Original Paper

Phonetica 2016;73:279–313
DOI: 10.1159/000449104

Received: March 17, 2015
Accepted after revision: August 10, 2016
Published online: February 23, 2017

Structural and Referent-Based Effects on Prosodic Expression in Russian

Tatiana Luchkina[a] Jennifer S. Cole[b]

[a]Central Connecticut State University, New Britain, Conn., and
[b]Northwestern University, Evanston, Ill., USA

Abstract

This study examines prosody in read productions of two published narratives by 15 Russian speakers. Two distinct sources of variation in acoustic-prosodic expression are considered: structural and referent-based. Structural effects refer to the particular linearization of words in a sentence or phrase. Referent-based effects relate to the semantic and pragmatic characteristics of the discourse referent of a word, and to grammatical roles that are partially dependent on referent characteristics. Here, we examine referent animacy and the related grammatical function of subjecthood, and the relative accessibility or information status of a word. We document patterns of *prosodic augmentation* and prosodic reduction due to structural and referent-based factors, as evident from change in values of acoustic-prosodic measures mean intensity, duration and f0 range. Prosodic augmentation due to structural effects is observed for words positioned ex-situ, independent of their semantic, grammatical or pragmatic features. Prosodic augmentation due to referent-based effects is observed for words that are grammatical subjects with animate referents. Prosodic expression is further affected by referent information status. Discourse-given and discourse-new information show greater prosodic augmentation than inferable information. A closer look at individual speakers' production styles reveals that structural and referent-based variations occur in combination and interact.

1. Introduction

Languages offer a variety of syntactic, prosodic and morphological tools to encode the relative accessibility and salience of concepts and entities evoked in everyday language use (Morgan et al., 1987). In connected speech or discourse, prosodic expression is one such tool (Pierrehumbert and Hirschberg, 1990; Ladd, 2008; Watson et al., 2008; Kaland et al., 2011). It involves perceptually salient changes in the voice quality of the speaker, in the relative duration and intensity of various discourse segments, and changes in pitch. The grammatical category of a word, its position in a sentence

KARGER

E-Mail karger@karger.com
www.karger.com/pho

Tatiana Luchkina
Central Connecticut State University
1615 Stanley Street
New Britain, CT 06050 (USA)
E-Mail tatiana.luchkina@ccsu.edu

or phrase and its information status (*new* or *given*) have all been found to affect its prosodic expression. To illustrate, grammatical and positional effects on prosodic measures are demonstrated in Brazilian Portuguese and Hindi, among other languages. In Brazilian Portuguese, there is an increase in duration and f0 range for grammatical subjects compared to grammatical objects, and an increase for utterance-initial subjects compared to non-initial subjects (Antão et al., 2013). There are similar prosodic effects in Hindi, an SOV language, for words that are situated in non-canonical positions, e.g., with the placement of an object noun in sentence-initial position (Patil et al., 2008). Prosodic effects due to information status are demonstrated in numerous studies, most extensively for English, a fixed word order language, but also for languages with more flexible word order, such as Greek, Turkish or Hindi (Baltazani and Jun, 1999; Baltazani, 2003; Işsever, 2003; Patil et al., 2008). For example, English words expressing previously unmentioned novel information, and contrastively focused or emphasized words, have been reported to have increased pitch, greater duration and greater intensity compared to words that are not focused or are already given in the discourse context (Xu and Xu, 2005; Mo et al., 2008; Breen, Fedorenko, Wagner, Gibson, 2010; Cole, Mo, Hasegawa-Johnson, 2010). In Hindi, a free word order language, an increase in intensity and f0 maxima, with expanded pitch range, have been found to mark (contrastively) focused constituents and novel (and also more prominent) information in discourse (Patil et al., 2008; Genzel et al., 2010; Luchkina et al., 2015).

An accurate characterization of the prosodic encoding of discourse meaning must take into account the effects on prosody of both *structural* factors, i.e., the position of a word in an utterance and the properties related to the word's referent, such as inherent semantic features and grammatical functions that are (partly) dependent on those features and information status. For the purposes of this study, we refer to these non-structural properties as *referent-based* properties. We focus, in particular, on (a) referent animacy analyzed in conjunction with the grammatical function of the corresponding referring expression and (b) referent information status, which relates the word to the preceding discourse. The present study examines these factors and their interaction in conditioning variation in acoustic-prosodic measures in Russian. Russian poses an interesting case study because, as in English, the intonational prominence of a word is sensitive to the position of the word in the prosodic phrase, but unlike in English, word order in Russian is quite variable (Yokoyama, 1986; Sekerina, 2003; Slioussar 2011a). Moreover, variation in word order in Russian may be sensitive to referent features, such as animacy and information status (Lobanova, 2011; Jasinskaya, 2013), further strengthening the potential for interaction between structural and referent-based factors on the prosodic expression of words.

In this study, we examine the effects from structural and referent-based factors on Russian prosody through the analysis of read productions of two published narratives by fifteen Russian speakers, asking how variation in the acoustic-prosodic parameters of intensity, duration and fundamental frequency are affected by: (1) the surface ordering (or linearization) of arguments in a sentence or phrase and (2) the characteristics of discourse referents, including the inherent semantic feature of animacy and grammatical functions that are sensitive to animacy and referent information status. In the first series of analyses, we examine changes in prosodic expression triggered by a discourse-motivated change in word order. In the following discussion, we determine if readers' prosody reflects referent-based properties. Specifically, we look for prosodic effects due to animacy in conjunction with grammatical function (subjecthood), and

prosodic effects of the information status of discourse referents. We present evidence for the distinct effects on prosodic expression, structural and referent-based. Our findings also reveal considerable inter-speaker differences in the effects of these factors on variation of acoustic-prosodic measures.

This paper is organized as follows. In section 2, we review evidence from prior studies for prosodic effects related to structural and referent-based factors in a variety of languages, motivating our focus on these factors in the analysis of Russian. In section 3, we provide an overview of the discourse and production data analyzed in the present study and formulate our hypotheses. In section 4, we report our experimental findings and discuss what these findings mean for our understanding of prosodic expression in the read discourse in Russian. Section 5 provides a general discussion of our findings and section 6 provides the conclusion.

2. Prior Work on Structural, Grammatical and Semantic Effects on Prosody

2.1. Word Order Effects on Prosody

Even more so than in fixed word order languages, in a 'free word order' language like Russian or Greek, the discourse status of a word, related to its information status and pragmatic focus, may be (probabilistically) reflected in its location in a dedicated clausal position (Clark and Clark, 1978; Baltazani, 2003; Féry and Krifka, 2008; Yokoyama, 1986). Favored positions place discourse-given information before discourse-new information, which may facilitate sentence processing and ease comprehension (Clark and Haviland, 1977; McDonald et al., 1993; Clifton and Frazier, 2004). Thus, just as with prosodic encoding, word order variability, when available, may be used to signal the information status of a word in relation to the discourse context.

In Hindi, Finnish, Romani, and possibly other languages that exhibit discourse-motivated word order variability, deviation from the canonical word order can alter the prosodic properties of an utterance or phrase. To illustrate, Arvaniti and Adamou (2011) report that in the variety of Romani spoken in Komotini, narrow focus on a nominal expression may be realized by positioning the focused noun ex-situ, preverbally, and accenting it, along with deaccenting the following verb. Vainio and Järvikivi (2006) report that in Finnish, a change in word order alters the intensity profile and tonal shape of an utterance and affects the perception of the ex-situ constituent as prominent. Similarly, Patil et al. (2008) reported that in Hindi, ex-situ preverbal constituents have a greater pitch excursion and greater duration.

2.2. Word Order and Prosody in Russian

Russian is known as a highly free word order language.[1] The six possible word orders in Russian are SVO (canonical), OVS, SOV, OSV, VSO and VOS. The ordering of words in a sentence serves a pragmatic function (Kallestinova, 2007; Slioussar,

[1] According to analyses of written Russian corpus data (Bivon, 1971), 79% of 3-word sentences have the canonical SVO order. The OVS order is the second most frequent word order in Russian and accounts for 11% of such sentences. SOV, VSO, VOS orders are possible and account for 1–4% of sentences each. Slioussar (2011) cites Sirotinina (1965/2003) who estimated that 16–30% of sentences in written texts in Russian contain postverbal subjects. Lobanova (2011) reports that in a corpus of 300 sentences, 88% were SVO, 6% – OVS, 4% – OSV, 1.5% SOV and 0.5% – VOS.

Phonetica 2016;73:279–313
DOI: 10.1159/000449104

2010, 2011): when presented out of context, all word order permutations express the same propositional content, but once presented in discourse, they differ in pragmatic meaning. Consider the following example from Russian, in which the sentence in (1a) can be continued with the canonically ordered sentence in (1b) or the non-canonical word ordering in (1c):

(1a) *Tri druga, Ivan, Petr, i Andrey, nahsli novjiy retsept pizzj*
Three friends, Ivan Petr and Andrey, found a new pizza recipe

(1b) Ivan gotovit pizzu
Ivan-NOM cooks-3SG pizza-ACC

(1c) Pizzu gotovit Ivan
Pizza-ACC cooks-3SG Ivan-NOM

'Ivan cooks pizza.'

Both the canonical SVO order and the non-canonical OVS order are possible for the continuation of the sentence in (1a). In the non-canonical OVS continuation shown in (1c), the word Ivan, critical to our understanding of who is doing the cooking, appears in the rightmost position, where it is structurally prominent and pitch accented. Previous work shows that in Russian examples such as this, a change in word order typically triggers a change in the acoustic-prosodic realization of the ex-situ word (Botinis et al., 2005; Luchkina and Cole, 2014). A growing body of research shows that in this respect, Russian is similar to other languages, in which structural and prosodic means are engaged in parallel when encoding referent status or information prominence in discourse (Greek: Baltazani, 2003; Finnish: Vainio and Järvikivi, 2006; Romani: Arvaniti and Adamou, 2011; Hindi: Patil et al., 2008; Samoan: Calhoun, 2015).

The interaction between argument linearization and prosodic expression in Russian (in comparison with Greek) was investigated by Botinis et al. (2005), who performed a comparative analysis of f0 and syntactic correlates of focus using elicited production data from over a hundred Russian speakers. Botinis and colleagues report that narrow focus productions in Russian involve a marked word order, OVS, and are clearly reflected in the 'tonal' or prosodic realization of an utterance, through a local f0 range expansion in the vicinity of the focused constituent and the concurrent f0 compression in the vicinity of the unfocused material. Botinis et al.'s findings suggest that the f0 correlates of narrow focus in Russian are independent of the syntactic correlates, and that when used concurrently, prosodic and syntactic effects of focus may reinforce each other reciprocally. While Botinis et al.'s work provides a first important step to understanding the relationship between structural and prosodic cues in connected speech in Russian, it does not tease apart prosodic variation conditioned by constituent reordering, referent properties and the pragmatic phenomenon of narrow focus.

2.3. Referent-Based Effects on Prosody

2.3.1. Animacy and Subjecthood

Apart from the influence of argument linearization on prosodic expression, the inherent properties of discourse referents, including animacy and definiteness, present other, potentially indirect, sources of prosodic variation. Animacy is an inherent property of the referent of nominal expressions, and through the notion of conceptual accessibility, it is closely related to the thematic roles of the agent and patient for simple transitive verbs, as in the Russian example (1 a–c), and similarly in English (Bock and Warren, 1985; Bornkessel-Schlesewsky and Schlesewsky, 2009). Referent animacy is

also related to the grammatical function of a referring expression, particularly subjecthood, via the association of prototypical animate agents with grammatical subjects, and prototypical inanimate patients with grammatical objects (Comrie, 1989; Hoeks et al., 2004; de Swart, 2007). Cross-linguistic studies, e.g Bresnan, Dingare, Manning (2001), have demonstrated that nominal expressions with animate referents not only have a tendency to occur in higher syntactic positions, such as that of the sentence subject, but also tend to occur early in a sentence or clause. We therefore recognize that animacy plays a role in determining the thematic role and grammatical function of a discourse referent in relation to a predicate, and that these factors may in turn influence the word order.

Cross-linguistically, morphological (case marking) and syntactic (linearization) devices are used to make distinctions such as those between animate and inanimate referents, and between grammatical subjects and objects (Bornkessel-Schlesewsky and Schlesewsky, 2009). Convergence between syntactic and conceptual representations, achieved when argument roles in the sentence are filled prototypically (i.e., when the subject referent is animate and the object referent is inanimate) has been found to facilitate sentence processing (Traxler et al., 2002; Bornkessel-Schlesewsky and Schlesewsky, 2009). In English, where the word order flexibility is limited, animacy plays an important role in grammatical role assignment, but has no direct effect on linearization of major sentence constituents (Bock and Warren, 1985; McDonald et al., 1993, among others). However, in a free word order language, animacy may affect the linear order of sentence constituents and determine argument linearization preferences, as shown by Prat-Sala and Branigan (2000) and Verhoeven (2009, 2014). The so called 'animate-first' effects, which translate into a preference for an animate referent to appear early in a sentence or phrase, have been found in a number of languages with relatively flexible constituent order, including Greek and Turkish (Branigan and Feleiki, 1999; Verhoeven, 2014), Japanese (Branigan et al., 2008), Spanish (Prat-Sala, 1997) and German (van Nice and Dietrich, 2003; Verhoeven, 2014). Lobanova (2011) examined the role of animacy on argument ordering in two Russian written corpora and found that animate nouns bear a strong association with the sentence-initial position, regardless of their grammatical function as the subject in a canonical SVO sentence or the object in an object-initial OVS sentence. Turning to the potential for direct effects of animacy on prosodic variation, Antão et al. (2013) found that animacy and subjecthood significantly affected a number of acoustic-prosodic parameters, including mean f0, f0 range and duration, which were greater for animate referents and grammatical subjects in Brazilian Portuguese. These findings suggest that the prosodic augmentation of animate referents, and grammatical subjects may be reflective of their greater discourse salience than that of other types of referring expressions (McDonald et al., 1993; Mak et al., 2002; Traxler et al., 2005).

2.3.2. Relative Accessibility and Information Status

Apart from the effects of animacy and subjecthood, prosodic variation may also arise due to the information status of words and the relative accessibility of their referents for speech comprehension. Information structure relates the referent of a word to the preceding discourse, distinguishing the referent as given (theme), via prior mentions in discourse, or novel (rheme), introduced to discourse for the first time. These categories of information may occur together in a single utterance or phrase, partitioning the utterance into distinct information components, such as given information and

novel information. While the given-novel dichotomy is central to many information structure approaches (e.g., Halliday, 1967), more recently, Baumann and Riester (2012, 2013) proposed that information status effects can be considered in two forms: referential and lexical. *Referential information status* relates to the discourse status of the referent of a word, which is dynamic, reflecting changes in the accessibility of the referent based on the evolving discourse context. In cognitive accounts (Chafe, 1976, 1994; Lambrecht, 1994), the accessibility or givenness of discourse entities is described in terms of the activation costs associated with bringing these entities into the focus of the speaker's or hearer's attention. Referent accessibility may be viewed as a continuous measure, signaled by means of special morphological markers, word order and/or prosody (Morgan et al., 1987). *Lexical information status* relates to the prior mentions of a lexical item, and along with lexical frequency (token frequency of a lexeme in the language), is known to have an effect on the ease of lexical access. The breakdown of information status into the referential and lexical levels is of particular relevance to this study, since it allows for a close-up analysis of referent-specific information status effects on prosodic expression in discourse.

Rich empirical evidence shows effects of information status and word predictability on acoustic measures of prosody (Aylett and Turk, 2004; Breen et al., 2010; Cole et al., 2010; Watson, 2010; Baumann and Riester, 2012, 2013; Cruttenden, 2006; de Ruiter, 2015). It is well-known that in many languages, and especially in English, the prosodic expression of a word reflects its information status (new or given) and its focus status (broad, narrow, contrastive). In English, the absence of morphological focus or topic markers, alongside rigid constraints on word order, means that prosody is the primary mechanism for encoding information status. It is of interest then that prosodic encoding of information status is also identified for languages with 'free' word order. For example, f0 and duration are among the acoustic-prosodic correlates of information status in Samoan (Calhoun, 2015), Hungarian (Genzel et al., 2015) and Greek (Baltazani, 2003) – languages with some degree of variable word order.

2.4. Referent-Based Effects on Prosody in Russian

Russian has been shown to exhibit prosodic effects of referent information status in patterns of pitch-accenting, with accenting of novel information and deaccenting of given information (Neeleman and Titov, 2009; Jasinskaja, 2013). In addition, information status is reliably associated with the clausal positioning of a word (King, 1995; Brun, 2001). Specifically, the default (pragmatically neutral) pattern is for discourse-new information to occur clause-finally, while contrastive information may surface in various positions or remain *in-situ*.

2.5. Research Questions

We have seen that the prosodic status of a word, expressed in acoustic measures of f0, intensity and duration, is variable and reflects structural factors such as word order, and referent-based factors related to semantic and grammatical properties, and information status. We have also seen that referent-based factors interact with the word order in the assignment of prosodic prominence in languages such as Russian, which further complicates prosodic analysis. To date, there is no study that considers word order against the range of referent-based factors discussed above, which means that no study has fully addressed the interaction among these factors in the prosodic expression of a word. Examination of structural and referent-based factors is necessary to

determine, for example, if word order or acoustic prosodic cues are the primary means for encoding discourse meaning, if the two functions are in tandem, and to what extent factors related to the discourse referent of a word mediate the relationship between word order, prosody and information status.

The goal of the present study is to test the effects of word order, animacy and grammatical function, and information status on the acoustic expression of prosody in Russian discourse. Our first research question is whether the word order affects acoustic-prosodic measures, such that words that are ex-situ relative to their canonical positioning (SVO) are distinct from canonically positioned words in their acoustic-prosodic measures. We address this question by examining acoustic-prosodic variation associated with two types of ex-situ positions, fronted (sentence-initial) and post-posed (sentence-final), while controlling for other potential sources of prosodic variation stemming from grammatical, semantic and information-structural properties of discourse referents. In line with the finding that ex-situ words in a number of order languages tend to be prosodically distinct (e.g., Vainio and Järvikivi, 2006; Patil et al., 2008), we recognize that such effects may be orthogonal to discourse meaning, arising as the acoustic-prosodic 'aftermath' of an ex-situ position in a sentence or phrase. Alternatively, such effects may be directly related to discourse meaning, cuing the referent features and information status of the ex-situ word. We test the following hypothesis:

Hypothesis 1: Deviations from canonical word order trigger acoustic-prosodic effects that are word order-specific, i.e., structural in nature, and that are independent from the semantic and grammatical properties of a word or its information status.

The second research question addressed in our study concerns the effect of referent-based factors and the grammatical function of referring expressions on acoustic-prosodic measures. As discussed above, prior work (e.g., Branigan et al., 2008; Bornkessel-Schlesewsky and Schlesewsky, 2009; Breen et al., 2010; Baumann and Riester, 2012), shows that animate entities, grammatical subjects and discourse-novel information are inherently more salient in discourse. It has also been shown that animacy, grammatical function and information status may influence the linear ordering of sentence constituents and may trigger special prosodic and structural properties in spoken and read discourses. We, therefore, ask how semantic, grammatical and information-structural properties of discourse referents affect acoustic-prosodic measures in Russian, and, specifically, if observable differences in prosodic expression can be traced to the animacy and subjecthood, and to the information status of discourse referents. To answer this question, we evaluate the independent effects of animate vs. inanimate referents in conjunction with (1) their grammatical function and (2) referent information status. We also test the interaction of word order and referent-based factors on acoustic-prosodic variation. We test the following hypothesis:

Hypothesis 2: The animacy, subjecthood and referent information status of a word affect its acoustic-prosodic properties as independent factors and in their interaction with word order.

The research questions addressed in this study will help uncover sources of prosodic variation in discourse in a free word order language like Russian. Analysis of the reading performance of fifteen Russian speakers will enhance our understanding of the conditions under which a speaker utilizes acoustic-prosodic resources in the expression of discourse meaning. It will additionally allow us to gauge, although tentatively, speaker-specific variability in two types of prosodic variation: structural, pertaining

Table 1. Definitions of referential information categories adapted from the RefLex scheme by Baumann and Riester (2012, 2013)

Referential information status			
r-given	r-bridging	r-new	r-unused
anaphor co-referring with an antecedent in previous discourse (given status)	non-co-referring anaphor dependent on preceding context (inferable status)	referent/concept introduced to discourse for the first time (new status)	discourse-new item which is generally known (e.g, a toponym) (new status)

to word order, and referent-based. More detailed predictions about how structural and referent-based factors may affect acoustic prosodic measures are presented in the next section, where the coding schemes and measurements are introduced.

3. Materials and Method

The speech materials used in this study come from two published narratives, an excerpt from a biography and a complete folk tale (344 content words, 69 function words total). Two stylistically different texts were chosen to reflect standard (text 1) and colloquial (text 2) language use. The word orders present in text 1 include 29 SVO clauses, 3 OVS and 1 SOV clauses. The word orders present in text 2 include 25 SVO, 3 OSV, 2 VSO, 2 SOV, 4 OVS, 2 OV and 3 VS clauses. Such uneven distribution of word orders in the study materials is expected, given that SVO and OVS are the two most common word orders in Russian, and that SVO is the pragmatically neutral order compatible with all information structural configurations. The average sentence length in the corpus is 5.2 content words (SD = 1.77); 18% of all content words (61 words, 45 referring expressions) occur in ex-situ positions associated with non-SVO orders.

The information status of each referring expression in the corpus was independently annotated by one of the authors (TL) and another native Russian speaker for a total of 259 content words. Inter-rater agreement (linearly weighted Kappa) between the annotators across texts was satisfactory: $\varkappa = 0.86$, SE = 0.03, $\alpha = 0.05$. Information status was classified based on Baumann and Riester (2012, 2013). As discussed in section 2.3.2, RefLex allows for specification of information status at two qualitatively distinct levels: referential, pertaining to properties of the discourse referent of the word, and lexical, pertaining to the lexical choices a speaker makes to identify a discourse referent. This study is aimed at determining the prosodic effects of word order and referent-based factors. Hence, we focus on the referential level of information status. Following Baumann and Riester (2012, 2013), we distinguish between four distinct classes of referents: r-given, r-bridging, r-new and r-unused[2], defined in table 1. Each referring expression in the corpus was assigned to one of these classes.

Each content word in the corpus was also annotated for its position in the sentence, being either in-situ or ex-situ relative to the canonical SVO order. More specifically, we distinguished between fronted sentence-initial and post-posed sentence-final ex-situ positions. All constituents in SVO sentences were coded as *in-situ*. Following Slioussar (2011) and Ionin and Luchkina (under review), we treat both the subject and object as ex-situ in the non-canonical OVS order; we, therefore, coded subject nouns as *ex-situ post-posed* and object nouns – as *ex-situ fronted* in the OVS sentences (cf. Bailyn, 2004). Objects were coded as ex-situ fronted in the SOV and OSV non-canonical orders. Verbs and non-referring expressions in ex-situ positions were not included in the following analyses. The coding scheme for ex-situ constituents is illustrated in (2) and (3), both taken from text 2.

[2] The category of r-unused information was only represented by 2 toponyms in the corpus. Because of being underrepresented, data from both r-unused words were excluded from statistical analyses.

Table 2. Independent variables for MANOVA model. The same factors were used as predictor variables in multinomial regression model

Factors	Factor levels
Word order	in-situ ex-situ, fronted ex-situ, post-posed
Information status	r-given r-bridging r-new
AGRC	object, animate object, inanimate subject, animate subject, inanimate
Vowel height	stressed open other

(2) V eto vremya po doroge shol kozyol. ex-situ post-posed
at this time along road walked-M goat-NOM
'At this time, a goat walked along the road.'

(3) vody v kolodce bylo ne mnogo
ex-situ fronted water-GEN in well was not much
'There was not much water in the well.'

The animacy and grammatical function of discourse referents were coded jointly, by associating each nominal expression in the corpus with one of the four levels of the variable *AGRC* (AnimacyGRammaticalClass), which combines animacy and the grammatical function into a single category: animate subject; inanimate subject[3]; animate object and inanimate object.

3.1. Acoustic Features Pre-Processing and Statistical Modeling of Production Data

All materials were read aloud by 15 native speakers of Russian (9 females), ages 21–52 years. All speakers read the narratives silently and then were instructed to read them aloud in a lively naturalistic manner, as if addressing an audience. Recordings were made in a sound-proof recording booth using a Marantz PDM 750 solid state recorder and a head-mounted microphone. Recorded data were digitized at a sampling rate of 44.1 kHz and submitted to acoustic analyses. The acoustic measures of f0 range, mean intensity and raw duration were taken from every syllable of each word in the corpus. All measurements were extracted automatically in Praat (Boersma and Weenink, 2016). Fundamental frequency and intensity measures were taken from the center region of the vowel, excluding the 10-ms sub-regions from the vowel edges, to minimize the influence of adjacent consonants at vowel onset and during inter-segmental transitions. Each f0 output was transformed to semitone values relative to a fixed value of 100 Hz. The acoustic measures of f0 range, mean intensity and duration were then examined for their relationship to animacy, subjecthood and the referent status of discourse entities, and word order. To minimize variability between speakers due to individual characteristics and speech rate, intensity values were log transformed, and duration values were subject to mean-centered coding using within-subject z-scores (Bush, Hess, and Wolford, 1993).

A multivariate analysis of variance was fit to three dependent variables: *f0 range*, *mean intensity* and *duration*. The following predictor variables entered the analysis: *AGRC*, *IS REF*, *word order* and *speaker*. The factor *open vowel* was added as a control factor to account for possibly greater intensity

[3] Only one grammatical subject in the corpus was inanimate. The category inanimate subject was, therefore, excluded from statistical analyses.

of unreduced open vowels in stressed syllables (e.g., word-final vowel in the word Moskvá). The predictor variables and their levels are summarized in table 2.

The omnibus MANOVA returned tests of significance for the overall model using four different multivariate criteria, Wilks' lambda, Lawley-Hotelling trace, Pillai's trace and Roy's largest root. The model was overall highly significant (all p values <0.001, e.g., using Wilks lambda, $F(23, 8171) = 475.1$, $p < 0.001$). The MANOVA revealed that the control variable *open vowel*, although significant overall, accounted for the least amount of variance in the dependent variables ($F(1, 8169) = 21.4$, $p < 0.001$, $\eta^2 < 0.01$). Variable *speaker* accounted for the largest amount of variance in the dependent variables and the largest effect size in the model ($F(14, 8171) = 759.2$, $p < 0.001$, $\eta^2 = 0.53$). Variables *word order* ($F(3, 8170) = 55.64$, $p < 0.001$, $\eta^2 = .1$), *IS REF* ($F(3, 8171) = 52.05$, $p < 0.001$, $\eta^2 = 0.1$) and *AGRC* ($F(3, 8171) = 73.81$, $p < 0.001$, $\eta^2 = 0.1$) in turn, proved to be robust, however, with small effect sizes.

Following the multivariate analysis of variance, a mixed-effects linear regression model[4] was fit to the data. Consistent with MANOVA, *mean intensity*, *duration* and *f0 range* were introduced as dependent variables. *AGRC*, *word order*, *IS REF* and *vowel height* were included as fixed effects. *Speaker* was introduced as a random effect. The model also included interactions between *AGRC, word order and IS REF*.

3.2. Predicted Effects of Structural and Referent-Based Factors on Acoustic-Prosodic Measures

We are now able to formulate the specific effects that are predicted by our two hypotheses, as stated earlier. For all of the predictions below, we consider greater values for f0 range, mean intensity or duration as an *augmented* expression of a word's prosodic features, and conversely, diminished values of the same measures are considered as a *reduced* expression of a word's prosodic features. In this manner, we examine the effects of structural and referent-based factors in augmenting or reducing the acoustic-prosodic expression of a word.

(4) Predicted effects of structural and referent-based factors on acoustic-prosodic measures:

(a) Hypothesis 1: structural effects on prosody. In line with findings from prior work on prosodic effects of non-canonical word order, we predict prosodic augmentation in Russian for words in ex-situ positions relative to words located in-situ.

(b) Hypothesis 2: effects of animacy and subjecthood on word order. Here, we consider predictions for effects of animacy and subjecthood on word order. We are interested in factors affecting word order because, due to the hypothesized effects of word order on acoustic-prosodic measures (see prediction (a)), any effect on word order may indirectly influence prosody. Following Lobanova's (2011) finding that animate nouns in Russian tend to occur sentence-initially, whereas inanimate nouns tend to occur sentence-finally, independent of their grammatical function, we predict a greater rate of fronting for animate objects and a greater rate of post-posing for inanimate subjects. Our corpus provides does not provide a sufficient number of inanimate subjects, so the second prediction here cannot be evaluated in the present study.

(c) Hypothesis 2: effects of animacy and subjecthood on prosody. Because of greater inherent salience attributed to animacy and subjecthood, we predict prosodic augmentation for words with animate referents and for grammatical subjects, compared to words with inanimate referents and grammatical objects.

(d) Hypothesis 2: effects of referent information status on word order. Here, we consider predictions for effects of referent information status on word order, which again, is of interest due to the effect of word order on prosodic expression. Following findings from prior research showing a cross-linguistic preference for given information to precede novel information in a sentence or phrase, and considering the word order variability in Russian, we predict that words will be assigned to sentence positions depending on their information status. More specifically, and consistent with the preference for discourse-given information to occur sentence-initially and discourse-new information to occur sentence-finally, we predict that words labeled as r-given will be fronted more often than post-posed and that words labeled as r-new will be post-posed more often than fronted.

[4] In a multivariate regression analysis, several dependent variables are jointly regressed on the same independent variables (Afifi, Clarc, and May 2004). The individual coefficients and standard errors produced by a multivariate regression are identical to those that would be produced by sequential linear regressions estimating each regression equation separately. The difference is that a multivariate regression is a joint estimator, and as such, estimates the between-equation covariances, allowing for meaningful direct comparison of coefficients across equations.

Table 3. Model coefficients for significant main effects and interactions obtained in multinomial regression analysis. Shaded cells indicate lack of significant effect

Fixed effects and interactions	Levels of fixed effects	β coefficients for acoustic-prosodic parameters		
		f0 range	mean intensity	duration
AGRC	object A	–0.61	–3.24	
	object I	–0.34	–1.67	–0.13
Word order	ex-situ fronted	1.10	3.13	
	ex-situ post-posed	–0.68	–0.02	0.60
IS REF	new	–0.26	2.03	–0.34
	bridging	–0.27	0.04	–0.16
*AGRC*word order*	ex-situ fronted*object A			0.49
	ex-situ post-posed*subject A		0.59	0.72
*IS REF*word order*	ex-situ fronted *r-bridging	–1.71	–0.76	–0.31
	ex-situ post-posed *r-bridging	–0.31	–0.40	–0.45
*IS REF*word order*AGRC*	r-new*ex-situ post-posed*subject A	1.58	5.73	0.84
	r-new*ex-situ fronted*object A		5.62	0.43
	r-new*ex-situ fronted*object I		3.76	0.99

All effects significant at $p < 0.05$. 'A' and 'I' represent 'animate' and 'inanimate', respectively.

(e) Hypothesis 2: effects of referent information status on prosody. Consistent with the cross-linguistic preference for discourse-new information to be pitch-accented, and for discourse-given information to be deaccented, we predict prosodic augmentation for words whose referents are r-new compared to words with other information status labels. Further, given the relatively higher accessibility and lower information value associated with r-given and r-bridging information, we predict reduced prosodic expression for words whose referents are r-given and r-bridging.

4. Results

Table 3 lists the model coefficients (β) for significant main effects and interactions obtained in the multivariate regression analysis organized by acoustic-prosodic dependent variable. Beta coefficients listed in table 3 allow for direct comparisons of effects across regression equations. In what follows, we discuss these results based on the hypotheses and predictions formulated in (4) above. In section 4.1, per (4a), we report the effect of word order on prosodic variation in the read productions of the corpus. In section 4.2., per (4b) and (4c), we examine prosodic variations in conjunction with two related properties of discourse referents, animacy and subjecthood. Section 4.3 presents an interim summary of these findings before turning to the results for information status. In section 4.4, we examine prosodic variation in conjunction with information status of discourse referents, per (4d) and (4e). For each of these analyses, we present

significant main effects and interactions based on the read production data from all fifteen speakers.

In the omnibus MANOVA model reported in section 3.1, the factor *speaker* accounted for more variation in the prosodic parameters examined in this study than any other predictor did. In the post-hoc analyses of the interactions between *word order, AGRC* and *IS REF*, we analyze production of individual speakers and illustrate inter-speaker differences in prosodic variation in response to these effects. Post-hoc analyses of individual speaker productions with focus on *word order* and *AGRC* are reported in section 4.2.1; post-hoc analyses with focus on *word order* and *IS REF* are reported in section 4.4.1.

4.1. Ex-situ Position

Our first hypothesis concerns changes in prosodic expression related to a discourse-driven change in word order in Russian[5]. In the multivariate regression analysis, acoustic-prosodic features of ex-situ fronted and post-posed words were estimated relative to the prosodic characteristics of in-situ words. Controlling for the independent variables *AGRC* and *information status (IS REF)*, the dependent variables *mean intensity* and *f0 range* were greater for words fronted relative to their canonical position (*mean intensity*: $t = 5.74$, $p < 0.001$; f0 range: $t = 3.70$, $p < 0.001$). On the contrary, smaller *f0 range* ($t = –2.69$, $p < 0.01$) but greater *duration* ($t = 3.31$, $p = 0.001$) were associated with words post-posed relative to their canonical position. All significant results were in the predicted direction, per (4a), though not all predicted results were significant.

4.2. Animacy and Subjecthood

Considering the interrelatedness of referent animacy and argument linearization reported in earlier work on Russian (Lobanova, 2011) and other languages with variable word order (Branigan and Feleki, 1999; Tanaka et al., 2005), we evaluated the rate of fronting and post-posing of a word in relation to the animacy of its referent. The observed distribution of *AGRC* categories across in-situ, fronted and post-posed sentence positions is illustrated in figure 1. Figure 1 demonstrates that approximately 20% of animate subjects in the corpus occur sentence-finally. Due to the insufficient number of inanimate subjects in the corpus, prediction (4b) cannot be tested. We, therefore, proceed to evaluate the effect of animacy based on the ex-situ occurrence of objects.

Figure 1 also demonstrates that approximately 12% of animate objects and 14% of inanimate objects are fronted relative to their canonical position. We observed highly comparable rates of fronting for animate and inanimate objects in the corpus, hence prediction (4b) was not borne out – we do not find differences in word order due to a word's animacy. Of particular interest for this work is prosodic variability specific to the grammatical function and animacy of discourse referents. Hence, read productions of the corpus were examined for prosodic variation specific to the animacy and grammatical function of discourse referents.[6] Results of the regression analysis confirm that

[5] Appendix A presents summary statistics for the acoustic-prosodic measures f0 range, mean intensity and duration computed for production data from all speakers across three sentence position types, in-situ, ex-situ fronted and ex-situ post-posed.

[6] Appendix B presents summary statistics for the acoustic-prosodic measures f0 range, mean intensity and duration computed for production data from all speakers across the levels of *AGRC*, 'subject animate', 'object animate', 'object inanimate'.

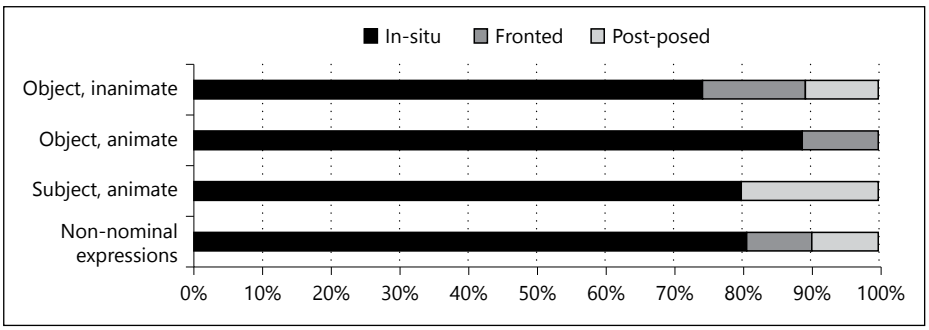

Fig. 1. Distribution of *AGRC* across sentence positions. Y-axis: levels of *AGRC*; X-axis: percent occurrences.

animacy and subjecthood have a robust direct effect on acoustic-prosodic measures, confirming prediction (4c).

The animacy effect: Recall that animacy and grammatical function are crossed as levels of one variable, *AGRC,* in the regression model reported in section 3. This coding scheme allows direct comparison of the acoustic-prosodic outcomes for all levels of *AGRC* relative to the baseline level of animate subjects, including the critical comparisons between animate and inanimate objects, and animate subjects and animate objects. We use these comparisons to evaluate, separately, effects of animacy and subjecthood on the acoustic-prosodic expression. Results reveal that the animacy of a word's referent significantly predicts variation in vowel duration; specifically, we found that, relative to animate subjects, *duration* was significantly reduced for inanimate objects ($t = –3.38$, $p < 0.01$), but not for animate objects ($t = –0.8$, $p = 0.43$). There was no animacy effect on objects for dependent variables *mean intensity* or *f0 range*.

The subjecthood effect: As shown in table 3, controlling for *word order*, *mean intensity* and *f0 range* were significantly reduced for every category of *AGRC* relative to that of animate subjects. Specifically, animate subjects had greater *mean intensity* than animate objects ($t = –9.78$, $p < 0.001$) and inanimate objects ($t = –5.34$, $p < 0.001$). Similarly, *f0 range* was significantly greater for animate subjects than objects, animate ($t = –3.39$, $p < 0.005$) or inanimate ($t = –4.37$, $p < 0.001$).

The mean values of the acoustic-prosodic variables for each level of *AGRC* are plotted in figure 2 and reflect production data from all speakers in the sample. Significant two-way interactions between *AGRC* and *word order,* illustrated in figure 2, included greater mean intensity for ex-situ post-posed animate subjects ($t = 4.74$, $p < 0.001$) and greater duration for fronted animate objects ($t = 2.62$, $p < 0.01$) and post-posed animate subjects ($t = 3.43$, $p = 0.001$).

4.2.1. Inter-Speaker Variability and Interaction with Word Order

Further analysis of the read productions of narratives reveals that individual speakers differ in their use of acoustic-prosodic parameters, which in our data gives rise to differences in the observed effects of structural and referent-based factors on acoustic-prosodic measures, and in their interaction. Individual speaker effects were tested by computing predicted marginal effects at the means for acoustic-prosodic parameters duration, f0 range and mean intensity for *AGRC* and *word order,* using production data

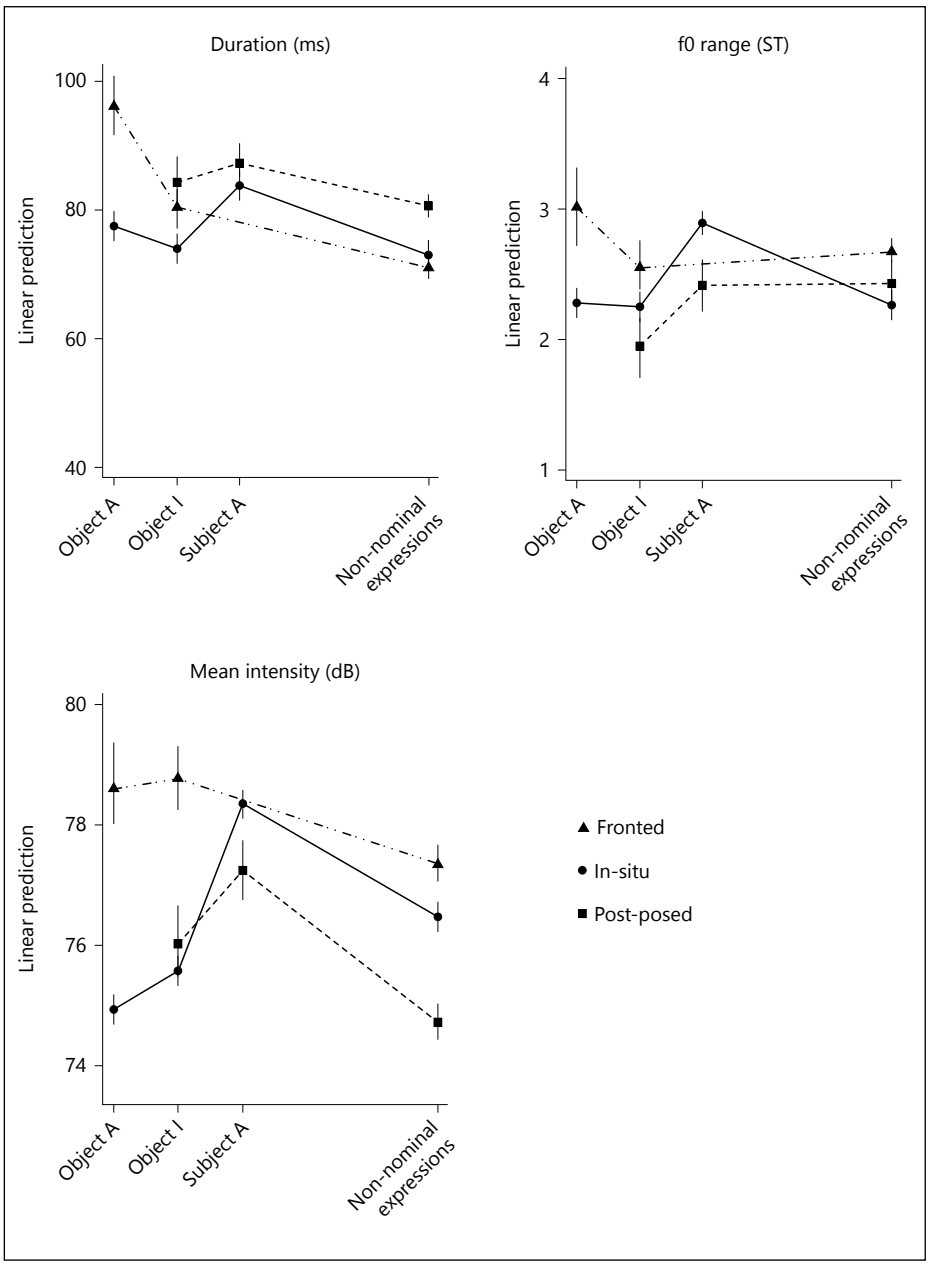

Fig. 2. Predicted marginal effects at the means with 95% CIs for parameters duration (ms), mean intensity (dB) and f0 range (st) across levels of *AGRC* and *word order*. Data from fifteen speakers. Y-axes: acoustic-prosodic parameter; X-axes: levels of *AGRC*.

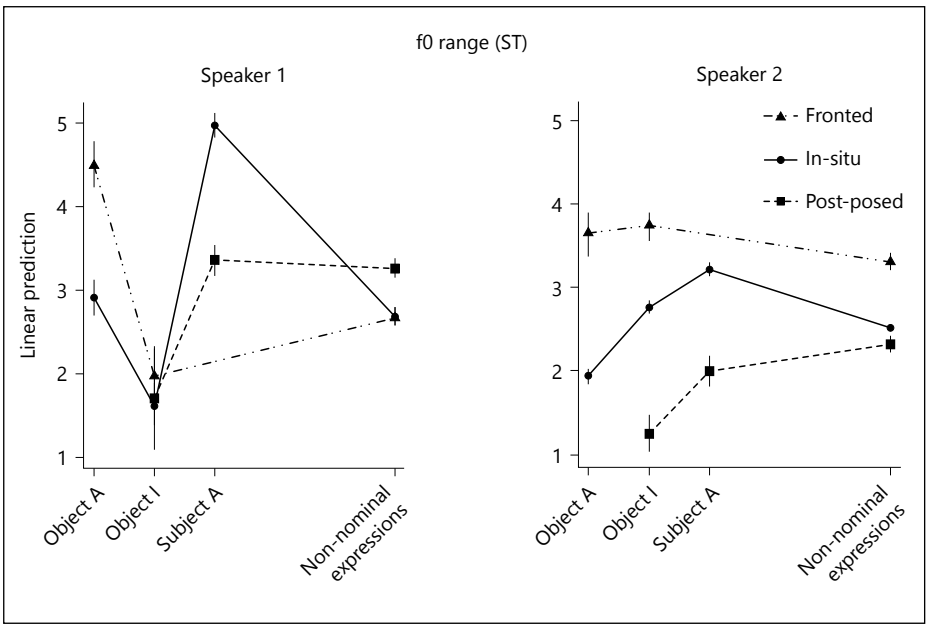

Fig. 3. Predicted marginal effects at the means with 95% CIs for parameter f0 range across levels of *AGRC* and *word order*. Data from speakers 1 and 2. Y-axes: f0 range (st); X-axes: levels of *AGRC*. 'A' and 'I' represent 'animate' and 'inanimate', respectively.

from each individual speaker (see Appendices C and D). Due to space limitations, we do not present the model results for each individual speaker; rather, for illustration purposes, for each acoustic-prosodic parameter of interest, we select two speakers who differ in the effects of *AGRC* and *word order* on prosody. Specifically, for each acoustic-prosodic measure, we plot the predicted marginal effects for two speakers, identified by their ID numbers, one who actively deploys that parameter, referred to as a high-profile speaker, and one who deploys the parameter to a lesser degree, referred to as a low-profile speaker.

f0 range co-varied with referent animacy in the productions of eight speakers, increasing by 2–3 ST for animate referents relative to inanimate referents. Four speakers showed an increase in f0 range for animate objects that is 2–3.5 ST higher than for inanimate objects. Visual examination of individual speakers' plots of predicted marginal effects revealed that *word order* interacted with *AGRC* for seven speakers. The interaction pattern was uniform across these speakers: the animacy effect was greater for words occurring in ex-situ fronted positions but reduced for words occurring in in-situ. Figure 3 demonstrates plots of predicted marginal effects for f0 range for a high-profile speaker 1 (showing animacy, subjecthood and word order effects) and a low-profile speaker 2 (showing subjecthood and word order effects).

Greater mean intensity in the corpus was observed in ex-situ fronted positions; this boost was most visible in productions of five speakers when the fronted constituent was an animate object. Mean intensity also co-varied with subjecthood, with significant increase of 3–7 dB observed in productions from six speakers. Visual examination

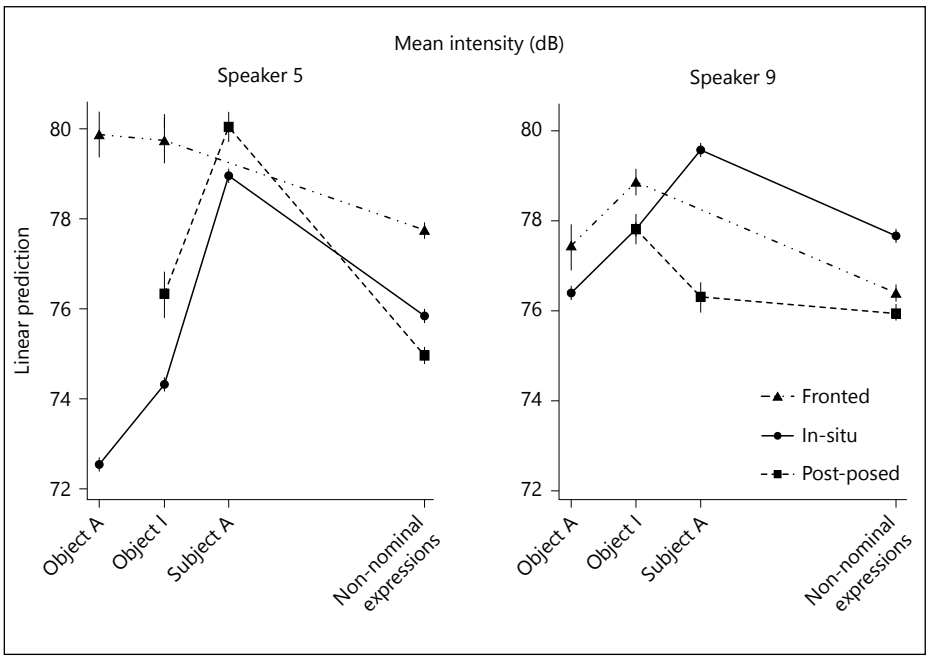

Fig. 4. Predicted marginal effects at the means with 95% CIs for parameter mean intensity across levels of *AGRC* and *word order*. Data from speakers 5 and 9. Y-axes: mean intenisty (dB); X-axes: levels of *AGRC*. 'A' and 'I' represent 'animate' and 'inanimate', respectively.

of individual speakers' plots of predicted marginal effects revealed that the animacy effect was consistently conservative and could be cancelled out by the effect of word order: for three speakers there was no increase in intensity for post-posed animate nouns. Figure 4 demonstrates plots of predicted marginal effects for mean intensity for a high-profile speaker 5 (subjecthood and word order effects) and a low-profile speaker 9 (no significant effects of interest).

Duration reliably co-varied with referent animacy in the productions of ten speakers. On average, an increase of 10–70 ms was observed for words that are animate objects, compared to inanimate objects. Visual examination of individual speakers' plots of predicted marginal effects revealed that for eight speakers, the animacy effect was particularly apparent in the fronted, sentence-initial position. Duration also reliably co-varied with subjecthood for six speakers, although the increase in duration associated with grammatical subjects was considerably smaller, ranging between 5 and 30 ms. Figure 5 demonstrates plots of predicted marginal effects for duration for a high-profile speaker 3 (animacy and subjecthood effects) and a low-profile speaker 9 (no effects of interest).

4.3. Interim Discussion

In the first series of analyses, we examined the effects of word order and two highly related properties of discourse referents, animacy and subjecthood, on acoustic-prosodic expression in the read production of two published narratives in Russian. We

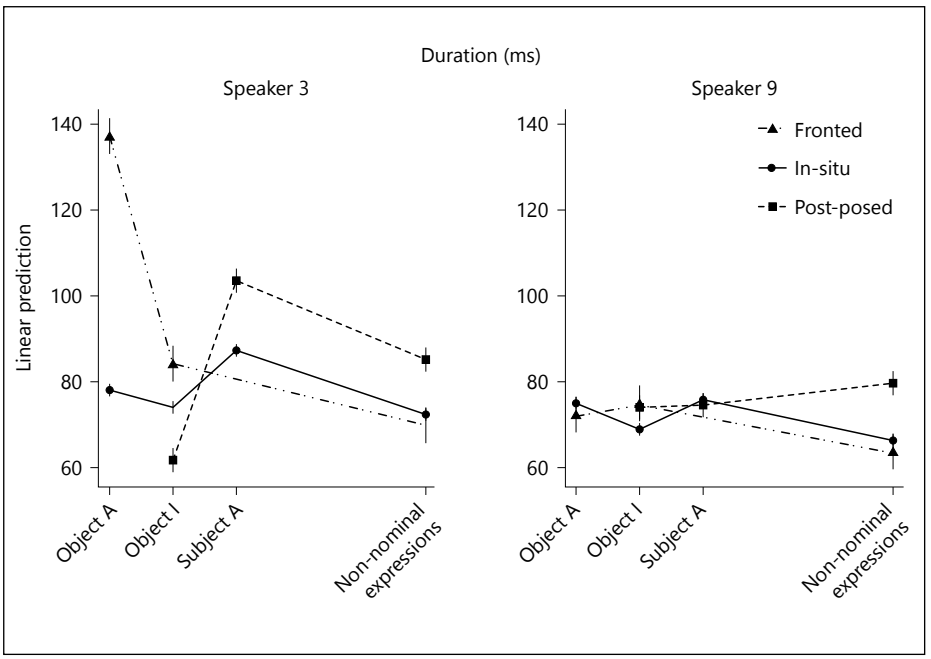

Fig. 5. Predicted marginal effects at the means with 95% CIs for parameter duration across levels of *AGRC* and *word order*. Data from speakers 3 and 9. Y-axes: duration (ms); X-axes: levels of *AGRC*. 'A' and 'I' represent 'animate' and 'inanimate', respectively.

found that dislocating a word from its canonical position in a sentence or clause, not uncommon for Russian, triggers a chain of prosodic effects specific to the new surface position of that word. Analysis of the production data from fifteen native Russian speakers revealed that words fronted relative to their canonical position have greater mean intensity and f0 range, possibly reflecting articulatory strengthening at the left edge of a sentence or clause, a position typically aligned with the start of a prosodic phrase. Post-posed sentence-final words, occurring at the likely end of a prosodic phrase, have smaller f0 range but greater duration, indicative of a final lengthening phenomenon.

These results confirm our first hypothesis that a deviation from the canonical word order in discourse triggers prosodic effects, which we refer to as structural, i.e., not directly related to semantic and grammatical referent properties or referent information status.

Next, we examined effects of referent-based factors, looking first for effects of animacy and subjecthood on word order. If such effects are found, then we would understand word order to be a mediator for effects of animacy and subjecthood on acoustic-prosodic measures. We predicted that word order may act as a mechanism that maintains the optimal distribution of animate and inanimate referents across sentence positions, wherein an animate subject precedes an inanimate object. This prediction was not borne out: 20% of the animate subjects in the corpus occurred sentence-finally (as in $OVS_{+animate}$ order) and slightly more inanimate objects (approximately 14%)

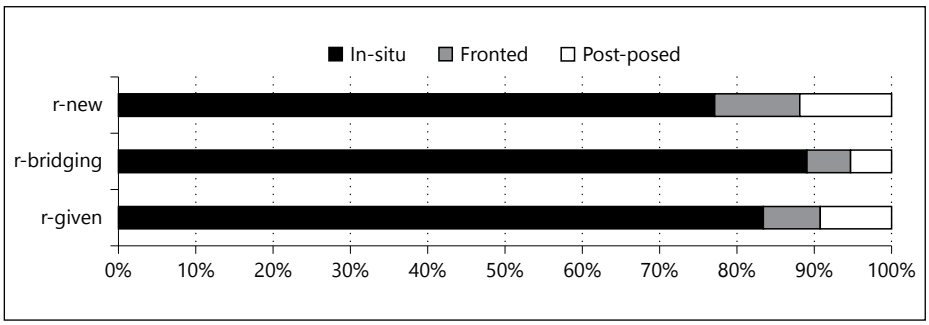

Fig. 6. Distribution of *IS REF* across sentence positions. Y-axis: information status. X-axis: percent occurrences.

occurred sentence-initially (as in $O_{-animate}VS$ order) than animate objects (approximately 12%). These results suggest that for the narratives used in this study, animacy is an unlikely factor driving the change in word order.

We further tested for direct effects of animacy and subjecthood on acoustic-prosodic measures. Analysis of the production data reveals greater f0 excursion and intensity for words that are subjects and for words with animate referents, and greater duration for words with animate referents. Follow-up analyses of individual speakers' production data lead us to qualify the effects of animacy and subjecthood on acoustic-prosodic expression: considerable inter-speaker variability in the use of acoustic-prosodic parameters in relation to animacy and subjecthood suggests that observed effects represent options rather than rule-like principles governing the reading performance of the study participants. Besides the finding of individual speaker differences, we uncovered multiple cases of interaction among animacy, subjecthood and word order that further modulate acoustic-prosodic variation. In particular, an ex-situ fronted position is where we observed the most dramatic increase in duration and f0 range for animate referents.

In summary, we presented an initial evidence for concurrent and incremental acoustic-prosodic effects of structural and referent-based features during the read production of discourse. In the following section, we address prosodic variation attributable to referent information status, reflecting changes in the readers' knowledge state as they progress through a text or narrative.

4.4. Information Status

The information status of all content words in the corpus, as entered in statistical analyses, was classified using three referential information categories from the RefLex scheme (table 1). The choice of the RefLex categories was based on how well-represented they were in the study materials. We begin by examining the distribution of the information categories r-given, r-new and r-bridging, across in-situ, ex-situ fronted and ex-situ post-posed sentence positions in the corpus shown in figure 6. The first part of prediction (4d) was not borne out: words labeled as r-given were equally likely to be fronted (approximately 7% of all r-given words) or post-posed (approximately 9% of all r-given words), while occurring in-situ 83% of the time. The second part of prediction (4d) was partially borne out: figure 6 shows that words labeled as r-new accounted for more non-canonical occurrences in the corpus than words representing any other

information status. Discourse-new information accounted for the largest number of post-posed ex-situ positions (62.4% of all post-posed occurrences), and fronted ex-situ positions (62.9% of all fronted occurrences). The observed distribution, however, does not support the tendency for discourse-new information to be post-posed, as predicted in (4d).

We now turn to examine the direct effects of referent information status on acoustic-prosodic variation, in the three information categories that are well-represented in our corpus: r-given, r-new and r-bridging.[7]

Results of the multivariate regression analysis provide partial support for the predictions in (4e).

Discourse-new status: Relative to the reference category of r-given and controlling for word order and animacy/subjecthood, words labeled as r-new had significantly higher mean intensity ($t = 2.32$, $p < 0.05$). However, no further evidence for prosodic augmentation of discourse-new information was obtained. In fact, f0 range and duration measures were systematically greater for r-given words in the corpus ($t = 3.84$, $p = 0.001$ for *f0 range* and $t = 5.36$, $p < 0.001$ for *duration*), regardless of word order.

Discourse-bridging status: Consistent with prediction (4e), relative to the reference category of r-given and controlling for word order and animacy/subjecthood, discourse-bridging words had reduced *f0 range* ($t = –4.97$, $p < 0.001$) and reduced *duration* ($t = –8.77$, $p < 0.001$).

The mean values of acoustic-prosodic measures for each level of referent information status are plotted in figure 7, based on production data from all speakers in the sample. Analysis of the two-way interaction between referent information status and word order illustrated in figure 7 reveals that highly inferable r-bridging referents, when occurring ex-situ, underwent further reduction in *f0 range* (ex-situ fronted: $t = –3.1$, $p < 0.005$; ex-situ post-posed: $t = –3.4$, $p < 0.001$), *duration* (ex-situ fronted: $t = –2.79$, $p < 0.01$; ex-situ post-posed: $t = –2.05$, $p < 0.05$) and *mean intensity* (ex-situ post-posed: $t = –5.98$, $p < 0.001$).

As shown in table 3, *IS REF* also entered into a number of significant interactions with *AGRC* and *word order*. Specifically, discourse-novel post-posed animate subjects were prosodically augmented in terms of each acoustic-prosodic parameter of interest (*f0 range*: $t = 3.57$, $p < 0.001$, *mean intensity*: $t = 4.80$, $p < 0.001$; *duration*: $t = 3.43$, $p = 0.001$). Discourse-novel fronted objects were also prosodically marked as follows: animate objects had greater *mean intensity* ($t = 2.45$, $p < 0.01$) and *duration* ($t = 2.62$, $p < 0.01$) and inanimate objects had greater *mean intensity* ($t = 3.54$, $p < 0.001$).

Next, we complement these results with post-estimation analyses of individual speakers' contribution to the variance in the acoustic-prosodic parameters of interest.

4.4.1. Inter-Speaker Variability and Interaction with Word Order

We again notice individual speaker differences in the acoustic parameters that show variation due to referent-based factors, considering the referent information status. To examine individual differences in main effects of information status, and its interaction with word order, we computed predicted marginal effects at the means for the acoustic-prosodic parameters duration, f0 range and mean intensity for *IS REF*

[7] Appendix E presents summary statistics for the acoustic-prosodic measures of interest computed using production data from all speakers across these three levels of *IS REF.*

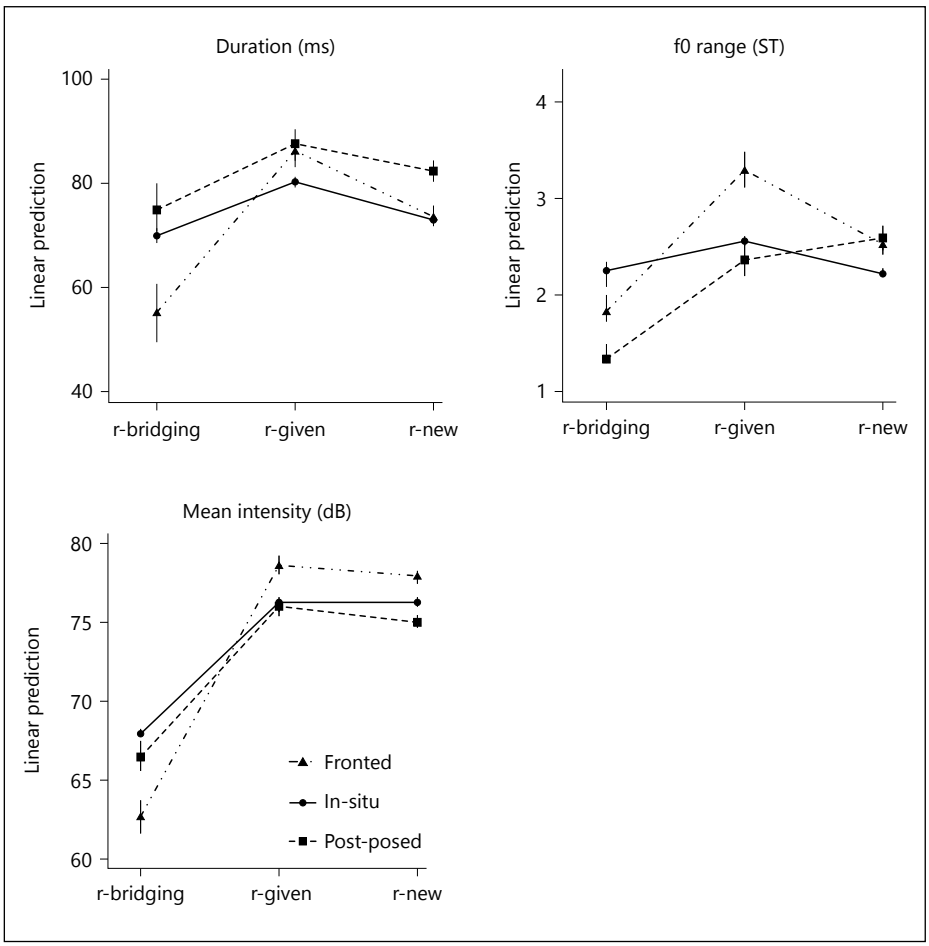

Fig. 7. Predicted marginal effects at the means with 95% CIs for parameters duration (ms), mean intensity (dB) and f0 range (st) across levels of *IS REF* and *word order*. Data from fifteen speakers. Y-axes: acoustic-prosodic parameter; X-axes: levels of *IS REF*.

and *word order*, using production data from each individual speaker (Appendix F). As in section 4.2, for each acoustic-prosodic parameter of interest, we plot the predicted marginal effects for two speakers, identified with their ID numbers, one who actively deploys that parameter, referred to as a high-profile speaker, and one who deploys that parameter to a lesser degree, referred to as a low-profile speaker.

f0 range was greater for r-given information, contrary to what was predicted in (4e). Visual examination of the individual speakers' plots of predicted marginal means reveals that f0 range was dually affected by the information status of a word and its position in the sentence or phrase. Figure 8 shows that in the production of the high-profile speaker 1, f0 range was largest for fronted r-given words and post-posed r-new words. While this pattern of results holds for ten speakers in our sample, for nine out of these ten speakers, the increase in the f0 range associated

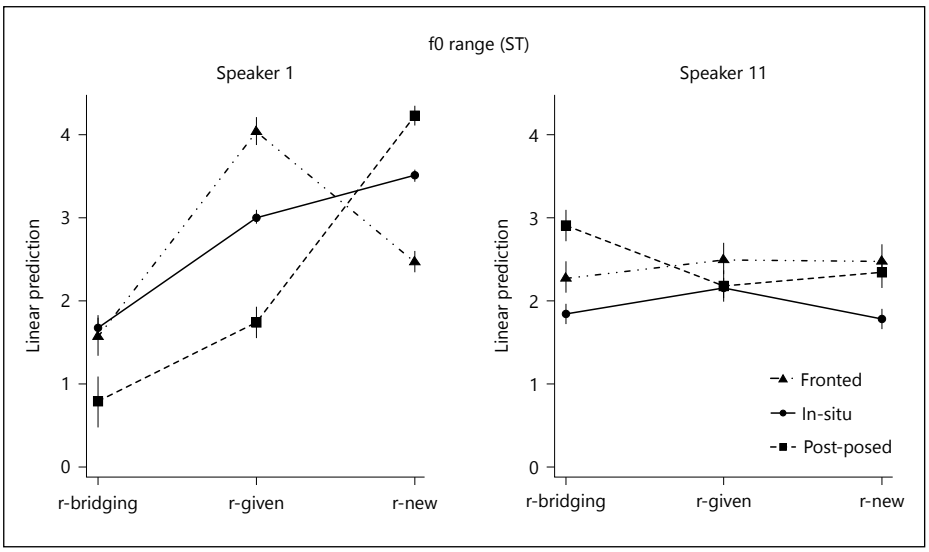

Fig. 8. Predicted marginal effects at the means with 95% CIs for parameter f0 range across levels of *IS REF* and *word order*. Data from speakers 1 and 11. Y-axes: f0 range (st); X-axes: levels of *IS REF*.

with post-posed discourse-new information was more modest than that observed for fronted discourse-given words, hence the direction of the main effect. The plot for a low-profile speaker 11 (fig. 8) demonstrates a lack of effect of information status or word order.

Mean intensity in the corpus served as the only robust cue for r-new information, with modest but significant increases of 5–7 dB observed in the productions of eleven speakers. Visual examination of the individual speakers' plots reveals that the effect was conservative. Figure 9 demonstrates plots of predicted marginal effects for mean intensity for a high-profile speaker 7 (main effect of *IS REF*) and a low-profile speaker 8 (main effect of *Word Order*).

Duration was consistently greater for r-given information than for r-bridging or r-new information. The plot illustrating productions of speaker 15 shown in figure 10 is highly representative of this effect and characterizes eleven speakers in our sample. The four remaining speakers did not demonstrate an increase in duration for r-given information. In three speakers' productions, fronted discourse-new information had significantly greater duration (see the plot illustrating productions of speaker 7).

5. Discussion

As discourse unfolds, information which may be perceived as less accessible or novel at the beginning of a narrative undergoes an increase in accessibility and changes its status as the reader progresses through the narrative. In this study, we ask if the information status of a word's referent, which reflects the dynamic knowledge

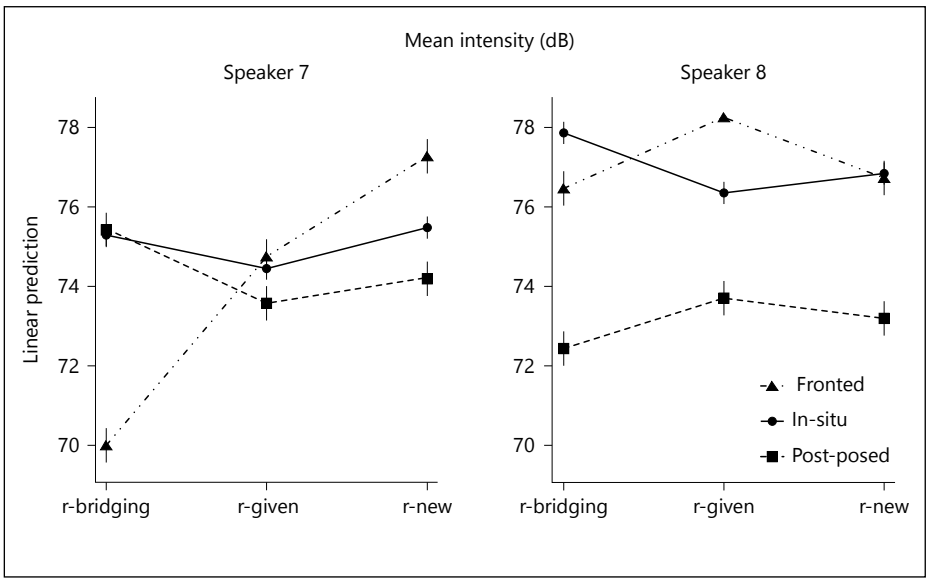

Fig. 9. Predicted marginal effects at the means with 95% CIs for parameter mean intensity across levels of *IS REF* and *word order*. Data from speakers 7 and 8. Y-axes: mean intensity (dB); X-axes: levels of information status.

state of the reader, is reflected in the placement of the word in the sentence or phrase, and/or has an effect on prosodic expression in read production of discourse. Using a corpus of two published narratives in Russian, a free word order language, we first examined the distribution of content words falling into distinct referent information classes across in- and ex-situ sentence positions. Following Baumann and Riester (2012, 2013), we distinguished three categories of referents, new, given and bridging, reflecting the dynamic knowledge state of the reader as they progress through discourse. We found that the distribution of these information types across in-situ and ex-situ positions in a sentence or phrase is indicative of their relative accessibility for the reader. Specifically, the relative accessibility of a word, as indexed by a RefLex category, was negatively associated with an ex-situ position, as evident from the finding that highly inferable discourse-bridging words had the most in-situ occurrences in the corpus, whereas discourse-new words, introducing new discourse referents and considerably less accessible information, had the most ex-situ occurrences. Furthermore, when positioned ex-situ, discourse-new information in the corpus was equally likely to occur sentence-initially and sentence-finally. A number of studies on discourse-driven word order variability in Russian (Slioussar 2010, 2011; Jasinskaja 2013) draw attention to qualitatively different processes in discourse that call for fronting or post-posing an argument. Traditionally, in Russian, the sentence-initial position is associated with topics and contrastively focused arguments (Ionin and Luchikina, under review; Neeleman and Titov, 2009), whereas non-contrastive new information is considered to favor the sentence-final, nuclear pitch accented position. The apparent interrelatedness of referent information status and ex-situ position confirms that word order variability in Russian is discourse-motivated.

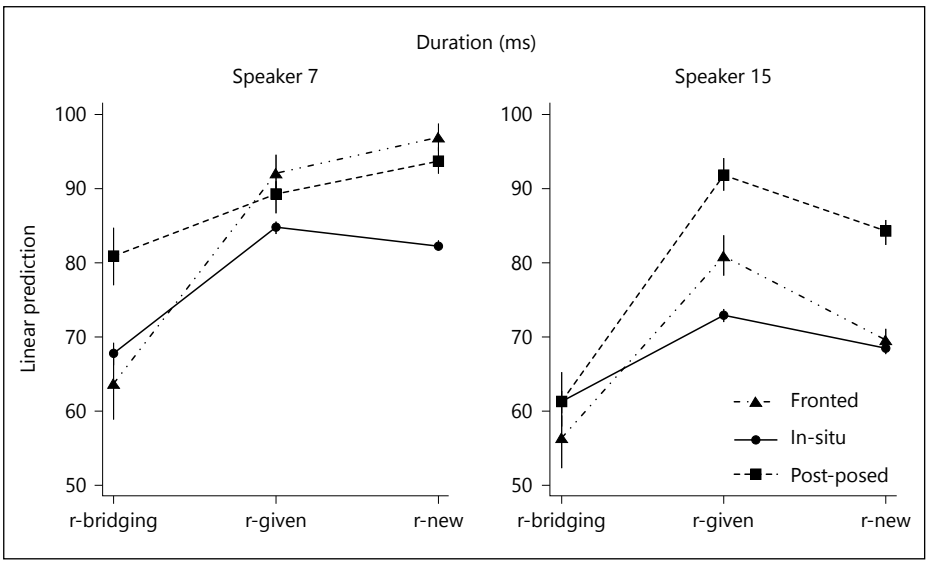

Fig. 10. Predicted marginal effects at the means with 95% CIs for parameter duration across levels of *IS REF* and *word order*. Data from speakers 7 and 15. Y-axes: duration (ms); X-axes: levels of *IS REF*.

Our results lend support to previous work on the interrelatedness of prosody and word order variability in Russian (Svetozarova, 1998; Jasinskaja, 2013) and select other free word order languages. According to our first hypothesis, a non-canonical word order in Russian has its own prosodic signature. Analysis of the prosodic expression of ex-situ words in our corpus confirmed this hypothesis. Fronting or post-posing a word relative to its canonical position affects its prosodic qualities via scaling (expanding or compressing) the magnitude of prosodic parameters (f0 range, duration and mean intensity) associated with that word. We presented evidence that acoustic-prosodic reflexes of an ex-situ position may be co-incidental with, and orthogonal to, patterns of acoustic-prosodic variation indicative of the semantic, grammatical and information-structural properties of a word. To illustrate, a post-posed ex-situ position in our data triggered reduction in f0 excursion size. However, f0 range underwent expansion when the reader encountered an ex-situ post-posed word that introduced a conceptually salient animate referent that was discourse-new. Similarly, a fronted ex-situ position, often associated with topical discourse-given information in Russian, received a boost in intensity and a more dramatic expansion of f0 range, possibly due to its proximity to the leftmost boundary of a prosodic domain (Cho, 2016). This effect, too, was not observed when the fronted word was easily inferable from the context.

A qualitatively different source of acoustic-prosodic variation that we examined in this study is related to the semantic and grammatical features of nominal expressions. We formulated our second hypothesis to test if these 'referent-related' features trigger parallel prosodic encoding in discourse. Our results show that in the read production data, the acoustic-prosodic measures of f0 range and mean intensity reached

their maximum values for animate subjects, which are conceptually more salient than inanimate referents with object status. Vowel duration, for the majority of our speakers, showed systematic variation in response to referent animacy and was greater for animate referents. These findings are largely consistent with the results of Antão et al. (2013) who examined prosodic variation related to subjecthood effects in Brazilian Portuguese. Antão et al. found that compared to objects, grammatical subjects in Brazilian Portuguese have greater duration and f0 range, and that both measures are greater for utterance-initial subjects compared to non-initial subjects. One plausible generalization of these findings may be that subject-first effects, in part, are motivated not only in the propensity of grammatical subjects to occupy a position high up in the syntactic tree (Branigan et al., 2008), but also a position that is perceptually highly prominent in a sentence or phrase, due to being associated with default greater prosodic prominence.

Studies of the effect of animacy on grammatical function assignment and argument linearization (Prat-Sala, 1997; Branigan and Feleiki, 1999; van Nice and Dietrich, 2003; Verhoeven, 2014; Tanaka et al., 2005) report that cross-linguistically, animate entities, via greater accessibility and salience in discourse, tend to occur in higher syntactic positions and early in a sentence or clause. In this way, animacy has been proposed as a leading factor that determines grammatical function assignment and, in free word order languages, argument linearization. Our findings lend support to the special status of animate entities, in particular, grammatical subjects, via augmented prosodic expression. However, despite the observed variation in acoustic-prosodic parameters, no meaningful association was observed between referent animacy and its sentence position. Our results fail to support the finding of Lobanova (2011) who reported that sentence-initial nouns have a strong tendency to be animate, regardless of their grammatical function, in a corpus of 600 Russian sentences. In our materials, sentence-initial nouns were equally likely to be inanimate, moreover, slightly more inanimate nouns occurred sentence-initially. We attribute the lack of consensus with Lobanova's findings to the differences in study materials: our corpus is considerably smaller than Lobanova's and the distribution of different constituent orders in our materials is highly unbalanced.

One focus of the referent-centered analyses in this study is the effect of referent information status on acoustic-prosodic expression. In the read productions of narratives, two referent categories, discourse-given and discourse-new, showed greater prosodic augmentation than discourse-bridging information. Whereas mean intensity was systematically greater for discourse-new information, in the reading performance of most of our participants, discourse-given information was associated with greater f0 range and duration than any other information category. One possible explanation for this finding may lie in the greater salience of discourse-given referents, which have multiple mentions in discourse. This explanation, however, goes against the copious evidence that discourse-given information, which is more accessible due to its increased activation in the speaker's/reader's memory, is typically prosodically reduced (Aylett and Turk, 2004; Watson, 2010; Breen et al., 2010; Baumann and Riester, 2013). We, therefore, hypothesize that the unexpected acoustic-prosodic effects of discourse-given status found in this study may stem from the reading mode of the production data or may reflect the ways in which individual speakers reconcile two distinct sources of prosodic variation, word order-based and referent-based. When crossed with other factors of interest investigated in this study,

discourse-new status was in fact associated with augmented prosodic expression. Specifically, all acoustic-prosodic parameters, including duration, mean intensity and f0 range, were greater for discourse-new post-posed animate subjects, relative to all other word types. Similarly, discourse-new fronted objects had greater mean intensity and duration when the referent was animate and greater mean intensity when the referent was inanimate.

Overall, our findings present evidence for the incremental nature of acoustic-prosodic effects in Russian: concurrent prosodic adjustments that occur during speech production originate in qualitatively distinct discourse phenomena. At a more basic level, the invariant semantic feature animacy and the related grammatical feature subjecthood scale prosodic parameters such that greater prosodic prominence is given to referents that are animate and grammatical subjects. As he/she progresses through discourse, the reader perceives information as new, given, or easily inferable. At the level of information structure, each information status is associated with distinct positional and acoustic-prosodic properties. In the materials used in this study, discourse-new information is a highly 'mobile' and prosodically prominent information category. In individual speakers' productions, the prosodic expression of new and given information was often influenced by the ordering of sentence constituents. This leads us to conclude that referent information status in discourse may be signaled by placing the critical argument into a designated position in a sentence or clause, where it may attract greater attention of the hearer (or reader), by virtue of being structurally and prosodically distinct.

The findings of this study invite a straightforward and falsifiable proposal that referent status and information structural constraints have an impact on argument linearization in Russian, resulting in prosodic variability that is mediated by structural variability.

5.1. Speaking Mode Effect and Inter-Speaker Variability

One important corollary we add here concerns the possible influence of the speech mode on the results of acoustic-prosodic analyses reported in this study. Read speech has been characterized as syntactically more complex than spontaneous speech and may be articulated more slowly and with greater pitch range and pitch declination (Swerts, Strangert and Heldner, 1996). The use of read speech has been shown to affect results of prosodic analyses, as reported by Baumann and Riester (2013) and de Ruiter (2015). Baumann and Riester (2013) compared the association between information structure, coded using RefLex, and prosody, in two corpora of German speech, spontaneous and written. The authors reported that prosodic encoding of information status was most apparent in their read speech corpus, where pitch accent distribution among information categories was highly consistent with the expectation that novel information in discourse is accented, whereas given information is deaccented. De Ruiter's (2015) analysis of German, similarly, shows that the rate of deaccenting of discourse-given referents is greater in read speech. De Ruiter attributes this effect to the more careful use of prosody and decreased cognitive load during reading than during spontaneous speech. The only study of accentuation patterns reflecting referent information status in Russian that we are aware of was conducted by Sityaev (2000). Sityaev used a corpus of read speech to compare accenting of discourse-new and discourse-given referents. Contrary to results presented by Baumann and Riester (2013) and de Ruiter (2015) for German, Sityaev reported that an unusually high proportion

(79–97%) of discourse-given referents in his corpus of reading Russian speech were accented.[8]

In the current study, the special status of reading intonation may be slightly mitigated due to the selection of study materials. Recall that one of the narratives we used was a folk tale, highly conversational in nature and with multiple instances of direct speech. The second narrative, however, was an excerpt from a biography and featured characteristics typical of written language, including longer sentences and a stricter adherence to the standard language register. The text genre and read speech mode, therefore, may have affected the production styles of the speakers, leading some to use prosody as a cue for sentence structure more than for referent features.

Visual examination of the predicted marginal effects plots using individual speakers' production data revealed that prosodic encoding of animacy, subjecthood and information status of a word often interacted with the position of that word in a sentence or phrase (fig. 3–5, 8–10). Specifically, the finding that fronted discourse-given words featured increased f0 range in most speakers' production, whereas those occurring in-situ or post-posed did not, suggests that such outstanding prosodic marking may be conditional on word order. Our preliminary analyses of speaker-specific differences in prosodic encoding calls for further investigation. In particular, the question of which cognitive features, oral production styles, or narrative-specific properties account for what we refer to as a 'high' or a 'low' profile speaker merits future investigation.

6. Conclusion

As we speak, prosody signals information about discourse entities, their grammatical relationships and their information status in discourse. Results of this study reveal prosodic effects due to the animacy of discourse referents and their grammatical function, and due to dynamic information status grounded in the knowledge state of the speaker or reader. In a free word order language like Russian, prosody is not the only means of encoding discourse information. Depending on the status of the information that a word contributes to discourse, it may be more or less likely to occur in an ex-situ position in a sentence or phrase. We presented evidence that sentence-initial and sentence-final ex-situ positions have their own prosodic signatures which may be orthogonal to the information value of a word or its relative discourse salience. Preliminary examination of individual speakers' read productions has revealed that the two underlying sources of acoustic-prosodic, structural and referent-based, come together in a variety of ways, frequently reflecting the dominance of one of these sources over the other in their interaction.

[8] We treat Sityaev's (2000) results as preliminary. The author used a dichotomous accenting scheme, with levels 'accented' and 'unaccented'. H* notation was applied to all instances of accented words without further commentary on which criteria or reliability analyses were used when labeling accents.

Appendix

Appendix A

Summary statistics for prosodic parameters duration (ms), mean intensity (dB) and f0 range (st) across levels of word order based on the read production data from fifteen speakers.

	Duration (ms)			
	n words	mean	SD	range
fronted	28	75.88	38.33	264.34
in-situ	208	74.57	39.57	362.12
post-posed	33	82.42	41.83	233.65
	Mean intensity (dB)			
	n words	mean	SD	range
fronted	28	77.81	5.75	32.85
in-situ	208	76.50	6.34	58.68
post-posed	33	75.60	6.69	42.32
	F0 range (ST)			
	n words	mean	SD	range
fronted	28	4.69	2.47	13.64
in-situ	208	2.33	2.47	25.85
post-posed	33	2.36	2.67	25.05

Appendix B

Summary statistics for prosodic parameters duration (ms), mean intensity (dB) and f0 range (st) across levels of AGRC based on the read production data from fifteen speakers.

	Duration (ms)			
	n words	mean	SD	range
object, animate	112	79.58	44.64	253.45
object, inanimate	80	75.75	36.70	331.57
subject, animate	66	84.45	43.20	356.74
non-nominal expressions	85	73.34	38.88	341.49
	Mean intensity (dB)			
	n words	mean	SD	range
object, animate	14	75.36	6.34	41.51
object, inanimate	15	76.20	6.36	48.18
subject, animate	29	78.15	5.83	35.25
non-nominal expressions	85	76.46	6.37	58.68

	F0 range (ST)			
	n words	mean	SD	range
object, animate	14	2.36	2.86	24.03
object, inanimate	15	2.27	2.42	22.12
subject, animate	29	4.80	2.78	25.03
non-nominal expressions	85	2.31	2.40	25.85

Appendix C

Predicted marginal means, with standard errors, for parameters f0 range (panel A), duration (panel B) and mean intensity (panel C) across levels of AGRC for each individual speaker in the sample.

Panel A: f0 range (ST)

Speaker ID	Object, animate	Object, inanimate	Subject, animate
1	3.52 (0.68)	1.78 (0.63)	4.33 (0.46)
2	2.15 (0.37)	2.78 (0.28)	3.02 (0.3)
3	2.22 (0.37)	2.37 (0.27)	3 (0.3)
4	1.7 (0.42)	1.84 (0.34)	2.39 (0.36)
5	1.75 (0.37)	2.33 (0.28)	2.43 (0.3)
6	3.95 (0.41)	3.52 (0.3)	4.38 (0.36)
7	2.32 (0.44)	2.82 (0.32)	3.15 (0.32)
8	3.44 (0.37)	2.43 (0.28)	3.35 (0.29)
9	2.47 (0.29)	2.02 (0.21)	2.7 (0.24)
10	2.52 (0.37)	2.5 (0.29)	3.2 (0.31)
11	1.58 (0.39)	1.85 (0.28)	2.4 (0.31)
12	1.4 (0.37)	1.76 (0.28)	2.23 (0.3)
13	3.53 (0.38)	2.14 (0.32)	2.52 (0.31)
14	2.32 (0.38)	2.16 (0.28)	2.29 (0.3)
15	1.4 (0.38)	1.57 (0.28)	1.95 (0.3)

Panel B: duration (ms)

Speaker ID	Object, animate	Object, inanimate	Subject, animate
1	77.21 (10.61)	69.71 (9.88)	74.2 (7.10)
2	92.3 (5.76)	91.4 (4.36)	93.15 (4.67)
3	84.65 (5.76)	74.13 (4.35)	89.96 (4.67)
4	83.81 (6.55)	70.28 (5.25)	77.3 (5.58)
5	82.82 (5.77)	77.58 (4.39)	92.87 (4.67)
6	79.3 (6.38)	72.09 (4.67)	94.88 (5.58)
7	81.03 (6.76)	81.74 (4.94)	93.7 (4.86)
8	96.24 (5.83)	93.73 (4.33)	103.86 (4.67)
9	74.6 (4.45)	69.93 (3.22)	75.74 (3.77)
10	92.75 (5.83)	91.82 (4.48)	105.78 (4.78)
11	84.08 (6.12)	75.92 (4.42)	81.25 (4.78)
12	62.41 (5.77)	64.28 (4.45)	70.97 (4.67)
13	56.13 (5.90)	56.57 (4.90)	58.32 (4.78)
14	72.1 (5.90)	68.65 (4.35)	77.41 (4.67)

Speaker ID	Object, animate	Object, inanimate	Subject, animate
15	76.96 (5.83)	73.64 (4.39)	77.38 (4.71)

Panel C: mean intensity (dB)

Speaker ID	Object, animate	Object, inanimate	Subject, animate
1	78.95 (1.31)	78.11 (1.22)	77.84 (0.88)
2	75 (0.71)	76.69 (0.54)	78.15 (0.58)
3	63.12 (0.71)	62.82 (0.53)	64.4 (0.57)
4	74.79 (0.81)	75.14 (0.65)	76.58 (0.69)
5	73.36 (0.71)	75.31 (0.54)	79.14 (0.58)
6	70.75 (0.79)	71.48 (0.58)	74.3 (0.69)
7	74.95 (0.83)	74.77 (0.61)	75.73 (0.61)
8	75.76 (0.72)	76.76 (0.53)	78 (0.58)
9	76.42 (0.55)	77.85 (0.4)	79.14 (0.46)
10	79.58 (0.55)	79.96 (0.59)	82.12 (0.24)
11	79.75 (0.76)	79.18 (0.54)	81.69 (0.59)
12	77.23 (0.71)	78.55 (0.55)	80.93 (0.58)
13	79.31 (0.73)	79.52 (0.6)	81.17 (0.59)
14	75.22 (0.73)	77.6 (0.54)	80.22 (0.58)
15	77.8 (0.72)	79.22 (0.54)	80.71 (0.58)

Appendix D

Predicted marginal means, with standard errors, for parameters f0 range (panel A), duration (panel B) and mean intensity (panel C) across levels of word order for each individual speaker in the sample.

Panel A: f0 range (ST)

Speaker ID	Fronted	In-situ	Post-posed
1	2.82 (0.38)	2.89 (0.19)	3.24 (0.38)
2	3.5 (0.34)	2.6 (0.11)	2.14 (0.33)
3	2.37 (0.33)	2.28 (0.11)	2.61 (0.32)
4	1.75 (0.36)	1.83 (0.13)	1.83 (0.35)
5	3.65 (0.33)	2.17 (0.11)	2.25 (0.33)
6	5.02 (0.52)	3.42 (0.13)	3.33 (0.49)
7	3.3 (0.37)	2.67 (0.12)	2.62 (0.34)
8	2.92 (0.32)	2.8 (0.11)	2.8 (0.32)
9	2.35 (0.31)	2.36 (0.09)	1.71 (0.3)
10	3.27 (0.34)	2.6 (0.12)	2.95 (0.32)
11	2.45 (0.34)	1.9 (0.12)	2.36 (0.31)
12	2.24 (0.37)	1.8 (0.11)	2.18 (0.35)
13	2.34 (0.36)	2.64 (0.12)	2.24 (0.38)
14	2.15 (0.33)	2.03 (0.11)	1.95 (0.31)
15	1.54 (0.33)	1.45 (0.11)	1.9 (0.32)

Panel B: duration (ms)

Speaker ID	Fronted	In-situ	Post-posed
1	58.12 (5.84)	65.74 (2.93)	77.37 (5.71)
2	84.39 (5.26)	85.1 (1.74)	93.3 (5.12)
3	79.28 (5.31)	74.6 (1.74)	86.08 (5.07)
4	61.74 (5.71)	69.19 (2.11)	82.44 (5.53)
5	92.53 (5.16)	78.96 (1.75)	96.74 (5.21)
6	86.16 (8,16)	74.23 (2.03)	74.05 (7.66)
7	92.31 (5.77)	80.03 (1.82)	91.04 (5.26)
8	98.07 (5.03)	96.15 (1.77)	95.88 (5.03)
9	66.92 (4.9)	68.4 (1.39)	77.42 (4.64)
10	95.56 (5.26)	91.53 (1.8)	93.85 (5.03)
11	72.33 (5.26)	73.59 (1.82)	74.36 (4.99)
12	64.08 (5.77)	63.06 (1.76)	72.95 (5.53)
13	51.18 (5.59)	57.67 (1.82)	53.61 (5.47)
14	62.79 (5.21)	68.35 (1.75)	74.55 (4.90)
15	70.42 (5.16)	68.31 (1.76)	84.2 (4.94)

Panel C: mean intensity (dB)

Speaker ID	Fronted	In-situ	Post-posed
1	78.22 (0.72)	75.58 (0.36)	75.34 (0.7)
2	78.55 (0.65)	76.91 (0.22)	75.69 (0.63)
3	64.68 (0.66)	63.56 (0.21)	61.93 (0.62)
4	76.71 (0.7)	75.15 (0.26)	75.01 (0.68)
5	78.36 (0.64)	75.74 (0.22)	76.21 (0.64)
6	75.4 (1)	71.4 (0.25)	72.2 (0.95)
7	75.86 (0.71)	75.14 (0.23)	74.2 (0.65)
8	77.08 (0.62)	76.89 (0.22)	73.29 (0.62)
9	77.08 (0.61)	77.8 (0.17)	76.4 (0.57)
10	81.97 (0.65)	80.58 (0.22)	78.98 (0.62)
11	81.9 (0.65)	80.31 (0.22)	79.96 (0.61)
12	80.23 (0.71)	78.94 (0.22)	76.44 (0.68)
13	80.66 (0.68)	80.02 (0.69)	79.35 (0.23)
14	78.4 (0.64)	77.46 (0.22)	77.29 (0.61)
15	80.69 (0.64)	79.12 (0.22)	79.7 (0.61)

Appendix E

Summary statistics for prosodic parameters duration (ms), mean intensity (dB) and f0 range (st) across levels of IS REF based on the read production data from fifteen speakers.

	Duration (ms)			
	n words	mean	SD	range
r-given	84	81.63	41.02	360.73
r-bridging	53	67.01	31.70	222.56
r-new	121	74.79	40.91	341.55

	Mean intensity (dB)			
	n words	mean	SD	range
r-given	84	76.49	6.43	50.28
r-bridging	53	77.23	5.88	40.71
r-new	121	76.31	6.43	58.68
	F0 range (ST)			
	n words	mean	SD	range
r-given	84	2.62	2.68	24.04
r-bridging	53	2.10	2.16	24.80
r-new	121	2.31	2.47	25.85

Appendix F

Predicted marginal means, with standard errors, for parameters f0 range (panel A), duration (panel B) and mean intensity (panel C) across levels of IS REF for each individual speaker in the sample.

Panel A: f0 range (ST)

Speaker ID	r-bridging	r-given	r-new
1	1.58 (0.35)	2.99 (0.27)	3.47 (0.22)
2	2.4 (0.24)	2.69 (0.18)	2.69 (0.14)
3	2.05 (0.23)	2.89 (0.18)	2.08 (0.14)
4	1.54 (0.28)	2.21 (0.22)	1.71 (0.16)
5	2.31 (0.24)	2.43 (0.18)	2.26 (0.14)
6	3.08 (0.31)	3.76 (0.22)	3.48 (0.17)
7	2.33 (0.25)	2.82 (0.2)	2.8 (0.15)
8	2.19 (0.24)	3.18 (0.18)	2.82 (0.14)
9	2.13 (0.2)	2.73 (0.15)	2.14 (0.11)
10	2.63 (0.24)	2.79 (0.19)	2.67 (0.14)
11	1.93 (0.24)	2.17 (0.19)	1.94 (0.14)
12	1.83 (0.24)	2.04 (0.19)	1.78 (0.14)
13	2.22 (0.26)	2.9 (0.20)	2.52 (0.15)
14	1.87 (0.24)	2.41 (0.18)	1.88 (0.14)
15	1.37 (0.24)	1.68 (0.18)	1.44 (0.14)

Panel B: duration (ms)

Speaker ID	r-bridging	r-given	r-new
1	49.8 (5.22)	65.6 (4.15)	74.4 (3.44)
2	72.8 (3.68)	93.95 (2.85)	85.64 (2.18)
3	66.34 (3.66)	84.54 (2.85)	74.67 (2.18)
4	60.15 (4.31)	78.16 (3.43)	68.75 (2.55)
5	72.89 (3.68)	87.9 (2.86)	81.51 (2.18)
6	68.87 (4.79)	81.2 (3.38)	72.86 (2.61)

Speaker ID	r-bridging	r-given	r-new
7	68.15 (3.86)	85.6 (3.04)	84.95 (2.25)
8	85.88 (3.68)	93.8 (2.88)	95.7 (2.2)
9	61.82 (3.07)	77.63 (2.35)	66.5 (1.75)
10	81.66 (3.8)	99.97 (2.94)	91.25 (2.22)
11	68.08 (3.8)	79.69 (2.95)	71.93 (2.23)
12	60.8 (3.76)	68.16 (2.89)	62.62 (2.23)
13	52.3 (3.88)	58.46 (3.03)	56.59 (2.26)
14	64.82 (3.68)	75.54 (2.86)	65.67 (2.18)
15	60.84 (3.68)	75.28 (2.86)	70.41 (2.19)

Panel C: mean intensity (dB)

Speaker ID	r-bridging	r-given	r-new
1	77.78 (0.65)	77.5 (0.52)	76.95 (0.43)
2	78.2 (0.46)	76.43 (0.36)	76.8 (0.27)
3	64.43 (0.46)	63.31 (0.35)	66.29 (0.26)
4	75.94 (0.54)	75.08 (0.43)	75.2 (0.32)
5	76.97 (0.46)	76.53 (0.36)	78.4 (0.27)
6	73.12 (0.6)	71.62 (0.42)	71.34 (0.33)
7	75.07 (0.49)	74.39 (0.38)	82.51 (0.28)
8	77.51 (0.46)	76.26 (0.36)	76.37 (0.27)
9	78.4 (0.38)	77.3 (0.29)	77.51 (0.22)
10	81.34 (0.47)	80.33 (0.37)	80.39 (0.28)
11	74.26 (0.47)	78.44 (0.37)	80.12 (0.27)
12	79.96 (0.47)	78.77 (0.36)	78.47 (0.28)
13	76.41 (0.48)	80.52 (0.38)	84.94 (0.28)
14	77.86 (0.45)	78.31 (0.36)	76.96 (0.27)
15	79.7 (0.46)	79.65 (0.36)	79.01 (0.27)

References

Afifi A, Clark V, May S (2004): Computer-Aided Multivariate Analysis, ed 4. Boca Raton, Chapman & Hall/CRC.

Antão C, Arantes P, Cunha Lima ML (2013): Interrelation between subjecthood, referential status and prosody. Presentation at DGfS 2013 workshop 'Prosody and Information Status in Typological Perspective'. http://www.sfb632.uni-potsdam.de/dgfs-2013/AGs/slides/ag1_antao_etal.pdf (accessed from December 21, 2014).

Arnold JE, Losongco A, Wasow T, Ginstrom R (2000): Heaviness vs. newness: the effects of structural complexity and discourse status on constituent ordering. Language 76:28–55.

Arvaniti A, Adamou E (2011): Focus expression in Romani. Proceedings of the 28th West Coast conference on Formal Linguistics. Somerville, Cascadilla Proceedings Project.

Aylett M, Turk A (2004): The smooth signal redundancy hypothesis: a functional explanation for relationships between redundancy, prosodic prominence, and duration in spontaneous speech. Lang Speech 47(pt 1):31–56.

Baltazani M (2003): Pragmatics, intonation, and word order in Greek. Proceedings of Interfaces Prosodiques IP, pp 14–18.

Baltazani M, Jun S-A (1999): Focus and topic intonation in Greek. Proceedings of the XIVth International Congress of Phonetic Sciences, vol 2, pp 1305–1308.

Baumann S, Riester A (2012): Referential and lexical givenness: semantic, prosodic and cognitive aspects; in Elordieta G, Prieto P (eds): Prosody and Meaning. Berlin, New York, Mouton De Gruyter.

Baumann S, Riester A (2013): Coreference, lexical givenness and prosody in German. Lingua 136:16–37.

Bailyn JF (2004): Generalized inversion. Nat Lang Linguist Theory 22:1–50.
Birner BJ (1994): Information status and word order: an analysis of English inversion. Language 70:233–259.
Bivon R (1971): Element Order. Studies in the Modern Russian Language, 7. Cambridge, Cambridge University Press.
Bock JK, Warren RK (1985): Conceptual accessibility and syntactic structure in sentence formulation. Cognition 21:47–67.
Boersma P, Weenink D (2016): Praat: doing phonetics by computer. Version 6.0.21.
Bornkessel-Schlesewsky I, Schlesewsky M (2009): The role of prominence information in the real-time comprehension of transitive constructions: a cross-linguistic approach. Lang Linguist Compass 3:19–58.
Botinis A, Themistocleous C, Kostopoulos Y, Nikolaenkova O (2005): Syntactic and tonal correlates of focus in Greek and Russian. Proceedings Fonetik 2005, the XVIIIth Swedish Phonetics Conference. Goteborg, Sweden.
Branigan HP, Feleki E (1999): Conceptual accessibility and serial order in Greek language production. Proceedings of the 21st Conference of the Cognitive Science Society, Vancouver.
Branigan HP, Pickering MJ, Tanaka M (2008): Contributions of animacy to grammatical function assignment and word order during production. Lingua 118:172–189.
Breen M, Fedorenko E, Wagner M, Gibson E (2010): Acoustic correlates of information structure. Lang Cogn Process 25:1044–1098.
Bresnan J, Dingare S, Manning CD (2001): Soft constraints mirror hard constraints: Voice and person in English and Lummi. Proceedings of the LFG '01 Conference. CSLI Publications.
Brun D (2001): Information structure and the status of NP in Russian. Theor Linguist 27:109–135.
Bush LK, Hess U, Wolford G (1993): Transformations for within-subject designs: a Monte Carlo investigation. Psychol Bull 113:566–579.
Calhoun S (2015): The interaction of prosody and syntax in Samoan focus marking. Lingua 165:205–229.
Chafe WL (1976): Givenness, contrastiveness, definiteness, subjects, topics, and point of view; in Li C (ed): Subject and Topic. New York, Academic Press.
Chafe WL (1994): Discourse, Consciousness and Time. Chicago/London, The University of Chicago Press.
Cho T (2016): Prosodic boundary strengthening in the phonetics-prosody interface. Lang Linguist Compass 10:120–141.
Clark E, Clark H (1978): Universals, relativity, and language processing; in Greenberg JH (ed): Universals of Human Language. Stanford, Stanford University Press.
Clifton C, Frazier L (2004): Should given information come before new? Yes and no. Mem Cogn 32:886–895.
Cole J, Mo Y, Hasegawa-Johnson M (2010): Signal-based and expectation-based factors in the perception of prosodic prominence. Lab Phonol 1:425–452.
Comrie B (1989): Linguistic Universals in Language Typology, ed 2. Oxford, Blackwell.
Cruttenden A (2006): The deaccenting of given information: a cognitive universal; in Bernini G, Schwartz M (eds): Pragmatic Organization of Discourse in the Languages of Europe. Berlin, Mouton de Gruyter, pp 311–356.
de Ruiter LE (2015): Information status marking in spontaneous vs. read speech in story-telling tasks – evidence from intonation analysis using GToBI. J Phon 48:29–44.
de Swart P (2007): Cross-Linguistic Variation in Object Marking. LOT, Utrecht, The Netherlands.
Féry C, Krifka M (2008): Information structure: notional distinctions, ways of expression; in van Sterkenburg P (ed): Unity and Diversity of Languages. Amsterdam, John Benjamins.
Genzel S, Kügler F (2010): The prosodic expression of contrast in Hindi. Proceedings of Speech Prosody, Chicago, IL, USA.
Genzel S, Ishihara S, Surányi B (2015): The prosodic expression of focus, contrast and givenness: a production study of Hungarian. Lingua 165:183–204.
Halliday M (1967): Intonation and grammar in British English. The Hague: Mouton.
Haviland S, Clark H (1974): What's new? Acquiring new information as a process in comprehension. J Verbal Learning Verbal Behav 13:512–521.
Hinterhölzl R (2009): Information structure and unmarked word order in (Older) Germanic; in Zimmermann M, Féry C (eds): Information Structure: Theoretical, Typological, and Experimental Perspectives. Oxford, Oxford University Press.
Hoeks JC, Stowe LA, Doedens G (2004): Seeing words in context: the interaction of lexical and sentence level information during reading. Brain Res Cogn Brain Res 19:59–73.
Hróarsdóttir T (2009): Information structure and OV order; in Zimmermann M, Féry C (eds): Information Structure: Theoretical, Typological, and Experimental Perspectives. Oxford, Oxford University Press.
Ionin T, Luchkina T (Under revision): Focus on Russian Scope: An Experimental Investigation of the Relationship between Quantifier Scope, Prosody, and Information Structure. Manuscript under review.
Işsever S (2003): Information structure in Turkish: the word order-prosody interface. Lingua 113:1025–1053.
Jasinskaja K (2013): Information Structure in Slavic; in Féry C, Ishihara S (eds): Handbook of Information Structure. Oxford, Oxford University Press.
Kaland CCL, Krahmer EJ, Swerts MGJ (2011): Contrastive intonation: speaker- or listener-driven; in Lee W-S, Zee E (eds): Proceedings of the 17th International Congress of Phonetic Sciences, pp 1006–1009.
Kallestinova E (2007): Aspects of word order in Russian. Doctoral dissertation, Iowa University.

King T (1995): Configuring Topic and Focus in Russian. Stanford, CSLI Publications: Center for the Study of Language and Information.
Ladd RD (2008): Intonational Phonology. Cambridge, Cambridge University Press.
Lambrecht K (1994): Information Structure and Sentence Form. Cambridge, Cambridge University Press.
Lobanova A (2011): The role of prominence scales for the disambiguation of grammatical functions in Russian. Russian Linguist 35:125–142.
Luchkina T, Cole J (2014): Structural and prosodic correlates of prominence in free word order language discourse. Proceedings of the 2014 Meeting of the Speech Prosody Conference (SP 7), Dublin, Ireland.
Luchkina T, Puri V, Jyothi P, Cole J (2015): Prosodic and structural correlates of perceived prominence in Russian and Hindi. Proceedings of International Congress of Phonetic Sciences, Glasgow, Scotland.
Mak WM, Vonk W, Schriefers H (2002): The influence of animacy on relative clause processing. J Mem Lang 47:50–68.
McDonald JL, Bock K, Kelly MH (1993): Word and world order: semantic, phonological, and metrical determinants of serial position. Cogn Psychol 25:188–230.
Mo Y, Cole J, Lee E (2008): Native listeners' prominence and boundary perception. Proceedings of Speech Prosody, Campinas, Brazil.
Morgan JL, Meier RP, Newport EL (1987): Structural packaging in the input to language learning: contributions of prosodic and morphological marking of phrases to the acquisition of language. Cogn Psychol 19:498–550.
Neeleman A, Titov E (2009): Focus, contrast, and stress in Russian. Linguistic Inquiry 40:514–524.
Nakayama M (1995): Scrambling and probe recognition; in Mazuka R, Nagai N (eds): Japanese Sentence Processing. Hillsdale, Lawrence Erlbaum Associate, Hillsdale, NJ, USA, pp 257–273.
Patil U, Kentner G, Gollrad A, Kügler F, Féry C, Vasishth S (2008): Focus, word order, and intonation in Hindi. J South Asian Linguist 1:53–70.
Pierrehumbert J, Hirschberg J (1990): The meaning of intonational contours in the interpretation of discourse; in Cohen P, Morgan J, Pollack M (eds): Intentions in Communication. Cambridge, MIT Press, Cambridge, MA, USA, pp 271–311.
Prat-Sala M (1997): The production of different word orders: a psycholinguistic and developmental approach. Ph.D. Dissertation. Edinburgh, University of Edinburgh.
Prat-Sala M, Branigan HP (2000): Discourse constraints on syntactic processing in language production: a cross-linguistic study in English and Spanish. J Mem Lang 42:168–182.
Prince E (1981): Toward a taxonomy of given/new information; in Cole P (ed): Radical Pragmatics. New York, Academic Press, New York, NY, USA, pp 223–254.
Sekerina I (2003): Scrambling processing: dependencies, complexity, and constraints; in Karimi S (ed): Word Order and Scrambling. Oxford, Blackwell, Malden, MA, USA, pp 301–324.
Sirotinina OB (1965/2003): Porjadok slov v russkom jazyke ('Word order in Russian') (ed 2). Moscow, Editorial URSS.
Sityaev D (2000): The relationship between accentuation and information status of discourse referents: a corpus-based study. UCL Working Papers in Linguistics 12:285–304.
Slioussar N (2010): Russian data call for relational information structure notions; in Zybatow G, et al (eds): Formal Studies in Slavic Linguistics. Proceedings of Formal Description of Slavic Languages. Frankfurt am Main, Peter Lang, vol 7, pp 329–344.
Slioussar N (2011): Grammar and Information Structure: A Novel View Based on Russian Data. Utrecht institute of Linguistics OTS and St. Petersburg State University.
Slioussar N (2011a): Processing of a free word order language: the role of syntax and context. J Psycholinguist Res 40:291–306.
Svetozavora N (1998): Russian intonation; in Hirst D, Di Cristo A (eds): Intonation Systems: A Survey of Twenty Languages. Cambridge, Cambridge University Press.
Swerts M, Strangert E, Heldner M (1996): F0 declination in spontaneous and read-aloud speech. Proceedings of the 4th International Conference on Spoken Language Processing (ICSLP). Philadelphia, PA, USA, pp 1501–1504.
Traxler M, Williams RS, Blozis SA, Morris RK (2005): Working memory, animacy, and verb class in the processing of relative clauses. J Mem Lang 53:204–224.
Traxler MJ, Morris RK, Seely RE (2002): Processing subject and object relative clauses: evidence from eye movements. J Mem Lang 47:69–90.
Vainio M, Järvikivi J (2006): Tonal features, intensity, and word order in the perception of prominence. J Phon 34:319–342.
van Nice KY, Dietrich R (2003): Task sensitivity of animacy effects: evidence from German picture descriptions. Linguistics 41:825–849.
Verhoeven E (2009): Subjects, agents, experiencers, and animates in competition: modern Greek argument order. Linguistische Berichte 219:355–376.
Verhoeven E (2014): Thematic prominence and animacy asymmetries. Evidence from a cross-linguistic production study. Lingua 143:129–161.
Watson D, Arnold JA, Tanenhaus MK (2008): Tic Tac TOE: effects of predictability and importance on acoustic prominence in language production. Cognition 106:1548–1557.

Watson DG (2010): The many roads to prominence: understanding emphasis in conversation; in Ross B (ed): The Psychology of Learning and Motivation. Burlington, Academic Press, pp 163–183.
Xu Y (1999): Effects of tone on the formation and alignment of f0 contours. J Phon 27:22–106.
Xu Y, Xu CX (2005): Phonetic realization of focus in English declarative intonation. J Phonetics 33:159–197.
Yamashita H (1997): The effects of word-order and case-marking information on the processing of Japanese. J Psycholinguist Res 26:163–188.
Yokoyama O (1986): Discourse and word order. Amsterdam, John Benjamins.