (11)	69 (15)	68 (16)	96.4%

Examples of typical intervocalic fortis and lenis stops are given in (12a) and (12b).

(12a) **Russian** intervocalic fortis stop (VOT highlighted), *lapa* ‘paw’ (female)



(12b) Russian intervocalic lenis stop (highlighted), *baraban* ‘drum’ 100% voiced (male)

5. Discussion

Over 97% of the Russian initial lenis stops were prevoiced. This result is similar to what was reported for initial stops in another true voice language, Hungarian; Gósy & Ringen (2009) reported that 100% of the Hungarian initial stops were prevoiced. This contrasts with the lower numbers reported for other true voice languages such as Dutch (75%), Fennno-Swedish (87%) and Canadian French (58%). Why are these results different if these are all true voice languages?

In all the languages with percentages of prevoiced stops that are lower than those we found in Russian, the authors suggest that the explanation is that there is influence from another language with different laryngeal contrasts. In the case of Dutch, the authors suggest the influence comes from English in the media and at school. In the case of Fennno-Swedish, all the speakers were bilingual in Finnish, a language which has no prevoiced (or aspirated) stops. In the case of Canadian French, the authors suggest the influence comes from English, which also lacks prevoicing in utterance-initial stops. Thus, our results suggest that a plausible explanation for the fact that there is overlap in the two stop series in Dutch, Fennno-Swedish and Canadian French is,

as the authors suggest, contact with a language with a different laryngeal contrast. Considering that no such overlap was found for our monolingual Russian subjects, our results corroborate the claim that the overlap in the two stop series that has been observed in languages such as Dutch, Fennno-Swedish and Canadian French is due to contact with a language with a different laryngeal contrast. Further evidence of influence from a second language with a different laryngeal contrast is reported by Dmitrieva et al. (2010) for Russian-English bilinguals.

Turning now to intervocalic stops, we found that over 97% of the Russian intervocalic lenis stops were fully voiced. These results are similar to those reported by Barry (1995) who found that 95.3% of the intervocalic lenis stops produced by Russian speakers in her study were fully voiced. Thus, voicing in intervocalic lenis stops in Russian is quite different from the voicing of intervocalic German stops reported by Beckman et al. (2010) who found that only 62.5% of intervocalic lenis tokens had voicing of over 90% of the closure.

6. Conclusion

Our study of Russian stops investigated whether there is variation in the phonetic voicing of (i) utterance-initial lenis stops and (ii) intervocalic lenis stops in the Russian of monolingual speakers who have little or no experience with a language with a different laryngeal contrast. Van Alphen & Smits (2004) found variation in the voicing of utterance-initial lenis stops in Dutch, a language that is usually classified, like Russian, as a true voice language. Van Alphen & Smits attribute the variation they found to influence from English, an aspirating language. If van Alphen & Smits are right that the variation they found for their Dutch speakers was due to influence from English, we might conclude that speakers of another true voice language with no such experience would not exhibit the same type of variation found for the Dutch speakers in van Alphen & Smits study. We tested monolingual speakers of Russian and found that, indeed, they

exhibited little variation in the voicing of utterance-initial lenis stops. Hence, our findings support the suggestion of van Alphen & Smits that the variation found for their Dutch speakers could be due to influence from English.

As noted by Docherty (1992), following the publication of Lisker & Abramson (1964), the focus of studies of voicing and aspiration was almost exclusively on (utterance) initial obstruents and hence there is a paucity of information in the literature about voicing in intervocalic position. Such information is important because it bears on the controversy about the features of contrast in true voice languages and aspirating languages. Many have recently suggested that [spread glottis], not [voice], is the feature of contrast in aspirating languages. One argument for this position is that in German the voicing of intervocalic lenis stops is variable, suggesting that the voicing is the result of the voiced environment, not any active gesture on the part of speakers (Jessen & Ringen, 2002). We found no variation in voicing of intervocalic stops in Russian, supporting the claims that the feature of contrast is [voice] in Russian. This finding also lends support to the claim that the feature of contrast in an aspirating language such as German is not [voice].

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Appendix: Word list

1. Words with initial stops

baba '(old) woman'	papa 'Dad'
baklažan 'eggplant'	papka 'fold'
baraban 'drum'	parad 'parade'
bl'uda 'dish (Gen.sing.)'	parik 'wig'
bol'no '(it) hurts'	piramida 'pyramid'
bolšije luga 'big meadows'	podgib 'fold'
bolšoj vorot 'big collar'	pogodki 'children with one year's difference of age'
dary 'gifts'	pogodok 'a child with one year's difference of age'
davka 'crush'	po kaple 'by drop'
duga 'bow'	potakat' 'indulge'
druga 'friend (Gen.sing.)'	tanec 'dance'
dvuxletka 'two-year-old'	tabor '(Gypsy) camp'
dl'a druga 'for a friend'	tabak 'tobacco'
dl'a papy 'for Dad'	tuman 'fog'
dva goda 'two years'	tumannij 'misty'
dva zuba 'two teeth'	kadka 'keg'
dvuxletnij 'two-year-old'	kapkan 'trap'
galop 'gallop'	karandaš 'pencil'
gazy 'gases'	kitajskij 'Chinese'
god 'year'	koška 'cat'
gorod 'city'	

2. Words with intervocalic stops

baba ‘(old) woman’	vraga ‘enemy (Gen.sg.)’
baraban ‘drum’	drugə ‘friend (Gen.sg.)’
tabor ‘(Gypsy) camp’	dl’ɑ drugɑ ‘for a friend’
tabak ‘tobacco’	duga ‘bow’
zuby ‘teeth’	net luga ‘no meadow’
dva zuba ‘two teeth’	mnogo let ‘many years’
ruda ‘ore’	vs’o vz’ato ‘everything is taken’
bl’uda ‘dish (Gen.sg.)’	net luka ‘no onion’
piramida ‘pyramid’	na parovoze ‘on an engine’
vody mor’ɑ ‘waters’	papa ‘Dad’
dva goda ‘two years’	po kaple ‘by drop’
pogodok ‘a child with one year’s difference of age’	na tancy ‘for a dance’
pogodki ‘children with one year’s difference of age’	kitajskij ‘Chinese’
lúga ‘meadow’ (Gen.sg.)	lapa ‘paw’
bol’sije lugá ‘big meadows’	potakat’ ‘indulge’
na naberežnoj ‘on the embankment’	dl’ɑ papy ‘for Dad’