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Tonal alignment patterns in Russian under changes in pitch range

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1.Introduction

1.1. Background

The alignment of fundamental frequency (F0) contours has been the concern of recent intonational research. Studies of several European languages (Caspers and van Heuven 1993, Ladd et al. 2000 for Dutch, Prieto et al. 1995 for Mexican Spanish, Arvaniti et al. 1998 for Greek, Ladd et al. 2003 for English) have observed that the F0 valley at the beginning of a rising pitch accent consistently aligns with the onset of the accented syllable. The location of the F0 peak at the end of the rise is more variable, being affected by a number of factors. The factors that cause the variations in peak alignment could be divided into two types: "phonetic factors", such as speech rate and intrinsic vowel or consonant duration, and "prosodic factors", such as upcoming word or phrase boundaries and following stressed syllable. In general, when a syllable is lengthened due to phonetic factors, the F0 peak moves forwards from the syllable or vowel onset. In contrast, when a syllable is lengthened due to prosodic factors, the F0 peak moves in the other direction: closer to the syllable onset (Silverman and Pierrehumbert 1990 for English, Prieto et al. 1995).

An important finding along this line of research is a phenomenon found by Arvaniti et al. (1998), which is later called "segmental anchoring". They found that in Modern Greek, when the location of nearby word boundaries and other accents (i.e. "prosodic factors") is duly controlled, *both* the F0 valley and the peak of the rising pitch accents are consistently anchored to specific points in the segmental string. Specifically, the valley is anchored at the onset of the accented syllable and the peak at the onset of the following unstressed vowel (see Figure 1).

Segmental anchoring is of theoretical importance. First, it casts light on the issues as to the invariant features of a given type of pitch accent. The fact that the alignment of both the F0 valley and peak of rising accents is invariant means that the accentual duration and slope are not invariant, but rather are precisely influenced by the *segmental* duration of the accented word (i.e. the duration due to "phonetic factors"). For example, Arvaniti et al. showed that in a word with shorter composition like [ro ditiko], the rise duration is shorter and the slope is steeper than in a word with longer composition like [pa remvasi] (see Figure 1). Second, segmental anchoring has relevance to "the levels versus configurations debate" (cf., Ladd 1996: 59-73), a longstanding discussion that opposes those that analyze intonational contour as consisting of primitive level tones ("level view") to those that see it as consisting of primitive pitch movements or configurations ("configuration view"). Specifically, these two views make different predictions with regard to the slope and duration of F0 movements. In the configuration view, it is reasonable to expect that a given F0 movement has relatively constant slope and/or duration. In the level view, by contrast, F0 movements are defined in terms of their constant beginning and ending points. Arvaniti et al. argue that segmental anchoring provides evidence in favor of the level view, which is widely assumed in current intonational work (e.g. Pierrehumbert 1980, Ladd 1996). The rising F0 movement is, for example, regarded as merely transition from its beginning point or "low tone", to its ending point or "high tone", which are independently aligned with the segmental string.

In addition, the finding is interesting from a cross-linguistic point of view. The existence of segmental anchoring in other languages was confirmed in study by Ladd et al. (1999) for English and study by Igarashi (2003) for Russian, in which it was shown that the alignment of the valley and peak of a rising pitch accent is unaffected by changes in segmental duration brought about by modifications of speech rate (i.e. "phonetic factors"), suggesting that, at least for European languages, segmental anchoring is a universal phenomenon[1].

Figure 1 Schematized F0 contours of rising accents in Modern Greek (Arvaniti et al. 1998). Dotted lines indicate F0 contour and solid lines shows the onset of the stressed syllable and the onset of following unstressed vowel of the words [ro ditiko] and [pa remvasi]. Note that the rise is shorter and steeper in the former word than in the latter.

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[1] Segmental anchoring was confirmed also in Dutch (Ladd et al. 2000). Exact alignment points are, of course, language specific. In Russian, for example, the peak aligns somewhere in the onset consonant of the following unstressed syllable (Igarashi 2003).

1.2. The aim of the present study

The aim of the present study is to explore the invariant features of Russian pitch accents, and test general plausibility of segmental anchoring in this language. Specifically, an experiment was performed to examine variations in F0 contours related to rising pitch accents under changes in pitch range. While in the previous studies, such variations have been examined under the changes along "horizontal" dimension, i.e. the changes in segmental duration caused by either phonetic or prosodic factors, in the present study they are examined under conditions which vary along "vertical" F0 dimension. Since the experimental manipulations in this study should be free from durational changes due to factors that may affect the alignment of the F0 peak, I expect that both the valley and the peak of the accents should be anchored to specific points in the segmental string, and that the accentual slope should be steeper as pitch range expands.

2. Experiment

2.1. Method

The approach in this experiment was to measure the alignment of the F0 valley and peak, rise duration, and slope of rising pitch accents in prepared sentences read aloud at three different pitch ranges. Pitch range manipulation was done by asking speakers to modify loudness. I expected that speakers would produce higher F0 value of the peak and hence expand their pitch range as loudness increases. In order to avoid a potential effect of sentence boundaries on the alignment of the F0 peak, I examined only the non-sentence-final or "prenuclear" rising accents, namely, F0 rise occurring at lexically stressed syllable of the non-final content words in a neutral reading of a short declarative sentence[2].

2.1.1 Materials, speakers and recordings

Twenty sentences were designed[3]. A typical sentence is *Románova guljála v górode* (Romanova was walking in the city), in which the rising accents were expected to occur on the first and the second words (see Figure 2). The accent I measured is the one on the first word. Each sentence consists of three content words, which are incorporated into the Subject- Verb- Object or Adverbial syntactic structure. Each test word was followed by one or two unstressed syllables, and the test word always had a lexical stress on the antepenultimate syllable. This criterion is adopted in order to avoid potential effects of the proximity of word boundary and of following accent on the alignment of the F0 peak. The consonants flanking the stressed vowel of the accented syllable are nasals or trills, because they would minimize segmentally-induced perturbation in the vicinity of the accented syllable.

The materials were read by six native speakers of Russian, three female and three male. In what follows, the speakers are identified as FA, FT FZ, MM, MK and MS, where F or M stands for female or male respectively, and the second letter is an initial. FA and MK are nineteen years old, and the other speakers were in their twenties. And at the time of recording they all had been studied at institutes or universities in Tokyo. Results of FZ and MM had to be discarded, because they produced different intonation patterns from the one I had expected. The speakers had any known speech or hearing problems and were naïve as to the purpose of the experiment.

The recordings were made on Digital Audio Tape (DAT) in the recording studio at Tokyo University of Foreign Studies or in a quiet room at the speakers' home. Speakers read the entire list of sentences once in each of three different loudness. On the first reading, speakers were asked to read the list at their normal voice. After the first reading, half of the speakers were asked to read loudly on the second reading and calmly on the third and the other half were asked to read calmly on the second reading and loudly on the third. Speakers were asked to repeat any misread sentences. The recorded materials were digitized at a sampling rate of 16 kHz. The sentences were analyzed using ESPS Waves+ software.

2.1.2. Measurements

All measurements were performed manually in a simultaneous display of the waveform, wide-band spectrogram, and F0 track. The F0 valley was defined as the F0 minimum located in the vicinity of the onset of the accented syllable and was marked as "L". The peak was measured at the highest F0 point around the offset of the accented syllable. This point was marked as "H". The four segmental points measured were the onset of the initial consonant, the onset of the stressed vowel, the offset of the stressed vowel, and onset of the following unstressed vowel. These points were marked as "C0", "V0", "C1" and "V1" respectively (see Figure 2).

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[2] This intonation pattern is called "sawteeth pattern", "neutral intonation", "intonation pattern of an isolated declarative sentence" and "IK-1" in the systems of Odé (1989), Yokoyama (2001), Svetozarova (1998) and Bryzgunova (1980), respectively. In my own system, the pattern is transcribed as "L+H* L+H* H+L*" (Igarashi 2002).

[3] The sentences designed in the present experiment are the same as the ones in my previous study (Igarashi 2003).

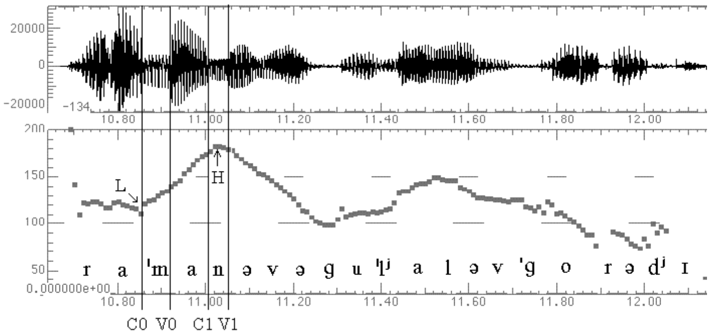

Figure 2. Waveform and F0 track for one of the test sentences *Románova guljála v gópode* (Romanova was walking in the city), showing the segmental points obtained and the point at which the F0 valley and peak were measured.

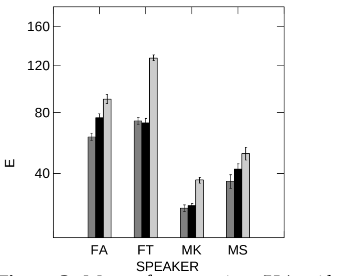

Figure 3. Means for excursion (Hz) with standard error bars.

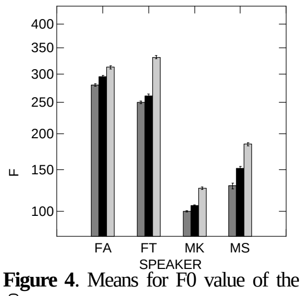

Figure 4. Means for F0 value of the peak (Hz) with standard error bars.

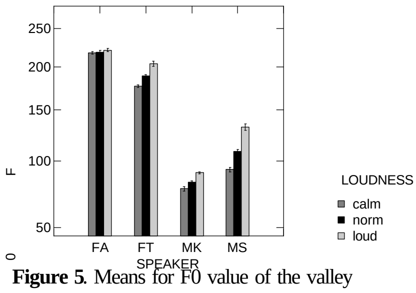

Figure 5. Means for F0 value of the valley (Hz) with standard error bars.

2.2. Results

All data were analyzed by means of one-way repeated measures analyses of variance (ANOVAs), with items as the random factor, loudness (calm, normal, loud) as a repeated measures fixed factor for each speaker separately.

2.2.1 Confirmation of pitch range manipulation

First, I confirmed whether the speakers had indeed produced significantly different pitch ranges for the three conditions. To examine this, I calculated F0 change in Hz between the valley and the peak (excursion). Figure 3 illustrates the means for excursion. As the figure indicates, speakers all produced larger excursion as loudness increased. One-way ANOVAs with excursion as a dependent variable showed a significant effect of loudness for all speakers [P<0.01 or better]. When excursions were measured in semitones[4] rather than Hz, similar results were obtained except for MS: this speaker produced relatively constant excursions and the effect of loudness was not significant [P=0.986].

In addition, I checked whether speakers produced different F0 values of the valley and peak. First, I measured F0 value in Hz of the peak. Means are shown in Figure 4. It can be seen that speaker all produced higher F0 value as loudness increased. One-way ANOVAs with F0 value of the peak as a dependent variable showed a significant effect of loudness for all speakers [P<0.001]. Second, F0 value of the valley was calculated. Means are presented in Figure 5. As can be seen, FT, MK and MS produced higher F0 value as loudness increased, while FA produced relatively constant F0 value. One-way ANOVAs with F0 value of the valley as a dependent variable showed a significant effect of loudness for all speakers [P<0.001] except for FT [P=0.140].

In sum, all speakers produced significantly different excursions, and this means the pitch range manipulation was successful. There was a speaker specific difference as to changes in F0 values of the peak and valley. While FA raised the peak keeping the valley constant, FT, MK and MS raised both. MS raised valley to such a degree that there was no significant difference in excursions when they are measured in semitones.

2.2.2. Alignment of the F0 valley and peak

I examined whether loudness had an effect on the alignment of the F0 valley and peak. As noted in Introduction, since potential "prosodic factors" that have been reported to affect the alignment were avoided in the present experiment, I expected that both the valley and the peak would be consistently anchored to specific points regardless changes in loudness. I did these analyses separately for the valley and the peak.

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4 Semitone is an appropriate scale for expressing the perceptual equivalence of F0 excursions in different voice range (see e.g., 't Hart et al. 1990: 24).

To examine an effect of loudness on the alignment of the valley, I measured the temporal distance between the onset of the accented syllable and the F0 valley (L to C0), and conducted one-way ANOVAs with L to C0 as a dependent variable. Means, F-ratios and *P*-values are indicated in Table 1. It can be seen that FA showed relatively constant alignment. Against expectation, other speakers showed variable alignment. FT showed significantly earlier alignment of the valley as loudness increased, and MS showed a non-significant tendency in the same direction. MK showed earliest alignment at loud voice and the effect was significant.

I used the same approach to investigate the alignment of the peak. I measured the temporal distance between the onset of the following unstressed syllable and the peak (H to V1), and ran one-way ANOVAs with H to V1 as a dependent variable. Means, F-ratios and *P*-values are shown in Table 2. As the table indicates, FM and MK showed relatively constant alignment and the effect of loudness for these speakers is not significant. Again, contrary to expectation, FT and MS showed significantly earlier alignment of the peak as loudness increases.

In sum, the results showed that, except in the case of FA, the alignment of the valley and/or peak were not stable, and that segmental anchoring was, therefore, not fully confirmed. The F0 valley was moved backward relative to the syllable onset when loudness increased for FT and MK, and MS showed non-significant tendency in the same direction. The results were rather unexpected, since previous studies of several European languages cited in Introduction have reported constant alignment of the valley. The F0 peak was also moved backwards as loudness increased FT and MS. Again, the results were unexpected, since "prosodic factors" that have been reported to cause retraction of the peak were carefully controlled in the present experiment. These results lead us to explain why some speakers moved the valley and/or the peak backwards when loudness increased. Moreover, it is not clear whether this effect on the alignment is due to pitch range expansion or to other factors. These issues are will be discussed in 2.3.

2.2.3. Rise duration

The fact that some speakers showed retraction of the valley and peak seems to support a view that a given type of F0 movement has a constant duration. Given, for configuration view, that F0 movement is a unit gesture, when the peak is retracted then the valley should be retracted to the same extent, keeping the rise duration constant. To examine this, I correlated the temporal duration between the valley and the onset of the accented syllable (LtoC0) and the temporal duration between the syllable onset and the peak (C0toH). If rise duration is constant, there should be a significant positive correlation. Result revealed that FT showed a significant correlation. [R=0.377, *P*=0.003], while other speakers showed no significant correlation [for FA R=0.116, *P*=0.378; for MK R=0.159, *P*=0.225; for MS R=0.060, *P*=0.651]. Thus, result does not fully confirm the view that F0 rise has a constant duration but suggests that retraction of the valley and that of the peak is somewhat independent phenomena.

I, then, calculated the temporal distance between the valley and the peak (rise duration), and conducted one-way ANOVAs with rise duration as a dependent variable. If rise duration is constant, then there should be no significant effect. Figure 6 illustrates the means. It can be seen that, while FA and MK produced relatively constant rise duration [for FA *P*=0.959; for MK *P*=0.279], for FT and MS rise duration are significantly longer as loudness increases [for FT *P*=0.017; for MS *P*=0.010]. The result clearly shows that rise duration is not a constant property of the accent.

Finally, I correlated syllable duration and rise duration. If rise duration is constant regardless changes in syllable duration, then there should be no significant correlation. Result revealed that there was a significant positive correlation for all speakers [for FA R=0.509, *P*<0.001; for FT R=0.570, *P*<0.001; for MK R=0.361, *P*=0.005; for MS R=0.304, *P*=0.018]. This means that rise duration is rather influenced by segmental duration: as syllable duration increases, rise duration also increases.

Overall, it is fair to say that rise duration is not a constant property of the rising accents. Rather, rise duration is influenced by segmental duration of the accented syllable. Thus, the configuration view was not supported. It was also suggested the valley and the peak are aligned independently from each other. It is noteworthy that the independent alignment of the valley and the peak is consistent with a view that treats level tones as intonational primitives.

Speaker	CALM	NORM	LOUD	F(2,59)	*P*
FA	-2.9(4)	-0.0(2)	-3.8 (2)	0.707	0.506
FT	20.4 (6)	3.8(4)	-2.3 (1)	5.682	0.012*
MK	-1.2(4)	-0.6 (1)	-20 (6)	4.388	0.028*
MS	-9.0(4)	-11.3 (6)	-17.6 (7)	0.605	0.557
Overall	4.9(2)	-0.0 (1)	-9.6 (2)		

Table 1 Means for Alignment of L to C0 (milliseconds) with standard errors in parentheses. Negative values mean that L precedes C0.

Speaker	CALM	NORM	LOUD	F(2,59)	*P*
FA	-7.0 (3)	2.1(3)	-2.9 (4)	3.403	0.056
FT	-14.0 (4)	-27.4 (5)	-52.5 (5)	11.750	0.001***
MK	-6.6 (5)	-8.6 (5)	-7.0 (3)	0.058	0.944
MS	-28.0 (5)	-36.9 (4)	-47.9 (4)	3.750	0.044*
Overall	-5.7 (2)	-11.9 (2)	-18.9 (2)		

Table 2 Means for Alignment of H to V1 (milliseconds) with standard errors in parentheses. Negative values mean that H precedes V1.

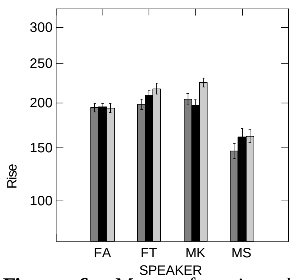

Figure 6. Means for rise duration (millisecond) with standard error bars.

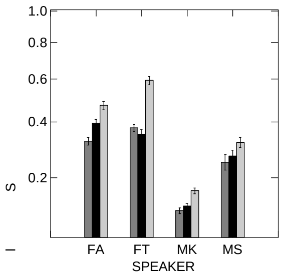

Figure 7. Means for slope value (Hz/ millisecond) with standard error bars.

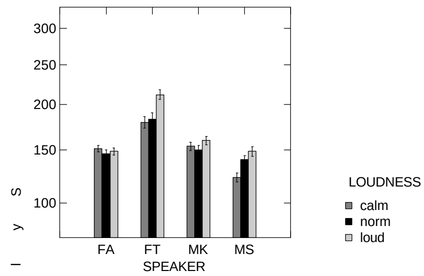

Figure 8. Means for syllable duration (millisecond) with standard error bars.

2.2.4. Slope

Finally, I investigated an effect of loudness on slope. I expected that slope would become steeper as pitch range expands. To examine this, I measured excursion in Hz divided by rise duration in milliseconds (slope value), and ran one-way ANOVAs with slope value as a dependent variable. If, for the configuration view, a given F0 movement has a constant slope, there should be no significant effect. The means are given in Figure 7. As can be seen, slope became steeper as loudness increased for FA, MK, and MS. FT showed the highest slope value at loud voice with lower value at both calm and normal voice. Note that these relations of slope values fairly correspond to those of excursions (see Figure 3). ANOVAs showed that the effect of loudness was significant for FA, MK and FT [$P<0.001$], but no significant effect for MS [$P=0.070$]. Similar results were obtained when excursions were measured in semitone.

In sum, it was shown that slope was not a constant feature of the accent, but it was highly dependent on changes in pitch range. The configuration view, therefore, was not supported.

2.3. Discussion

The results of this experiment do not support a view that a given type of F0 movement has a constant duration and/ or a constant slope. At the same time, however, they do not fully confirm segmental anchoring either: except for one speaker, the F0 valley and/or the peak were retracted when loudness increased. In this section, the factors that cause the earlier alignment will be explored.

As I pointed out in 2.2.2, it is not clear whether the factor that causes earlier alignment is expansion of pitch range. If pitch range expansion caused earlier alignment, it would be impossible to explain why FA showed a constant alignment. It might be safe to assume that the earlier alignment is attributed not to pitch range expansion, but to other factors relating to the experimental manipulation of the present study.

The retraction of the F0 peak reminds us of the effect of “prosodic factors” that I mentioned in Introduction. Recall that the previous studies have been reported that the F0 peak aligns earlier when a syllable is lengthened by the upcoming word or phrase boundaries or by the following stressed syllable. Suppose that increasing of loudness might have caused syllable lengthening for some speakers and this lengthening had an effect of retraction of the peak. To examine this account, I measured syllable duration of the accented syllable, and conducted one-way ANOVAs with syllable duration as a dependent variable. If this account is valid, then there should be a significant effect for FT and MS. Means are presented in Figure 8. Indeed, syllable duration became longer as loudness increased for FT and MS and the effect is significant [for both speakers $P<0.001$], while FA and MK produced relatively constant syllable duration and the effect of is not significant [for FA $P=0.156$; for MK $P=0.099$]. This result supports the account that retraction of the peak is due to syllable lengthening brought about by increasing of loudness.

Retraction of the valley, however, cannot be attributed to syllable lengthening, since MK, who retracted the valley, did not show the syllable lengthening. Here we may recall that FA produced relatively constant F0 value of the valley, whereas FT, MK, and MS, who showed retraction of the valley, raised it as loudness increased (see figure 5). It seems reasonable to suppose that the F0 valley aligns earlier as its F0 value is scaled lower. To examine this account, I correlated F0 value of the valley and temporal distance between F0 valley and the onset of the accented syllable. If the earlier alignment of the valley is due to its lower F0 value, there should be a significant negative correlation for FT, MK, and MS. However, result revealed that none of the speakers showed a significant correlation [for FA $R=0.032$, $P=0.811$; for FT $R=-0.251$ $P=0.053$; for MK $R=-0.250$ $P=0.054$; for MS $R=0.109$, $P=0.408$], though for FT and MK the effects approach significance. Thus, a link between F0 value of the valley and its alignment was not confirmed.

To sum up, it was suggested that the factor that causes earlier alignment of the peak was syllable lengthening brought about by increasing of loudness. I had assumed that such syllable lengthening had an effect similar to the lengthening due to “prosodic factors” that have been reported to cause earlier alignment of the peak. The factor that causes earlier alignment of the valley, however, could not be found. Since, as noted in introduction, there is fairly general agreement that the F0 valley of a rising pitch accent constantly aligns with the onset of the accented syllable, variable alignment of the valley found in this experiment should be an issue for further study.

There is anther matter that should not be ignored. The fact that earlier alignment of the valley and that of peak seems to be caused by different factors suggests that the valley and peak are independent from each other. Recall that in 2.2.3, it was suggested that the alignment of the valley and that of the peak were somewhat independent phenomena. This independency of the valley and peak is fairly compatible with a view that F0 movement is defined by its beginning and ending point (the level view) but not with a view that treats F0 movement *per se* as primitive unit (the configuration view).

3. Conclusion

In the present study, an experiment was performed to explore the invariant features (alignment of the F0 valley and peak, rise duration or slope) of Russian rising pitch accents under changes in pitch range, and to test general plausibility of segmental anchoring (Arvaniti et al. 1998) in this language. Pitch range was manipulated by asking speakers to modify loudness. The results revealed that 1) except for one of four speakers, the F0 valley and peak were moved backwards when loudness increased, 2) rise duration was not constant but was rather influenced by segmental duration of the accented syllable, and 3) slope was not the invariant feature of the accents but highly dependent on changes in pitch range. The results did not support a view that a given type of F0 movement has a constant duration and/ or constant slope, which should underlie a theory that treats F0 movements *per se* as primitive. Nor did they fully confirm segmental anchoring, a phenomenon which can be regarded as a strong support for a theory in which intonational contours consist of primitive level tones.

The factor that causes retraction of the valley and peak was also explored. It was found that speakers who retracted the peak produced longer syllable duration as loudness increased. It was suggested that increasing of loudness had an effect similar to factors such as the upcoming word or phrase boundaries or the following stressed syllable, which have been reported to cause syllable lengthening and retraction of the peak in the previous studies (e.g. Silverman and Pierrehumbert 1990, Prieto et al. 1995). The factors which cause the retraction of the valley could not be found. The variable alignment of valley, found in the experiment against general agreement that it should be consistently anchored with the onset of the accented syllable, should be an issue for further research.

The results also revealed that the valley and peak were somehow independent from each other: retraction of the valley and that of peak seems to be caused by different factors, and they are independently aligned with some segmental points not keeping constant rise duration. It was suggested that this independency is fairly consistent with a theory that treats not movements but level tones as intonational primitive.

References

Arvaniti, Amalia, Robert D. Ladd and Menen, Ineke 1998 Stability of tonal alignment: the case of Greek prenuclear accents, *Journal of phonetics* 26, 3-25.
Bryzgunova, Elena A. 1980 Intonacija. In: Švedova, N. et al. (eds.) *Russkaja grammatika*, Tom I, pp. 96-122. Moscow: Akademija Nauk SSSR.
Casper, J. and van Heuven, V.J. 1993 Effects of time pressure on the phonetic realization of the Dutch accent-lending pitch rise and fall. *Phonetica* 50, 161-171.
Igarashi, Yosuke 2002 Tak nazyvaemaja "nejtralizacija intonacii" -Fonologiè e skoe opisanie russkoj intonaeii *Bulletin of the Japanese Association of Russian Scholars* 34, 15-21.
———— 2003 Variability and stability of F0 movements in Russian under changes in speech rate. *Proceedings of the 126th conference of the Linguistic Society of Japan*, 274-279.
Ladd, Robert D. 1996 *Intonational phonology*. Cambridge: Cambridge University Press.
————, Dan Faulkner, Hanneke Faulkner, and Schepman, Astrid 1999 Constant segmental anchoring of F0 movements under changes in speech rate. *Journal of Acoustic Society of America* 106, 1543-1554.
————, Ineke Mennen and Schepman, Astrid 2000 Phonological conditioning of peak alignment in rising pitch accents in Dutch. *Journal of Acoustic Society of America* 107, 2685-2696.
————, and Schepman, Astrid 2003 "Sagging transitions" between high pitch accents in English: Experimental evidence. *Journal of Phonetics* 31, 81-112.
Odé, Cecilia 1989 *Russian Intonation: A perceptual description*. Amsterdam: Rodopi.
Pierrehumbert, Janet. 1980 *The phonology and phonetics of English intonation*. Doctoral dissertation, MIT.
Prieto, Pilar, Jan van Santen and Hirschberg, Julia. 1995 Tonal alignment patterns in Spanish. *Journal of Phonetics* 23, 429-451.
Silverman, Kim. and Pierrehumbert, Janet 1990 The timing of prenuclear high accents in English. In J. Kingston and M. Beckman (eds.), *Papers in laboratory phonology* I, pp. 72-106. Cambridge: Cambridge University Press.
Svetozarova, Natalija 1998 Intonation in Russian. In Hirst, D. & A. Di Cristo (eds.) *Intonation Systems. A Survey of Twenty Languages*, pp. 261-274: Cambridge University Press.
't Hart, Johan., René Collier and Cohen, A. 1990 *A perceptual study of intonation: An experimental-phonetic approach to speech melody*. Cambridge: Cambridge University Press.
Yokoyama, Olga T. 2001 Neutral and non-neutral intonation in Russian: A reinterpretation of the IK system. *Die Welt der Slaven* XLVI, 1-26.