PARAFOVEAL PREVIEW DURING READING IN RUSSIAN: NATIVE SPEAKERS AND SECOND LANGUAGE LEARNERS

BY

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DISSERTATION

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ABSTRACT

The experiments in this dissertation investigated the influence of word order and attentional processes (between vs. within words) on the parafoveal processing during reading of inflectional morphology of nouns and verbs in Russian by native speakers and L2 learners via the boundary-change paradigm (Rayner, 1975) and it's modified within-word version (Hyöna, Bertram, and Pollatsek, 2004). Syntactic position of the target word and allocation of attention on the target word affect the time-course of morphological processing in native speakers but not in L2 learners due to increased processing during all stages of word identifications: orthographic, lexical access, and post-lexical integration.

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CHAPTER 1:

INTRODUCTION

Reading is one of the most complex cognitive activities people engage in on a daily basis (Huey, 1908). Each individual word needs to be identified and processed on multiple levels: orthographically, phonologically, semantically, morphologically, and syntactically. Individual words also need to be integrated together. Evidence suggests that many of the cognitive processes involved in reading are interactive. Highly predictable words are often identified more quickly than less predictable words because they are constrained by their semantic and/or syntactic contexts (Balota, Pollatsek, & Rayner, 1985; Ehrlich, Rayner, 1981; Rayner, Ashby, Pollatsek, Reichle, 2004). Yet there is also emerging evidence that low-level factors (e.g., word length) affect eye movements and word-skipping independently from higher-level factors (e.g., word predictability) (Rayner, Slattery, Drieghe, & Liversedge, 2011).

Reading is a learned skill. It takes training and practice to achieve automatic coordination of so many interrelated processes in native language (Haikio, Bertram, Hyöna, & Niemi, 2009; Rayner, 1986). Reading in a non-native language in a world with increasing globalization is becoming almost as common as in a native language (Bialistok & Hakuta, 1994). Yet how the cognitive, linguistic, and visual processes interact in reading in a non-native language (L2) are still not well understood (Grabe, 2009; Koda, 2007).

Eye-tracking methodology, when readers' eye movements are mapped to the reading material and recorded with high precision (to the millisecond), provides a time-sensitive window into the cognitive processes during reading (Rayner, 2009). Studies that used eye-tracking to investigate cognitive processes during silent reading have found uniformity of the integration of lower-level information cross-linguistically. The region of the effective vision (perceptual span) is stable across different languages and orthographies. It equals approximately 5 degrees of visual angle, about 15-20 characters of an alphabetic script or three to four words (English: McConkie & Rayner, 1975; Finnish: Haikio, Bertram, Hyöna, & Niemi, 2009; Hebrew: Pollatsek, Bolozky, Well, & Rayner, 1981). This is true even for Chinese if we use words as a counting unit rather than Chinese characters (Inhoff & Liu, 1998); although whether the basic units are Chinese characters or words is still an open question. However, emerging evidence suggests that the perceptual span in L2 learners is reduced (Luke & Christianson, submitted).

When it comes to higher-level processing (e.g., morphological and syntactic), cross-linguistic differences emerge. The processing of verbal inflectional morphology, but not nominal morphology, is linked to early pre-processing stages of lexical access in Hebrew (a language with non-concatenated morphology) (Deutsch, Frost, Peleg, Pollatsek, & Rayner, 2003; Deutsch, Frost, Pollatsek, & Rayner, 2005). Morphology is integrated at a later point in English (Lima, 1987; Kambe, 2004) and Finnish (Bertram & Hyöna, 2003; Hyöna, Bertram, & Pollatsek, 2004). Syntactic context has been shown to affect word pre-processing in Hebrew (Deutsch et al., 2005, Experiment 4). Recently, Vainio, Hyöna, and Pajunen (2011) showed that syntactic context influenced lexical access of long but not short words in Finnish, confirming the hypothesis that word length can modulate morphosyntactic processing (Hyöna et al., 2004; Rayner, Slattery, & Drieghe, 2011).

Finally, L2 learners' difficulties with morphosyntax in general and inflectional morphology in particular are well-documented across various linguistic domains (e.g., Hawkins & Chan, 1997; Hawkins & Hattori, 2006; Haznedar & Schwartz, 1997; Jiang, 2004, 2007; Johnson & Newport, 1989; Lardiere, 1998a, 1998b; Prevost & White, 2000; Tsimpli, 2003; Tsimpli & Dimitrakopoulou, 2007; Tsimpli & Mastropavlou, 2008; Vainikka & Young-Scholten, 1994, 1996, 2006, 2007, 2009). A number of researchers proposed the stage of lexical word identification as the source of difficulties (McCarthy, 2008; Clahsen, Felser, Neubauer, Sato & Silva, 2010). Other researchers point towards post-lexical integration as the main source of difficulties for L2 learners (Keating, 2009; Felser, Sato, Bertenshaw, 2009; Felser & Cunning, 2011). Yet another view maintains that a general increase in the cognitive processing (McDonald, 2000, 2006) possibly due to a reliance on a qualitatively different memory system (Ullman, 2001) can be the source of observed difficulties of L2 learners with inflectional morphology.

Studies investigating eye-movements of second language (L2) learners during silent reading can help adjudicate between proposed theoretical accounts as specific eye-tracking measures correspond to different processing stages: orthographic processing (first fixation), lexical access (gaze), and post-lexical integration (total time, go-past time, second-pass and regressions). The relationship between the eye tracking measures and low (nonlinguistic) and higher-level (linguistic) factors during silent reading is an area of active research in the literature on the eye movements of native speakers (See Rayner, 2009, Schotter, Angele, & Rayner, 2012 for reviews). The investigation of the relationship between the linguistic, cognitive, and visual factors during silent reading in L2 is nonexistent. What type of information L2 learners integrated from the parafovea, the area of text that is within the limits of the visual field but not fixated directly by the eyes? Is it only low-level information as is believed to be the case for native speakers. However the relationship between the the perceptual span in L2 and the effects of the low level, nonlinguistic and higher-level linguistic factors on different stages of word identification (from orthographic processing to the integration into the active sentence) can potentially not only explain the documented increased processing, but also reveal specific stages that cause difficulty (e.g. orthographic processing vs. lexical vs. post-lexical integration).

The purpose of the experiments reported in this dissertation is to extend this research in two ways. I will investigate the influence of low-level (word length) and higher-level (morphology and syntax) factors on parafoveal processing during silent reading. I will examine eye movements of native speakers of a language that is typologically different from the languages examined so far – Russian, an Indo-European language from the Slavic subgroup, which has rich inflectional paradigms and flexible word order. Finally, I will investigate the effect of syntactic context on the parafoveal processing of morphology in English-speaking L2 learners of Russian.

To accomplish these goals, a series of four eye-tracking experiments were conducted. Experiment 1 (Chapter 3) examined parafoveal (when the eyes are on the word preceding a target word) effects of syntactic position on the processing of short nouns. Experiments 2 and 3 (Chapters 4 and 5 respectively) explored the effects of syntactic position on morphological processing of long nouns and verbs. Experiment 1 included both native Russian speakers and L2 Russian learners in order to explore whether any differences exists in the time-course of parafoveal morphological processing as modulated by syntactic context. The results for L2 learners are reported in Chapter 6. Prior to reporting the experiments, Chapter 2 contains a literature review of research on the factors affecting parafoveal processing and the use of eye tracking for investigation of morphosyntactic processing in native speakers and L2 learners.

CHAPTER 2:

LITERATURE REVIEW

Basic facts about Eye-Movements

Visual Field

Because of the anatomy of the retina, the visual field can be divided into three areas: fovea, parafovea, and periphery. Vision is sharpest in the foveal region (2^o in the central visual field that usually corresponds to approximately seven characters of an alphabetic script). Visual acuity decreases in the parafovea (5^o on either side of fixation) and drops dramatically in the periphery, which extends approximately 4^o beyond the parafovea (see Figure 1 for an illustration of how a sentence can be perceived by the eyes).

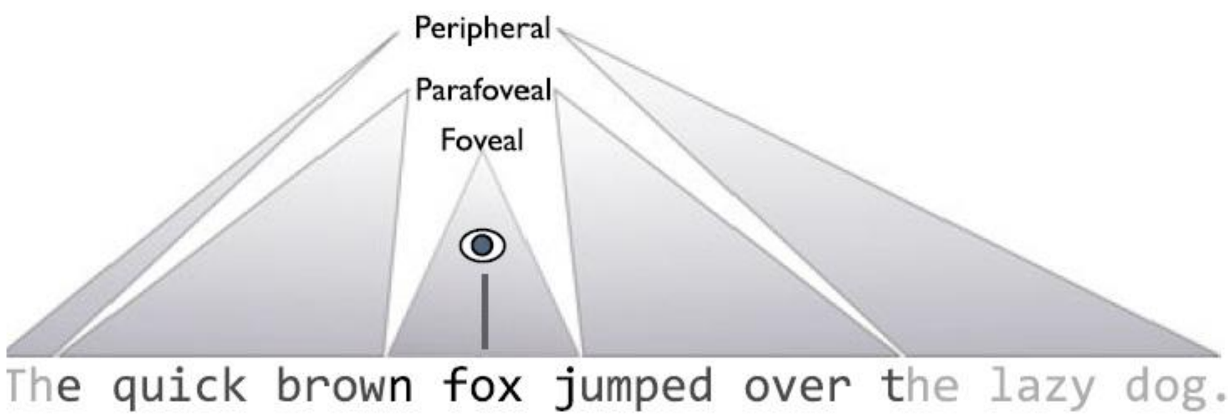

Figure 1. The foveal, parafoveal, and peripheral regions when three characters make up 1° of visual angle. The eye icon and the line point to the location of the fixation (adapted from Schotter, Angele, & Rayner, 2012).

Perceptual Span

Reading studies have demonstrated that the perceptual span (the range of printed information that is visible to the eyes while they stay focused on a single spot) is relatively stable cross-linguistically and equals 5° of visual angle (foveal and parafoveal vision). This corresponds to 15-25 characters of an alphabetic script depending on the font size and distance between the monitor and the eyes (English: McConkie & Rayner, 1975, 1976; Rayner & Bertera, 1979; Rayner, Well & Pollatsek, 1980; Hebrew: Pollatsek, Bolozky, Well, & Rayner, 1981; Finnish: Haikio, Bertram, Hyöna, & Niemi, 2009). The perceptual span in Chinese is significantly smaller: one character to the left of fixation and three characters to the right of fixation (Inhoff & Liu, 1998). There is much more information revealed in one character of logographic systems, such as Chinese, than in one letter of the alphabet. However, if a word is instead the unit of comparison, then the perceptual span is relatively constant (three to four words) (Schotter, Angele, & Rayner, 2012) across alphabetic and logographic scripts.

While perceptual span is relatively constant, different type of information is extracted from different regions within the perceptual span. Such information as word length is available as far as 14-15 characters to the right of the fixation (Rayner, 1998). Information about the letter shape is available as far as 11-12 character spaces to the right (Rayner, 1998). Finally, information about the exact identity of the letters is available only as far as 7^{th}-8^{th} character to the right of the fixation (Haikio et al., 2009; Rayner, 1998).

Eye-Movements

The purpose of eye movements during reading is to bring new information into the foveal region for processing (Rayner, 1998; 2009). Basic eye movements in reading can be identified as fixations (the relatively still state of the eyes between saccades), saccades (the movement of the eye), regressions (backward saccades in the text), and skipping (some words are never fixated) (see Rayner, 1998, 2009, for detailed reviews). While average saccade length is 7-9 characters in

English (Rayner, 2009), it is only 2-3 characters in Chinese (Rayner, 2009) and 5.5 in Hebrew (Pollatsek et al., 1981). This suggests that language and/or orthography can modulate eye-movements during reading.

Eye-tracking during reading provides examination of the moment-by-moment comprehension processes during reading in a natural way. Different eye movement measures capture different stages of information processing (Rayner, 1998). First fixation – the first time the eyes fixate on the region of interest (ROI) – is associated with the processing of orthographic information. Gaze duration (all fixations on the ROI before moving the eyes off the word) is associated with lexical access. Regression-path duration or go-past time (all fixations on the ROI prior to moving off it to the right, including regressions to prior material) and total time (the sum of all fixations on the ROI) are believed to reflect later, post-lexical stages of integration (Rayner, 1998, 2009).

Attention

It takes around 50 milliseconds to propagate the visual features on the printed page from the retina to the brain, according to physiological research (Clark, Fan, & Hillyard, 1995; Foxe & Simpson, 2002; Mouchetant-Rostaing, Giard, Bentin, Aguera, & Pernier, 2000; VanRullen & Thorpe, 2001). Consequently, it takes time to program the saccade to the new location on the page. As a result, the attention shifts to the saccade target before the eyes fixate on it. Thus, information is obtained during any given fixation not only from the word being fixated, but also from a word or two to the right of fixation, i.e. from the parafovea (see Rayner, 1998, 2009; Schotter, Angele, & Rayner, 2012).

Factors Affecting Parafoveal Processing

Boundary Change Paradigm

To investigate the nature of the information obtained parafoveally, an experimenter places an invisible boundary to the left of the target word. While the eyes are fixated to the left of the boundary, a preview word (identical, or similar to the target word in some way, or a non-word) is the parafoveal stimulus (as shown in Figure 2).

Figure 2. The + sign shows the location of the eye during a fixation on the line above the +. The vertical line shows the location of the invisible boundary.

The weather| today is extremely cold.

The weather| trklp is extremely cold.
          +
The weather| today is extremely cold.
                    +

As the eyes are crossing the boundary during a saccade, the preview word is replaced by a target word automatically by the eye tracker. The participants normally do not notice the change because the eyes are essentially blind during saccades (saccadic suppression, (Matin, 1974)). The critical dependent variables are the fixation durations on the target word. Generally, the fixation time on the target is faster in identical and/or similar preview conditions compared with the non-word preview, the obtained effect is called a preview benefit effect. This paradigm is called a boundary-change paradigm (Rayner, 1975), and it has been used in dozens of experiments over the past 40+ years.

Low-level Information

Research using the boundary change technique has shown that readers use low-level information such as word length (since words in most alphabetic scripts are separated by spaces) available parafoveally to decide where to move the eyes (Patterson & Jordan, 2010; Rayner, 1998, 2009; Schotter, Angele, & Rayner, 2012). The visual system uses word length information of the upcoming words to program saccades that land approximately in the center of the word, optimal viewing location (OVL); however, due to the oculomotor errors (undershoots), the eyes quite often land to the left of the word center, preferred viewing location (PVL) (see Rayner, 1998, for a detailed discussion about OVL and PVL).

Additionally, research using the boundary change manipulation has established that information about initial and final letter position (e.g., Briihl & Inhoff, 1995), orthographic codes (Balota, Pollatsek, & Rayner, 1985), abstract letter codes (McConkie & Zola, 1979; Rayner, McConkie, & Zola, 1980; Johnson, 2007; Johnson, Perea, & Rayner, 2007), and phonological codes (e.g., Ashby, Trieman, Kessler, & Rayner, 2006; Chace, Rayner, & Well, 2005) are processed parafoveally.

Higher-level Information

Predictability of a word from a prior sentential context affects parafoveal preview benefit (e.g., Balota, Pollatsek, Rayner, 1985; Drieghe, Rayner, & Pollatsek, 2005). A predictable word (*liver*) in a sentence as seen in (1) is skipped significantly less when a preview word is a pronounceable non-word that is different by only one letter (e.g., *liver/livor*) than when the preview is the target word itself. This finding points to a very high degree of letter identification in parafoveal processing.

(1) The doctor told Fred that his drinking would damage his liver very quickly.

Cross-linguistic differences in parafoveal processing emerge at the morphological level of analysis. There is no evidence that morphology is processed parafoveally in English (Juhasz, White, Liversedge, & Rayner, 2008; Kambe, 2004; Lima, 1987) or Finnish (Bertram & Hyöna, 2003; Hyöna, Bertram, & Pollatsek, 2004), but there is evidence that morphological information is processed parafoveally in Hebrew (Deutsch, Frost, Pelleg, Pollatsek, & Rayner, 2003; Deutsch, Frost, Polatsek, & Rayner, 2000; 2005).

Morphosyntactic Processing in Native Speakers: Cross Linguistic Differences

Foveal Processing

Lima (1987) and Kambe (2004) examined the extent of parafoveal preview benefit on the morphological processing of derivational prefixes using eye-tacking methodology. Lima (1987) examined effects of partial preview where only a prefix was available (rexxxx) on the processing of a prefixed verb (*remind*) and pseudoprefixed verb (*relish*) in comparison with the full (identical) preview and did not find any significant difference between the partial availability of the prefix on prefixed or pseudoprefixed verbs. The author concluded that the processing of prefixes is a foveal rather than parafoveal process.

Kambe (2004) found that a non-word preview that shared a prefix (*rehsxc*) or stem (*zvduce*) with the target (*reduce*) obtained significant parafoveal preview benefit only for the whole word (identical) condition. The author argued against morphological processing in the parafovea and attributed the source of facilitation obtained in the manipulated identical condition to the abstract letter code. However, it is also possible that the use of x's or letters in the non-word preview conditions were overly strong manipulations that inhibited any effects induced by prefix or stem previews (Taft, 2004).

In two eye-tracking experiments, Bertram & Hyöna (2003) examined the role of word length on morphological processing of short (<8 characters long) and long compounds (>12 characters) in Finnish, manipulating frequencies of compound constituents and the compound as a whole. In the first experiment the frequency of the first constituent was manipulated (high/low), holding constant the frequency of the whole-word and the second constituent. In the second experiment, constituent frequencies were controlled and whole-word frequencies varied. The manipulated compound nouns were inserted into sentence frames that were the same up to the second word after the compound. Differences in the initial landing position of the eyes on the word imply that some aspect of the target word (first constituent frequency and/or the length of the word) results in a longer or shorter saccade from a previous word into the target word. The results showed that initial landing position was located further in the word for long compounds then for short nouns regardless of whole-word or first constituent frequencies, suggesting that only the word length information was processed parafoveally and affected the decision where to locate the next eye fixation.

For long compounds, frequency of the first constituent affected first fixation durations, suggesting that the first morpheme was used to limit potential lexical candidates. First constituents with higher frequencies elicited shorter fixations. Whole-word frequency affected gaze durations suggesting that short compounds were not decomposed during lexical access. Shorter fixations were observed for compounds with higher whole-word frequency. For short compounds no effect of frequency of the first constituent was observed. Whole-word frequency affected first fixation duration and gaze duration. Researchers accounted for the observed pattern of results through the visual acuity benefit hypothesis: if the whole word (8 characters or less) is in the fovea, it will be accessed lexically as a whole word because all the letters are in the region of the effective vision. Long words (12+ characters) are only partially in the fovea. As a result, the beginning of the word will be analyzed first to gain access to the meaningful substring.

Within Word Boundary Change. In order to examine morphological processing within the long words, Hyöna, Bertram, and Pollatsek (2004) modified the between-word boundary change paradigm (Rayner 1975) and moved the boundary inside long compound nouns (12 to 18 characters) in Finnish. They manipulated the frequency of the first constituent (high/low) while controlling for whole-word frequency, word length, frequency of the second constituent and the lengths of the constituents. The invisible boundary was set between constituents. The parafoveal preview was either identical (no change) or all but the first two letters of the second constituent were replaced with visually similar letters. The manipulated compound nouns were inserted into sentence frames that were the same up to the second word after the compound. The absence of the effects of boundary change manipulation on the first fixation on the first constituent showed that the second constituent was not preprocessed parafoveally and confirmed earlier findings (Bertram et al., 2003) that in Finnish compound constituents are processed serially.

Gaze duration showed effects of frequency of first constituent and of the change manipulation, but not in the direction expected. The low-frequency, first-constituent condition showed a larger difference (120 ms) between manipulated preview and no-change preview. The high-frequency condition had significantly less interference (80 ms) from the impaired second constituent. The authors assigned such effect to the predictability of the second constituent. Compounds with low-frequency first constituents make the second part more predictable than compounds with a high-frequency first constituent, which can be part of many more compounds than the low-frequency first constituents.

Although the study found that constituents in long Finnish compounds were processed serially and ruled out morphological processing in the parafovea, the results yielded higher effects (80-120 ms) than the 30-40 ms effects usually reported for the preview benefit. The authors ascribed this difference to the attentional processes within a word that warrant parafoveal processing within the word boundary at deeper level than integrating information between words.

Drieghe, Pollatsek, Juhasz, and Rayner (2010) confirmed the hypothesis proposed by Hyöna et al. (2004), regarding the deeper level of processing within a word for compound nouns. They also found that readers fixated longer on the first part of a monomorphemic word when the preview for its second part was not available. This suggests that the presence of a morpheme boundary causes readers to process the constituents of compound words serially but, when they first encounter a word, it is not evident whether it is a monomorphemic word or a compound word. As a result, it is possible that all the letters in a word can be accessed at the same time during a very early stage until the morphemic boundary becomes salient.

Juhasz, Pollatsek, Hyöna, Drieghe, and Rayner (2009) also demonstrated larger preview benefit effects (*ball* vs *bakd*) in line with Hyöna et al. (2004) for unspaced compound words in English as compared with the spaced compounds (e.g., *basketball*/*tennis ball*). Surprisingly, the effect size of the preview benefit observed for the spaced compounds was larger (31 ms benefit) then reported in previous experiments (-7 ms, Hyona et al., 2004). The authors offered two possibilities to account for the observed pattern of results. First suggests that a spaced compound forms an “attentional unit” and is processed in parallel. Second suggests that attention shifts between the two words forming a spaced compound sooner than between two words that do not form a spaced compound.

To adjudicate between the two possibilities, Juhasz and colleagues (2009) conducted a follow-up boundary change experiment comparing spaced compounds with adjective-noun pairs (e.g. *tennis ball/ yellow ball*). Although numerically preview benefit for spaced compounds was larger (34ms) than for the adjective noun pair (20 ms), the difference did not reach significance. The obtained results ruled out the possibility that spaced compounds formed a linguistic unit and thus were processed in parallel.

Interestingly the effect size for the adjective- noun pairs (20 ms) was again larger than the expected (-7 ms) based on previous research (Hyona et al., 2004). All experimental sentences were constructed in such a way that made the syntactic category of the target word (*ball*) very predictable. This suggests that syntactic predictability of the noun from the prior sentential context can facilitate parafoveal processing just as lexical predictability (Balota, Pollatsek, & Rayner, 1985; Drieghe, Rayner, & Pollatsek, 2005).

It has been demonstrated in the literature that syntactic category of the upcoming word is computed online and affects early eye tracking measures on the target word (Staub & Clifton, 2006; Staub, Rayner, Pollatsek, Hyöna, & Majewski, 2007). Results reported by Juhasz and colleagues (2009) suggests that syntactic predictability might increase parafoveal preview benefit for the noun in both spaced compounds and adjective- noun pairs analogous to the lexical predictability through a faster attention shift.

Syntactic affects. Syntactic context has been shown to modulate lexical access of long (Vainio, Bertram, Pajunen, & Hyöna, 2011), but not short (Vainio, Hyöna, & Pajunen, 2003, 2008) inflected words in Finnish. Vainio et al. (2003, 2008) demonstrated late facilitative effects (gaze duration of word *n+1*) for short target head nouns (5 characters) preceded by a modifier compared with the same head nouns without the modifier. This led the researchers to the conclusion that syntactic information is integrated at a later post-lexical stage. Recently Vainio et al. (2011) investigated the interaction between cognitive resources (attention allocation), higher level linguistic information (inflectional processing of the modifier-head agreement) and low-level information (word length) in Finnish. Long head nouns (12+ characters) preceded by agreeing modifiers elicited faster gaze durations then the same head nouns without modifiers. The observed pattern of results suggests that syntactic information facilitates lexical identification of the target compounds. The study also showed a late facilitative effect of the agreeing modifier preceding the head noun that was observed in the gaze duration on the word *n+1*. This was taken as the evidence for post-lexical syntactic integration of the target word.

Vainio and colleagues (2011) account for different time-course of the integration of syntactic information depending on the word length via the cognitive allocation of attentional resources. Since the processing of longer word is more effortful, more attention is allocated and there is more time for the prior syntactic information (such as preceding agreeing modifier case marking) to exert its role during lexical access.

Parafoveal Processing

Morphology. Although the eye movement evidence reviewed so far demonstrates that speakers of English and Finnish do not process morphology parafoveally, investigations in Hebrew point to the existence of parafoveal morphological processing when the orthography of the language, and perhaps the morphological system of the language, are conducive to it. Deutsch and colleagues (2000, 2003, 2005) studied derivational morphology in Hebrew, a Semitic language. They used the boundary-change paradigm (Rayner, 1975) to demonstrate that in a language with rich morphology, readers do integrate such information in the parafovea.

Hebrew morphology differs from the linear concatenated morphology of either Indo-European languages or agglutinative languages as Finnish. In Hebrew, three-letter consonant roots are interwoven with either a nominal or a verbal vowel pattern. The root usually bears the main semantic meaning of the word, and the word-pattern defines the word's grammatical class, a noun's grammatical gender, and a verb's transitivity or mode (active/passive). It should also be noted that the specific meaning of a word cannot be derived independently from the root and the word-pattern. For example, the root *xbr* 'to assemble' can be combined with the feminine nominal pattern *ma*- - *e – et* to form the word *maxberet* 'notebook' or with the active verbal pattern -*i* - - *e* - to form a causative transitive verb *xibber* 'he combined'.

Deutsch et al. (2003) used eye tracking to examine the processing of the root morpheme in the Hebrew nouns. The authors compared three preview conditions: identical, morphologically related, and orthographic control. The measures that are believed to reflect early stages of lexical access, first fixation duration and gaze duration, showed that both identical and morphologically related conditions were read significantly faster than the orthographic control condition. The advantage for the morphologically related condition disappeared at the total time but not for the identical condition, and at the second pass time there was no difference between all three conditions. The authors concluded that root morphemes were decomposed during preview and facilitated the activation of the target word.

In another series of eye-tracking experiments, Deutsch, Frost, Pollatsek, and Rayner (2005) examined the processing of verbal and nominal patterns in the parafovea. In the first experiment the target and the three preview words had the same two letters. The preview conditions were identical, morphological (same verbal pattern but different roots), and orthographic control. The results almost mirrored the results found in the root morpheme manipulation of Deutsch et al. (2003). At the first fixation duration, the morphologically related preview provided significant benefit (9 ms) over the orthographic control. It is also worth mentioning that, unlike Deutsch et al. (2003), there was also significant difference (7 ms) between the identical and morphological previews. The second experiment manipulated the nominal pattern preview, but the results mirrored the findings in English (Kambe, 2004; Lima, 1987), where only the identical preview condition demonstrated any significant facilitation. Morphological and orthographic control conditions did not differ significantly from each other. The authors attributed the differences in parafoveal processing to the peculiarities of Hebrew morphology. There are only seven main classes for the verbs and about 100 classes for nominal patterns, making nominal patterns less salient. The authors suggested that in Hebrew morphological processing is sublexical, i.e. subordinate to lexical access.

Syntax. Experiment 4 in Deutsch et al. (2005) investigated syntactic predictability on the processing in the parafovea. The preview conditions were identical, syntactically congruent (same part of speech with different root and different nominal pattern), and syntactically incongruent control (verbal instead of nominal pattern). First fixation durations revealed significant facilitation in the identical condition in the size of 8 ms. Gaze duration demonstrated both significant 12 ms facilitation of the identical preview and 13 ms inhibition in the syntactically incongruent condition relative to the control condition (syntactically congruent). Second-pass time revealed significant inhibition in the syntactically incongruent condition (-25ms). The results suggest that the grammatical category of the word was predicted from the prior context and guided the integration of the parafoveal word into the structure being built, consistent with what Vainio et al. (2011) demonstrated for Finnish long words.

Recently, Warren, and McConnell (2007) tested selectional restriction violations in English to explore how the role of semantic constraints that a predicate places on its argument would affect eye movements during silent reading. Participants read three types of sentences: possible and plausible (2a), possible but implausible (2b), or impossible due to selectional restriction violation as seen in (2c) and implausible.

(2a) Possible-plausible: The man used a strainer to drain the thin spaghetti…

(2b) Possible-implausible: The man used a blow-dryer to dry the thin spaghetti…

(2c) Impossible-implausible: The man used a photo to blackmail the thin spaghetti…

First fixation duration of the target word *spaghetti* in the impossible condition was significantly slower than both possible conditions that were not different from each other. This indicates that restriction violation (presumably a post-lexical process) was detected quite early and affected the decision not to move the eyes of the target word.

The idea of multiple sources of information (low-level: word length, orthographic letter codes, etc., and higher-level: word frequency, morphology, semantics, syntactic role) affecting the processes involved in silent reading is not a new one. It has been suggested by Henderson and Ferreira (1990) as the attentional span hypothesis.

Attentional Span and Integration of Syntactic Information

Using the boundary change paradigm, Henderson and Ferreira (1990) demonstrated that frequency and syntactic difficulty of the foveal word affected the size of the preview benefit. When the foveal word had a high frequency, the preview benefit for identical and similar non-word (first 3 characters were the same) preview conditions was significantly larger compared to the fixation time on the target word in a dissimilar non-word condition. However this preview benefit disappeared when the foveal word had a low frequency. Similarly, when a foveal word was syntactically difficult to integrate (i.e., a garden path as seen in 3b), there was no significant preview benefit for identical and similar preview conditions.

(3a) She warned that Harry bought| small gifts

smadd

tipoa

(3b) She warned Harry bought| small gifts

smadd

tipoa

The finding that the perceptual span is reduced when the foveal word is either lexically (low frequency) or syntactically (garden path) difficult to integrate paints a picture of a dynamic perceptual span that is tightly coupled with attention. Henderson and Ferreira (1990) even suggest the term *attentional* span instead of perceptual span. The attentional span hypothesis is strengthened by findings that beginning readers (Haikio, Bertram, Hyöna, & Niemi, 2009; Rayner, 1986) and dyslexic readers (Rayner, Murphy, Henderson, & Pollatsek, 1989) have reduced spans compared with skilled readers. It has been recently suggested that L2 learners also have reduced spans in silent reading (Luke & Christianson, submitted).

Facilitatory effects of frequency of the foveal word affecting the availability of the preview of the upcoming word has been replicated in a number of studies (Slattery, Angele, & Rayner, 2011; White, Rayner, & Liversedge, 2005). The second finding that syntactic structure can affect parafoveal processing has also been getting indirect support from findings in Hebrew (Deutsch et al., 2005 Experiment 4), Finnish long nouns (Vainion et al., 2011), and English (larger effect sizes for preview benefit with spaced compound nouns, Juhasz et al., 2009.) To summarize the evidence from three different languages, it seems that orthographic differences as well as linguistic differences could potentially explain the cross-linguistic variation in the time-course of morphological processing by native speakers.

Modeling of orthographic and linguistic effects on eye movements

While all models of eye movements incorporate the influence of both low-level non-lexical factors and higher-level linguistic factors on eye-movements, models differ in the emphasis they put on either oculomotor or linguistic information. Some models (e.g., strategy-tactics (O'Reagan, 1992), stochastic model of eye movements in reading incorporating foveal splitting (SERIF) (McDonald, Carpenter, & Shillcock, 2005), competition-interaction theory (Yang & McConkie, 2001, 2004)) ascribe eye movements to purely lower-level, nonlexical oculomotor factors (e.g., word length).

Other models, also called cognitive models (Starr & Rayner, 2001), emphasize lexical processing as the main engine driving eye-movements. Cognitive models vary in their conceptualization of attention shifts. Serial shifts of attention from one word to the next are the key mechanism driving the eye movements under the E-Z Reader model (Pollatsek, Reichle, & Rayner, 2006; Reichle, Pollatsek, Fisher, & Rayner, 1998; Reichle, Rayner, & Pollatsek, 2003). In contrast, parallel processing models (e.g. SWIFT (Engbert, Longtin, & Kliegl, 2002; Engbert, Nuthmann, Richter, & Kliegl, 2005)) assume that several words can be processed in parallel.

The assumption that higher-level linguistic information can exert its influence as early as the parafovea can be found in both cognitive models. The SWIFT model (Engbert et al., 2005) can account for the early morphological effects due to the assumption that a word *n+1* is processed fully in the parafovea. E-Z Reader 10 (Reichle, Warren, McConnell, 2009) accounts for early influences of linguistic information via the assumption that attention moves ahead of the eyes. While the eyes are still on word *n*, the lexical preprocessing of the upcoming word *n+1* is initiated in the parafovea (L_1 or familiarity check stage). At the same time the higher-level postlexical integration stage (I) is postulated to run on word *n* concurrently with the lexical access stage. This stage is not without cost – a constant of 25 ms in the most simple, difficulty-free case is added to the model for integrating each word into the syntactic structure of the sentence. This means that the higher-level information from the word *n* can, in principle, influence the lexical access of the next word *n+1* very quickly. If the word *n* is difficult to integrate into the sentential structure being built, the signal can be sent to bring the attention only or together with the eyes if they have already moved to word *n+1* back to the source of difficulty (word *n* in this case).

The addition of a postlexical stage to a model of eye movements allows a principle examination of the relationships between eye movements and higher-level linguistic phenomena that have been shown to affect reading (see Clifton, Staub, & Rayner, 2007 for a detailed review). A model of eye-movements that seeks to account for the time-course of cognitive processing from orthographic word identification to postlexical integration allows a simultaneous examination of cognitive, linguistic, and visual factors on silent reading. This dissertation represents a first attempt to investigate the influence of higher level (syntactic and morphological) and low-level (word length) factors on perceptual span as evidenced by eye-movements of native speakers of a language that has not been examined yet - Russian.

Researchers using eye-tracking methodology to investigate L2 morphosyntactic processing have focused mostly on the foveal effects (Felser & Cunning, 2011; Felser, Sato, Bertenshaw, 2009; Keating, 2009). Recently, it has been suggested that syntactic processing can affect L2 perceptual span along with the morphological processing in silent reading (Luke, 2011) This dissertation investigates the type of information processed parafoveally by L2 learners along with the time-course of morphosyntactic processing.

Morphosyntactic Processing in L2 Learners

Second language learners consistently have persistent difficulties with L2 morphosyntax (e.g., Jiang, 2004, 2007; Johnson & Newport, 1989; Keating, 2009). A number of theories point towards a processing difference between L1 and L2 at the level of lexical word identification. This can be due to either differences in the underlying implicit grammatical knowledge (Jiang, 2007), or an increased demand on the general cognitive processing that impedes lexical retrieval (McDonald, 2000, 2006), or a different processing route that relies on qualitatively different memory systems during lexical access for L2 learners (Silva & Clahsen, 2008; Ullman, 2001).

In a self-paced reading study, Jiang (2007) examined the integration of plural morphemes (4a-4b) during online processing of native speakers of English and Chinese L1 English L2 learners. He presented grammatical (4a, 4c) and ungrammatical (4b, 4d) sentences and found that, unlike a group of control native speakers, L2 learners did not slow down at the italicized regions in (4b).

(4a) The visitor took several of the rare *coins in the* cabinet.

(4b) *The visitor took several of the rare *coin in the* cabinet.

(4c) The teacher wanted the student to *start all over* again.

(4d)* The teacher insisted the student to *start all over* again.

Jiang concluded that the insensitivity towards plural morpheme errors, but not to the verb subcategorization errors, indicate that the underlying implicit (automatic) knowledge of plural morphology of English nouns for the L2 participants in his experiment have not reached the same qualitative level of native speakers.

A number of researchers have suggested that differences between L1 and L2 are of the quantitative rather than the qualitative nature. McDonald (2000) accounts for the performance differences between L1 and L2 speakers during decoding of surface level forms via a processing load hypothesis. Because L2 learners operate under an increased cognitive load, they have less resources to compute either the morphosyntactic agreement or complex morphosyntactic structure. Importantly, due to the general cognitive nature of the difficulty, native speakers under pressure or with restricted availability of cognitive resources should exhibit similar deficits in morphosyntactic processing. McDonald (2006) provides support for such a view. When native speakers were required to perform a dual-task, a grammaticality judgement task and either together with a digital load task (to limit memory resources) or accompanied by perceptual noise (to limit decoding abilities), their performance resembled that of L2 learners under normal conditions. Native speakers made more mistakes in identifying errors in inflectional morphology (regular verbal past tense) than in word order.

Ullman (2001) also proposes an account of L1/L2 differences in a declarative/procedural model that is based on general cognitive recourses. Ullman expands a Dual-Route model of words and rules for native language acquisition proposed by Pinker (1999) and provides a neurological base to the words and rules distinction. Lexical knowledge is acquired via the declarative memory, while rule-based knowledge is acquired via the procedural memory. Ullman hypothesizes that procedural memory decreases with age but strengthens with practice. As a result, late L2 learners rely more on declarative memory, which is less efficient for grammatical tasks such as morphological processing. Since procedural memory is based on rules and is computational while declarative memory is not, L2 learners under this view lexicalize inflectional forms (store them as full-forms) more heavily than native speakers, who rely on procedural memory to decompose structurally complex words.

Lexical-Decision Masked Priming Paradigm

Influenced by the declarative/procedural model, the majority of studies on L2 morphological processing adopt the lexical-decision, masked-priming paradigm from the field of visual word recognition. Under this paradigm participants are presented a prime for a very short time in the range of 45-60 ms. The display of the prime t is not perceived consciously by the participants. The prime is followed by a target word that the participants are asked to determine to be a word or a non word. They indicate their decision by pushing a button on the controller. The time it took participants to push the button on the controller is taken to represent how long it took participants to decide whether the target word is a word or not. Based on the obtained response time measures, researchers judge how much facilitation or inhibition a prime caused during lexical access of the target word. Based on the obtained results, researchers make inferences about the organization of the mental lexicon.

Evidence from this paradigm to date is inconclusive at best. On one hand, there is evidence yielding support to the hypothesis that L2 learners, unlike native speakers, rely more heavily on whole-word processing in their second language (Clahsen, Felser, Neubauer, Sato, & Silva, 2010; Ullman, 2004, 2005). There is also evidence that L2 learners with increased proficiency adopt the strategies of native speakers (Lemhofer, Dijkstra, Schriefers, Baayen, Grainger, & Zwitselood, 2008; Feldman, Kostic, Basnight-Brown, Filipovic-Durdevic, & Pastizzo, 2009; Diependaele, Duñabetia, Morris, & Keuleers, 2011). These findings in principle do not disprove the declarative/procedural model, which postulates that with increased practice any knowledge (language-related or not) can become proceduralized. The studies on morphological processing (especially inflectional morphology) of L2 that use the lexical-decision, masked priming paradigm can be challenged on methodological grounds.

There are a number of problems with using masked-priming lexical decision tasks to study morphological processing. First, by asking participants to make a conscious decision on whether the string of letters represents a word or not, such experiments impose unnecessary cognitive demands that are not encountered during normal silent reading. Second, by presenting a word without at least a sentential context, such experiments ignore the influence of prior information on the processing of a given word and the effects of parafoveal processing of a word before it is fixated, because most words are presented in the fovea. More specifically, in normal silent reading the information obtained about a word prior to fixation affects its later fixation location and duration (Rayner, 1998). It is not surprising then that in light of the above-mentioned shortcomings, there is emerging evidence that points to differences in processing words in isolation and in sentential contexts not only by native speakers (Bertram, Hyöna, & Laine, 2000; Bertram, Laine, Schreuder, Baayen, & Hyöna, 2000; Luke & Christianson, 2011) but also for L2 learners (Luke & Christianson, submitted).

Additionally, the masked-priming paradigm only provides a snapshot rather than the full time-course of morphological processing. This is due to the built-in logic that the morphological processing should occur or not occur within the time frame as specified by the time difference between the presentation of the prime and the target. If L2 learners are sensitive to the morphological structure but process it slower then native speakers, the masked-priming studies that use the same presentational rates for native speakers and L2 learners will miss such sensitivity.

Eye Tracking Methodology

Eye-tracking has been suggested by a number of SLA researchers as a more ecologically valid alternative to investigate the time course of morphosyntactic processing during silent reading (Dussias, 2010; Luke, 2011; Roberts, 2012). To date there are only a handful of studies that have examined on-line morphosyntactic processing of L2 learners using eye-tracking methodology (Felser & Cunning, 2011; Felser, Cunning, Batterham, Clahsen, 2012; Felser, Sato, & Bertenshaw, 2009; Keating, 2009; Luke, 2011; Roberts, Gullberg, & Indefrey, 2008). Among them Keating (2009) and Luke (2011) have examined the integration of inflectional morphology during the processing of agreement.

Keating (2009) provides evidence that English-speaking learners of Spanish can detect adjective-noun gender disagreement, but only when the adjective and noun are in the same phrase. In an eye-tracking experiment that investigated the processing of gender agreement violations, Keating found that the learners slowed down at post-nominal adjectives that disagreed with the noun they modified, as compared to control sentences with the correct agreement. This was true only when both the noun and the adjective were in the same syntactic phrase (DP). When the syntactic distance (both linear and structural) increased and crossed the local phrase, learners did not slow down. Native controls, on the other hand, were sensitive to the disagreement and slowed down irrespective of the syntactic or linear distance.

Recently, in a series of eye-tracking experiments, Luke (2011) and Luke and Christianson (submitted) examined morphosyntactic processing of L1 Korean L2 English learners. They inserted inflected and derived words that sometimes contained letter transpositions at the morpheme boundary (e.g., ente*er*d, kin*nd*ess) into a sentence frame. Syntactic structure of the sentence frames were manipulated independently of the letter transpositions (plural versus singular: e.g., *the dogs jumped* versus *the dog jumped*). Letter transpositions across the morpheme boundary has been shown to be more disruptive for native speakers compared with the transpositions within morphemes (e.g., sun*hs*ine) (Christianson, Johnson, & Rayner, 2005; Duñabietia, Perea, & Carreiras, 2007). Examining eye-tracking data for L2 learners, Luke (2011) and Luke and Christianson (submitted) report longer first fixations and gaze durations for L2 learners for the conditions in which letter transpositions crossed the morphemic boundary. This suggests that L2 learners were disrupted by the transpositions and as a result were sensitive to the morphological structure during lexical access of the target word. Interestingly, native speakers' sensitivity towards the morphological structure interacted with the syntactic structure of the sentence. Native speakers were less disrupted by the transpositions within the less-syntactically-important suffix: in the plural sentences. This in turn suggests a very interactive processing of morphosyntactic information. Importantly, unlike native speakers, syntactic context did not seem to affect the integration of morphology during lexical access stages for L2 speakers.

Luke's (2011) and Luke and Christianson's (submitted) findings seem to suggest that L2 learners sensitivity towards structural cues is reduced. It is important to note that Luke (2011) and Luke and Christianson (submitted) also found that years of immersion and not proficiency (as measured by Cloze test scores) predicted the degree of sensitivity towards the morphological structure. Luke and Christianson (submitted) proposed that if years of immersion are operationalized as a proxy for the measure of the strength of the procedural system, their findings also give support for the declarative/procedural model. Learners can become more reliant on procedural memory and identify disruptions in morphological processing more quickly with increased years of immersion. But their morphological processing might never become as automatic as that of native speakers. L2 learners did not display any modulation of syntactic structure on the morphological processing, unlike native speakers. In light of these findings, native Russian speakers might show modulation of syntactic context on the availability of parafoveal morphosyntacitc processing while L2 learners' morphosyntactic processing, although possible in principle in the parafovea, might not be modulated by syntactic structure.

Relevant Characteristics of Russian

Word order

Russian is a language that allows all six basic word orders (SVO, OVS, VOS, VSO, SOV, and OSV) but has a canonical SVO word order (Babyonyshev, 1996; but cf. King, 1995, who favors VSO). Russian's flexible surface word order and allowance of pro-drop (null subjects and dropping of object pronouns) are taken as evidence of scrambling that is much less restricted than in many other scrambling languages. Scrambling accounts for as much as 17% of the Russian sentences in a corpus study by Bailyn (1995), compared to Japanese, for example, in which less than 1% of all sentences display scrambling (Yamashita & Suzuki, 1995). In Russian morphological case markings are obligatory for the nouns, adjectives, pronouns, and verbs. Due to its relatively free word order Russian, unlike English, does not conflate the agentivity of the noun with the sentence position. For example, an assertion that *A fox sees a meadow* can be expressed in 6 different ways in Russian, as seen in (4a-f).

(4a) Лиса увидела поляну.

Fox$_{NOM}$ see$_{3rdPsSG}$ meadow$_{ACC}$

(4b) Поляну увидела лиса.

Meadow$_{ACC}$ see$_{3rdPsSG}$. fox$_{NOM}$

(4c) Лиса поляну увидела.

Fox$_{NOM}$ meadow$_{ACC}$ see$_{3rdPsSG}$

(4d) Поляну лиса увидела.

Meadow$_{ACC}$ fox$_{NOM}$ see$_{3rdPsSG}$.

(4e) Увидела поляну лиса.

See$_{3rdPsSG}$ meadow$_{ACC}$. fox$_{NOM}$

(4f) Увидела лиса поляну.

See$_{3rdPsSG}$ fox$_{NOM}$ meadow$_{ACC}$.

According to several corpora analysis studies (Lobanova, 2011; Bivon, 1971) in the NVN word order, SVO has much higher frequency (68%) then OVS (32%). In the VNN word orders, subject and object are equally possible first arguments VSO (50%) VOS (50%) (Kempe & McWhinney, 1999).

Morphology

Russian is a morphologically rich language with obligatory inflectional paradigms for nouns, adjectives, verbs, numerals, and pronouns. Only prepositions and adverbs are exempt from inflections. The declensional paradigm for nouns is based on grammatical gender: masculine, feminine, and neuter. Each has six cases. Table 1 illustrates the declension for nouns of 1st class singular, since only nouns from this class were used in the experiments.

Table 1.

Example of the Declension Paradigm for the Nouns of 1st Class

	‘doll’
Nominative	кукл**а** kukla
Genetive	кукл**ы** kukly
Dative	кукл**е** kukle
Accusative	кукл**у** kuklu
Creative	кукл**ой** kukloj
Instrumental	кукл**е** kukly

Russian has 11 verb classes ranging in morphological complexity and size. Russian verbs consist of a stem and an easily decomposable inflection. The stem comprises a root and a suffix, or verbal classifier, which determines all of the parameters of the conjugational paradigm: conjugation type, suffix alterations, vowel alterations, special infinitive inflections, and all other idiosyncratic features.

Russian verbs have two tenses: the non-past-tense (present or future, depending on the aspect of the stem) and the past tense. The non-past-tense includes six forms: three marked for person in the singular and three in the plural. The past tense includes four forms: three marked for gender and one plural form. An example of a complete conjugational paradigm for a single verb in a non-past-tense that was used in all four experiments is given in Table 2.

Table 2.

Example of the Conjugation Paradigm for a Verb писать /pisat'/ "to write"

Person	Singular	Plural
1st	пиш**у** /pishu/	пиш**ем** /pishem/
2nd	пиш**ешь** /pishesh'/	пиш**ете** /pishete/
3rd	пиш**ет** /pishet/	пиш**ут** /pishut/

Morphosyntactic Processing in Russian

Information provided by case marking in Russian is integrated quickly by native speakers. In a self-paced reading experiment, Fedorenko, Babyonyshev, and Gibson (2004) found that case marking allomorphy caused processing difficulty only when two nouns had the same case (as seen in 5a). Participants read the verb after two identically-marked nouns more slowly than a control condition (5d). The processing of the verb after the two nouns of the same case but different case marking (as seen in 5b) or of different cases but with the same case marking (as seen in 5c) did not differ from the control condition.

(5a) Same abstract case/ same case-markers
Uvažavšuju skripačk**u** pianistk**u** razozlil dirižer iz izvestnoj konservatorii
posle generalnoj repetitsii.
respecting violinist-fem-Acc pianist-fem-Acc angered conductor-Nom
from famous conservatory after final rehearsal
'The conductor from a famous conservatory angered the pianist who
respected the violinist after the final rehearsal.'

(5b) Same abstract case/ different case-markers
Uvažavšuju skripač**a** pianistk**u** razozlil dirižer iz izvestnoj konservatorii posle generalnoj repetitsii.
respecting violinist-masc-Acc pianist-fem-Acc angered conductor-Nom from famous conservatory after final rehearsal
'The conductor from a famous conservatory angered the pianist who respected the violinist after the final rehearsal.'

(5c) Different abstract case/ same case-markers
Pozvonivšuju skripač**u** pianistk**u** razozlil dirižer iz izvestnoj konservatorii posle generalnoj repetitsii.
calling violinist-masc-Dat pianist-fem-Acc angered conductor-Nom from famous conservatory after final rehearsal
'The conductor from a famous conservatory angered the pianist who called the violinist after the final rehearsal.'

(5d) Different abstract case/ different case-markers
Pozvonivšuju skripačk**e** pianistk**u** razozlil dirižer iz izvestnoj konservatorii posle generalnoj repetitsii.
calling violinist-fem-Dat pianist-fem-Acc angered conductor-Nom from famous conservatory after final rehearsal
'The conductor from a famous conservatory angered the pianist who called the violinist after the final rehearsal.'

The nouns used in 5b and 5c to create the contrasts between case marking endings of the case where of two different declension types and also of different genders (masculine and feminine). This manipulation, however, confounded morphology with gender as the disambiguating source of information in two conditions: same case/different case marking (5b) and different case/same case marking (5c).

The modifiers in Russian mark the gender through an inflection at the end of the word. The modifier *respecting-fem* is the first word in all the stimuli and has feminine case ending. In manipulation for 5b and 5c the noun following the modifier is masculine. In principle, participants could have used the gender information communicated by the case ending of the modifier as a cue instead or in addition to the case information communicated by the case markings of the nouns to determine which noun is the head of the modifier *respecting*.

Regardless of the above mentioned confound, however, Fedorenko et al study demonstrates that Russian native speakers use inflectional information quite early during sentence processing and even might use the processed information to form predictions for the upcoming constituents.

Native speakers of Russian are sensitive towards the syntactic canonicity of the argument positions. In a self-paced reading study, Slioussar (2011) demonstrated that native speakers of Russian process syntactic arguments in non canonical positions (preverbal objects and post verbal subjects) slower than in the canonical positions (postverbal objects and preverbal subjects).

To date there are no eye-tracking investigations of morphosynactic processing in Russian during silent reading. This dissertation seeks to fill in this gap.

Rationale for the Present Studies

The research described in this document uses eye movements as reflections of cognitive processes during reading in native and non-native language (Rayner, 1998; Luke & Christianson, submitted). The preview benefit effect (Rayner, 1975) was used as a diagnostic for the integration of morphological information parafoveally (Experiments 1 and 4, Chapters 3 and 6). An identical preview (no change) condition is taken to be the baseline. A non-word condition is treated as the control condition and is expected to cause the most disruption to the processing of morphology. The morphologically related preview condition is taken as the test condition and is expected to pattern with the identical condition if Russian morphology is processed in the parafovea and with the non-word condition if it is not.

Because the average length of Russian words is relatively long (10+ characters), the majority of words are only partially available for processing within the region of effective vision (fovea). This means that the morphological processing of the upcoming word *n*+1 might not be part of the lexical identification of the word that is not within the foveal region, while it could be part of the lexical identification of the word that is partially in the fovea. The traditional boundary-change paradigm that inserts the boundary between the words might not be sensitive enough to investigate parafoveal morphosyntactic processing in long words. Experiment 2, reported in Chapter 4, and Experiment 3, reported in Chapter 5, use a modified version of the boundary change paradigm, a within-word boundary change, to investigate the morphological processing of inflectional morphology of long nouns and verbs.

The effect of syntactic information on the integration of morphology is examined in two ways: by varying the word order (Experiments 1-4) and examining the processing of inflectional morphology of two grammatical categories: nouns (Experiments 3 and 4) and verbs (Experiment 4). The interaction of syntactic information and morphological information is investigated in Experiments 1-4 by varying the syntactic context prior to the target word.

CHAPTER 3:

BETWEEN WORDS - NOUNS

Research on eye movements during silent reading has established that word length information is used to program where to move the eyes next (Rayner, 1998). Research using the boundary change paradigm has demonstrated that low-level nonlinguistic information such as the length of the upcoming word *n+1* is integrated in the parafovea while the eyes are fixated on the word *n* (Ashby et al., 2006; Balota et al., 1985; McConkie & Zola, 1979; Rayner, 1998).

To date there is no conclusive evidence that higher-level linguistic information such as morphology and syntax is integrated parafoveally in any language other than Hebrew (Deutsch et al., 2005). Hyöna et al. (2004) demonstrated that short compound words can be integrated as whole words foveally. This suggests the possibility that short words might also be integrated as one unit when they are in the parafovea. In such cases, there is a possibility that inflectional morphology in short Russian nouns might be registered in the parafovea and used during pre-lexical stages of word identification.

Syntactic information has been shown to effect parafoveal processing in Hebrew (Deutsch et al., 2005). However, different languages indicate syntactic information differently. Inflectional case marking for short nouns in Russian, if integrated, can affect the assignments of syntactic roles in the active syntactic structure. In Experiment 1, word order prior to the target word was manipulated to investigate the effect of prior syntactic context on the information processed from the parafoveal preview. VNN word order in Russian has an equal chance of a subject or object following the verb (VSO 50%, VOS 50%), according to the corpora counts reported by Kempe and McWhinney (1999). This makes the position of the first argument right after the verb less restrictive. The position of the second argument is syntactically more restrictive. Since all verbs in Experiment 1 were transitive, the chances of getting an object after processing the verb and the subject are much higher than getting any other syntactic constituent. To probe whether readers in Russian are sensitive to these syntactic constraints, the VSO word order was held constant while the physical position and the syntactic role of the target word varied. It was either the first argument after the verb (subject) or second (object). If syntactic processing in Russian is just as predictive as in other languages (see Bader & Meng, 1999; Hemforth & Konieczny, 2000, for German; Staub & Clifton, 2006; Staub, Rayner, Pollatsek, Hyöna, & Majewski, 2007, for English; Yamashita, 2000, for Japanese), then the target word should be processed faster in the more predictive, object position. As a result, eye fixations should be longer on the target word in the first (subject) position than in the second (object).

Allocation of cognitive resources during reading can be modulated by the syntactic context (Henderson & Ferreira, 1990) in two ways. The syntactically less predictive subject position might elicit more allocation of resources, reduce perceptual span, and reduce the level of processing of the information in the parafovea. Alternatively, increased allocation of attentional resources to the less predictive subject position might widen the perceptual span, which in turn would be predicted to result in higher deeper processing of information in the parafovea. Any differences in the eye movements elicited on the target word as a result of the syntactic position in the sentence will help differentiate between these two possibilities.

Experiment 1: Between-Word Boundary Change

Experiment 1 had two goals: to determine if morphological information is integrated in the parafovea between words in Russian, and to see how the syntactic predictability of an upcoming word affects the time course of the morphological processing of that word (target word: subject/object). Using the eye movement contingent boundary change paradigm (Rayner, 1975), morphological processing in the parafovea was examined through three preview manipulations on the target word: identical (no change), morphologically related (different inflectional ending), and non-word (inflection replaced with a consonant). See Table 3 for the example of preview manipulations for the target word in two syntactic positions.

Table 3.

Preview Manipulation Conditions for the Two Syntactic Categories

	Identical	Morphologically Related	Non-word
Subject	лодк**а** boat (NOM)	лодк**у**	лодк**д**
Object	лодк**у** boat (ACC)	лодк**а**	лодк**д**

The target word was inserted into a sentence frame either at the argument position immediately after the verb (1a) or at the second argument position (1b). The vertical lines indicate the position of the invisible boundary. When the eyes made a saccade across the boundary, the preview word (See Table 3) was replaced with the target word.

(1a) В доке загораживала| **лодка** *NOM* доску у мостка.

In the dock blocked boatNOM logACC by the bridge.

(1b) В доке загораживала доска| **лодку** *ACC* у мостка.

In the dock blocked logNOM boatACC by the bridge.

Method

Measures. Orthographic processing is associated with first fixation durations. The effects of preview manipulations in the parafovea can be observed as early as the first fixation because the planning for the fixation takes place during a prior fixation and is affected by parafoveal information (Rayner, 1998; Bertram & Hyöna, 2003). Any effects reflected in first fixation durations will be taken to indicate the influence of the experimental manipulations on orthographic processing.

Gaze duration, associated with lexical access (Deutsch et al., 2005; Hyöna et al., 2004), will reveal preview manipulation effects if morphology is integrated during the stages of lexical word identification. When lexical access is affected by predictability of the prior context, gaze duration reveals such effects (Rayner & Pollatsek, 1989). If syntactic predictability modulates lexical pre-processing of morphological information in Russian, then gaze duration measures should be sensitive to the manipulation of syntactic context and reveal the effects of syntactic and preview manipulations (Deutsch et al., 2005, Experiment 4). If allocation of attentional resources is modulated by syntactic context during word identification stages then gaze durations might reveal an interaction between syntactic context and preview manipulations.

Importantly, in short and medium sized words quite often there is only one fixation on the word. In such cases it is assumed that lexical identification also has happened during such fixation. Any effects of the experimental manipulations observed in first fixation and gaze duration will be compared in order to adjudicate between orthographic and lexical identification.

Total time, go-past time, first-pass, second-pass, and regressions are associated with post-lexical integration of the target word into the active structure of the sentence. These measures have been found to reflect the influence of high-level, linguistic factors on foveal processing (semantic processing in Finnish, White, Bertram, & Hyöna (2008) and semantic and syntactic predictability in Hebrew (Deutsch et al, 2005, Experiments 3 and 4)). In Hebrew, syntactic context affected parafoveal processing. A morphologically related word in a different syntactic category (noun instead of the intended verb) served as the morphologically related condition and elicited inhibitory effects in gaze durations and total time. Any effects of the experimental manipulations observed in the later measures and not in gaze duration will indicate that in Russian higher-level linguistic information, such as syntactic context and morphology, are delayed until post-lexical processing.

Predictions. If morphology is integrated during the early pre-processing stages of Russian word identification, then identical and morphologically related conditions will show facilitatory effects in gaze duration and possibly as early as first fixation as compared to the non-word condition. If inflectional morphology of the Russian nouns exerts an immediate influence on the integration of the upcoming word into the active syntactic structure, then the morphologically related condition will show inhibitory effects on gaze duration as compared to the non-word condition. Such an inhibition, if not suppressed during word identification stages, may also affect later post-lexical processes. Consequently, later measures that reflect post-lexical integration might also display inhibitory effects for the morphologically related condition.

Syntactic context can modulate the allocation of attention (Henderson & Ferreira, 1990) in two ways. Less predicted context can elicit more cognitive resources and expand the perceptual span. In such a case, the target word in the subject position can be processed at a deeper level. As a result, the effects of preview manipulations can be more pronounced in the subject position than in the object position. Alternatively, attention can be focused on the word identification processes. In such a case, an effect of object-target vs. subject-target condition without an effect of the preview manipulation (no significant difference between identical, morphological and non-word previews on any of the eye movement measures) will constitute evidence only for foveal effects of syntactic predictability and the absence of morphological processing in the parafovea.

Materials. Short Russian nouns (five characters) were chosen as stimuli for this experiment. The materials were balanced for word (mean 123 per one million of occurrence, 78 sd) and lexeme (mean 103 per one million of occurrence, 83 sd) frequencies. Currently, there are no corpora in Russian that provide counts of individual inflections in Russian.

Norming Study. The plausibility of the sentential arguments was assessed in a separate norming procedure. Since the main goal of the norming study was to access the thematic relationships between the arguments and the verb and not syntactic predictability, a decision was made to use the default or most frequent word order (SVO). As a result, for the norming study, the word order was changed for all experimental sentence frames (1a-b) from VSO to SVO. Two sentences were constructed in such a way that the target word was the subject in one and object in another, while the second argument from the experimental sentence was always the opposite argument. One hundred eighty sentences were divided into two lists to ensure that two versions of the same experimental sentence are in separate lists. Twenty Russian native speakers who did not take part in the experiment provided plausibility judgments on 1 to 7 scale for each sentence. The instructions included examples for each of the ratings on the scale. Only items that had a plausibility rating higher than 3 and equal plausibility ratings were used in the experiment. After the plausibility ratings were calculated for each sentence, 60 sentences were selected for the experimental stimuli with a mean plausibility score of 3.9. The plausibility scores between the sentence pairs did not differ significantly ($p<.72$).

In the main experiment, the boundary change was always at the end of the word *n* before the target word *n+1*. In these types of experiments participants might occasionally see a change if the preview and target word are not the same length. Therefore, only nouns of the first declension type were used, as they are equal in length between the nominative and accusative forms.

Design. The word order was held constant across all conditions. The target position in the sentence was manipulated (subject x object) together with the parafoveal preview (identical x morphologically related x non-word) resulting in a 2 x 3 Latin square design. The target noun appeared in both the subject and object position to investigate if syntactic information affects parafoveal processing in Russian. In the control condition the non-word served as the preview. In the test conditions, inflections were replaced with the inflection indicating the opposite syntactic category (object accusative case for the subject nominative and vice versa) or with an identical inflection. A total of 60 experimental sentences were constructed. Due to the relatively limited subject pool of native Russian speakers in the Champaign-Urbana area, this experiment was run concurrently with the other native speaker experiments reported in this dissertation. All sentences served as fillers for each other.

Participants. Forty-eight Russian native speakers (25 female; mean age 32, range 18-69) residing or visiting in the Urbana-Champaign area participated in the experiment. A total of six participants were excluded from the analyses; five participants reported seeing the change manipulation, and one participant's eye movements could not be consistently tracked. All participants were compensated $15.00 for their time.

Apparatus. Eye movements were recorded via the SR Research Ltd. Eyelink 1000 eye tracker, which records the position of the reader's eye once every millisecond (1000Hz sampling rate), and has a high spatial resolution of 0.01°. Text was displayed in 14 point Courier New mono-space font. Participants were seated 72.5 cm away from a 20 inch monitor with the refresh rate set to 120Hz. At this distance, approximately 3.03 characters subtend 1° of visual angle. Head movements were minimized with chin and head rests. Although viewing was binocular, eye movements were recorded from the right eye.

Procedure. Each trial began with a gaze trigger, which consisted of a black circle presented in the position of the first character of the text. Once a stable fixation was detected on the gaze trigger, the sentence was presented in full. The participants pressed a button on a standard game controller to indicate that they had finished reading the sentence**.** At this point, the sentence disappeared. On 25% of the trials a question about the content of the sentence appeared, which the participants answered by pressing the corresponding button on the controller. Then the next trial began. Sentences were presented in random order for each participant.

Results

Data exclusion criteria. It has been established that foveal processing on average corresponds to 6-7 characters (Schotter et al., 2012). As seen in the example (1a-b), the short words in the Experiment 1 are five characters long. If the fixation prior to the target word occurs immediately before the boundary change (on the last two characters of the previous word) then the target word might be in the fovea and the case marking will be 7th or 8th character – right on the edge of the fovea. It was intended prior to data collection to analyze such trials separately. Analysis of the landing position on the word before the target word revealed zero instances when the eyes landed on the region within two characters before the invisible boundary. As a result, it is safe to conclude that any effects reported in the results section can be attributed to parafoveal processing and not foveal processing.

Fixation durations shorter than 80 ms or longer than three standard deviations from the grand mean for the target word were eliminated. These criteria resulted in the removal of less than .05% of the data. The reading time data were analyzed using linear mixed effects modeling (Baayen, Davidson & Bates, 2008). Linear mixed effects (LME) modeling is a type of linear regression that can statistically control for systematic variation in participants and items. This is accomplished by modeling independent intercepts (and, if necessary, slopes) for each participant and each item, essentially creating a separate regression line for each level of participant and item. While it is possible to control for between-participant and between-item variability in ANOVAs by averaging across items and performing an ANOVA on the participant means and vice versa, LME has several significant advantages over ANOVAs that make it preferable for the analysis of these data. First, with LME it is possible to control for both participant and item variability in a single analysis, while two separate analyses are required in order to accomplish the same thing using ANOVAs. Often, the by-participants and by-items ANOVAs can provide contradictory or inconsistent results, making a single LME analysis less ambiguous. Second, LME analyses often have more power than ANOVAs, and can reveal effects that ANOVAs would not detect (Luke & Christianson, 2011). Given the relatively limited participant pool reported in this experiment, maintaining maximum statistical power was of paramount importance. Third, ANOVA results do not indicate the directionality of an effect, and so clarifying follow-up *t*-tests are typically required. LMEs eliminate the need for these follow-up tests by skipping the *F*-tests altogether and applying *t*-tests directly. Finally, ANOVAs are not appropriate for the analysis of binomial data such as regression rates (Jaeger, 2008), and so for the analyses of regressions reported below I relied on a logit version of the mixed model analyses. Separate analyses were conducted for first fixation duration, gaze duration, total time, first-pass, second-pass, and go-past time. Items and participants were included as random effects. All models were fitted using a forward stepwise model selection procedure, in which only those predictors that were significant or marginally so ($p<.1$) were retained in the model. P-values were obtained using Markov Chain Monte Carlo sampling. Items and participants were included as random factors. Preview manipulations and target position were included as fixed effects along with their interaction. The patterns observed in the models were identical whether they were run on log-transformed or untransformed fixation durations. To increase transparency, the results of the models run on the untransformed fixation durations are reported, since regression weights can be interpreted as effect sizes. Condition means with standard deviations for the reading measures are reported in addition to the summaries of LME coefficients. Indications of statistical significance refer to the observed difference between the indicated mean and the mean in the non-word condition. Although LME analyses are performed over individual data points, all figures are plotted on the Y-axis according to means for ease of interpretation.

Eye fixations for the pre-boundary word (*n-1*), target word (*n*), and a word after the target word (*n+1*) were analyzed. No significant differences were obtained for the word *n-1* or word *n+1*. Results reported below reflect eye movement measures for the target word *n*.

First Fixation Duration. This measure is traditionally associated with orthographic processing in those instances when there are more than one fixation on the target word. The results of the best-fitted model for first fixation durations included preview manipulation and syntactic role of the target word, and no interaction. The output of this model is reported in Table 4. Mean first fixation durations are summarized in Table 5 and Figure 2. Neither preview manipulation nor syntactic role of the target word affected first fixation durations. The pattern of results on the graph in Figure 2 looks like there might be an interaction between the syntactic position and the preview condition in the morphologically related condition. In the subject position the morphologically related condition patterns with the identical condition and in the object position with the non-word condition. But the differences in means provided in Table 5 are very small, so not much weight can be given to this numeric trend.

Table 4

Fixed effects for First Fixation Duration in Experiment 1

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for First Fixation				
Intercept	247.81	8.96	27.66	0.000*
Preview: identical vs. non-word	-2.82	5.88	-0.48	0.62
Preview: related vs. non-word	0.98	5.88	0.17	0.87
Target Syntactic Role: Subject vs. Object	1.62	4.81	0.34	0.74

Note. * p<.05

Table 5

Mean First Fixations with Standard Deviations in Parenthesis

	Subject	Object
Identical	249 (133)	243 (128)
Related	249 (132)	250 (128)
Non-word	244 (127)	254 (123)

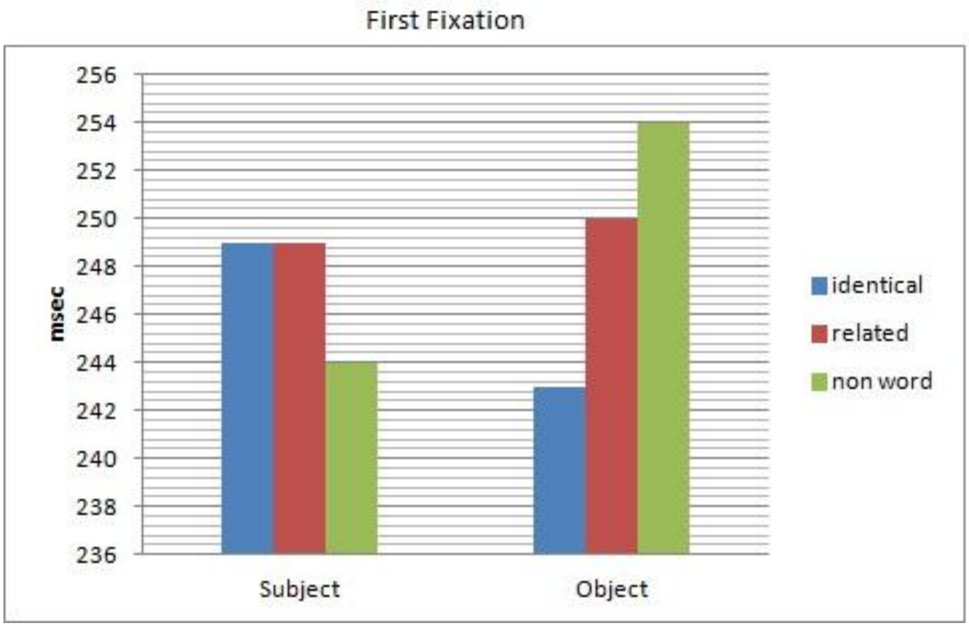

Figure 2. First fixation.

Gaze Duration. This measure is associated with lexical access for the target word. The results of the best-fitted model for gaze durations included preview manipulation and syntactic role of the target word, but no interaction. The output of this model is reported in Table 6. Mean gaze durations are summarized in Table 7 and Figure 3.

There was an effect of preview manipulation and a significant effect of the syntactic role of the target word. The effects did not interact. This means participants read the target word on average 21 ms longer when the preview was a non-word than when the preview was identical, regardless of whether the target word was a syntactic subject or a syntactic object. This is a typical preview benefit effect. It indicates that the paradigm worked and participants were sensitive to the parafoveal manipulations.

The morphologically-related preview condition did not differ from the non-word. This suggests that the morphological information of the target word was not integrated parafoveally, and the preview benefit in the identical condition was orthographic in nature, rather than morphological. However, further examination of numerical means in Table 7 suggests that there might have been an interaction between the word order positions in the morphologically related condition that did not reach significance. An inhibitory effect of 9 ms in subject position and 18 ms facilitatory effect in the object position for the morphologically related condition as compared with the non word are both in the range of parafoveal morphological effects reported for Hebrew (7 ms in gaze duration reported in Deutsch et al. (2005)). Furthermore, a comparison of standard deviations in Table 7 indicated that the morphologically related preview in the subject condition was highly variable (210 ms). Although the morphologically related condition was not significantly different from the non-word condition, the numeric inhibition in the subject position and facilitation in the object position suggest the participants might be sensitive to the syntactic context and allocate more attention to the processing of the target word in a less restrictive syntactic context, when case marking is still useful in determining the unfolding syntactic parse. The significant effect of syntactic role on the target word further supports this view. The direction of the effect suggests that participants read the target word on average 18 ms faster in the object position than in the subject position. This is consistent with the proposal that readers engage in predictive parsing and are expecting an object NP after they have processed a subject NP and a transitive verb.

Table 6

Fixed effects for Gaze Duration in Experiment 1

Predictor	Coefficient	SE	*t* value	*p*
		Fixed effects for Gaze		
Intercept	329.09	14.63	22.50	0.000*
Preview: identical vs. non-word	-21.00	8.30	-2.52	0.01*
Preview: related vs. non-word	-4.50	8.30	-0.54	0.60
Target Syntactic Role: Subject vs. Object	-17.8	6.78	-2.63	0.01*

Note. * p<.05, ^p <.1

Table 7

Mean Gaze with Standard Deviations

	Subject	Object
Identical	303 (179)	295 (183)
Related	333 (208)	297 (161)
Non-word	324 (206)	316 (183)

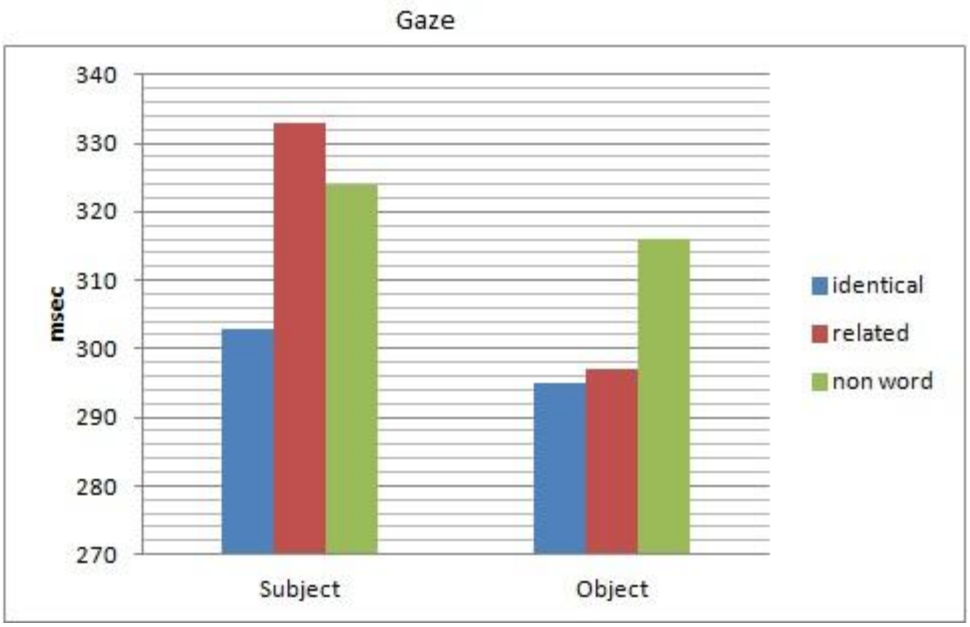

Figure 3. Gaze.

Total Time. This measure represents the sum of all fixations on the target word and is associated with the post-lexical integration of the target word into the sentence. The results of the best-fitted model for total time included preview, syntactic role of the target word, and their interaction. The output of this model is reported in Table 8. Mean total time results are summarized in Table 9 and Figure 4.

There was an effect of the preview manipulation in the morphologically related condition, along with an interaction between the target position and preview manipulations and a marginally significant effect of syntactic context. The morphologically related condition elicited a 72 ms inhibitory effect in the subject position and a 22 ms facilitatory effect in the object position as compared to the non-word condition. The identical condition did not differ significantly from the non-word condition in either position. Participants spent 45 ms longer fixating the target in the subject position than in the object position. This difference was marginally significant.

The fact that in the object condition the morphologically related preview condition elicited shorter fixations than the non-word suggests that in a more restricted syntactic context participants were only sensitive to orthographic information and did not concern themselves with checking whether the ending was morphologically licit. This might be taken as evidence for underspecification of the case marking, similar to what has been proposed for "good-enough" syntactic processing (e.g., Ferreira, Bailey, & Ferraro, 2002).

Total time is a composite measure that is derived by summing up first fixation, gaze duration, the time participants spend on the word after re-reading earlier parts of the sentence, and the time participants spent fixating the word after they regressed to it (if they regressed to it). Whereas gaze duration elicited fixations that numerically patterned in the same direction as total time measures, these numeric trends did not reach significance. Total time, as a cumulative measure, cannot point to the precise source of the observed effects. As a result the following late measures of post-lexical processing will be examined next: regressions into the target word, go-past time, first-pass time, and second-pass time.

Table 8

Fixed effects for Total Time in Experiment 1

Predictor	Coefficient	SE	*t* value	*p*
	Fixed effects for Total time			
Intercept	630.79	36.65	17.21	0.001*
Preview: identical vs. non-word	4.12	26.97	0.15	0.89
Preview: related vs. non-word	71.01	26.94	2.64	0.01*
Target Syntactic Role: Subject vs. Object	-45.48	26.95	-1.69	0.09^
Interaction: Object x identical	-60.00	38.13	-1.57	0.12
Interaction: Object x related	-90.12	38.12	-2.36	0.02*

Note. * p<.05, ^ p<.1

Table 9

Mean Total Time with Standard Deviations

	Subject	Object
Identical	634 (460)	529 (362)
Related	702 (497)	564 (424)
Non-word	630 (460)	586 (391)

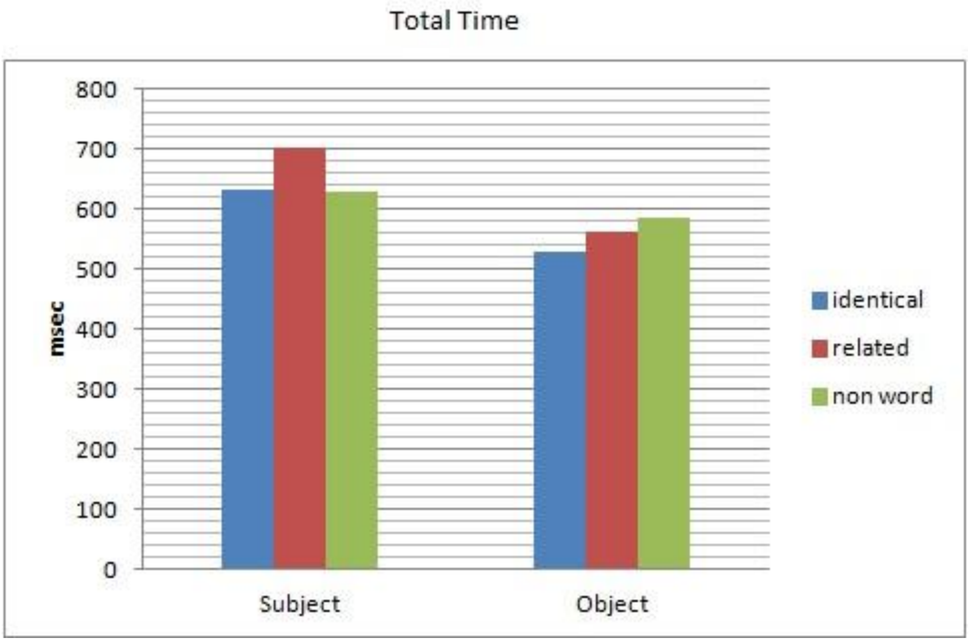

Figure 4. Total Time.

Regressions into the Target Word. Regression rates were analyzed by a binomial logit regression model with items and participants as random factors. The results of the best-fitted model for regressions included preview, syntactic role of the target word, and their interaction. The output of this model is reported in Table 10. The mean total time results are summarized in Table 11 and Figure 5.

A significant effect for the morphologically related condition along with a marginally significant interaction between target position and preview manipulation indicated that when the target was in the subject position, participants regressed into the target word significantly less when the preview was morphologically related than in the identical and non-word conditions. This is in the opposite direction from the observed result in the total time fixations. The observed pattern of results suggests that total time fixations and regressions into the target word reflect two sides of the same process. If total time reflects post-lexical integration difficulties, caused presumably by the interfering case marker from the morphologically related preview, then regressions into the target word reflect later stage of post lexical integration. A decreased probability of regression in the target subject for the morphologically related preview implies that any difficulty was resolved earlier either when participants regressed from the target word or during the first pass reading. These two measures will be examined next.

Table 10

Fixed effects for Regressions into the Target word in Experiment 1

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Regressions into the target word				
Intercept	-1.32	0.16	-8.45	0.001*
Preview: identical vs. non-word	-0.28	0.18	-1.56	0.12
Preview: related vs. non-word	-0.40	0.18	-2.19	0.03*
Target Syntactic Role: Subject vs. Object	0.11	0.17	0.63	0.53
Interaction: Object x identical	0.20	0.25	0.80	0.42
Interaction: Object x related	0.44	0.25	1.80	0.07^

Note. * $p<.05$, ^ $p<.1$

Table 11

Mean Regressions into the Target word with Standard Deviations

	Subject	Object
Identical	.19 (.39)	.23 (.42)
Related	.17 (.38)	.25 (.44)
Non-word	.23 (.42)	.25 (.42)

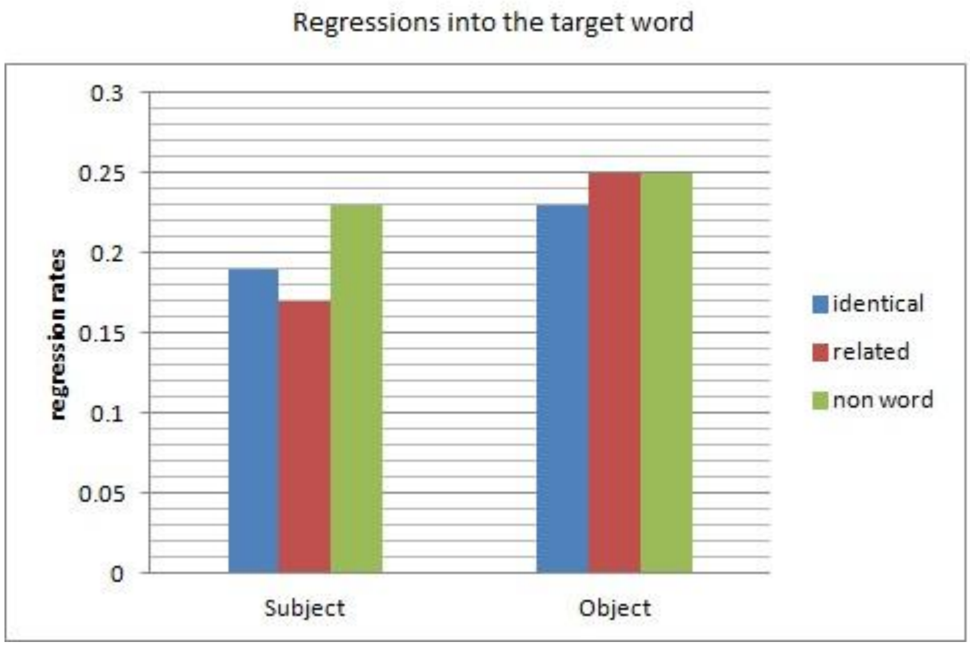

Figure 5. Regressions into the Target.

Go-Past Time. Go-past time reflects the amount of time participants spend re-reading earlier parts of the sentence before moving their eyes to the right of the target word. The results of the best-fitted models for go-past time included preview and syntactic role of the target word, but no interaction. The output of this model is reported in Table 12. Mean total time results are summarized in Table 13 and Figure 6.

Only a preview benefit effect in the identical condition was significant. This indicates that in the identical preview condition, on average participants spent 48 ms less re-reading earlier parts of the sentence than in the non-word control regardless of the syntactic role of the target word. For the morphologically related condition, an observed numeric facilitation of 18 ms in the subject position along with a 7 ms facilitation in the object position was not significant. This suggests that the morphologically related preview caused participants to re-read the earlier parts of the sentence as much as the non-word preview, regardless of the syntactic position of the target word.

Table 12

Fixed effects for Go-Past Time in Experiment 1

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Go-Past Times				
Intercept	466.10	23.94	19.55	0.000*
Preview: identical vs. non-word	-48.43	17.18	-2.82	0.01*
Preview: related vs. non-word	-12.51	17.18	-0.73	0.47
Target Syntactic Role: Subject vs. Object	22.55	14.04	1.61	0.11

Note. * p<.05

Table 13

Mean Go-Past Time with Standard Deviations

	Subject	Object
Identical	417 (325)	441 (350)
Related	451 (345)	478 (428)
Non-word	469 (362)	485 (397)

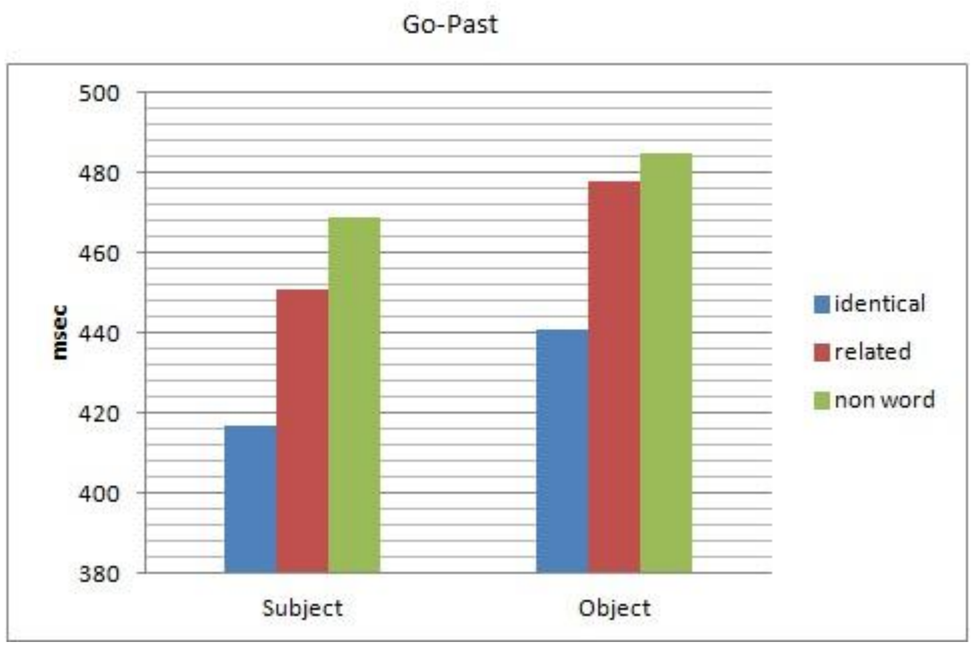

Figure 6. Go-Past Time.

First-Pass Time (Right Bounded Duration). This measure represents a sum of gaze duration plus any time spent fixating the target word after re-reading earlier parts of the sentence before moving the eyes to the right. It reflects post-lexical stages of processing. The results of the best-fitted models for the first-pass time included the preview and syntactic role of the target word, but no interaction. The output of this model is reported in Table 14. Mean first-pass results are summarized in Table 15 and Figure 7.

A significant effect of the identical preview benefit shows that participants on average spent 31 ms less on the target word when the preview did not differ from the foveal display than in the non-word control, regardless of the syntactic role of the target word. In the object position, the morphologically related condition did not differ from the non-word condition even numerically (379 ms vs. 378 ms, respectively). The 23 ms mean difference between the morphologically related (356 ms) and the non-word condition (373 ms) in the subject position was also not significant. In the literature on eye-tracking, the amount of the time the eyes fixate on the target is associated with the degree of difficulty of fitting the target word into the active structure of the sentence (Rayner, 1998). The first-pass time results suggest that on the first pass the target word was more difficult to incorporate into the active sentence when the parafoveally available preview was either a morphologically related word or a non-word than when the parafoveally displayed preview did not differ from the foveally displayed word, regardless of the syntactic context of the target word.

Table 14

Fixed effects for First-Pass Time in Experiment 1

Predictor	Coefficient	SE	*t* value	*p*
		Fixed effects for First-Pass Times		
Intercept	380.23	16.66	22.82	0.000*
Preview: identical vs. non-word	-30.50	9.41	-3.24	0.001*
Preview: related vs. non-word	-7.27	9.42	-0.77	0.44
Target Syntactic Role: Subject vs. Object	-9.13	7.70	-1.19	0.24

Note. * p<.05

Table 15

Mean First-Pass Times with Standard Deviations

	Subject	Object
Identical	345 (202)	345 (203)
Related	379 (232)	356 (200)
Non-word	378 (230)	373 (210)

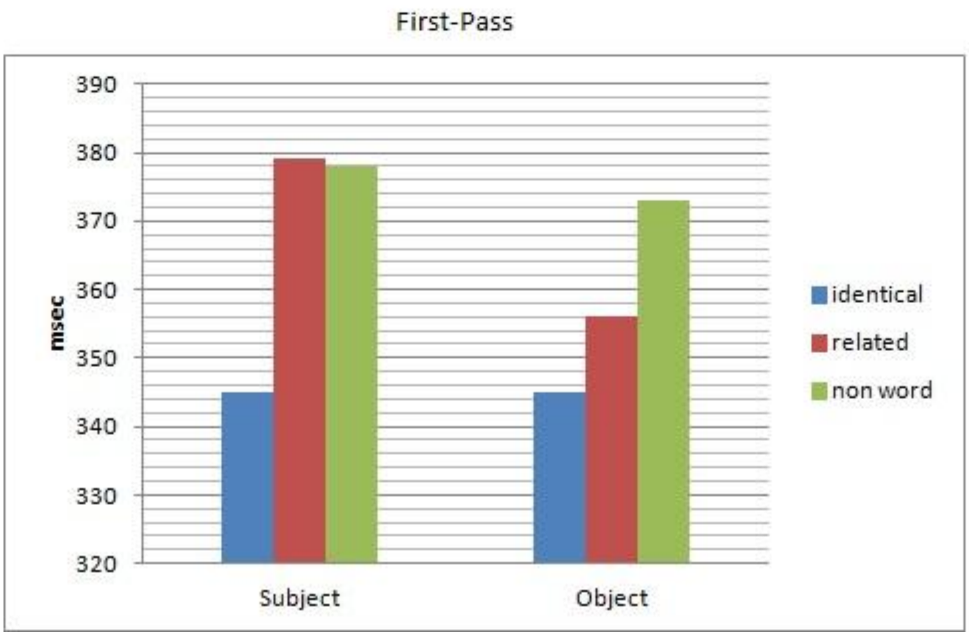

Figure 7. First-Pass.

Second-Pass times. Second pass times included eye fixations elicited on the target word when the participants returned to the target word after the eyes had moved to the right on the first pass. This measure registered the amount of time readers spent re-reading the target word. The results of the best-fitted models for the second-pass time included preview, syntactic role of the target word, but no interaction. The output of this model is reported in Table 16. Mean second-pass time results are summarized in Table 17 and Figure 8.

None of the preview manipulations affected the re-reading time. This suggests that any difficulties with preview manipulations observed in total time, regressions, and go-past times were resolved during the first-pass reading. A significant effect of syntactic context revealed that participants on average spent 40 ms longer re-reading the target when it was in the object position. The observed result is in the opposite direction from the effect of the syntactic position reported for the gaze duration and the marginally significant effect observed in total time. Such a pattern of behavior can be explained best under the view that the participants were sensitive to the predictability of the syntactic structure. As a result, gaze durations reveal that they allocated more attention to the target when it was in the less predictable subject position. Longer fixations during the second reading of the target object imply that participants compensated for the less detailed word identification during later post-lexical integration. The opposite direction of the effect of syntactic position can explain the marginal significance in the cumulative measure of total time, as the longer gaze duration for subject and longer rereading in the object position are likely canceling each other out. However, the exact mechanisms and relations between the measures of word identification and post-lexical integration need further investigation.

Table 16

Fixed effects for Second-Pass Time in Experiment 1

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Second-Pass Times				
Intercept	144.83	20.00	7.12	0.001*
Preview: identical vs. non-word	-27.45	16.72	-1.64	0.11
Preview: related vs. non-word	-7.93	16.73	-0.47	0.64
Target Syntactic Role: Subject vs. Object	40.27	13.66	12.95	0.01*

Note. * p<.05

Table 17

Mean Second-Pass Time with Standard Deviations

	Subject	Object
Identical	113 (300)	145 (330)
Related	117 (312)	180 (407)
Non-word	144 (333)	168 (385)

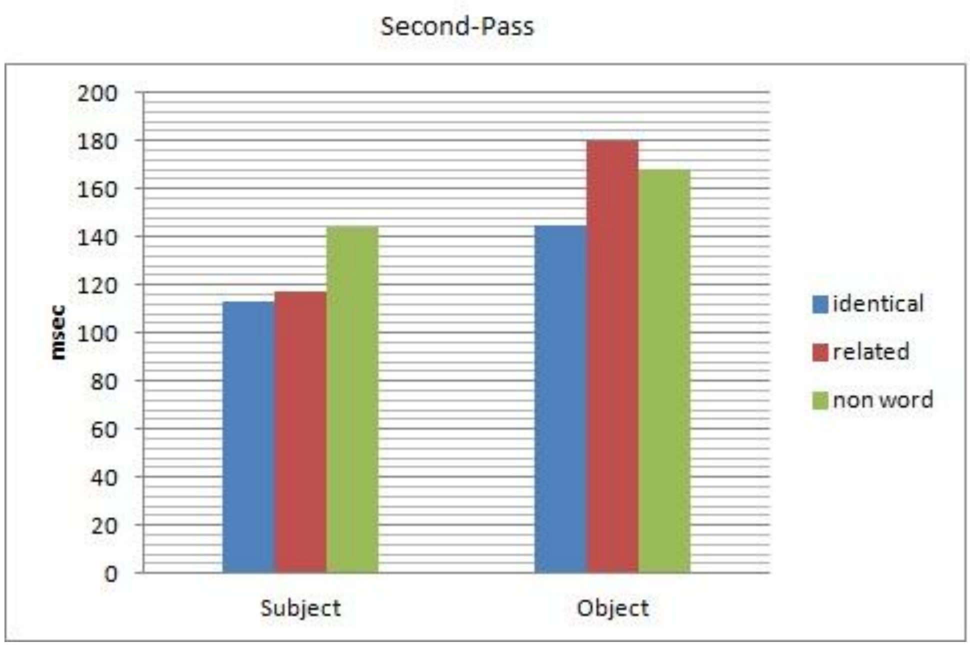

Figure 8. Second-Pass.

General Discussion

The main purpose of Experiment 1 was to determine whether morphological information is extracted between words in the parafovea in Russian, and how the information regarding the syntactic predictability of an upcoming word affects the time course of the morphological processing of that word. The experimental goals were achieved by implementing a gaze contingent boundary change manipulation with three preview conditions (identical, morphologically related, non-word). Non-word and morphologically related conditions differed from the identical condition in just the last letter of the target word. The effects of the preview manipulation were monitored across early (first fixation, gaze duration) and late (total time, go-past time, first and second pass) reading measures. The influence of syntactic context was probed by placing the target word in one of two different syntactic positions (subject vs. object) in the same word order (VSO).

If morphology is pre-processed in the parafovea, then the morphologically related condition was expected to differ from the non-word preview condition. If syntactic context modulated allocation of attention and morphological integration in the parafovea, then the preview benefit effect for the morphologically related condition was expected to be higher in the less restrictive subject position. An absence of preview benefit effect for the morphologically related condition was expected under the view that only orthographic processing is carried out for the short nouns in the parafovea.

A consistent preview benefit effect for the identical condition in gaze duration, and go-past time was observed, indicating that the experimental paradigm worked properly. An absence of any significant effects for the morphologically related preview in the early measures (first fixation, gaze duration) suggests that morphological information is not integrated parafoveally between words in Russian. Late measures (go-past, first-pass, second-pass times) in large part support the conclusion that morphological information was not integrated parafoveally and did not affect syntactic structure.

The morphologically related preview affected the total time participants fixated target word as wells as regressions into the target word. The total time reflects post-lexical integration of the target word into the sentence structure. Results revealed that participants looked longer at the target word only in the target subject position when the preview was a morphologically related word. Additionally, participants regressed into the target word in the target subject position significantly less when the preview was morphologically related than when it was identical or non-word. This implies that parafoveally available morphological information affected post-lexical integration of the target word only in the target subject. This result is at odds with the results obtained from the measures associated with lexical access (gaze duration), that indicate that morphology was not integrated during lexical identification.

Only the target in the subject position was affected by the parafoveal manipulation. This suggests that when the syntactic context was less restrictive, participants slowed down and took more time to integrate not only low-level orthographic information, but also higher-level case-marking information. This did not happen when the target word was in the object position. Moreover, the target object was processed significantly faster than the target subject regardless of the preview manipulations during word identification stages (as reflected in the gaze durations). Such a result can be explained under the framework of ‘Good-enough” processing (e.g., Christianson et al., 2001; Ferreira et al., 2002), which proposes that when the syntactic context is restrictive, participants can choose to allocate their cognitive resources elsewhere. Thus, they did not seem to integrate the word initially, as reflected in the gaze duration, to the same level of detail as they did when the target was immediately after the verb. Target word was reread more in the object than in the subject position. The opposite direction observed during second-pass reading suggested that participants compensated during post-lexical integration for the underspecification observed during word identification stages. However, more research is needed to establish the exact mechanisms and relationship between lexical and post-lexical processes.

Summary

Experiment 1 reported in this chapter revealed that morphological information is not processed parafoveally during between word processing in Russian, but foveal word identification is affected by prior syntactic context. More attentional resources are allocated initially to the word identification of the target in less restrictive (less predictable) syntactic contexts, but the underspecification of words that are less closely attended to is compensated for during post-lexical integration.

Average Russian words are long (average 8-12 characters). As a result, the morphological information of the target word is usually in the parafovea. If allocation of cognitive recourses is modulated by syntactic context, as Experiment 1 demonstrated, then it is quite possible that more attention is allocated to within-word processing than to between-word processing in Russian, as has been suggested for Finnish (Hyöna et al., 2004) and English (Juhasz, Pollatzek, Hyöna, Drieghe, & Rayner, 2009). It is therefore possible that morphological information subserves lexical access in Russian and becomes active only during lexical word identification stage that is believed to begin once the eyes are fixating the target word (Warren et al., 2009). If this is the case then the morphological information can be integrated parafoveally during within word processing. Experiments reported in the next two chapters explored this possibility.

CHAPTER 4:

WITHIN WORDS - NOUNS

The experiment reported in this chapter investigated the influence of morphological and syntactic information during within word processing of Russian nouns. The average length of the words in this experiment was 12 characters. Morphological information was conveyed by the last character at the end of the word. Previous research indicates that the eyes usually land to the left of the middle of a word (preferred viewing location (PVL), Rayner, 1998). This means that on average the eyes would land between the third and the fifth character of a 12-letter word. About three characters to the right of the fixation will be in the foveal vision, and the last four characters in the parafoveal vision. To investigate the level of processing of the last character in Russian long nouns, the experiment reported in this chapter implemented a modified version of the boundary-change paradigm: within word boundary-change (Hyöna et al., 2004), i.e., the invisible boundary was placed within the word *n* instead of the end of the word *n+1*.

Previous research using the within-word boundary change paradigm has demonstrated a preview benefit effect size in the range of 80-100 ms (Hyöna et al., 2004; Juhasz et al., 2008). The preview benefit effect size reported for the between-word boundary change is in the range of 30-40 ms (Rayner, 1998). This difference has been attributed to augmented attentional allocation of cognitive processing at the word level (Juhasz et al., 2008). Attentional allocation within long words in Russian can, in principle, modulate morphological processing during early stages of lexical access. In such a case, the morphology of long nouns can be integrated during the pre-lexical stage of word identification.

To date there is evidence that only Hebrew verbal morphology is integrated parafoveally (Deutsch et al., 2005). Deutsch and colleagues accounted for the absence of parafoveal processing in Hebrew nouns by proposing the inflectional saliency hypothesis. Seven distinct verbal classes in Hebrew make the verbal morphological inflectional paradigm more salient than the nominal paradigm, which has 100 classes. Unlike Hebrew, Russian nouns have only three declensional classes. If the regularity of inflectional paradigm affects processing of morphology, then it is possible that morphology is pre-processed for Russian nouns. Experiment 2 examined the morphological processing of long inflected nouns.

To investigate the effect of syntactic information on parafoveal processing in Russian, the syntactic role of the target word was varied in Experiment 2. The V-initial string is equally likely to continue as VOS or VSO (Kemp & McWhinney, 1999). Consequently, the expectation for the subject is reduced after the verb (for the target word in the subject position: V**S**O) as compared with the expectation for the object after the transitive verb and subject (for the target word in the object position: VS**O**).

Experiment 2 – Within-Word Boundary Change

Experiment 2 investigated syntactic and morphological processing parafoveally during within-word processing of long Russian nouns. How the syntactic predictability of an upcoming word affects the time course of morphological processing of that word was investigated by manipulating the syntactic role (subject vs. object) of the target word. To investigate the degree of parafoveal processing, a boundary-change paradigm was implemented within the word. An invisible boundary was inserted in the word such that the case-marking suffix appeared in one of three preview conditions (identical, morphologically related, or non-word). Table 18 contains an example of the preview manipulations for the target word in the two syntactic positions. A vertical line indicates the location of the boundary. When the eyes made a saccade over the boundary, which was invisible to the participants, the preview character was replaced with the correct target character.

Table 18.

Preview Manipulation Conditions for Two Syntactic Categories

	Identical	Morphologically Related	Non-word
Subject	путешестве|нниц**а** traveler (NOM)	путешестве|нниц**у** traveler (ACC)	путешестве|нниц**д**
Object	путешестве|нниц**у** traveler (ACC)	путешестве|нниц**а** traveler (NOM)	путешестве|нниц**д**

Each target word was inserted into a sentence frame either in the subject position immediately after the verb (1a) or in the object position after the subject (1b).

(1a) На вокзале спросила **путешестве|нница***NOM* собеседницу о расписании поездов.

At the railway station asked travelerNOM interlocutorACC about the train schedule.

(1b) На вокзале спросила собеседница **путешестве|нницу***ACC* о расписании поездов.

At the railway station asked interlocutorNOM travelerACC about the train schedule.

Method

Measures. Such early measures that reflect lexical access, as first fixation (orthographic identification) and gaze duration (lexical integration) were calculated for both the first (first fixation_1, gaze_1) and second (first fixation_2, gaze_2) parts of the target word. The results also include an additional measure for the second part of the word, referred to as subgaze_2 (Pollatsek & Hyöna, 2005). Subgaze_2 represents the time spent fixating the second part of the word, including any regressions back to the first part, before moving to the right off of the target second part of the word. This measure is associated with the later stages of lexical processing.

Later measures that reflect post-lexical integration of the word into the syntactic structure of the sentence included gaze duration for the whole word, total time, go-past time, and regressions into the target word.

Predictions. If morphology is integrated during lexical access, then the early measures $gaze_1$, $gaze_2$, and $subgaze_2$ for identical and morphologically related preview conditions should differ from the non-word preview condition. If syntactic integration is affected by the pre-processed information, then the morphologically related preview will interfere with the construction of the syntactic structure of the sentence. In such cases, late measures beginning with the $subgaze_2$ might show inhibitory effects in the morphologically related condition.

The morphologically related condition, if integrated, can modulate syntactic integration of the target word depending on the syntactic position. When the target is in the subject position, the morphologically related object is also possible. If case marking is integrated parafoveally, early measures can point towards facilitation, while later measures should be inhibitory. In the target object, a morphologically related subject is illegal. If syntactic information interacts with word integration then even early measures of lexical access can be inhibitory.

Syntactic context might also modulate the allocation of attention. In a less predictable context, in the subject position, the target word might elicit a higher distribution of attentional resources. As a result, parafoveal information may be processed to a higher level of detail. Under such a scenario, a preview benefit effect for morphologically related condition might be observed in the target subject position and attenuated or absent in the target object position. An attenuated or absent preview benefit effect for the identical condition in target object position only would corroborate such a view. Any differences found between the object and the subject conditions in the absence of parafoveal preview would demonstrate foveal processing of syntactic predictability.

Materials. The VSO word order from the 1st experiment was kept constant to investigate any potential effects of word length on parafoveal morphological processing. The manipulations were identical to the ones described in Experiment 1. Long Russian nouns (range: 10-19 characters; mean length: 12.9 characters) were used as stimuli for this experiment. The materials were balanced for frequency (mean: 323 per million; SD: 85) and lexeme (mean: 295 per 1 million; SD: 76). Currently, there are no corpora in Russian that provide counts of individual inflections in Russian. Sentences were normed for plausibility ($p<.65$) and predictability (mean rating 5.2 on a 7-point Likert scale; SD: 1.2), following the same procedure as in Experiment 1.

The boundary change was always between the 5th and 6th character from the end of a word. Some of the words had multiple morphemes in addition to the word-final case-marking, but the boundary change was always in the middle of the morpheme immediately preceding the case-marking in these multimorphemic items. Nouns of the 1st declension were used in this experiment to ensure that the preview and the target were of the same length.

Design. Same as in Experiment 1.

Participants. Same native speakers who took part in Experiment 1.

Apparatus. Same as in Experiment 1.

Procedure. Same as in Experiment 1.

Results

Data exclusion criteria. The landing position of the eyes in the first part of the noun was monitored. Trials where the eyes landed on the last two characters before the boundary change were intended to be analyzed separately for evidence of foveal processing. But an analysis of the landing site revealed that across all conditions there were only three instances when the eyes landed on the two characters before the boundary change marker. Although numerically the pattern of results on these trials did not differ from the observed results, these trials were excluded to ensure that the results reflect truly parafoveal processing effects.

Fixations shorter than 80 ms and longer than three standard deviations from the grand mean were excluded from the analyses. This resulted in the loss of less than .03% of the data. The reading time data were analyzed using linear mixed effects modeling (LME). Separate analyses were conducted for each eye movement measure (first $fixation_1$ duration, $gaze_1$ duration, first $fixation_2$, $gaze_2$, $subgaze_2$, etc.). All models were fitted using a forward stepwise model selection procedure, in which only those predictors that were significant or marginally so ($p<.1$) were retained in the model. P-values were obtained using Markov Chain Monte Carlo sampling. Items and participants were included as random factors. Preview manipulations and the target position were included as fixed effects along with their interaction. The patterns observed in the models were identical whether they were run on log-transformed or untransformed fixation durations. To increase transparency, the results of the models run on the untransformed fixation durations are reported, since regression weights can be interpreted as effect sizes.

Condition means with standard deviations for the reading measures for the 1^{st} part of the noun (prior to the boundary), 2^{nd} half of the noun, and for the whole noun are summarized in Table 19. Indications of statistical significance refer to the observed difference between the indicated mean and the mean in the non-word condition. Although LME analyses are performed over individual data points, all figures are plotted on the Y-axis according to means for ease of interpretation.

Table 19.

Mean Fixation Durations with Standard Deviations for Reading Measures in Experiment 2

	Subject			Object		
	identical	related	non-word	identical	related	non-word
First fix$_1$	213(110)	199(108)*	220(119)	210(114)	203(114)*	220(111)
Gaze$_1$	288(195)*	262(198)*	318(312)	267(178)*	268(192)*	289(251)
First fix$_2$	118(111)*	132(124)*	167(125)	140(124)*	168(124)*	173(129)
Gaze$_2$	134(143)*	152(155)*	205(164)	160(154)*	200(168)*	207(164)
Subgaze$_2$	195(290)*	249(342)*	297(259)	200(285)*	284(382)*	271(294)
Gaze$_{word}$	446(250)*	426(241)*	508(366)	438(246)*	451(267)*	475(322)
Total$_{word}$	794(494)*	847(573)	794(545)	726(432)*	789(499)	820(570)
Go-Past	584(392)*	656(521)	682(492)	587(453)^	634(453)	607(502)
Regressions	.26(.44)*	.33(.47)	.30(.45)	.26(.44)^	.24(.42)	.22(.41)

Note:* $p<.05$, ^ $p<.1$

Fixation Measures on the 1st part of the nouns. Measures reported in this section refer to the eye fixations prior to crossing the boundary. This means that while the eyes were on the first half of the noun, the second half of the word displayed the manipulated preview material (same, morphologically related case ending, or non-word) in the parafoveal visual field.

First fixation$_1$ duration. This measure reflects orthographic processing. The results of the best-fitted model for first fixation duration on the first half of the noun before the eyes crossed the invisible boundary included preview manipulation and syntactic context before the noun, and no interaction. The output of this model is reported in Table 20. The mean first fixation durations are summarized in Table 19 and Figure 9.

There was a significant preview benefit effect for the morphologically related condition (b= -15.44, SE=5.12, p<.01). The identical condition did not differ significantly from the non-word condition. See the summary of numeric means (Table 19 and Figure 9). This result is surprising and unexpected. Since the first fixation measure usually reflects the initial stage of word identification, the obtained results imply that at this early stage the word in the morphologically related condition was easier to recognize than either identical or non-word. A number of possible explanations will be explored further in the discussion section.

Table 20

Fixed effects for First Fixation$_1$ Duration in Experiment 2

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for First Fixation$_1$				
Intercept	218.28	8.24	26.5	0.001*
Preview: identical vs. non-word	-5.13	5.11	-1.00	0.32
Preview: related vs. non-word	-15.44	5.12	-3.00	0.003*
Syntactic Context: Subject vs. Object	-1.94	4.18	-0.46	0.64

Note. * p<.05

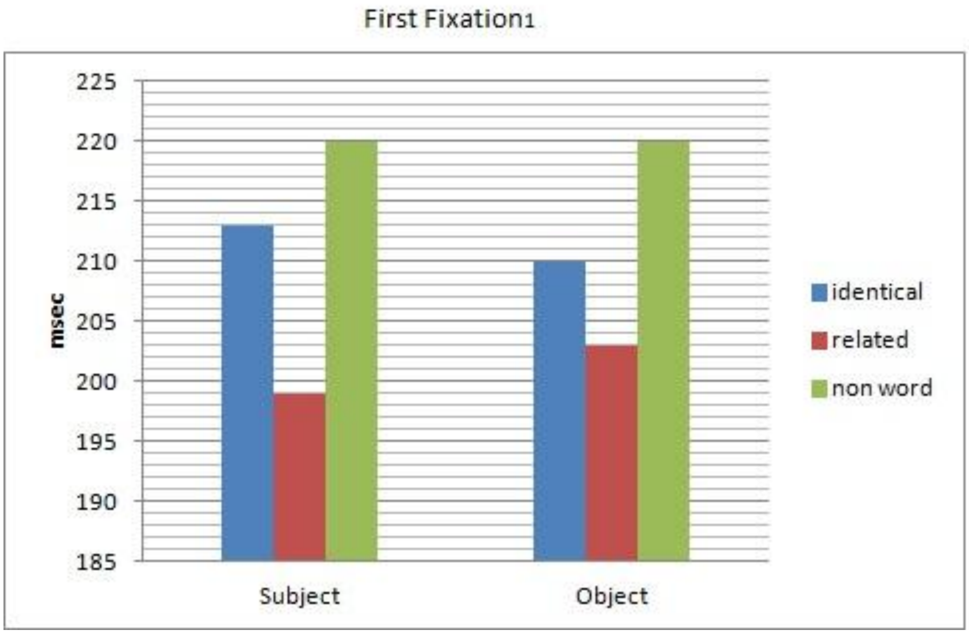

Figure 9. First fixation$_1$.

Gaze$_1$ duration. The results of the best-fitted model for all fixations on the first half of the noun before the eyes crossed the invisible boundary included preview manipulation and syntactic context before the noun, and their interaction. The output of this model is reported in Table 21. The mean gaze durations are summarized in Table 19 and Figure 10.

Gaze$_1$ duration demonstrated a significant preview benefit for the identical condition ($b= -30.72$, $SE=13.33$, $p<.01$), and morphologically related condition ($b= -57.33$, $SE=13.32$, $p<.001$), along with the interaction between the preview and target position for the morphologically related condition ($b=36.79$, $SE=18.87$, $p =.05$).

The results indicate that both identical and morphologically related conditions elicited shorter gaze durations than the non-word, regardless of the target position. The significant interaction observed between the preview manipulation and syntactic position suggests that the difference between the morphologically related and non-word conditions was significantly larger in the subject position (56 ms) than in the object position (21 ms) (see Figure 10).

The significant effect of target position (b=-30.88, SE=13.34, $p<.05$) indicates that, regardless of the preview manipulations, participants looked at the first half of the word before crossing the invisible boundary on average 31 ms longer in the less predictable subject position than in the more predictable object position (see Figure 10). Consequently, when participants fixated longer on the first part of the long noun, the morphological information located at the end of the word (and thus in the parafovea) was integrated faster in the subject than in the object position.

Table 21

Fixed effects for $Gaze_1$ Duration in Experiment 2

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for $Gaze_1$				
Intercept	319.39	20.28	15.75	0.001*
Preview: identical vs. non-word	-30.72	13.33	-2.31	0.02*
Preview: related vs. non-word	-57.33	13.32	-4.30	0.001*
Syntactic Context: Subject vs. Object	-30.88	13.34	-2.32	0.02*
Interaction: object x identical	10.07	18.88	0.53	0.60
Interaction: object x related	36.79	18.87	1.95	0.05^{*}

Note. * $p<.05$, ^ $p<.1$

Figure 10. Gaze$_1$.

Fixation Measures on the 2nd part of the noun. Analysis of the second part of the target word was restricted only to those instances when the participants fixated on the first part of the word. This restriction ensured that the preview was actually present in the parafovea prior to the eyes landing on the 2nd part of the word. This resulted in the exclusion of 0.02% of the trials.

First fixation$_2$ duration. The results of the best-fitted model for the first fixation duration on the second half of the noun after the eyes crossed the invisible boundary included preview manipulation, syntactic context before the noun, and their interaction. The output of this model is reported in Table 22. Mean first fixation durations are summarized in Table 19 and Figure 11.

First fixation$_2$ elicited a preview benefit effect for identical ($b= -48.66$, $SE=7.94$, $p<.001$) and morphologically related ($b=-34.47$, $SE=7.94$, $p<.001$) conditions and a significant interaction between preview and the syntactic role of the target word for the morphologically related condition ($b=28$, $SE=11$, $p<.01$).

The morphologically related preview, if integrated at the syntactic level, is an acceptable argument after the verb (VOS order is legal in Russian). In the object position, however, the morphologically related preview had a nominative case marking and thus, if integrated at the syntactic level, results in an illegal parse (*VS**S**). The difference between the morphologically related and non-word conditions was modulated by the position of the target. In the subject position, the second half of the target word was fixated on average 35 ms shorter in the morphologically related condition than in the non-word condition, but only 5 ms shorter than the non-word condition in the object position. This indicates that the second half of the target was identified 35 ms faster than the non-word when the preview was a syntactically acceptable continuation of a sentence. The observed pattern of results indicates that syntactic information affected the integration of morphological information during the pre-lexical stage of word identification. Syntactically illicit case marking for the morphologically related preview in the object position (*VS**S**) slows down word identification almost as much as non-word preview (only 5ms difference).

Table 22

Fixed effects for First Fixation$_2$ Duration in Experiment 2

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for First Fixation$_2$				
Intercept	167.31	9.61	17.42	0.001*
Preview: identical vs. non-word	-48.66	7.94	-6.13	0.001*
Preview: related vs. non-word	-34.47	7.94	-4.34	0.001*
Syntactic Context: Subject vs. Object	6.79	7.94	0.86	0.39
Interaction: object x identical	14.90	11.23	1.33	0.18
Interaction: object x related	29.68	11.23	2.56	0.01*

Note. * p<.05,

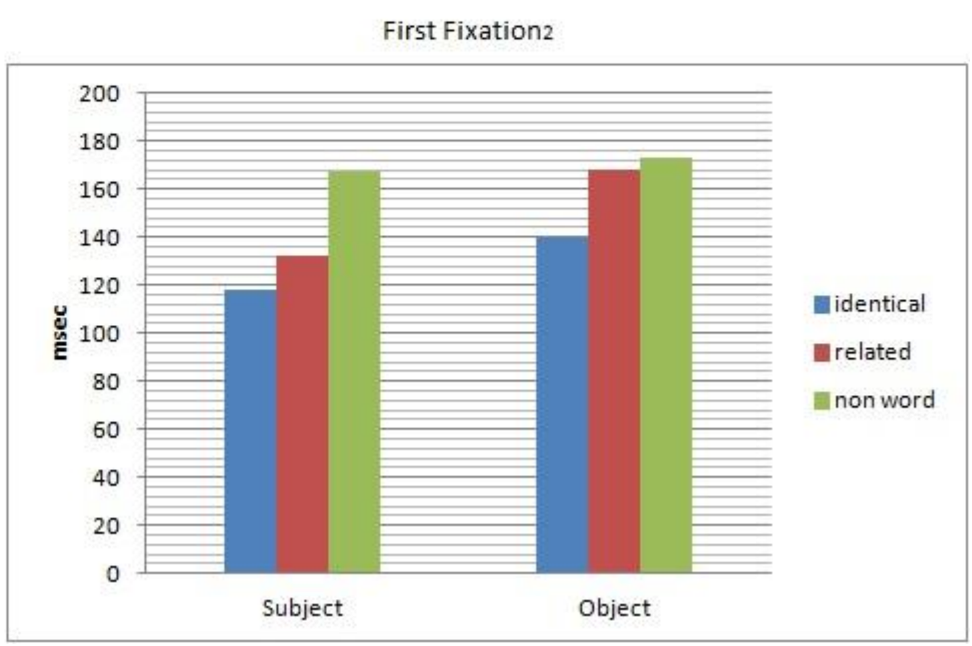

Figure 11. First Fixation$_2$.

Gaze₂ duration. This measure is associated with the lexical access for the target word. The results of the best-fitted model for the gaze duration on the second half of the noun after the eyes had crossed the invisible boundary included preview manipulation, syntactic context before the noun, and their interaction. The output of this model is reported in Table 23. Mean gaze durations are summarized in Table 19 and Figure 12.

Target position did not affect gaze duration for the second half of the word. $Gaze_2$ elicited a significant preview benefit effect for identical (b= -64.39, SE=9.84, p<.001) and morphologically related (b= -49.21, SE=9.84, p<.001) conditions and an interaction between the preview and target position for morphologically related condition (b=42.63, SE=13.92, p<.01).

The observed pattern of results mirrors the results reported in the first $fixation_2$ durations. The difference between the morphologically related and non-word conditions was modulated by the position of the target. In the subject position, the second half of the target word was fixated 50 ms shorter in the morphologically related condition than in the non-word condition, but only 7 ms shorter than the non-word condition in the object position. This indicates that the second half of the target was identified 50 ms faster than the non-word when the preview was a syntactically acceptable continuation of a sentence (V**<u>O</u>**S). When the preview contained a syntactically illegal case marking (*VS**<u>S</u>**), participants looked at the second half of the word almost as long as when the preview was a non-word. The results suggest that the inflectional case marking was integrated parafoveally and affected lexical retrieval and syntactic integration of the target word.

Table 23

Fixed effects for Gaze$_2$ Duration in Experiment 2

Predictor	Coefficient	SE	*t* value	*p*
		Fixed effects for Gaze$_2$		
Intercept	202.50	13.10	15.46	0.001*
Preview: identical vs. non-word	-64.39	9.84	-6.54	0.001*
Preview: related vs. non-word	-49.21	9.84	-5.00	0.001*
Syntactic Context: Subject vs. Object	2.10	9.84	0.21	0.83
Interaction: object x identical	19.64	13.93	1.41	0.16
Interaction: object x related	42.63	13.92	3.06	0.002*

Note. * p<.05

*Figure 12.*Gaze$_2$.

Subgaze$_2$. Subgaze$_2$ in the within-word boundary change literature reflects later integrative stages of word identification (Pollatsek & Hyöna, 2005). The results of the best-fitted model for subgaze$_2$ included preview manipulation and syntactic context before the noun, and their interaction. The output of this model is reported in Table 24. Mean subgaze$_2$ durations are summarized in Table 19 and Figure 13. A significant preview benefit effect for the identical condition ($b= -96.79$, $SE=20.67$, $p<.001$) indicates that participants spent 96 ms less re-reading the target word in the identical condition than in the non-word condition.

The preview benefit effect for the morphologically related ($b= -42.71$, $SE=20.67$, $p<.05$) condition along with a marginally significant interaction between the preview and target position for the morphologically related condition ($b=55.45$, $SE=29.24$, $p<.1$) indicate that when the target word was in the subject position, participants spent significantly less (48ms) time when the preview was morphologically related than when the preview was a non-word. In the object position, however, participants spent significantly longer (13ms) re-reading the target word when the preview was morphologically related than when it was a non-word. Taken together, the inhibitory effect in the morphologically related condition in the object position and facilitatory effect in the subject position suggest that the preview affected not only the lexical access of the target word but also its integration into the sentence structure.

Table 24

Fixed effects for Subgaze$_2$ Duration in Experiment 2

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Subgaze$_2$				
Intercept	293.13	21.24	13.80	0.001*
Preview: identical vs. non-word	-96.79	20.68	-4.68	0.001*
Preview: related vs. non-word	-42.71	20.67	-2.07	0.04*
Syntactic Context: Subject vs. Object	-21.56	20.67	-1.04	0.30
Interaction: object x identical	26.57	29.25	0.91	0.36
Interaction: object x related	55.45	29.24	1.90	$0.06^{\wedge}$

Note. * p<.05, $^{\wedge}$ p<.1

Figure 13. Subgaze$_2$.

Fixation Measures for the whole word. The measures reported in this section traditionally reflect later stages of post-lexical integration of the target word into the syntactic structure of the sentence.

Gaze duration ($Gaze_{word}$). This measure reflects the sum of all fixations on the first and second half of the target word before the eyes move off the word and is associated with later integrative stages of word identification (Pollatsek & Hyöna, 2005) The results of the best-fitted model for the gaze duration for the word included preview manipulation and syntactic context before the noun and their interaction. The output of this model is reported in Table 25. Mean whole word gaze durations are summarized in Table 19 and Figure 14.

$Gaze_{word}$ showed a preview benefit for the identical condition (b= 62.96, SE=16.67, p<.001). Participants spent less time looking at the target word when the preview was identical (63 ms) or morphologically related (83 ms; b= 82.61, SE=16.67, p<.001) than when the preview was a non-word regardless of the target position.

There was an interaction between the target position and preview condition for the morphologically related condition (b=59.83, SE=23.58, p<.01). The observed results indicate that a morphologically related preview facilitated word identification on average by 83 ms in comparison to the non-word preview in the subject position. Recall that the morphologically related preview was syntactically legal in the subject position, but not the object position. When the preview contained a syntactically illegal case marking in object position, the target word was still identified faster than when the preview was a non-word, but this difference was significantly smaller (24 ms) in the more syntactically restrictive object position than in the subject position. More effortful identification of the target word in the object position when the preview was syntactically illegal suggests that inflectional case marking, on which participants have not yet fixated, was integrated parafoveally and affected lexical retrieval and syntactic integration of the entire target word.

Table 25

Fixed effects for Gaze$_{word}$ Durations in Experiment 2

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Gaze$_{word}$				
Intercept	509.23	27.16	18.75	0.001*
Preview: identical vs. non-word	-62.96	16.67	-3.78	0.000*
Preview: related vs. non-word	-82.61	16.67	-4.96	0.001*
Syntactic Context: Subject vs. Object	-35.19	16.68	-2.11	0.04*
Interaction: object x identical	28.34	23.60	1.20	0.23
Interaction: object x related	59.83	23.58	2.54	0.01*

Note. * $p<.05$

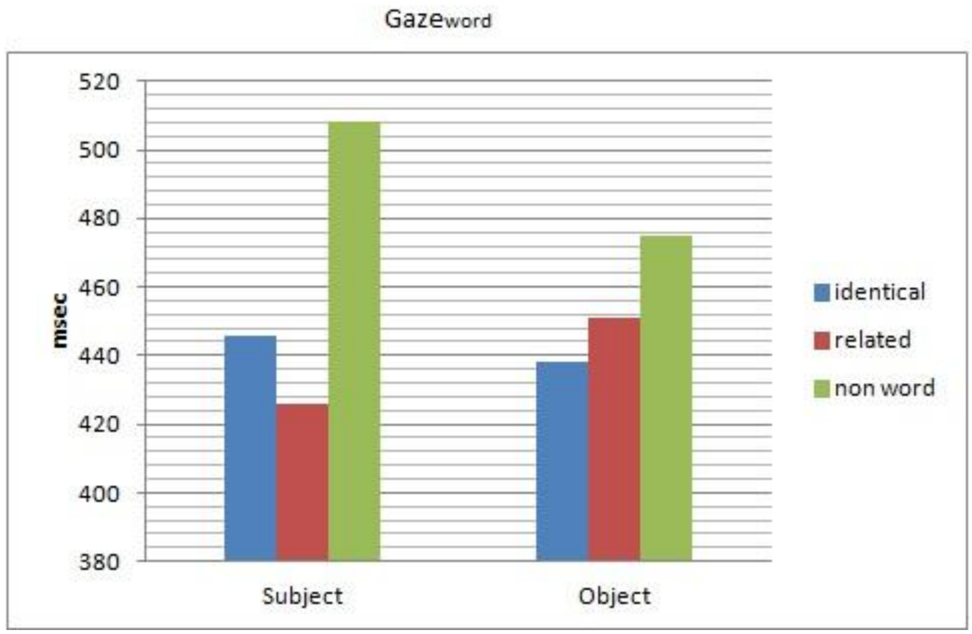

Figure 14. $Gaze_{word}$.

Total time (Total$_{word}$ Time). The results of the best-fitted model for the total time for the word included preview manipulation, syntactic context before the noun, and no interaction. The output of this model is reported in Table 26. Mean total time durations are summarized in Table 19 and Figure 15.

There was a significant effect of target position (b= -54.84, SE=18.19, p<.001) for the $total_{word}$ time. This indicates that participants spent on average 55 ms less time on the target word when it was in the object position than when it was in the subject position. The effect of target position suggests that participants were sensitive to the syntactic structure. It seems that in line with the attention allocation proposal, more resources were allocated to the target word in the subject position than in the object position regardless of the preview manipulation.

$Total_{word}$ time also revealed a preview benefit effect for the identical condition only (b= -83.75, SE=22.25, p<.001). $Total_{word}$ time in the within-word boundary change paradigm reflects post-lexical integration (Pollatsek & Hyona, 2005). No effect of the morphologically related condition (b=25.53, SE=22.25, p<.25) during total time indicates that the morphologically related condition proved to be as difficult to integrate into the sentence structure as the non-word. This is in sharp contrast with earlier measures when the morphologically related condition was as facilitatory as the identical condition. Further examination of the means (Table 19 and Figure 15) suggests an interaction between the target position and preview condition for the morphologically related condition: a 53 ms inhibitory effect in the subject position and a 31 ms facilitatory effect in the object position; however, standard deviations were twice the size of those in earlier measures. This suggests that the large variability among participants may explain the lack of significance.

Table 26

Fixed effects for $Total_{word}$ Time Spent on the Noun in Experiment 2

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for $Total_{word}$ Time				
Intercept	873.86	43.83	19.94	0.001*
Preview: identical vs. non-word	-83.75	22.25	-3.76	0.000*
Preview: related vs. non-word	-25.53	22.25	-1.15	0.25
Syntactic Context: Subject vs. Object	-58.84	18.19	-3.24	0.001*

Note. * p<.05

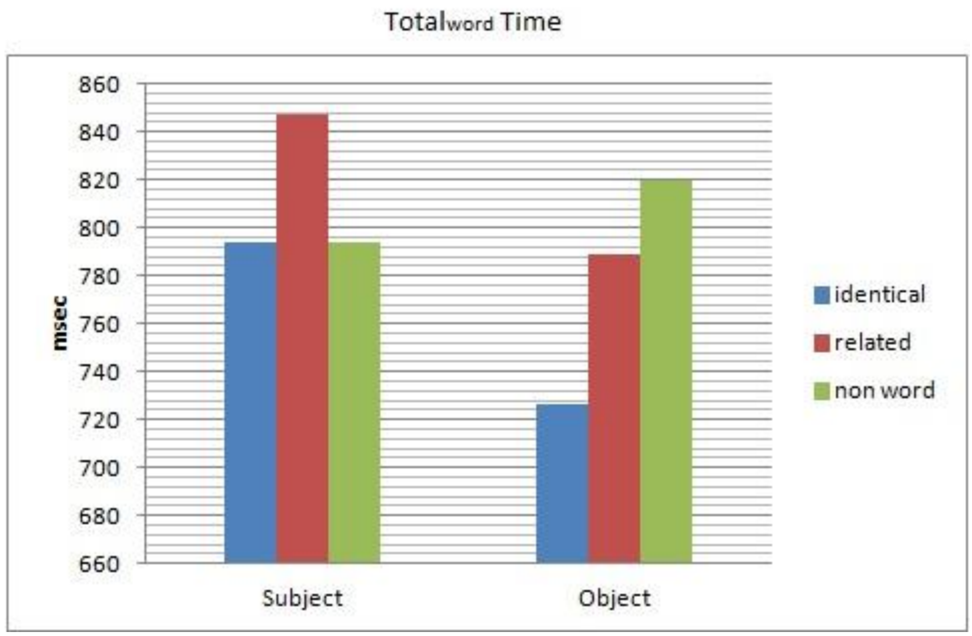

Figure 15. Total$_{word}$ Time

Go-past$_{word}$ time. This measure included the time participants spent re-reading the target word and earlier parts of the sentence before moving their eyes to the right of the target. The results of the best-fitted model for the go-past time for the target word included preview manipulation and syntactic context before the noun and their interaction. The output of this model is reported in Table 27. Mean go-past times are summarized in Table 19 and Figure 16.

The significant preview benefit effect only for the identical ($b=-98.02$, $SE=32.53$, $p<.001$) condition indicates that the morphologically related condition caused participants to re-read prior parts of the sentence as much as the non-word condition. The go-past results, along with results obtained from total time, indicate that inflectional case markings and syntactic information from the morphologically related preview were integrated early on and caused participants to re-read the target word and preceding information when the preview turned out to be inconsistent with the actual sentence structure.

A significant effect of target position ($b=-75.98$, $SE=32.53$, $p<.05$) was qualified by a marginally significant interaction with the preview manipulation for the identical condition ($b=78.64$, $SE=46.03$, $p<.1$). In the identical preview condition in the subject position, participants re-read earlier parts of the sentence 98 ms less than in the non-word condition. Results showed a 20 ms facilitation for identical preview as compared with the non-word preview condition in the object position was only marginally different. The morphologically related condition caused participants to re-read earlier parts of the sentence as much as the non word condition. This pattern supports the view that parafoveally available morphologically related information was integrated during lexical access and influenced the post-lexical integration of the target word.

Numeric means (Table 19 and Figure 16) indicate that in the object position the morphologically related condition caused readers to re-read previous parts of the sentence 27 ms longer than did the non-word condition. Standard deviations for go-past time means were as high as for the total time. The large variability in participants' eye movement measures associated with post-lexical processes imply that post-lexical integration was not as unified as word identification and was more prone to display individual differences.

Table 27

Fixed effects for Go-Past$_{word}$ in Experiment 2

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Go-Past$_{word}$ Times				
Intercept	682.71	37.30	18.30	0.001*
Preview: identical vs. non-word	-98.02	32.53	-3.01	0.002*
Preview: related vs. non-word	-25.49	32.52	0.78	0.44
Syntactic Context: Subject vs. Object	-75.98	32.53	-2.34	0.02*
Interaction: object x identical	78.64	46.03	1.71	0.08^
Interaction: object x related	53.30	46.00	1.16	0.25

Note. * p<.05, ^ p<.1

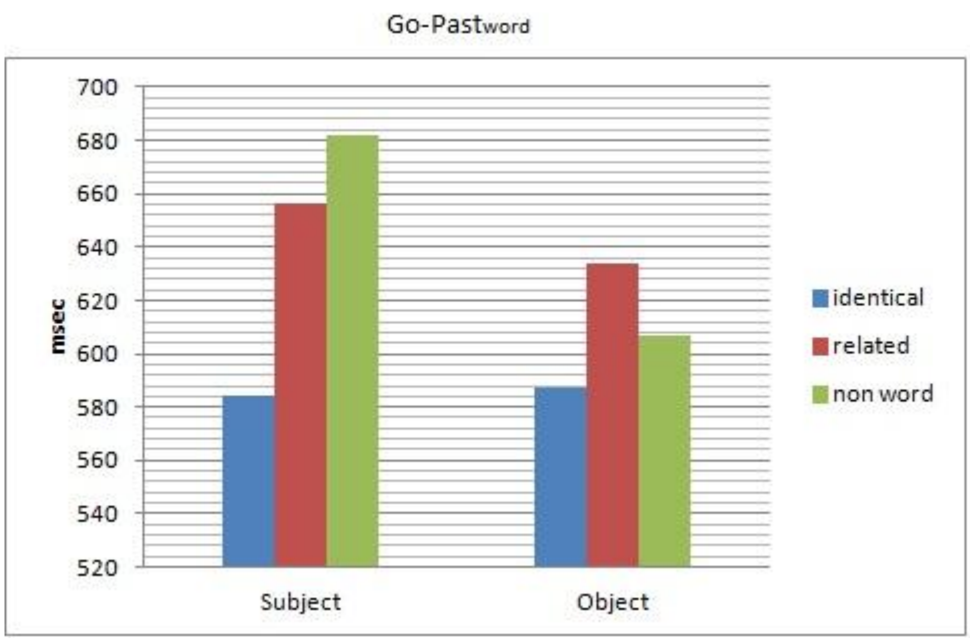

Figure 16. Go-past$_{word}$

Regressions into$_{word}$. Regressions into the target along with total time and go-past time for the whole word reflect post-lexical integration. These data were analyzed using a binomial logit mixed model. The results of the best-fitted model for the regressions into the target word included preview manipulation, syntactic context before the noun, and their interaction. The output of this model is reported in Table 28. Mean regression rates are summarized in Table 19 and Figure 17.

A significant effect of target position ($b=-.3$, $SE=.11$, $p<.01$) and significant effect of preview manipulation for the identical condition ($b=-0.35$, $SE=0.16$, $p<.05$) was further qualified by a marginally significant interaction between preview and syntactic position ($b=0.42$, $SE=0.23$, $p<.1$). After reading the verb and both arguments for the first time, participants returned to the target subject on average 4% more often when a parafoveally available preview was morphologically related or a non-word compared to in the identical condition. In the target object condition, the pattern of results was in the opposite direction. Participants re-fixated the target object 4% less often when the parafoveally available preview was morphologically related or a non-word compared to when the preview was identical. This pattern of results suggests that illicit case marking was integrated into the syntactic structure for the target in the subject position. Since the syntactic context did not prohibit the VOS string, it took longer to inhibit the illicit case marking. The reduced effect of preview manipulation in the target object position supports the view that the parafoveally available illicit case marking in the target object was inhibited during earlier processing stages as reflected in $subgaze_2$, $gaze_{word}$, $total_{word}$, and $go\text{-}past_{word}$ measures.

Table 28

Fixed effects for Regressions into$_{\text{word}}$ in Experiment 2

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Regressions into$_{\text{word}}$				
Intercept	-0.75	0.14	-5.54	0.001*
Preview: identical vs. non-word	-0.35	0.16	-2.23	0.03*
Preview: related vs. non-word	-0.17	0.15	-1.10	0.27
Syntactic Context: Subject vs. Object	-0.45	0.16	-2.82	0.005*
Interaction: object x identical	0.42	0.23	1.83	0.07$^{\wedge}$
Interaction: object x related	0.03	0.23	0.11	0.91

Note. * p<.05, $^{\wedge}$ p<.1

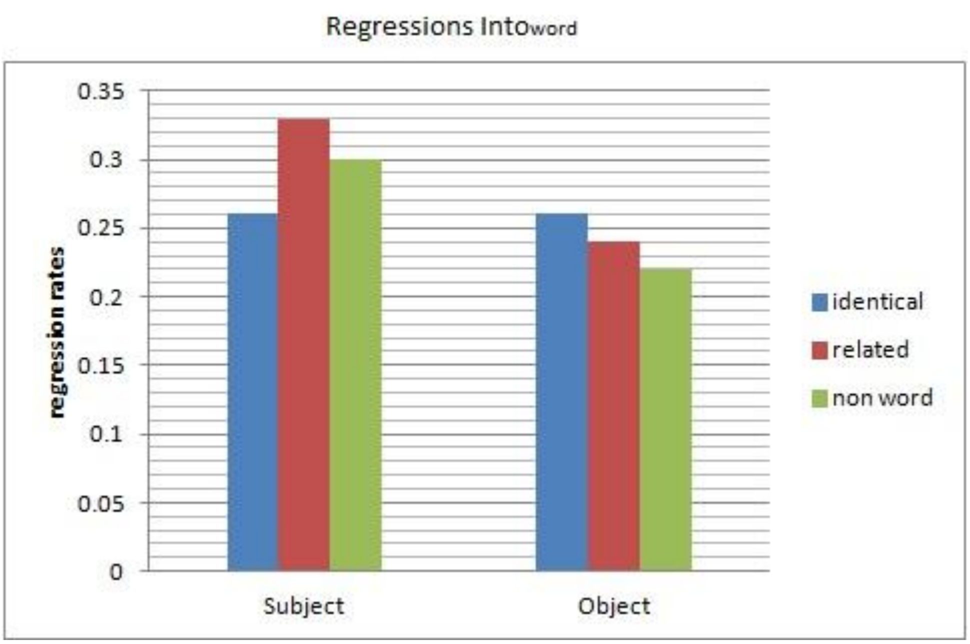

Figure 17. Regressions into$_{\text{word}}$

General Discussion

To date, evidence of parafoveal morphological processing is scant, mostly coming from Hebrew. Experiment 2 examined the effects of syntactic context on availability of morphological information during within-word processing of long Russian nouns.

The effects of morphological integration were examined via a within-word boundary-change manipulation with three preview conditions (identical, morphologically related, and non-word). Syntactic effects were investigated by varying the syntactic position of the target word in the VSO syntactic frame (subject vs. object). To examine the time-course of morphological and syntactic effects, the target word was divided into two parts (1^{st} part up to the invisible boundary, and 2^{nd} part after the invisible boundary). Early word identification measures were first fixation_1, gaze duration_1 (1^{st} part of the word), first fixation_2, gaze duration_2, and subgaze_2. Late measures tapping into post-lexical integration of the target word included gaze duration for the word ($\text{gaze}_{\text{word}}$), total $\text{time}_{\text{word}}$, go-past $\text{time}_{\text{word}}$ and regressions into the word (regressions $\text{into}_{\text{word}}$).

Early measures that correspond to lexical integration (gaze_1, gaze_2) reflected preview benefit effects for identical and morphologically related conditions. This indicates that morphological information was used during pre-lexical integration. Late measures showed inhibitory effects for morphologically related conditions, indicating that the morphologically related preview interfered with the construction of the syntactic structure of the sentence.

First fixation_1 revealed a surprising effect of preview benefit for the morphologically related condition. This result was not predicted. At this point it is possible to account for this pattern of results only by postulating two distinct processes. For the subject target, perhaps the morphologically related preview can be identified sooner because, despite the corpora counts, participants in the current experiment could be more prone to expect object after the verb in VSO orders.

A second possibility suggests that the morphologically related manipulation in object position might induce spurious compounding of the two nouns (2) and may tap into lexical processing that has been suggested in the literature to precede syntactic integration (Drieghe et al., 2010).

(2) На вокзале спросила *собеседницаNOM путешественницаNOM* о расписании.

At the railway station asked *interlocutorNOM travelerNOM* about the schedule.

Both of these accounts are speculative at this point and need to be investigated further.

Early measures on the second half of the word after the preview was replaced by the target confirmed the results reported in the early measures of the first half of the word. First $fixation_2$, $gaze_2$, and $subgaze_2$ all elicited preview benefit effects for identical and morphologically related conditions. Moreover, the fixations differentiate between syntactic integration of the morphologically related condition as evidenced by shorter fixations for the morphologically related condition than the non-word in target subject position. When a morphologically related ending was syntactically illegal in object position, the difference between morphologically related and non-word conditions was either significantly reduced (first $fixation_2$, $gaze_2$) or reversed ($subgaze_2$ was 13 ms longer for morphologically related than for the non-word). This implies that when the case markings are processed parafoveally, higher level information (morphological and syntactic information that is associated with the case marking) is integrated along with low-level orthographic information.

Later measures on the whole word, contrary to the facilitative effects reported in early measures, indicate that the morphologically related condition was not statistically different from the non-word condition. Such an inhibitory effect indicates that morphological information influenced post-lexical stages as reflected in total time, go-past time, and regressions. Numeric means in the late measures indicated that the target position might have interacted with the preview manipulation. The morphologically related condition in the subject position elicited numerically longer total time fixations than the non-word and a higher rate of regressions. Such a pattern of results suggests that the morphologically related condition was integrated into the syntactic structure very quickly in both cases, and in the subject position affected post-lexical integration only after the parser integrated the second argument. Go-past times and regression rates in the morphologically related condition were consistent with this interpretation, showing more re-reading and re-fixations of the first argument for the morphologically related condition. High individual variability, as evidenced by large standard deviations from the means, is likely the reason that the differences were not statistically significant.

Summary

Experiment 2 provides unambiguous evidence that morphological information is integrated parafoveally only during within word processing of nouns in Russian. Early measures (first $fixation_2$, $gaze_2$, and $subgaze_2$) indicated that morphological processing interacts with syntactic context and affects lexical access of long nouns in Russian. Marginally significant interactions between target position and preview manipulation in later measures suggest that it takes time to inhibit the morphologically related preview. However, more investigation into the time-course of morphological and syntactic information during later post-lexical integrative stages is still needed to understand the exact mechanisms involved.

Taken together with the results reported in Experiment 1, it can be concluded that, unlike Hebrew where morphological information is available during early pre-lexical stages of identification while attention is still on the word *n-1*, in Russian morphological information subserves lexical access and can be integrated parafoveally only when attention shifts within the target word. Importantly, in Hebrew only verbal morphology is integrated pre-lexically possibly due to the saliency of the inflectional paradigm (Deutsch et al., 2005). Experiment 2 reveals that in Russian morphological information is available parafoveally only during within-word identification stage. Next Chapter investigates if this is the case for morphological information of Russian verbs.

CHAPTER 5:

WITHIN WORDS - VERBS

The experiment reported in this chapter investigated the influence of morphological and syntactic information parafoveally during within word processing of Russian verbs. The average length of the words in this experiment was 12 characters. Morphological information was conveyed by the penultimate character of the word. To investigate the level of processing of the morphological inflections in Russian long verbs, the experiment reported below implemented a modified version of the boundary-change paradigm: a within word boundary-change (Hyöna et al., 2004) within the word *n*.

To date there is evidence that only Hebrew verbal morphology is integrated pre-lexically parafoveally during between word processing (Deutsch et al., 2005). Seven distinct verbal classes in Hebrew make the verbal morphological inflectional paradigm more salient than the nominal paradigm, which has 100 classes. Russian verbal morphology has seven declensional paradigms like Hebrew. Unlike Hebrew, Russian nouns have only three declensional classes. Experiments 1 and 2 reported in this dissertation have established that morphological information is available parafoveally in Russian only during lexical integration stage that begins when the eyes fixate the target word. If the regularity of inflectional paradigm affects morphological processing, then it is possible that morphology subserves lexical access for both Russian verbs and nouns. If, however, the relative regularity or complexity of the various inflection paradigms across word classes modulates the extent to which morphology is processed in the parafovea during within word processing, then this processing might only be expected to occur in the relatively morphologically simpler and more salient nouns. Experiment 3 examined the morphological processing of long inflected verbs.

Prior boundary-change research has shown that syntactic context affects parafoveal processing in Hebrew (Deutsch et al., 2005). A morphologically related preview target of a different grammatical category (noun instead of the verb) elicited longer fixation durations than a morphologically related constituent of the same grammatical category. The effects of syntactic context in Russian were probed by varying the syntactic argument appearing before the verb (SVO vs. OVS) to test whether the occurrence of a subject vs. object before the verb will change expectations and processing strategies on the verb.

Experiment 3 – Within-Word Boundary Change

Studies conducted by Deutsch and colleagues (2003, 2005) demonstrated that not all morphemes are processed in the same way. Thus, Hebrew verbal patterns are processed parafoveally while nominal patterns are not. The authors attributed this to the fact that nominal patterns are less salient due to 100 nominal paradigms for nouns vs. seven for verbs. Experiment 3 investigated the processing of Russian verbs to test this inflectional paradigm saliency hypothesis. The nominal paradigm is more salient in Russian, having only three declensional types. Seven inflectional paradigms for verbs make them less salient under the hypotheses proposed by Deutsch and colleagues (2005). If paradigm saliency modulates online processing of inflectional morphology, then the effects of verbal inflectional morphology should be attenuated in comparison to the results observed for the integration of inflections of nouns during within word integration.

Corpus counts (http://bokrcorpora.narod.ru / frqlist / frqlist-en.html) indicate that OVS word order is less frequent then the SVO order. It is possible that processing of the object before the subject might tax the cognitive processing capacities of the parser and effectively shrink the attention span (Ferreira & Henderson, 1990). Alternatively, more elaborate and effortful processing of the OVS order might result in more effective allocation of attentional resources and cause deeper processing of the information. Any interaction between syntactic factors and preview benefit effect will help adjudicate between these two hypotheses. An example item in all three preview conditions is given in Table 29.

Table 29

Preview Manipulation Conditions for a sample verb 'to show'

Identical (singular)	Morphologically Related (plural)	Non-word
показ|ыва**е**т (SG)	показ|ыва**ю**т (3rdPL)	показ|ыва**д**т
Note:	показ|ыва**ю** (1stSG)	

The target word was inserted into a sentence frame either after the subject (1a) or after the object (1b).

(1a) В конце лекции профессор *NOM* **показывает**SG студенту *ACC* свои любимые произведения искусства.

"At the end of the lecture the professor shows a student his favorite art piece."

(1b) В конце лекции профессору *ACC* **показывает**SG студент *NOM* свои любимые произведения искусства.

"At the end of the lecture the student shows a professor his favorite art piece."

Method

Measures. As in Experiment 2, the within-word boundary change paradigm was used. First fixation duration and gaze duration were calculated for both the first (first fixation_1, gaze_1)

and second (first fixation$_2$, gaze$_2$) parts of each verb. Later measure associated with lexical integration for long words was calculated, subgaze$_2$, which reflects the amount of time spend reading the second half of the noun and any refixations on the first half of the noun before leaving the word. Later measures that reflect post-lexical processing of the word included first fixation, gaze duration, and total time for the whole verb.

Predictions. If morphological information is processed parafoveally, then eye movements in identical and morphologically related conditions should differ from the eye movements in the non-word preview condition. If verbal inflections are processed orthographically in the parafovea, then only the identical manipulation will elicit shorter eye fixations. Additionally, the morphologically related manipulation can be identified faster than the identical manipulation based on an incomplete processing of *показыва**ю** (*'I show'; 1st person SG) instead of *показыва**ют*** ('they show'; 3rd person PL). In such a case, shorter eye fixations on the morphologically related condition in the absence of any significant differences between identical and non word manipulations will be taken as evidence for simple orthographic processing and the absence of morphological integration.

If syntactic context modulates extraction of morphological information from the parafovea, then there will be an interaction between the preview conditions across SVO and OVS word order for early measures (first fixation duration, gaze duration) and, possibly, for later measures (total time, go-past time, regressions). More specifically, the identical preview condition should be facilitatory across SVO and OVS in comparison to the control non-word preview condition. Only the OVS condition allows morphologically related preview in the plural form without penalty ($O_{sg}V_{pl}S_{pl}$ is a possible variant in Russian), while a morphologically related preview in the SVO condition results in an ungrammatical parse (*$S_{sg}V_{pl}O$). Therefore, early measures (first fixation and gaze duration) in the morphologically related preview conditions for both SVO and OVS word orders might be facilitatory as compared to the early measures for the control non-word preview condition. Late measures might show the influence of syntactic position of the preverbal argument. A significant difference in eye movements in the morphologically related condition between the word order conditions (SVO versus OVS) will be taken as evidence that native speakers not only processed the case marking parafoveally, but also integrated this information into the syntactic structure. More specifically, inflated total times due to increased rereading times of the verb in OVS and increased go-past times due to the regressions to the preverbal argument from the target verb in the SVO condition will indicate that the morphologically related preview affected the syntactic parse of the sentence.

Alternatively, syntactic context can affect the allocation of attentional resources during silent reading (Henderson & Ferreira, 1990). If native Russian speakers are sensitive to the less predictable OVS word order, more attentional resources might be allocated towards the processing of the target verb after the object. In this case, parafoveal information might be processed at a deeper level than when the target is in the more predictable position after the subject in canonical SVO word order. If this allocation of resources hypothesis is correct, the identical and morphologically related conditions might be identified as words sooner in the object condition. Alternatively, the less expected syntactic context might result in higher foveal load and modulate integration of parafoveal information by reducing the extent of parafoveal processing. Under such a scenario, no effects of the preview manipulation are predicted. Any differences found between the object and the subject conditions without effects of the preview manipulation will be evidence of syntactic frequency effects on foveal processing. Finally, if paradigm saliency modulates parafoveal processing of inflectional morphology, then verbal inflectional morphology might not be processed parafoveally in long verbs, unlike what was observed for long nouns.

Materials. Long Russian verbs (>9 characters; range: 10 to 22 characters; mean length: 13 characters) were used as stimuli for this experiment. The materials were balanced for word (mean: 208 per million; SD: 96) and lexeme (mean: 190 per million; SD: 89) frequencies. Currently, there are no corpora in Russian that provide counts of individual inflections in Russian. Sentences were normed for plausibility ($p<.65$) and predictability (mean: 3.4 out of a 7-point Likert scale, SD: 1.2; $p<.32$) following the same procedure as in Experiment 1.

The boundary change was always between the 5^{th} and the 6^{th} character from the end of a word. Some of the words had multiple morphemes in addition to the word-final case-marking, but the boundary change was always in the middle of the morpheme immediately preceding the case-marking.

Design. Word order was manipulated in this experiment (SVO x OVS) along with parafoveal preview (identical x morphologically related x non-word), resulting in a 2 x 3 Latin square design. To investigate if syntactic information of the processed arguments affects verbal parafoveal preview in Russian, the subject or object preceded the target verb. In the test conditions inflections were either identical prior to and after the eye crossed the invisible boundary, or were replaced with an inflections indicating different agreement, (plural instead of singular), or, in the non-word control condition, with a consonant inserted in the normal agreement slot. Sixty experimental sentences were constructed for this experiment, which was run at the same time as Experiments 1-2, with all items serving as fillers for each other.

Participants. Same as in Experiments 1 and 2.

Apparatus. Same as in Experiment 1 and 2.

Procedure. Same as in Experiments 1 and 2.

Results

Data exclusion criteria. The landing position of the eyes in the first part of the verb was monitored. Trials where the eyes landed on the last two characters before the boundary change were intended to be analyzed separately for evidence of foveal processing. But an analysis of the landing site revealed that across all conditions there were only five instances when the eyes landed on the two characters before the boundary change marker. Although numerically the pattern of results on these trials did not differ from the observed results, these trials were excluded to ensure that the results reflect truly parafoveal processing effects.

Fixations shorter than 80 ms and longer than three standard deviations from the grand mean were excluded from the analyses. This resulted in the loss of less than .02% of the data. The reading time data were analyzed using linear mixed effects modeling (LME). Separate analyses were conducted for each eye movement measure (first fixation $duration_1$, gaze $duration_1$, first $fixation_2$, $gaze_2$, $subgaze_2$, etc.). All models were fitted using a stepwise model selection procedure, in which only those predictors that were significant or marginally so ($p<.1$) were retained in the model. P-values were obtained using Markov Chain Monte Carlo sampling. Items and participants were included as random factors. Preview manipulations and word order were included as fixed effects along with their interaction. The patterns observed in the models were identical whether they were run on log-transformed or untransformed fixation durations. To increase transparency, the results of the models run on the untransformed fixation durations are reported, because then regression weights can be interpreted as effect sizes.

Condition means with standard deviations for the reading measures for the 1st part of the verb (prior to the boundary), 2nd half of the verb, and for the whole verb are summarized in Table 30. Significant and marginally significant differences are labeled accordingly; all comparisons were made using the non-word condition as the baseline. Although LME analyses are performed over individual data points, all figures are plotted on the Y-axis according to means for ease of interpretation.

Table 30

Mean Fixation Durations with Standard Deviations for Reading Measures in Experiment 3

	Subject			Object		
	identical	related	non-word	identical	related	non-word
First fix_1	201(115)	203(114)	196(117)	199(113)	204(107)	205(113)
$Gaze_1$	248(170)*	260(189)	265(184)	244(171)*	257(181)	287(219)
First fix_2	126(121)^	117(119)*	138(125)	151(122)^	151(123)*	173(129)
$Gaze_2$	142(144)	132(145)*	153(149)	172(152)	174(156)*	204(162)
$Subgaze_2$	188(243)	175(255)*	217(324)	257(326)	246(306)*	271(259)
$Gaze_{word}$	387(217)*	383(226)*	419(277)	427(249)*	432(255)*	436(266)
Total time	646(393)*	638(517)	697(562)	766(510)*	826(547)	814(576)
Go-Past	499(363)*	495(433)	541(455)	561(417)*	612(456)	612(475)
Reg In	.20(.4)*	.21(.41)	.21(.41)	.22(42)*	.29(.46)	.33(.53)

Note: Reg-Regressions,* p<.05, ^ p<.1

Fixation Measures on the 1st part of the verbs. Measures reported in this section refer to the eye fixations prior to crossing the boundary. This means that while the eyes are on the first half of the verb(*n*), the second half of the verb displays the manipulated material (same, morphologically related case ending, or non-word) in the parafoveal visual field.

First fixation$_1$ duration. This measure reflects an initial word familiarity check that is believed to be carried out at the level of orthographic letter identification (Pollatsek & Hyöna, 2005). The results of the best-fitted model for first fixation duration on the first half of the verb before the eyes crossed the invisible boundary included preview manipulation and syntactic context before the verb, and no interaction. The output of this model is reported in Table 31. The mean first fixation$_1$ durations are summarized in Table 30 and Figure 18. There were no effects of either preview manipulations or syntactic context on first fixation durations. Although examination of the conditional means in Figure 18 point towards an insignificant interaction between the preview manipulation and syntactic context for the non word condition, small numeric means in Table 30 indicate that not much weight should be given to this numeric trend. This suggests that, unlike in long nouns, parafoveal pre-processing in verbs might be carried out only at the orthographic level without involvement of morphology.

Table 31

Fixed effects for First Fixation$_1$ Duration in Experiment 3

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for First Fixation$_1$				
Intercept	199.75	9.48	21.07	.001*
Preview: identical vs. non-word	1.27	4.90	0.26	.80
Preview: related vs. non-word	3.76	4.90	0.60	.61
Syntactic Context: Subject vs. Object	-2.61	4.00	-0.65	.52

Note. * p<.05

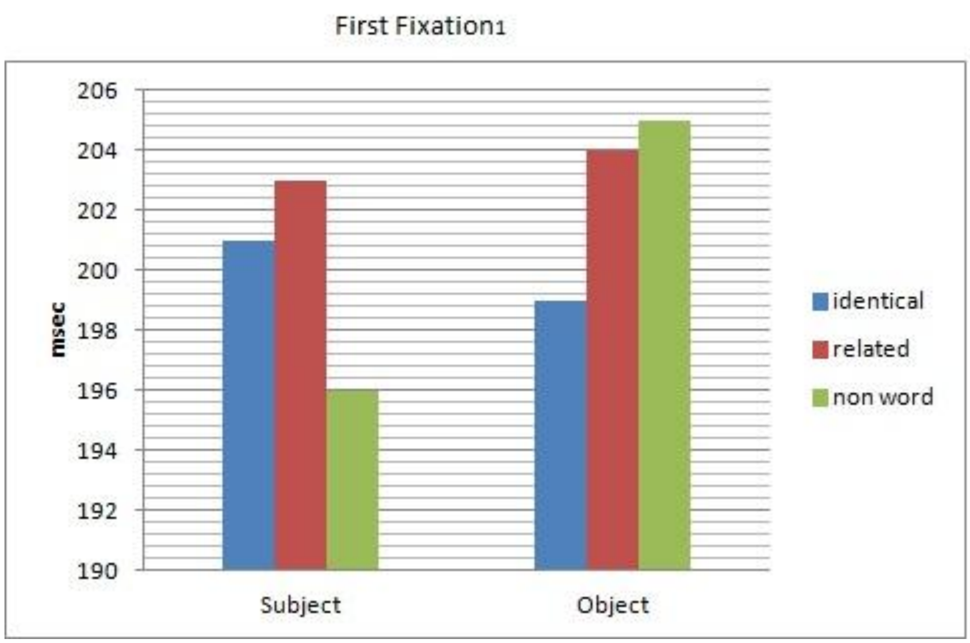

Figure 18. First Fixation$_1$.

Gaze$_1$ duration. This measure is traditionally associated with the early stages of lexical identification of the word. The results of the best-fitted model for gaze duration on the first half of the verb before the eyes crossed the invisible boundary included preview manipulation and syntactic context before the verb, and no interaction. The output of this model is reported in Table 32. The mean $gaze_1$ durations are summarized in Table 30 and Figure 19.

There was a significant (b= -15.99, SE=7.72, p=.04) preview benefit for the identical condition. The identical condition was fixated on average 16 ms shorter than the non-word condition regardless of previous syntactic context (subject or object). The morphologically related condition did not differ significantly from the non-word condition, suggesting that inflectional morphology is not integrated during early stages of lexical access. This pattern of results differs from the pattern observed for long nouns in Experiment 2, where inflectional morphology was integrated during the lexical word identification process as reflected in effects for the morphologically related condition on early fixation measures on the first half of the word before the eyes crossed the boundary.

Table 32

Fixed effects for Gaze $Duration_1$ in Experiment 3

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for $Gaze_1$				
Intercept	264.67	17.82	14.85	.001*
Preview: identical vs. non-word	-15.99	7.72	-2.07	.04*
Preview: related vs. non-word	-3.86	7.72	-0.50	.62
Syntactic Context: Subject vs. Object	-4.75	6.31	-0.75	.45

Note. * p<.05

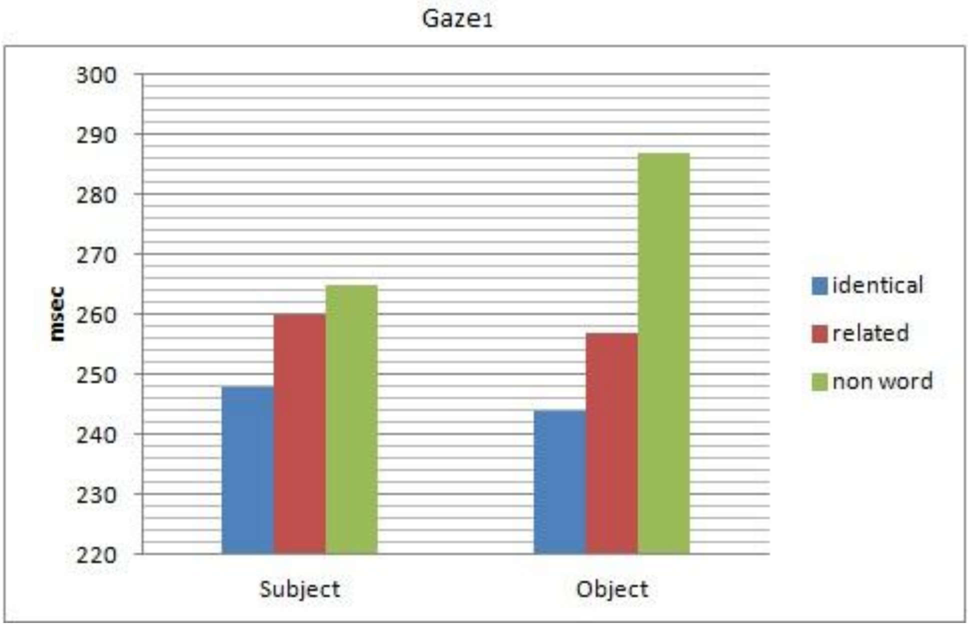

Figure 19. Gaze$_1$

Fixation Measures on the 2nd part of the verb. The measures reported in this section relate to the fixations on the second half of the verb, after the eyes have crossed the invisible boundary. This means that the preview material was changed to the target agreement ending by the time these measures were collected. To ensure that the preview was present in the parafovea prior to the eyes landing on the 2nd part of the word, trials with no fixations on the target region after the display change were excluded from the analysis. This resulted in the loss of less than .003% of the data.

First fixation$_2$ duration. This measure reflects orthographic letter identification. The results of the best-fitted model for first fixation duration on the second half of the verb after the eyes crossed the invisible boundary included preview manipulation and syntactic context before the verb, and no interaction. The output of this model is reported in Table 33. The mean first fixation$_2$ durations are summarized in Table 30 and Figure 20.

There was a significant preview benefit effect for the morphologically related condition (b=-14.96, SE=5.45, p<.01), a marginally significant effect for the identical condition (b=-9.83, SE=5.45, p<.1), and a significant effect of syntactic context (b=26.79, SE=4.45, p<.001). The morphologically related preview elicited on average 5 ms shorter fixations than the identical preview due to the incomplete processing of *показыва**ю*** ('I show' 1st person sg) in *показыва**ю**т* ('they show' 3rd person pl), suggesting that inflectional morphology is processed only at the level of familiarity check and is not fully integrated. A significant effect of syntactic context reveals that in a less frequent word order (after an object) verbal inflections are fixated on average 27 ms longer; however, the absence of interaction between preview benefit and syntactic position suggests that this is a foveal process.

Table 33

Fixed effects for First Fixation$_2$ in Experiment 3

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for First Fixation$_2$				
Intercept	135.28	9.73	13.91	.001*
Preview: identical vs. non-word	-9.83	5.45	-1.80	.07^
Preview: related vs. non-word	-14.96	5.45	-2.75	.01*
Syntactic Context: Subject vs. Object	26.79	4.45	6.02	.001*

Note. * p<.05 , ^ p<.1

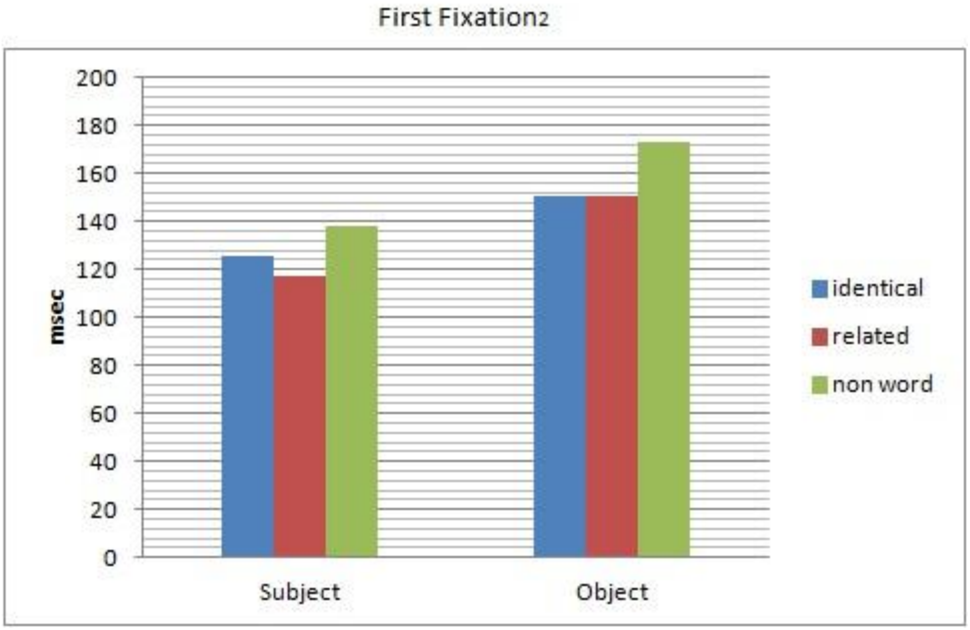

Figure 20. First Fixation$_2$

Gaze$_2$ duration. This measure reflects lexical word identification processes. The results of the best-fitted model for gaze duration on the second half of the verb after the eyes crossed the invisible boundary included preview manipulation, syntactic context before the verb, and no interaction. The output of this model is reported in Table 34. The mean gaze$_2$ durations are summarized in Table 30 and Figure 21.

The identical condition did not differ significantly from non word, suggesting that parafoveally visible letters were not integrated fully during lexical access. This interpretation is supported by a significant preview benefit effect observed for the morphologically related condition (b=-12.78, SE=6.64, p=.05), suggesting that parafoveally processed inflection was identified at the orthographic level based on an incomplete processing of *показыва**ю*** *(*'I show'; 1st person SG) instead of *показыва**ют*** ('they show'; 3rd person PL). This result suggests that unlike for long nouns, parafoveal pre-processing of verbal morphology is not required for the lexical identification of the verbs.

A significant main effect of word order (b=22, SE=6, p<.001) indicates that verbal inflections in a less frequent word order, after an object, are fixated on average 33 millisecond longer than after a subject (canonical word order) regardless of the preview manipulation. This confirms the interpretation of earlier results that morphological integration is a foveal process for the verbs.

Table 34

Fixed effects for $Gaze_2$ in Experiment 3

Predictor	Coefficient	SE	*t* value	*p*
	Fixed effects for $Gaze_2$			
Intercept	135.28	12.01	12.44	.001*
Preview: identical vs. non-word	-8.48	6.65	-1.28	.20
Preview: related vs. non-word	-12.78	6.64	-1.92	.05*
Syntactic Context: Subject vs. Object	32.86	5.43	6.05	.001*

Note. * p<.05

Figure 21. Gaze$_2$

Subgaze$_2$. This measure reflects later integrative stages of word identification and reflects the amount of time participants spent reading the second half of the verb and any refixations on the first half before moving the eyes to the right of the verb (Drieghe et al., 2010). The results of the best-fitted model for the subgaze$_2$ duration included preview manipulation, syntactic context before the verb, and no interaction. The output of this model is reported in Table 35. The mean subgaze$_2$ durations are summarized in Table 30 and Figure 22.

Eye movements in the identical condition did not differ from the non-word condition indicating that the second to last letter of the verb that bears the inflectional information was not processed fully during lexical integration. This interpretation is supported by a significant preview benefit effect for the morphologically related condition ($b=-31.4$, $SE=13.82$, $p<.05$). The morphologically related preview elicited on average 31 ms shorter rereading of the target verb than the non word preview. If a morphologically related case marking had been processed fully and integrated into the syntactic structure similarly to the case integration observed in the nouns, then the syntactically illicit case marking should have been inhibitory. A pattern of results in the opposite direction (facilitation), however, confirms the conclusions drawn from earlier measures suggesting orthographic processing only for the parafoveally available verbal inflections.

A significant effect of word order (b=63.51, SE=11.3, p<.001) shows that the verb after the object elicited 22 millisecond longer rereading times regardless of the preview manipulation. Since subgaze$_2$ is a measure that is associated with later stages of lexical access in the within-word boundary change literature (Pollatsek & Hyöna, 2005; Drieghe at al., 2010), the effect of syntactic context without the interaction with the preview manipulation implies that verbal morphology, unlike the inflectional morphology of the nouns, is integrated into the syntactic structure during foveal processing. The direction of the effect of the syntactic context suggests that the integration of the verb is more effortful in the less frequent word order (OVS).

Table 35

Fixed effects for Subgaze$_2$ in Experiment 3

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Subgaze$_2$				
Intercept	210.40	19.16	10.98	.001*
Preview: identical vs. non-word	-19.49	13.83	-1.41	.16
Preview: related vs. non-word	-31.40	13.82	-2.27	.02*
Syntactic Context: Subject vs. Object	63.51	11.30	5.62	.001*

Note. * p<.05

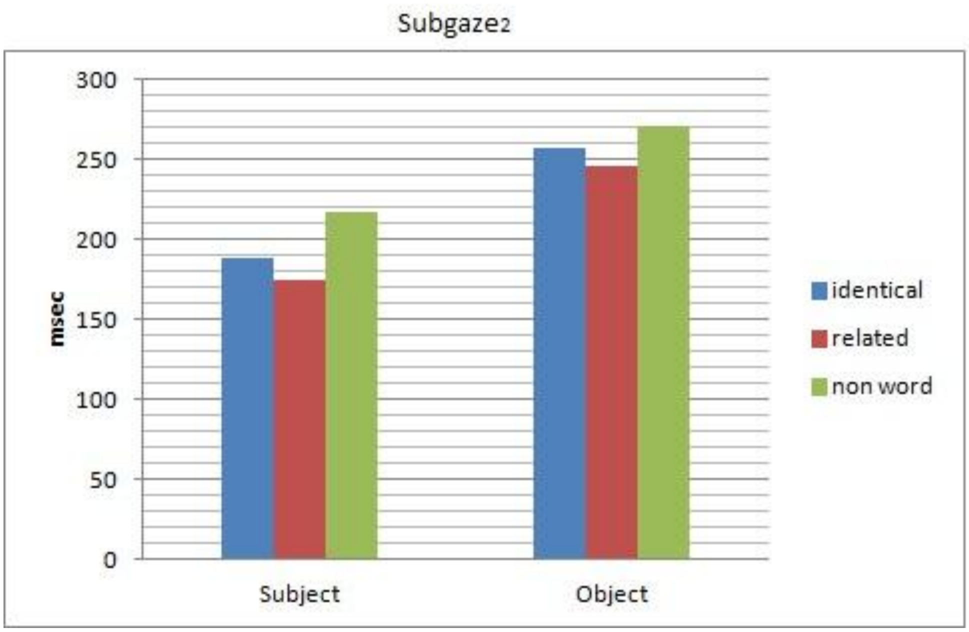

Figure 22. Subgaze$_2$.

Fixation Measures for the whole word. The measures reported in this section traditionally reflect later stages of post-lexical integration.

Gaze$_{word}$ duration. This measure indicates the sum of the durations of all fixations for the first and second parts of the verb on the first encounter with the verb, prior to the eyes leaving the verb, and is considered a global measure of the lexical identification (Pollatsek, & Hyöna, 2005). The results of the best-fitted model for gaze duration for the verb included preview manipulation, syntactic context before the verb, and no interaction. The output of this model is reported in Table 36. The mean gaze durations for the verb are summarized in Table 30 and Figure 23.

There was a significant preview benefit in the identical (b= -20.29, SE=9.98, p<.05) and the morphologically related (b=-19 SE=9, p=.05) conditions. Note that gaze durations on the first part of the verb showed a preview benefit only for the identical condition, while gaze on the second part of the verb demonstrated a preview benefit only for the morphologically related condition. It is no surprise that the results for the gaze durations on the whole verb reflect the accumulated patterns observed in the earlier measures. The observed pattern of results reinforces the definition of the gaze on the word as a global processing measure that needs to be followed up with more fine-grained analyses such as $gaze_1$ and $gaze_2$. The fact that both identical and morphologically related manipulations demonstrated statistically significant differences only in the summed eye fixation durations for the entire verb confirms interpretations of the earlier measures that verbal inflectional morphology processed parafoveally is not integrated during early pre-lexical stages of verb identification.

A significant main effect of word order ($b=36$, $SE=8$, $p<.001$) showed that the verb in OVS order elicited fixation durations that were 36 ms longer than in the canonical SVO order, regardless of the preview manipulation. This is in line with the results reported in earlier measures and confirms the interpretation that the verb is allocated more attentional resources in the less predictable word order.

Table 36

Fixed effects for $Gaze_{word}$ in Experiment 3

Predictor	Coefficient	SE	*t* value	*p*
	Fixed effects for $Gaze_{word}$			
Intercept	409.97	24.51	16.73	.001*
Preview: identical vs. non-word	-20.29	9.98	-2.03	.04*
Preview: related vs. non-word	-19.79	9.97	-1.98	.05*
Syntactic Context: Subject vs. Object	36.16	8.15	4.44	.001*

Note. * p<.05

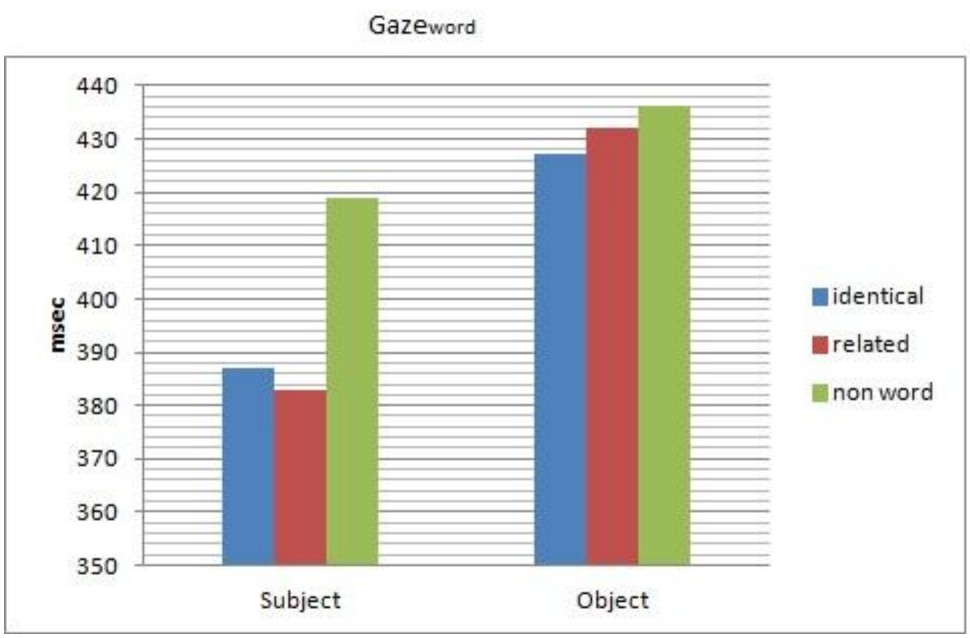

Figure 23. $Gaze_{word}$

Total$_{word}$ *time*. This measure represents the sum of all fixations on the word and reflects post-lexical processing stages. The results of the best-fitted model for total time participants fixated on the verb included preview manipulation, syntactic context before the verb, and no interaction. The output of this model is reported in Table 37. The mean total times for the verb are summarized in Table 30 and Figure 24.

There was a significant preview benefit for the identical (b= -48, SE=23, $p<.05$) condition. Although Figure 24 and the numeric means in Table 30 hint at a possible interaction between word order and preview for the morphologically related condition, the interaction was not significant. Further examination of standard deviations for the conditional means reveals extreme variability in total times across participants. Further research is needed to investigate later effects of parafoveal manipulations.

A significant effect of word order (b=141, SE=23, $p<.001$) shows that participants spent on average 141 millisecond longer reading the verb in OVS order than in SVO order, regardless of the preview manipulation. This result is in line with earlier observations that of longer overall reading times in non-canonical word orders. Increased allocation of attentional resources to the foveal processing of the verb may be the reason why there was no integration of parafoveally available verbal inflectional morphology.

Table 37

Fixed effects for $Total_{word}$ in Experiment 3

Predictor	Coefficient	SE	*t* value	*p*
	Fixed effects for $Total_{word}$			
Intercept	685.13	40.05	17.11	.001*
Preview: identical vs. non-word	-48.10	23.36	-2.07	.04*
Preview: related vs. non-word	-23.46	23.24	-1.01	.31
Syntactic Context: Subject vs. Object	141.67	19.00	7.46	.001*

Note. * p<.05

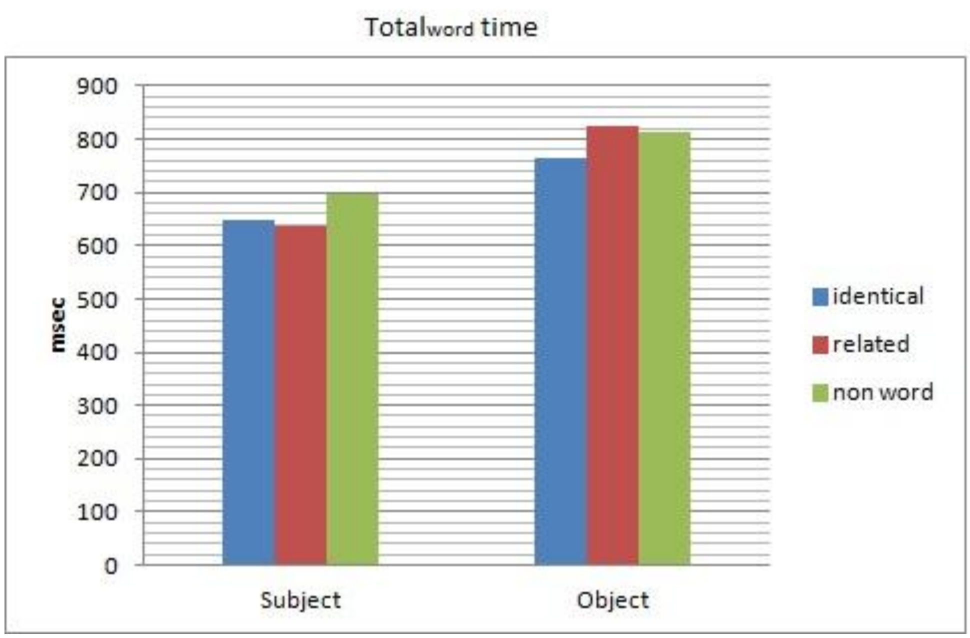

Figure 24. $Total_{word}$ Time.

Go-past$_{\text{word}}$ *time*. This measure represents the amount of time participants spent re-reading earlier parts of the sentence before moving their eyes off the target word to the right. The results of the best-fitted model for the go-past time for the verb included preview manipulation, syntactic context before the verb, and no interaction. The output of this model is reported in Table 38. The mean go-past times for the verb are summarized in Table 30 and Figure 25.

Go-past time mirrored the total reading time measures for the target verb reported above. There was a significant preview benefit for the identical preview condition ($b=-46$, $SE=19$, $p<.05$), along with significant effect of word order ($b=83$, $SE=15$, $p<.001$), confirming that the non-canonical word order elicited more re-reading during post-lexical integration. The absence of preview benefit in the morphologically related condition is in line with the view that syntactic information associated with inflectional case markings on verbs, which was available parafoveally, was not integrated.

Numeric means persistently point toward an insignificant interaction between target positions, likely due to the large standard deviations that were observed. Taken together with the with large participant variability observed in the post-lexical integration of the nouns, this result warrants further investigation of individual differences during post-lexical integrative processes.

Table 38

Fixed effects for Go-Past$_{word}$ in Experiment 3

Predictor	Coefficient	SE	*t* value	*p*
	Fixed effects for Go-Past$_{word}$			
Intercept	535.44	32.48	16.48	.001*
Preview: identical vs. non-word	-46.25	19.58	-2.36	.02*
Preview: related vs. non-word	-22.91	19.57	-1.17	.24
Syntactic Context: Subject vs. Object	83.39	15.99	5.22	.001*

Note. * p<.05

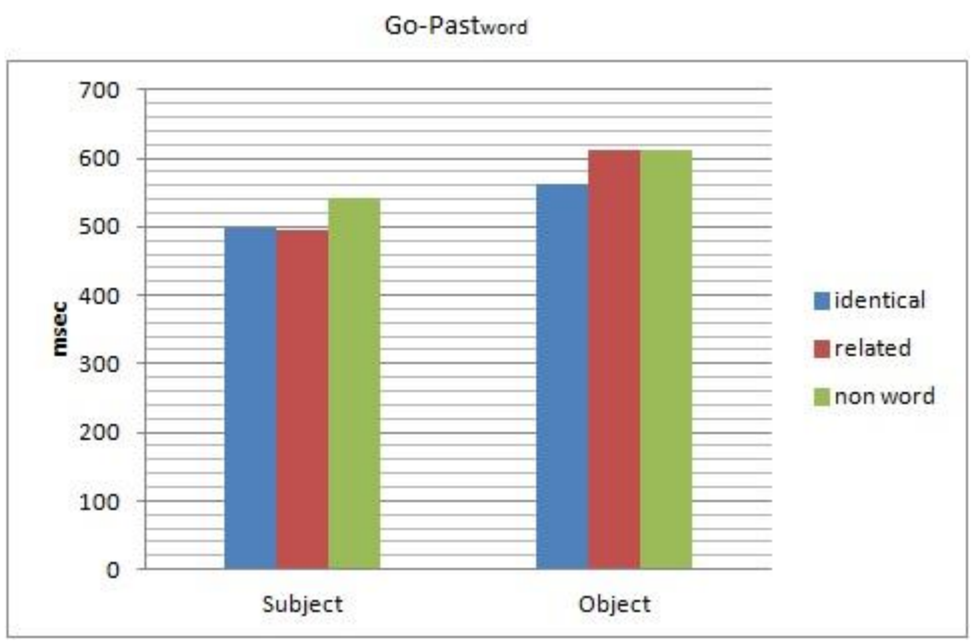

Figure 25. Go-Past$_{word}$

Regressions in. Regressions into the target along with total time and go-past time for the whole word reflect post-lexical integration. Regressions rates were analyzed by a binomial logit regression model with items and participants as random factors. The results of the best-fitted model for percent of regressions into the verb included preview manipulation, syntactic context before the verb, and no interaction. The output of this model is reported in Table 39. The mean percent of regressions into the verb is summarized in Table 30 and Figure 26.

Regression rates into the target verb revealed a significant preview effect in the identical condition ($b=-.26$, $SE=.12$, $p<.05$) and a significant effect of word order ($b=.38$, $SE=.09$, $p<.001$), further corroborating the view that non-canonical word order resulted in more effortful verb processing. The absence of a preview benefit in the morphologically related condition is in line with the rest of the measures of post-lexical integration. This supports the view that syntactic information associated with inflectional case markings for verbs that was available parafoveally was not integrated until later, post-lexical processing. Persistent insignificant interaction between syntactic context and preview manipulation with large standard deviations suggests that individual differences affect post-lexical integration to a larger degree than the low level word identification processes.

Table 39

Fixed effects for Regressions Into$_{word}$ in Experiment 3

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Regressions Into$_{word}$				
Intercept	-1.35	0.14	-10.02	.001*
Preview: identical vs. non-word	-0.26	0.12	-2.16	.03*
Preview: related vs. non-word	-0.03	0.11	-0.25	.80
Syntactic Context: Subject vs. Object	0.38	0.10	3.90	.001*

Note. * p<.05

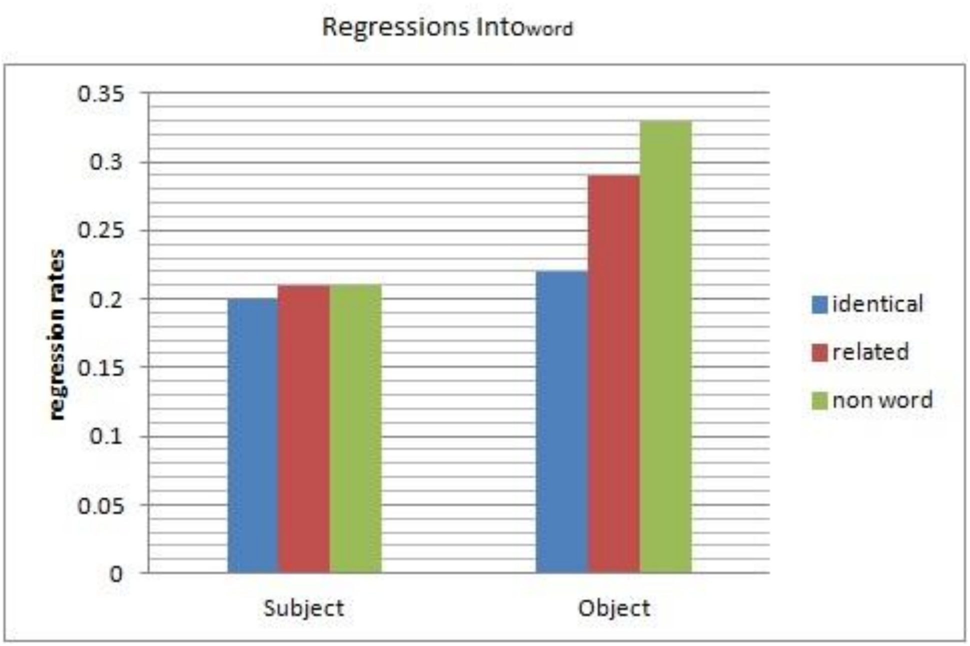

Figure 26. Regressions Into$_{word}$

General Discussion

Experiment 3 examined the effects of syntactic context on the parafoveal processing of morphology in Russian long verbs using a within-word boundary-change manipulation with three previews (identical, morphologically related, and non-word). Syntactic effects were investigated by varying preceding syntactic context (canonical SVO vs. non-canonical OVS). To examine the time-course of morphological and syntactic effects, the target word was divided into two parts (1^{st} part up to the invisible boundary, and 2^{nd} part after the invisible boundary). Word identification measures were first fixation$_1$, gaze$_1$ (1^{st} part of the verb); first fixation$_2$, gaze$_2$, and subgaze$_2$. Late measures tapping into post-lexical integration of the target word included gaze duration for the verb, total time, go-past time and regressions into the verb.

Orthographic processing of verbal inflections can elicit facilitation in the early measures of word identification (first fixation, gaze) only for identical or morphologically related conditions, based on incomplete processing. If morphological information were fully integrated during pre-processing in the parafovea, then word identification measures had been expected to reveal facilitatory effects for both identical and morphologically related conditions. Under such a view, syntactic integration was expected to be affected by the pre-processed information. As a result the morphologically related preview was predicted to interfere with the active syntactic structure of the sentence and reveal inhibitory effects for the morphologically related condition in later measures.

It was hypothesized that allocation of attention could interact with syntactic context in two ways. The non-canonical word order coul result in more effortful foveal processing and reduce parafoveal integration of the morphological information. In such a case, reduced preview benefit effects across all conditions for target object were expected. Alternatively, increased allocation of attention in the non-canonical word order could widen the perceptual span and result in deeper processing of the parafoveally available information and result in complete integration of morphology. Under such a view, an increased preview benefit effect for identical and morphologically related conditions in the OVS word order was expected. Absence of preview manipulation effects in early measure was expected if inflectional morphology is not integrated during pre-lexical verb processing.

Gaze durations on the first half of the verb demonstrated a preview benefit effect only for the identical condition, suggesting only orthographic processing of inflections. Fixations on the second half of the verb after the preview was changed to the target case ending elicited a significant preview benefit effect only for the morphologically related condition, further confirming orthographic level processing. A marginally significant effect for identical preview in the first fixation on the second half of the word that disappeared in the gaze and subgaze further corroborated incomplete processing of verbal case endings during early stages of lexical access for the verbs.

A persistent effect of word order that emerged as early as the first fixation on the second half of the verb and lasted as late as regressions into the target verb revealed that participants were sensitive to the syntactic frequencies of the word orders. The target verb in the less frequent OVS elicited consistently longer fixations than in the canonical SVO. The absence of interactions across all measures between the target position and preview manipulation indicate that syntactic context does not modulate morphological processing for Russian long verbs in the parafovea.

The only measure that revealed a significant preview benefit effect for both identical and morphologically related conditions was the cumulative gaze durations on the target verb. This is a measure that reflects the sum of the preview benefit reported for the first and second halves of the verb. The obtained results confirm that gaze duration for the whole word cannot be taken as evidence of early stages of lexical integration when the word identification processes of long verbs are investigated. Instead such fine-grained measures as $gaze_1$ and $gaze_2$ should be considered (Pollatsek & Hyöna, 2005).

Later measures on the whole word consistently revealed a preview benefit effect only for the identical condition and indicated that the morphologically related condition was not statistically different from the non-word condition. Such an inhibitory effect, the extent it is real, indicates that preview manipulations for both morphologically related and non word conditions influenced post-lexical stages as reflected in the total time, go-past time, and regressions. More research is needed to understand the exact nature of the post-lexical processing mechanisms.

Numeric means in the late measures indicated that the word order might have interacted with the preview manipulation as was predicted by a cognitive allocation of attention account. Numerically reduced preview benefit effects for all manipulations in the OVS order imply that effortful foveal processing in the non-canonical word order reduced the extent of pre-processing on the verbs. The morphologically related condition in the SVO order elicited numerically shorter total times than the non-word condition. Since this is a more frequent canonical word-order, reduced attention to the verb could have reduced the perceptual span and reduced the parafoveal processing of the verbal morphology. However, none of the observed interactive trends were statistically significant. High individual variability, as evidenced by large standard deviations, may be the reason for the lack of significance. Late measures that reflect post-lexical integrative processes should prove to be key measure in any subsequent investigations of the relationship between perceptual span and syntactic context. However, more research is needed to get a better understanding of the post-lexical mechanisms.

Summary

Experiment 4 provides clear evidence that morphological information is not integrated parafoveally in Russian verbs. Early measures indicated that morphological information available in the parafovea is not integrated during the lexical access of long verbs in Russian. Persistent effects of syntactic context as early as first fixation$_2$ along with the absence of interaction with preview manipulations across early and late measures indicate that syntactic context affects lexical access and post-lexical integration of Russian verbs. However, more investigation into the time–course of morphological and syntactic information during later post-lexical integrative stages is still needed to investigate the exact mechanisms.

CHAPTER 6:

L2 LEARNERS

Eye tracking research using the boundary change paradigm (Rayner, 1975) has demonstrated that native speakers of English and several other languages integrate information about the length of the upcoming word (*n+1*) available in the parafoveal visual field, while the eyes are fixated on the word *n* (Rayner, 1998). To date, evidence that higher-level linguistic information, such as morphology or syntactic context, is integrated in the parafovea is absent in the literature except for in Hebrew (Deutsch et al., 2005). Experiments 1-3 in this dissertation have established that native Russian speakers also process morphology parafoveally. Such integration is modulated by word length and syntactic context. This is the first evidence of parafoveal morphological processing in an Indo-European language.

There is still, however, no record of any active research on what type of information second language (L2) learners obtain in the parafovea during silent reading in their L2. Experiment 4, reported in this chapter, represents the first known investigation of parafoveal processing by L2 speakers of any language. To investigate the depth of processing in the parafovea in a non-native language, a group of L1-English L2 learners of Russian took part in the experiment. The L2 Russian speakers' results will be compared qualitatively to the native speakers' results reported in Chapter 3 of this dissertation.

Experiment 4: Between-Word Boundary Change – Nouns

Experiment 4 has two goals: (1) to determine if L2 learners process morphological information in the parafovea when reading short nouns in Russian, and (2) to determine how the syntactic predictability of an upcoming word affects the time course of the morphological processing of that word. Syntactic context was varied according to the same principles described in Chapter 3 (VSO word order; target word: subject/object). Morphological processing in the parafovea was examined through the same three preview manipulations on the target word: identical (no change), morphologically related (different inflectional ending), and non-word (inflection replaced with a consonant) as in Experiments 1 and 3. Table 40 presents an example of the preview manipulations for the target word in the two syntactic positions (cf., Experiment 1).

Table 40

Preview Manipulation Conditions for Two Syntactic Categories

	Identical	Morphologically Related	Non-word
Subject	лодк**а** boat (NOM)	лодк**у**	лодк**д**
Object	лодк**у** boat (ACC)	лодк**а**	лодк**д**

The target word was inserted into a sentence frame either at the argument position immediately after the verb (1a) or at the second argument position (1b). The vertical lines indicate the position of the invisible boundary. When the eyes made a saccade over the boundary, the preview word (See Table 40) was replaced with the target word.

(1a) В доке загораживала| **лодка** *NOM* доску у мостка.

In the dock blocked boatNOM logACC by the bridge.

(1b) В доке загораживала доска| **лодку** *ACC* у мостка.

In the dock blocked logNOM boatACC by the bridge.

Method

Measures. The effects of morphological processing in the parafovea can be observed as early as the first fixation. The planning for the fixation takes place during a prior fixation and is affected by parafoveal information (Rayner, 1998; Bertram & Hyöna, 2003). Gaze duration, according to previous research (Deutsch et al., 2005; Hyöna et al., 2004), is sensitive to parafoveal manipulations. Gaze duration on the target word can also reflect the influence of prior context, such as predictability from the prior text (Rayner & Pollatsek, 1989). This measure will be used to examine any effects of syntactic predictability on parafoveal processing (Deutsch et al., 2005, Experiment 4).

Go-past time has been found to reflect the effects of higher-level linguistic information on foveal processing (semantic processing in Finnish: White, Bertram, & Hyöna, 2008) and parafoveal processing (syntactic predictability in Hebrew: Deutsch et al., 2005). This measure, along with regressions into the target word, second pass, and total time, was used to examine later effects of syntactic context and parafoveally integrated information during post-lexical integration of the target word into the active structure of the sentence.

Predictions. Native speakers revealed preview benefit effect only for the identical preview condition in gaze duration, indicating that higher level information was not integrated during lexical word identification. Predictability of the syntactic context affected lexical word identification and post-lexical integration of native speakers. Gaze duration revealed shorter durations for the syntactically more predictable object position. Second-pass times revealed the effect in the opposite direction, indicating that the native speakers compensated for earlier shorter processing times in the object position. Total time revealed interaction between the syntactic position and preview manipulation indicating that participants looked longer at the target in the subject position when the morphologically related preview was displayed.

If L2 learners process morphosyntax the same way as native speakers then they will preprocess upcoming words at the orthographic level. Gaze durations should reveal a preview benefit effect for the identical condition as compared to the non-word condition. L2 learners will be sensitive towards predictability of the syntactic context and elicit shorter gaze durations on the target word in the object position. Syntactic context will modulate pre-processing of parafoveally available information during post lexical integration and total time will reveal interaction between syntactic position and preview manipulations for the morphologically related condition. Under such a view, longer total time in the subject position for the morphologically related condition as compared with the non-word is expected.

If L2 learners lexicalize non-native morphology, as has been proposed by Silva and Clahsen (2008) and Clahsen and Neubauer (2010), then in principle L2 learners should use morphological information during lexical word identification. Then the morphologically related condition can also elicit a preview benefit effect as compared with the non-word condition. If L2 learners integrate morphology during lexical access and post-lexical integration, then the morphologically related condition can exhibit inhibitory effects in the object position (*VS**S**) as early as gaze duration. The absence of any preview benefit effect will indicate that L2 learners do not integrate orthographic features of the upcoming words.

If L2 learners are sensitive towards the restrictiveness of the syntactic position of the target word in the same way as native speakers but cognitive resources are taxed to a higher degree than native speakers, as has been suggested by McDonald (2000, 2006), then no interaction between the preview benefit and syntactic position is expected in the total time.

Instead, the target word in the subject position should elicit elevated gaze durations and the target word in the object position should elicit longer second-pass durations. Absence of any effects of the target syntactic position will indicate that L2 learners are not sensitive toward the syntactic context.

Materials. Same as in Experiment 1.

Design. Same as in Experiment 1.

Participants. Forty-eight Russian native speakers who participated in Experiment 1 served as a control group for this experiment. See Chapter 3 for a detailed description of the native speakers.

Ten L2 learners of Russian who were native speakers of English from the University of Illinois at Urbana-Champaign community participated in Experiment 4. (An additional five participants were excluded from analysis for the following reasons: one was a native speaker of Spanish, one was a heritage speaker of Russian, and three participants scored below the minimum required score on the pre-test, see below). Relevant characteristics of the L2 group are summarized in Table 41. The data in Table 41 reveal that the group of L2 learners was rather homogeneous: not much variability in age or years of Russian study. Scores on the cloze test along with self-rated proficiency scores indicate that the group was at the beginning-intermediate level of proficiency in Russian. All participants were compensated $15.00 for their time.

Table 41

Characteristics of L2 learners

Characeristics	Mean	Range
Age	20	19-22
Cloze test score (out of 27)	7	0-11
Years spent formally studying Russian	2 years	2 years
Self-rated Russian proficiency (out of 10):		
Reading	4.5	2-6
Writing	5.1	3-6
Speaking	4.5	2-6
Grammar	5.3	3-6

Pre-Test. To ensure that the L2 learners had at least a rudimentary awareness of noun inflectional morphology, particularly accusative case markings, each participant completed a pre-test before the main reading experiment. Participants read simple transitive Russian sentences in canonical SVO and object initial OVS word orders as seen in (2a-b).

(2a) Мальчик догнал девочку.

A boyNOM caught up with the girlACC.

(2b) Девочку догнал мальчик.

The girlACC caught up by a boyNOM.

(2c) Question: Who was doing the catching?

Each sentence was followed by a question in English as seen in (2c). The test consisted of 10 items (5 in SVO and 5 OVS); none of the lexical items were repeated in either of the word order. The test was presented as an online form and accuracy ratings were recorded. Eye movement data for participants who scored 70% or less (three participants) were excluded from the analysis, as a score below 70% indicated that the participant was performing at chance on the pre-test, rendering the eye movement data highly unreliable.

Vocabulary check. To ensure that participants knew the lexical items from the experiment, they completed a vocabulary checklist after the main reading experiment. The vocabulary check list contained 180 lexical items (target word, main verb, and second argument) encountered in the main experiment. Participants were asked to provide a written translation for each of the lexical items in the checklist. Any sentences that contained the items a participant was not able to translate accurately were removed from that participant's data prior to analysis. This resulted in a loss of .005% of the data.

Apparatus. Same as in the Experiments 1-3.

Procedure. Same as in the Experiments 1-3.

Results

Data exclusion criteria. It has been established that foveal processing on average corresponds to 6-7 characters (Schotter et al., 2012). As seen in the example (1a-b) the short words in Experiment 4 are 5-characters long. If the fixation prior to the target word occurs immediately before the boundary change (on the last two characters of the previous word) then the target word might be in the fovea, as the case marking will be the 7th or 8th character – right on the edge of the fovea. It was intended prior to data collection to analyze such trials separately.

Analysis of the eye-landing location on the word before the target word revealed zero instances when the eyes landed on the region within two characters before the invisible boundary. As a result, it is safe to conclude that any effects reported in the results section can be attributed to parafoveal processing and not foveal processing.

Fixation durations shorter than 80 ms or longer than three standard deviations from the grand mean for the target word were eliminated. These criteria resulted in the removal of less than .05% of the data. The reading time data were analyzed using linear mixed effects modeling (Baayen et al., 2008). Items and participants were included as random effects. All models were fitted using a stepwise model selection procedure, in which only those predictors that were significant or marginally so ($p<.1$) were retained in the model. P-values were obtained using Markov Chain Monte Carlo sampling. Items and participants were included as random factors. Preview manipulations and target position were included as fixed effects along with their interaction. Detailed results for native speakers are reported in Chapter 3 and will be summarized when relevant along with the L2 learners' results. Eye fixations for the pre-boundary word (*n-1*), target word (*n*), and a word after the target word (*n+1*) were analyzed. No significant differences were obtained for word *n-1* or word *n+1*. Results reported below therefore reflect eye movement measures for the target word *n* only.

First Fixation Duration. This measure is traditionally associated with orthographic word identification. The results of the best-fitted model for first fixation durations included the preview manipulation and the syntactic role of the target word, but no interaction. The output of the model is reported in Table 42. Mean first fixation durations are summarized in Table 43 and Figure 27.

None of the experimental manipulations came up significant in the analysis of first fixation duration. The graph in Figure 27 suggests that both the identical and the morphologically related conditions are faster than the non-word condition. However, the L2 first fixation numeric means in Table 43 indicate that L2 learners' first fixations are almost twice the size of the first fixation durations for native speakers. For example, mean first fixation for native speakers in the identical condition was 249 ms (see Chapter 3), whereas for L2 learners the mean first fixation in the same condition was 400 ms. First, this suggests that there was significantly more variability in L2 learners (note the SDs in Table 43). Second, it may well be that due to either the wide variability in the fixation durations of L2 learners, or to the overall increased processing times, or to the very small number of L2 participants, the numeric advantage of 64 ms observed for the related condition in the target object condition (408 ms for related vs. 472 ms for non-word) is a spurious effect.

Table 42

Fixed effects for First Fixation Duration in Experiment 4

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for First Fixation				
Intercept	445.47	38.04	11.71	0.000*
Preview: identical vs. non-word	-42.64	31.20	-1.37	0.17
Preview: related vs. non-word	-38.89	31.20	-1.25	0.21
Target Syntactic Role: Subject vs. Object	16.68	25.53	0.65	0.51

Note. * $p<.05$

Table 43
Mean First Fixations with Standard Deviations in Parenthesis

	Subject	Object
Identical	400 (365)	423 (307)
Related	422 (287)	408 (319)
Non-word	435 (318)	472 (363)

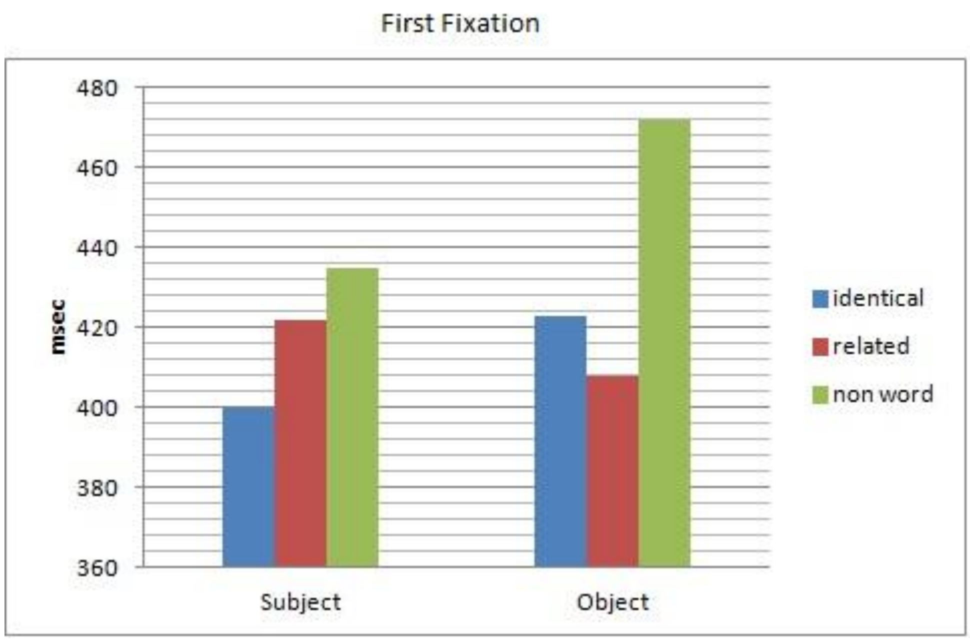

Figure 27. Mean first fixation durations.

Gaze Duration. This measure reflects stages of lexical access. The results of the best-fitted model for gaze duration included the preview manipulation and the syntactic role of the target word, but no interaction. The output of the model is reported in Table 44. Mean gaze durations are summarized in Table 45 and Figure 28.

None of the experimental manipulations came up significant in the analysis of gaze duration. The graph in Figure 28 suggests that only the identical condition elicited shorter fixations than the non-word. The morphologically-related preview elicited numerically longer (17 ms difference in subject position and 37 ms difference in object position) fixations than the non-word condition; however, the conditional means in Table 45 show that L2 learners' gaze durations were three as long as native speaker gaze durations, with extremely large standard deviations. First, this suggests that there was significantly more variability in L2 learners' reading patterns. Second, it is possible that either due to the wide variability in the gaze durations of L2 learners or increased processing times, the numeric difference between the preview conditions is not meaningful.

For native speakers, a 21 ms facilitatory preview benefit effect for the identical condition in gaze durations revealed that although native speakers did not integrate the morphology of the upcoming word in the parafovea, they pre-processed the target word at the orthographic level (see Chapter 3 for a detailed discussion). The absence of a preview benefit effect in the gaze duration in Experiment 4 indicates that L2 learners are not pre-processing the upcoming word *n*+1 even at the orthographic level.

Table 44

Fixed effects for Gaze Duration in Experiment 4

Predictor	Coefficient	SE	*t* value	*p*
		Fixed effects for Gaze		
Intercept	952.00	111.68	8.52	.001 *
Preview: identical vs. non-word	64.32	63.13	1.02	.68
Preview: related vs. non-word	-26.20	63.13	-0.42	.31
Target Syntactic Role: Subject vs. Object	13.49	51.7	0.26	.79

Note. * $p<.05$

Table 45

Mean Gaze with Standard Deviations

	Subject	Object
Identical	914 (758)	850 (629)
Related	963 (754)	979 (750)
Non-word	946 (739)	942 (623)

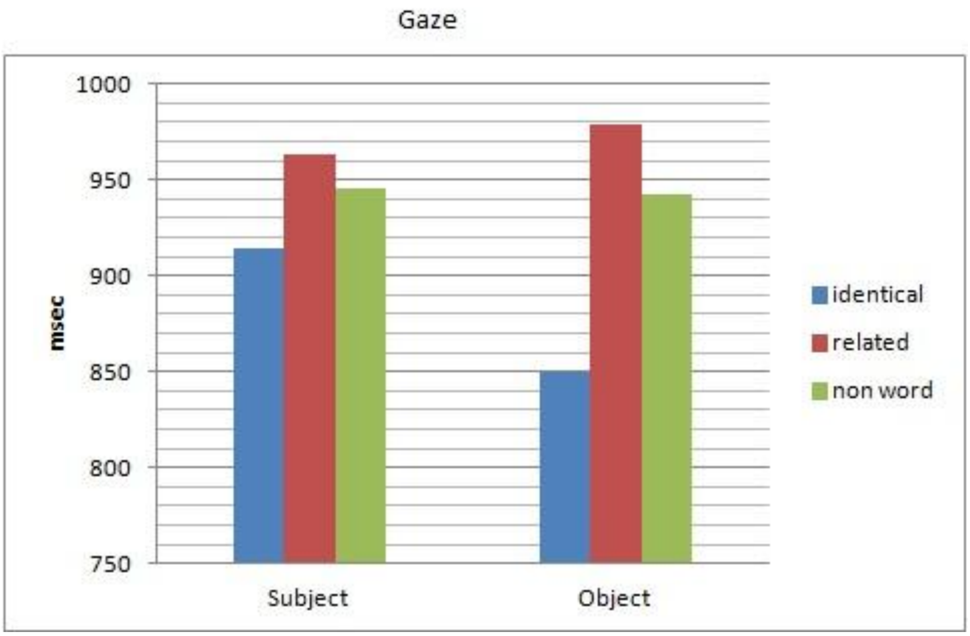

Figure 28 Mean gaze durations.

Total Time. This measure reflects post-lexical integrative stages of processing. The results of the best-fitted model for total time included preview and syntactic role of the target word, but no interaction. The output of this model is reported in Table 46. Mean total time results are summarized in Table 47 and Figure 29.

The absence of any significant effects of experimental manipulations reveals that L2 learners were not sensitive to either the preview manipulation or the syntactic position manipulations. The conditional means (Table 47 and Figure 29) show an inhibitory effect for the morphologically related condition (17 ms in the subject and 37 ms in the object positions) and a facilitatory effect (28 ms in the subject and 52 ms in the object positions) for the identical condition as compared with the non-word condition. Table 47 also points toward large standard deviations; this suggests a large variability among participants. Moreover, the comparison of the conditional means for L2 and native speakers indicates that L2 learners spent at least one third longer fixating the target word than native speakers in the identical preview condition in the subject position (914 ms vs. 634 ms). As a result, it is possible that due to the wide variability in the total time for the L2 learners, or increased processing times, or the small number of participants, the numeric difference between the preview conditions is not meaningful.

Results of the total time for native speakers, reported in Chapter 3, revealed an interaction between preview manipulation and syntactic position for the morphologically related condition. This suggests that the pre-processed information affected not only word identification stages but also later post-lexical integration. The insensitivity of L2 learners to the conditions is in line with the results observed in earlier measures. The persistent insensitivity towards preview manipulations indicates that all stages of word identification are impacted. This could mean that effortful decoding during orthographic processing, affected word identification and post lexical integration. Further research needed to investigate the exact nature of the relationship between all three stages in L2 processing.

Longer gaze durations and total times on the target word in the subject position reported for native speakers in Experiment 1, Chapter 3, indicated that native speakers were sensitive to the syntactic context. As a result, they allocated more attention to the target word in the less restricted subject position. L2 learners' gaze durations and in total times were not affected by the syntactic context. The observed pattern of results suggests that beginning L2 learners do not engage in predictive parsing as efficiently as native speakers do. This could be because of an increased processing load in the fovea that reduces the perceptual span and affects not only the lexical access of the target word, but also the integration of this word into the active structure of the sentence.

Table 46

Fixed effects for Total Time in Experiment 4

Predictor	Coefficient	SE	*t* value	*p*
		Fixed effects for Total time		
Intercept	1485.87	157.35	10.08	.001 *
Preview: identical vs. non-word	102.25	132.12	0.77	.44
Preview: related vs. non-word	76.04	131.92	0.58	.56
Target Syntactic Role: Subject vs. Object	173.96	132.12	1.32	.19
Interaction: Object x identical	38.58	187.12	0.21	.83
Interaction: Object x related	267.59	186.56	1.43	.15

Note. * p<.05

Table 47

Mean Total Time with Standard Deviations

	Subject	Object
Identical	914 (758)	850 (629)
Related	963 (754)	979 (750)
Non-word	946 (739)	942 (623)

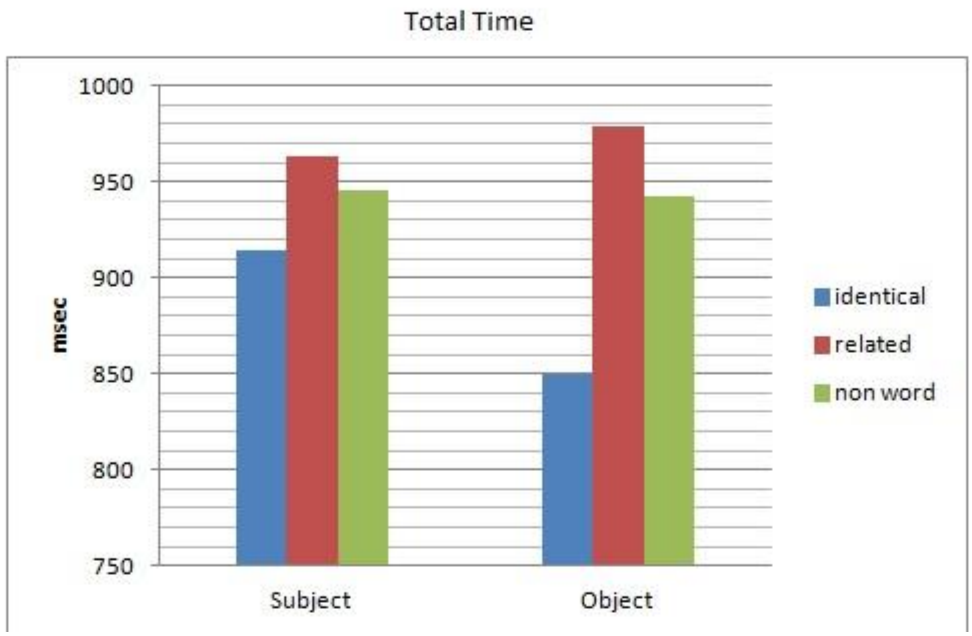

Figure 29. Mean total time.

Regressions into the Target Word. This measure is associated with later stages of post-lexical integration. Regressions into the target word were analyzed by a binomial logit regression model with items and participants as random factors. The results of the best-fitted model included preview, syntactic role of the target word, and no interaction. The output of this model is reported in Table 48. The mean total time results are summarized in Table 49 and Figure 30.

For L2 learners no experimental manipulations affected regressions. Large standard deviations consistently point toward large variability among participants. The mean percent of regressions in Figure 30 point towards an interaction between the preview manipulation and the syntactic context. But the numeric differences provided in Table 49 are very small, so not much weight can be given to this numeric trend. The obtained results suggest that L2 learners were insensitive to both the restrictiveness of the syntactic context and the parafoveal manipulations, possibly due to an increased allocation of cognitive resources to foveal processing and a reduced perceptual span (Henderson & Ferreira, 1990).

Table 48

Fixed effects for Regressions into the Target word in Experiment 4

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Regressions into the target				
Intercept	-1.67	0.29	-5.82.	0.000*
Preview: identical vs. non-word	0.09	0.27	0.30	0.77
Preview: related vs. non-word	0.11	0.26	0.42	0.67
Target Syntactic Role: Subject vs. Object	-0.05	0.22	-0.24	0.81

Note. * p<.05

Table 49

Mean Regressions into the Target word with Standard Deviations

	Subject	Object
Identical	.20 (.40)	.17 (.38)
Related	.18 (.39)	.20 (.40)
Non-word	.18 (.39)	.17 (.38)

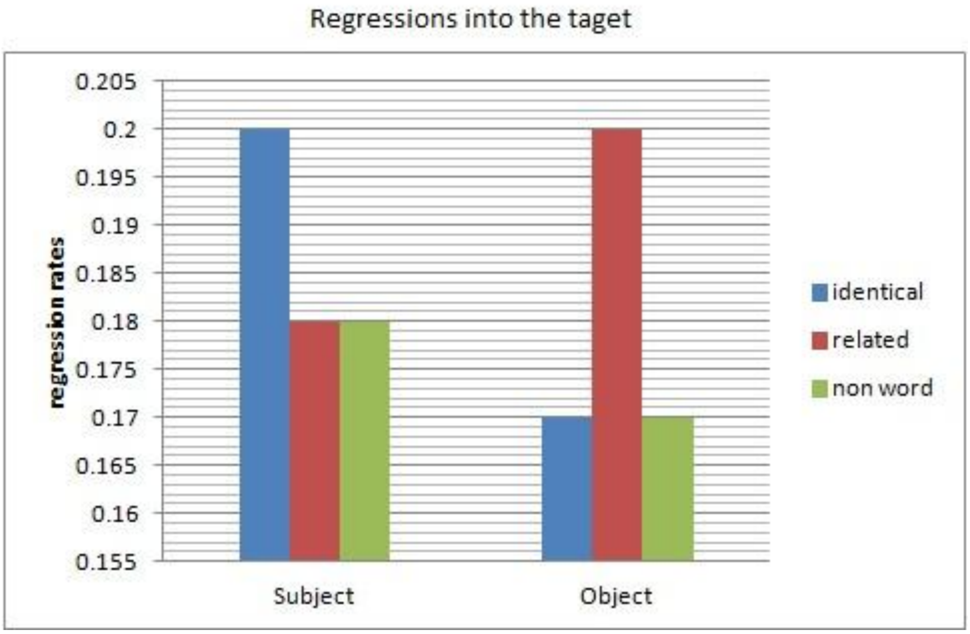

Figure 30. Mean regressions into the target.

Go-Past Time. This measure reflects the amount of time participants spent re-reading earlier parts of the sentence before moving their eyes to the right of the target word. The results of the best-fitted models for go-past time for both native speakers and L2 learners included preview and syntactic role of the target word, but no interaction. The output of this model is reported in Table 50. Mean total time results are summarized in Table 51 and Figure 31.

None of the experimental manipulations affected go-past time. The conditional means revealed quite long durations. Large standard deviations point towards a high degree of variability among participants. L2 learners spent three times longer than native speakers rereading the target word in the identical condition in the subject position (1283 ms vs. 417 ms from Chapter 3). This suggests more effortful integration of the target word into the sentence structure for L2 learners as compared to the native speakers. The graph in Figure 31 hints at an insignificant interaction, but numeric means in Table 51 indicate that this difference coupled with large durations and large variability among participants is spurious.

Table 50

Fixed effects for Go-Past Time in Experiment 4

Predictor	Coefficient	SE	*t* value	*p*
		Fixed effects for Go-Past		
Intercept	1332.48	165.65	8.04	.001 *
Preview: identical vs. non-word	80.59	84.75	1.41	.34
Preview: related vs. non-word	-18.34	84.75	-0.95	.82
Target Syntactic Role: Subject vs. Object	98.20	69.46	0.21	.15

Note. * p<.05

Table 51

Mean Go-Past Time with Standard Deviations

	Subject	Object
Identical	1283 (1039)	1121(891)
Related	1321 (1204)	1282 (842)
Non-word	1327 (1004)	1240 (891)

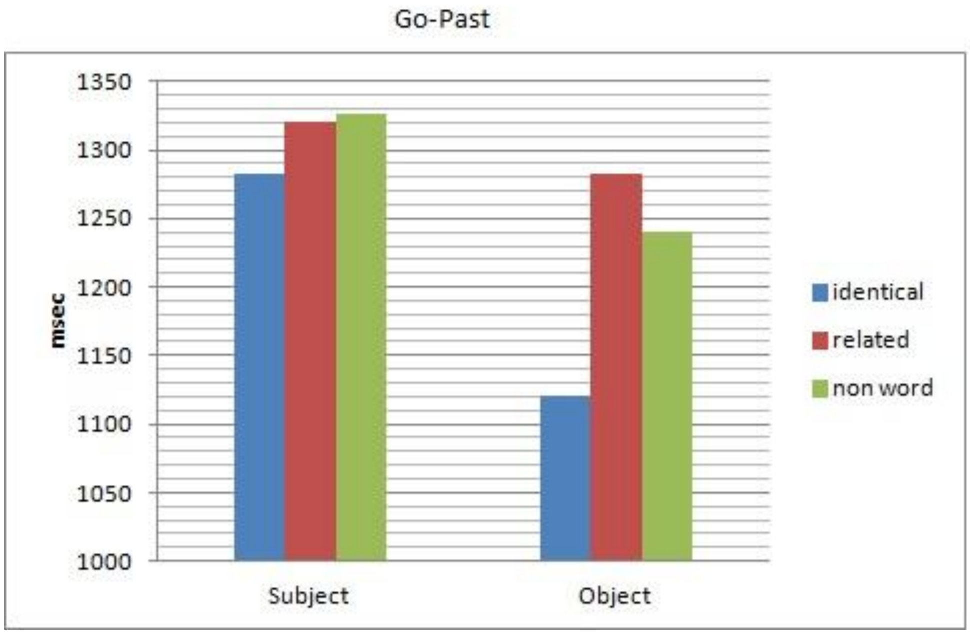

Figure 31. Mean Go-Past Times.

Second-Pass times. Second pass times included fixations on the target word after the eyes have moved to the right from it. This measure represents the amount of time readers spent re-reading the target word. The results of the best-fitted model for second pass times included preview and syntactic role of the target word, but no interaction. The output of this model is reported in Table 52. The mean total time results are summarized in Table 53 and Figure 32.

None of the experimental manipulations affected re-reading times for L2 learners. However, the conditional means and standard deviations in Table 53 indicate that the standard deviations are three times the size of the obtained means, i.e., there was extreme variability among participants. The results of second pass times are in line with the rest of the post-lexical integration measures, such as total time, go-past time, and regression rates. They all reveal that, unlike native speakers who reread the target word more in the object position to compensate for reduced earlier processing, L2 learners were not sensitive to either the preview manipulation or the syntactic restrictiveness of the target word position. This is possibly due to increased cognitive load processing foveal information in an L2, resulting in a reduced perceptual span.

Table 52

Fixed effects for Second-Pass Times in Experiment 4

Predictor	Coefficient	SE	*t* value	*p*
Fixed effects for Second-Pass				
Intercept	346.00	90.00	3.83.	.001 *
Preview: identical vs. non-word	-47.39	110.00	-0.60	.55
Preview: related vs. non-word	4.28	110.00	-0.03	.89
Target Syntactic Role: Subject vs. Object	-67.81	110.00	-0.40	.69

Note. * p<.05,

Table 53

Mean Second-Pass Time with Standard Deviations

	Subject	Object
Identical	287 (660)	201 (755)
Related	349 (981)	296 (891)
Non-word	347 (740)	270 (808)

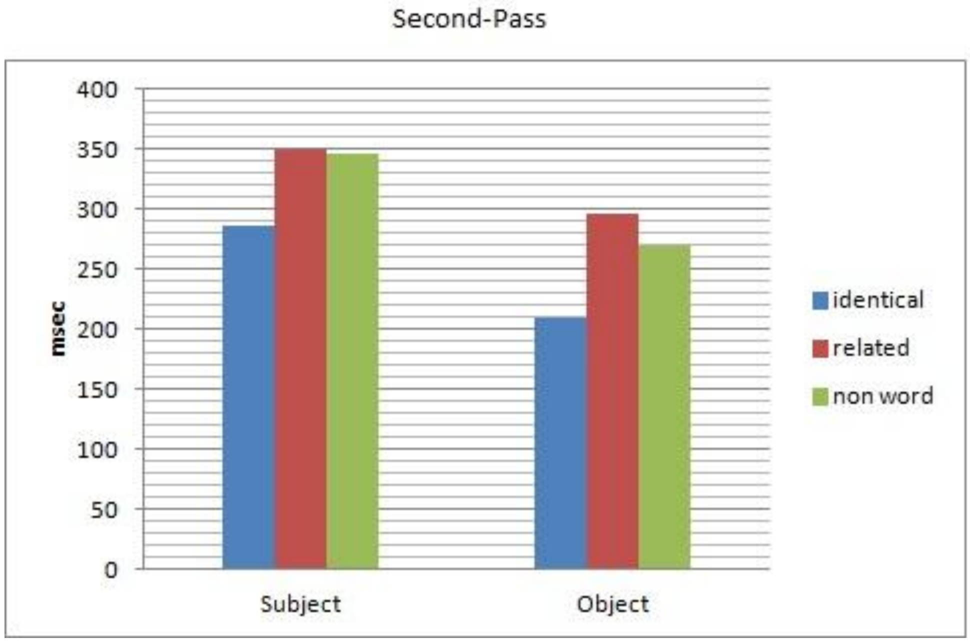

Figure 32. Mean second-pass times.

General Discussion

The main purpose of Experiment 4 was to determine what type of information is extracted from Russian short nouns in the parafovea by L2 readers of Russian, and how the information regarding the syntactic predictability of an upcoming word affects the time course of the morphological processing of that word. The experimental goals were achieved by implementing a gaze contingent boundary change manipulation with three preview conditions (identical, morphologically related, non word).

The non-word and morphologically related conditions differed from the identical condition in just the last letter of the target word. The effects of the preview manipulation were monitored across early (first fixation, gaze duration) and late (total time, go-past time) reading measures. The influence of the syntactic context was probed by placing the target word in two different syntactic positions (subject and object) in the same word order (VSO).

Native speakers revealed preview benefit effect only for the identical preview condition in gaze duration, indicating that higher level information was not integrated during lexical word identification. Predictability of the syntactic context affected lexical word identification and post-lexical integration of native speakers. Gaze duration revealed shorter durations for the syntactically more predictable object position. Second-pass times revealed the effect in the opposite direction, indicating that the native speakers compensated for earlier shorter processing times in the object position. Total time revealed interaction between the syntactic position and preview manipulation indicating that participants looked longer at the target in the subject position when the morphologically related preview was displayed.

Unlike native Russian speakers, L2 Russian learners were not affected by any of the experimental manipulations in any of the reported measures. The null results imply that L2 learners do not process information in the parafovea at any level of linguistic representation, possibly due to increased load associated with foveal processing in an L2 and consequential reduced perceptual span. The obtained results are based on only ten participants, however. Large variability and low statistical power might be the reasons for the null results, since numeric trends that patterned in the predicted directions point towards some sensitivity among L2 learners. In order to state conclusively whether L2 learners integrate parafoveal information, more subjects will need to take part in the experiment.

Summary

Experiment 4 revealed that morphological information is not pre-processed parafoveally by L2 Russian learners when the word n+1 is a short noun, and morphological processing is also not affected by the prior syntactic context. Moreover, the absence of any effects of the experimental manipulations reveals that L2 learners, unlike native speakers, do not pre-process parafoveally available information even at the orthographic level. This finding implies that the perceptual span in beginning to intermediate L2 learners of Russian might be reduced by at least 2 degrees of visual angle (5 characters of the experimental stimuli plus the space before the boundary). The results point towards a need for targeted investigations of the size of the perceptual span in L2 learners via a moving window paradigm (McConkie & Rayner, 1975).

CHAPTER 7:

GENERAL CONCLUSIONS AND FUTURE DIRECTIONS

The experiments reported in this dissertation examined the processing of morphological information in the parafovea, whether the processing of morphological information is modulated by attentional processes (between and within words), and whether syntactic information modulates allocation of cognitive resources during silent reading in a language not examined before - Russian. The experiments reported above provide a first demonstration that such high-level, linguistic information as inflectional morphology can be integrated parafoveally in an Indo-European language with linear morphology and is tied to lexical access. Moreover, the experiments demonstrate that the integration of inflectional morphology can be modulated by syntactic structure and attentional processes in the parafovea. Finally, the experiments reveal that cognitive allocation of resources modulates parafoveal integration of higher-level, linguistic information. The discussion that follows will focus on the contributions of the above experiments to the issues addressed in Chapter 2: the parafoveal processing of morphosyntactic information in native speakers; the nature of interaction between attentional processes, morphology, and syntax; and differences between parafoveal processing in L1 and L2.

Parafoveal Morphosyntactic Processing in Native Speakers

The experiments reported above provide the first account of eye movement research in Russian, a language with rich morphology and free word order. The experiments reported in Chapters 3-5 demonstrate that when low-level orthographic information is processed parafoveally in Russian, higher-level, linguistic information associated with it is integrated as well. The experiments in Chapters 4 and 5 revealed that the integration of morphological information during parafoveal processing is modulated by attentional processes (between vs. within words), the fixated word's syntactic category (noun vs. verb), and prior syntactic context.

Attentional processes between vs. within words.

The present investigation of attentional processes between (Experiment 1) and within (Experiment 2) nouns revealed differences in parafoveal integration of morphology. Morphological information was not pre-processed while the target word was in the parafovea (word n+1). The effects for parafoveal processing of morphology were found in total time, a later cumulative measure usually associated with stages of post-lexical integration. The results reported in Experiment 1 suggest that syntactic integration lags behind lexical integration. However, more research is needed to investigate the exact nature of the relationship between word identification and post-lexical integration. The delayed effects of the parafoveal manipulation suggest that the allocation of attention for the pre-processing of the upcoming word is reduced in Russian just as in English (Rayner & Pollatsek, 1987) and Finnish (Haikio et al., 2009).

A preview benefit was observed, however, when the boundary change was inserted within the currently fixated word, although the preview material was still outside of the fovea. This observed effect has two plausible, not necessarily mutually exclusive explanations: visual acuity and allocation of attention during lexical access. First, the initial landing position on the pre-target regions in Experiments 1 and 2 was about the same. In Experiment 1 the fixation prior to crossing the boundary landed within the first 4 letters of the five-letter word *n-1*. In Experiment 2 the fixation prior to crossing the boundary landed within the first 4 letters of the target 10+ letter word. As a result, the letter information from the target region in Experiment 1 was one space farther from the fixation than in Experiment 2, and may therefore have been of slightly poorer visual quality. In Experiment 1 the distance between the invisible boundary and the manipulated letter that denoted the inflectional case was six character spaces (one white space and four letters of a five-letter word). In Experiment 2 the distance between the invisible boundary and the manipulated letter of the inflection was shorter by one character of white space. However, visual acuity seems unlikely to be the only factor affecting the obtained experimental results. In Experiment 1 (between words) the effect size of the preview benefit for the identical condition was in the range of 21 ms: 303 ms vs. 324 ms in the non-word condition in the subject position and 295 vs. 316 ms in the non-word condition in the object position. If visual acuity were the cause of the differences observed in the results between the two experiments, then the preview benefit effects for the identical condition in the within-word manipulation, where the distance from the boundary was shorter by one character, should have been larger by 5-10 ms, as this is approximately how much it takes to process one character. Experiment 2 revealed preview benefit effects for the identical condition in the range of 71-47 ms (134 ms vs. 205 for subject position, and 160 vs. 207 for object position). This is two to three times larger than the effect sizes observed for between-word processing in Experiment 1 (21 ms). The comparison of the effect sizes suggests that the observed difference is more reasonably attributed to the difference in the allocation of attention to parafoveal processing within a word vs. between words.

Previous research on compound word processing using the boundary change paradigm has suggested that attention extends further to the right when the components of a compound are spatially unified (Hyöna et al., 2004; Juhasz et al., 2009; Haikio, Bertram, Hyöna, 2010). Research on multimorphemic word identification suggests that once the eyes are fixated on a word, there is a very early processing stage when all the letters are available and are used for identification of morphemic boundaries (Dreighe et al., 2010). Larger preview benefit effects and the presence of a preview benefit for the morphologically related condition only during the within-word processing observed in Experiment 2 can be attributed to the deeper processing of the information available in the parafovea of the same word versus another word available parafoveally.

The driving force for such a distinctive allocation of attention is most likely lexical access. During the stage of lexical word identification, morphemic units, including inflectional case markings, are used to reduce the number of lexical candidates. The absence of preview benefit effects for the morphologically related conditions during between word processing in Experiment 1 suggests that inflectional morphology in Russian is not integrated pre-lexically the way morphology is integrated in Hebrew (Deutsch et al., 2005). Participants do not pre-process the upcoming words in the parafovea at the morphological level; however, when the second part of a compound word is in the parafovea, the focus of the participants' attentional span spreads to a wider/deeper level over the parafoveal region. The pattern of results obtained here suggests that inflectional case markings play an integrative role in speeding up lexical access as evidenced by observed preview benefit effects for morphologically related conditions only during within-word processing, as examined in Experiment 2.

Early measures reported in Experiment 2 revealed that morphological information is integrated during lexical access once the eyes fixate the word. The morphologically related preview in the syntactically illegal context elicited significantly reduced gaze and inhibitory subgaze effects. This further indicates that morphological information processed parafoveally was used not only to identify the word but also to integrate the target word into the active structure of the sentence. The observed pattern of results suggests that when the low level information (last letter of the noun) is integrated parafoveally, higher-level information (morphological and syntactic) associated with it is integrated almost immediately as well.

However, the absence of preview benefit effect for morphologically related conditions in Experiment 3, which investigated within-word parafoveal processing of Russian verbs, suggests that attentional processes during silent reading are very flexible in nature. Moreover, results obtained in Experiment 3 call for further investigation of factors that affect the integration of morphology in the parafovea. The syntactic category (noun vs. verb) distinction may turn out to be an epiphenomenon that is driven by the following factors, which are not mutually exclusive: more complex internal structure; low-level, orthographic manipulations implemented in the experiment; and/or syntactic context in which target words occur.

Syntactic Category

Experiment 2 revealed that parafoveal integration of morphological information for nouns is a very robust and automatic process that is initiated during very early stages of lexical access. Effects of preview manipulations were observed as early as the first fixation. This stage is traditionally associated in the eye tracking literature with the stages of orthographic processing (Rayner, 1998) and implies that inflectional morphology is used during silent reading to limit the availability of lexical candidates. Later measures further corroborated parafoveal integration of morphological information by revealing evidence for the inhibition of the illicit case marker.

Experiment 3 revealed a different pattern of results for the integration of verbal morphology. None of the early measures indicated that morphology was processed parafoveally. Currently, three possible factors account for the absence of preview benefit for morphologically related condition during lexical access stage for Russian verbs, which are not necessarily mutually exclusive: morphologically complex internal structure, less salient inflectional paradigm, and/or decreased saliency of the penultimate (verbs) vs. final (nouns) letter.

Internal Structure. Russian nouns and verbs can have a rather complex internal morphological structure. While they all have obligatory roots, both nouns and verbs can have prefixes and suffixes, and most of them have inflectional case endings. In Experiment 3, 60% (36 out of 60) of the target verbs had prefix-root-inflection structure while the remaining 40% (24 out of 60) had root-inflection internal structure. At the time of the stimuli construction, it was impossible to obtain frequency counts for the prefixes that occurred in the target verbs. In principle, the processing of prefix and root in 60% of the target verbs could have required more cognitive resources and resulted in observed insensitivity to the preview manipulation, either due to low-frequency prefixes or to added internal complexity.

This explanation seems unlikely for at least three reasons, however. First, evidence from studies that employed the boundary change paradigm indicates that morphological complexity affects the processing of compound nouns (Drieghe, et al., 2010; Hyöna et al., 2004). Lexical embedding (e.g. *hat* in t*hat*) slows down processing, which suggests that embedded words are recognized automatically (Bowers, Davis, & Hanley, 2005; Davis, Perea, & Acha, 2009; Davis & Taft, 2005; Weingartner, Juhasz, & Rayner, 2012). However, it is not quite clear the extent to which attentional resources are devoted to the identification of prefixes that are not lexical entities and are not encountered as words. These kinds of prefixes were used in all the target verbs in the present study.

Second, the internal structure of the nouns that demonstrated a preview benefit effect in the morphologically related condition in Experiment 2 was far more complex than the internal structure of the verbs. 30% of the nouns had a prefix-root-suffix-inflection structure; 30% had a root-suffix-inflection structure; 18% had a root-root-suffix-inflection structure; 9% had a root-root-inflection; 9% had a root-inflection structure; and 4% had a root-suffix-suffix-inflection structure. The internal structure of the nouns in Experiment 1 was the simplest of all, with 100% root-inflection structure, yet there was no preview benefit effect for the nouns in Experiment 1 where the boundary was inserted between words. Finally, the boundary change in Experiments 2 and 3 was always in the middle of the penultimate morpheme before the inflection, and only one letter of the word was changing. This means that regardless of the differences, the internal structure of the target word was not changed by the preview manipulation, since all the inflections were the last component of the target nouns and verbs.

In follow-up studies it would be interesting to explore the role of the internal structure on the availability of the parafoveally available morphological preview. One can explore the role of prefixes by comparing the preview benefit in verbs with prefix-root-inflection vs. root-inflection structures. To examine the role of the prefix frequency, one can calculate frequencies for all the prefixes encountered in the target words and use frequency as a continuous predictor. Second, a more traditional but practically more challenging approach is to create two groups of verbs with high and low frequency prefixes. For the nouns then one can try to control the complexity of the internal structure of the nouns and/or manipulate the individual frequencies of the roots, prefixes, suffixes, and whole word frequencies. Then one can examine the effects of internal structure and frequencies of morphological components on the processing of the whole word. The practical challenge to the outlined follow up studies is that currently there are no available corpora counts of individual prefixes and suffixes in Russian. But it is quite possible that the creators of the major corpora of Russian language – National Russian Language Corpus (available online at http://www.ruscorpora.ru/index.html) – will implement such a feature in the future.

Inflectional Paradigm Saliency. The issue of inflectional paradigm saliency is two-fold. First, there is a difference between the regularity of noun and verb inflectional paradigms, with nouns being more regular. In Russian, verbs have seven conjugational classes (11 based on stem type, Chernigovskaya & Gor (2000,)) while nouns have three declensional types. As a result, verbal morphology is less salient then the nominal inflections. There is evidence in the literature that saliency of the inflectional paradigm might play a role in the availability of parafoveal morphological processing. Deutsch et al. (2005) demonstrated that more prominent verbal morphology (seven verbal classes vs. 100 nominal in Hebrew) can be processed parafoveally. The researchers employed between-word, boundary-change manipulation and obtained a preview benefit only for verbal inflections, but not for nouns. It is worth mentioning that in Hebrew vowels are omitted in writing. Thus, the results obtained in Hebrew are not directly comparable to the results obtained for Russian in the current experiments. However, the fact that the experiments described in this dissertation report a preview benefit for nouns and not for verbs only when the attention is allocated within the word suggests that *relative* saliency (three vs. seven to eleven classes in Russian) within a language might play a role in the availability of morphological processing in the parafovea in addition to (or instead of) *absolute* saliency, which was suggested for Hebrew (Deutsch et al, 2005).

The second issue related to morphological paradigm saliency is that differences emerged within the target words of each grammatical category: nouns and verbs. In order to maintain an equal number of letters for the preview display and the target word, nouns from second declensional type were used for both Experiments 1 and 2. Whether this type is more frequent then the nouns from the first declension type is not clear, as there are no corpora available yet that allow for inflection counts. But the case markings of the second type are more salient in the sense that nominative and accusative cases are always marked uniquely: *-a* for nominative and *-y* for accusative, while for the nouns of the first declensional type nominative and accusative are not marked for nouns of masculine gender and and marked with *–o* for both cases in the neuter gender. To explore the issue of noun inflectional paradigm saliency in the future, it would be important to investigate the availability of parafoveal morphological processing in masculine and neuter nouns of the 1st declensional type.

For the verbs in Experiment 3 the decision was made to use the present tense form because this tense does not mark the gender of the subject. Such a manipulation was crucial since the sentences were controlled for plausibility, and both the subject and object needed to be semantically reversible. The use of a verb form that is not marked for gender allowed the nouns of both genders to be used and reduced unnecessary restrictions on stimuli construction. All the target verbs used in Experiment 3 belonged to the most frequent type (Jakobson & Halle, 1956, Bybee, 1995, Chernigovskaya & Gor, 2000). Further investigation of the parafoveal processing of the verbs of less frequent types may shed further light into the processing of Russian verbal morphology and help adjudicate between existent theoretical approaches to psychological processes of word formation. For example, the evidence of parafoveal morphological processing in Russian verbs of less salient and frequent types taken together with the absence of parafoveal morphological processing in the verbs of the highly frequent type reported in Experiment 3 would suggest rule-governed verb formation for the verbs of salient, frequent, and consequently regular verb types and lexicalization of less frequent verb types.

Low-level Manipulations. Finally, we need to consider a low-level orthographic factor that might account for the observed differences in the processing of morphology between nouns and verbs. Whereas Experiments 1 and 2 employed manipulations of the last letter of the target words, Experiment 3 manipulated the penultimate letter. It is possible that more attention is allocated to the final letters of words, or that final letters are more visually salient, irrespective of their morphological status. It is a well-established fact that first and last letters are processed at the orthographic level in the parafovea (Briihl & Inhoff, 1995). As a result, the possibility remains that when inflectional information is associated with the last letter of the verb, it can be integrated parafoveally. It is possible to adjudicate between these two hypotheses by replicating the current Experiment 3 using verbs in the past tense, where the gender and number information is communicated through an inflection corresponding to the last letter of the word. If the manipulation of the last letter of the verbal inflections (e.g. *бежал**а**-бежал**и*** /*bezhala-bezhali*/ “ran 3rd SG fem-ran 3rd PL”) in future follow-up experiments yields a preview benefit in a morphologically related condition, this will serve as evidence that the low-level orthographic position of the letters plays an important role in the availability of higher-level linguistic processing. This manipulation will be easy to implement and would seem to be desirable to explore the role of paradigm saliency in verbal morphological processing as well, since all the verbs in the past tense regardless of the type of their stems follow the same structural template, which consists of the root-suffix of the past tense-*l*- and gender/number indicating inflection. If inflectional paradigm saliency plays a role in the availability of parafoveal morphological processing, then past tense forms of the verbs should all elicit preview benefit effects for morphologically related conditions.

A third possibility for the different processing patterns might be the different syntactic contexts for the nouns and verbs. Whereas for the nouns the inflections communicated relational information for the noun (case), manipulation of the verbal inflections focused on the number property: the morphologically related condition employed the plural number preview morpheme instead of the singular number for the target morpheme.

Syntactic Context

Experiments 1 - 3 revealed the two-fold role of syntactic context: native speakers were sensitive to the predictability of the syntactic context regardless of the preview manipulation. Experiments 1 and 2 indicated that low-level factors, such as word length, affects the time course of syntactic integration.

Experimental stimuli in all three experiments contained transitive verbs. Experiments 1 and 2 revealed that in the VSO word order the subject elicited longer eye fixations regardless of the length of the target word. The syntactic context made the object more predictable. Results revealed that native speakers were sensitive to this manipulation and fixated on the target object for significantly less time. The effect of syntactic context was observed in both early and later measures. Gaze duration for short nouns and on the first half of long nouns revealed that the target was fixated shorter in the object position. This suggests that the sensitivity to the syntactic context came online during the word identification stage regardless of word length.

Word length seems to modulate the influence of syntactic context in later measures that reflect post-lexical integration. For short nouns in Experiment 1, total time revealed only a marginally significant effect of the syntactic position in the same direction as gaze duration (shorter fixations in the object position). Second-pass times revealed an effect of syntactic position in the opposite direction. Participants spent more time rereading the object than the subject, possibly compensating for earlier underprocessing. Later measures on the long nouns in Experiment 2 all revealed an effect of syntactic position in the same direction as earlier measures: fixations on the target were shorter in the object position. The difference in the direction of the effect of the syntactic context in later measures for short and long nouns suggests that post-lexical integration could depend on lexical word identification. Participants have time to "recheck" shorter second arguments because they could be identified more quickly. The lexical identification of long nouns takes longer, and as a result, post-lexical integration does not reveal similar "rechecking" behavior.

Experiment 3 provides support for the view that syntactic context affects word identification and post-lexical integration, as well as evidence that the syntactic category modulates the influence of the syntactic context on word identification. Verbs in the canonical, more frequent SVO word order elicited shorter fixations later than did long nouns (which were the same length as the verbs). The syntactic context did not influence the initial stage of verb identification ($gaze_1$). Rather, it emerged on the first fixation on the second half of the verb. This suggests that participants spent more time looking at the verbal inflection in the less frequent OVS word order. Later measures, associated with the post-lexical integration, revealed the effect of syntactic position in the same direction as earlier measures. There was no evidence that participants compensated for shorter processing times on the verb in the canonical word order during post-lexical integration. This corroborates the proposal that word length modulates post-lexical integration, possibly through the attentional processes.

Allocation of Cognitive Resources

The experiments reported in this dissertation revealed that allocation of cognitive resources can be modulated by between- and within-word processes, syntactic category, and syntactic context. Experiments 1 and 2 revealed that attention modulates between- and within-word processing. Morphology was integrated parafoveally only during lexical word identification as part of the within-word attentional processes.

Syntactic category of the target word interacted with the allocation of attention and modulated the parafoveal processing of nouns and verbs. Experiments 2 and 3 revealed that, unlike nouns, morphology was not processed parafoveally for verbs even during lexical word identification. (However, as noted above, there may be several possible alternative reasons for this observed pattern of results.)

Syntactic context affected allocation of attention differently for nouns during within-word identification vs. between-word identification and for verbs during within-word identification. A syntactically more predictable position can reduce the amount of cognitive resources devoted to the processing of the target word. The reduced preview benefit effects for the target word in the syntactically more predictable position in Experiments 1 and 3 indicate that this might be the case for nouns during between-word identification and for verbs during within-word identification.

This was not the case for the nouns during within-word identification in Experiment 2. The syntactically more predictable condition was also more restrictive. In the object position, the syntactically illicit case marker for the morphologically related preview elicited an inhibitory effect as early as subgaze2, a measure associated with word identification. In the syntactically less restrictive subject position the morphologically related condition revealed inhibitory effects only in total time. This implies that participants inhibited the illicit case marker only during post-lexical integration.

For nouns, Experiments 1 and 2 established that more attention is allocated for within-word processing. It is quite reasonable to assume that a legal preview did not pose enough competition in a less predictable context and by the same token an illegal preview was not noticed in a more predictable context because attention was already reduced.

It is more desirable to explore the role of illegal previews across both predictable and less predictable contexts since this is a stronger manipulation in any possible follow-up studies. If morphology is used for pre-processing during between-word identification and such early processing is modulated by syntactic factors, then an illicit form could be either noticed sooner or result in more resources to inhibit than a syntactically legal preview. But, it is much more difficult to find an illegal case marking for the less restrictive syntactic context. By definition, a less restrictive context in a language with flexible word order like Russian allows all the case markings for the nouns immediately after the verb. In such case, if morphology is integrated during pre-lexical word identification, then the evidence of preview manipulation might not emerge until later measures (e.g. first pass, regressions or total time). A possible solution could be to obtain an acceptability rating for a variety of case marking continuations and choose a less acceptable case. A second best but practically more feasible option is to use legal previews across syntactically more restrictive and less restrictive contexts. In such a case the morphologically related condition for the object in VS**O** could be Genitive (instead of Nominative case, as used in the present experiments).

A third possible factor that could have contributed to the differences between nouns and verbs relates to the differences of morphology manipulated for nouns and for verbs. The morphologically related previews for the nouns manipulated the relational aspect communicated by the case marking, while for verbs it was the number feature. It is still not quite clear how plurality is computed online. Some researchers (e.g., Eberhard, Cutting, & Bock, 2005) believe that the number feature is communicated primarily by the noun (subject) and then is copied over to the verb (predicate). While other researchers (e.g. Vigliocco, Hartsuiker, Jarema, & Kolk, 1996, Vigliocco & Franck, 2001; Vigliocco & Harsuiker, 2002, among others) believe that the number from both the subject and the predicate (the noun and the verb) are read individually and then merged together to form one number entity (See Bock & Middleton, 2011, for a recent review of the research on this issue). Under the minimalist view advocated by Eberhard and colleagues (2005), the manipulation of the number for the preview condition is not the most desirable since it might not be used for lexical access during early stages initiated in the parafovea. The manipulation of the number in the verb is also not the most desirable under the maximalist view advocate by Vigliocco and colleagues. It is not quite clear whether the merging of two number categories from the subject and the predicate are initiated during lexical access or at a later stage. As a result, the use of a past tense verb form and the manipulation of the gender instead of the number, as proposed in the previous section, could help disentangle the contribution of attentional processes versus the structural processes for the parafoveal processing of morphology in verbs.

The experiments reported in this dissertation reveal a highly interactive relationship between lower level and higher level factors and the allocation of cognitive resources during silent reading in Russian. However, further research is needed to investigate the exact nature of the observed interactions.

Parafoveal Morphosyntactic Processing in L2 Learners

Experiment 4 provided clear evidence that L2 learners do not integrate parafoveal information to the same degree as native speakers. Moreover, the results indicated that L2 learners were not sensitive to the predictability of syntactic context. However, it is too early to state conclusively what exactly is causing such insensitivity. Inflated times across early and late measures indicate that all stages of word identification are impacted: orthographic decoding, lexical access, and post-lexical integration.

The participants in the present experiment are all beginning learners of Russian who have studied Russian in a classroom setting for about three semesters. Their exposure to the Russian language consisted of one hour teacher-lead instruction twice a week with some additional exposure as part of the homework. As a result, the results obtained during Experiment 4 reflect the very initial stages for beginning learners of a language that is significantly different from their native language. A follow-up study with intermediate and advanced learners of Russian, possibly with participants who have lived in Russia for an extended period of time, will attempt to capture developmental changes in parafoveal processing in L2 reading.

To complicate matters, parafoveal processing in L2 has not been investigated either in Russian or in any other language to date. However, there has been some work on parafoveal processing by older and younger readers in their native language that might be relevant to the development of parafoveal processing in L2.

Rayner, Castellano, and Yang (2009) used the moving window paradigm (McConkie & Rayner, 1975) in a series of experiments to compare the perceptual span of older and younger readers. They found that when two or three words to the right of fixation where displayed and the rest of the sentence was masked with X's, older readers' reading speed was significantly slower than without any masking. For younger readers, a three word condition did not differ from the unmasked condition, and the two-word condition reduced the reading speed only slightly. The results suggest that the area of active vision to the right of the fixation for older readers is reduced by at least two words.

In a follow up study, Rayner et al. (2009) found that a condition where a word to the left of the fixation was available along with the target word that was fixated improved reading speed significantly for older readers more than when only the fixated target word was available. Although young readers were numerically slightly faster in the condition when the word to the left of the target word was available along with the target word, there was no significant improvement in the reading speed as compared with the one word condition. The results lead Rayner and colleagues to conclude that the perceptual span of older readers is less asymmetric.

In a study examining the nature of parafoveal processing of the word to the right of the fixation in older readers, Rayner and colleague (2010) conducted a boundary change paradigm experiment with two invalid conditions: the first three letters were the same as the target (*abdcnor* for *abdomen)* or visually similar (*ohbcnor* for *abdomen*). There was no difference between the preview benefit effects for the preview with the same initial letters and visually similar letters regardless of the age group, suggesting that both groups pre-processed the word to the right of the fixation at the orthographic level. This evidence provides indirect support to the findings reported in this dissertation that suggests that in Indo-European languages parafoveal processing of linguistic information is associated with lexical access and does not come on-line during between word processing.

Rayner and colleagues (2010) reported that the preview benefit effects for an identical condition as compared with the visually similar condition at gaze duration and go-past time were attenuated for older readers as compared to younger readers. Since gaze duration reflects stages of lexical access, researchers have concluded that lexical identification for older readers is impaired during silent reading, possibly due to a less asymmetric perceptual span.

It has been suggested that either the physiological characteristics of the aging visual-processing system or the nature of cognitive attentional processes in older readers could be the reason for the reduced perceptual span in older readers (although these two possibilities are not necessarily mutually exclusive). The physiological characteristics of the visual system for the L2 learners in the present study were more comparable to typical younger readers and therefore cannot be a significant factor affecting parafoveal processing. However, effortful reading in L2 could have affected attentional processes in the participants in the present experiment and resulted in a more symmetrical perceptual span. Additionally, there is independent evidence that L2 learners perform quite similar to the native speakers who are under stress (McDonald, 2000; 2006). If L2 learners, whose physiological characteristics are more comparable to younger readers in studies of native speakers, perform similarly to older readers, this suggests cognitive causes for their inability to process information parafoveally during reading.

In support of this hypothesis, the perceptual span for beginning native language readers is also reduced (Haikio, Bertram, Hyöna, & Niemi, 2009; Rayner, 1986). However, evidence from the disappearing text paradigm, in which text disappears from the screen subsequent to fixation after a short (approx. 60 ms) time lag (Rayner, Castelhano, Yang, Liversedge, 2011), suggests that foveal lexical access of short to medium words (4-6 characters) for children as young as 8 years old is qualitatively the same as compared with proficient readers (Blythe, Liversedge, Joseph, White, & Rayner, 2009). Recently, Blythe, Haikio, Bertram, Liversedge, and Hyöna (2011), in a study using disappearing word paradigm, found that refixations rates for 8-year-old children where significantly higher than 10- and 11-year olds and adults. This suggests that word length modulates initial stages of lexical access only for beginning readers. This finding is relevant for the results obtained in the present experiment. L2 learners who participated in the present experiment are at the very beginning reading stages. As a result, their perceptual span and lexical access could have very well been affected in a way similar to beginning readers in their native language.

There is no record of active research on developmental stages of between- and within-word attentional processes, either in older adults or in beginning readers of a native language or L2 readers. More research is needed to investigate the exact nature of the relationship between the attentional processes and word identification stages for L2 learners along with the development of syntactic predictability in L2.

Conclusions

The experiments reported above provide an unambiguous demonstration that morphological information is integrated parafoveally in Russian nouns as part of lexical access. When integrated, morphology is modulated by the syntactic context of the active sentence. An investigation of between-word processing for nouns and within-word processing for verbs demonstrated that allocation of cognitive resources can modulate the availability of higher-level information in the parafovea. Future research is needed to understand the relationship between non-linguistic and linguistic factors in the allocation of attentional resources and how mechanisms of word identification interact with post-lexical processes in silent reading.

This is the first attempt to understand the nature of parafoveal processing in L2 learners in any language. More research is needed to understand the processes of parafoveal integration of low-level information, such as word length and different script (Cyrillic), along with higher-level information such as morphology and syntax.

Currently it is not clear whether the eye movement measures of L2 learners correspond to the stages of word identification in the same way as those of native speakers (e.g. first fixation=orthographic decoding; gaze duration=lexical access; go-past time = post-lexical integration). How is orthographic decoding of the script that is different from the native (Cyrillic vs. Latin) performed? Do L2 learners get the same detailed input as native speakers during the first fixation on the word that is sufficient for the initiation of lexical access? Is there any competition from letters that are visually identical to but phonologically different from letters of the native alphabet? For example, *cop* is pronounced /kɔp/ in English and means *policeman*, but the same combination of letters is pronounced /sor/ in Russian and means *garbage*. Is lexical access completed for L2 learners once they move their eyes off the word to the right? How is syntactic information from the word integrated? These and related questions need to be addressed in future studies.

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APPENDIX A:

STIMULI USED IN EXPERIMENT 1 AND 4

Stimuli are created from the base sentence (VSO) by switching positions of the arguments (VOS) and by providing different previews.

Среди бала искал принцNOM лакеяACC не обращая внимания на суету.

In the midst of the ball looked for the princeNOM the servantACC despite the commotion.

Среди бала искал лакейNOM принцаACC не обращая внимания на суету

In the midst of the ball looked for the servantNOM the princeACC despite the commotion.

VSO:Object target – identical preview

Среди бала искал принц лаке**я** не обращая внимания на суету

VSO:Object target - morphologically related preview

Среди бала искал принц лаке**й** не обращая внимания на суету

VSO: Object target – nonword preview

Среди бала искал принц лаке**д** не обращая внимания на суету

VSO: Subject target - identical preview

Среди бала искал лаке**й** принца не обращая внимания на суету

VSO:Object target - morphologically related preview

Среди бала искал лаке**я** принц не обращая внимания на суету

VSO: Subject target - nonword preview

Среди бала искал лаке**д** принца не обращая внимания на суету

The rest of the stimuli are given in the base (SVO) form.

Расчуствовавшись, женихNOM тестяACC пригласил отдохнуть и съездить на рыбалку. Being emotional, invited a son-in-lawNOM his father-in-lawACC to go fishing.
Уходя из комнаты баринNOM слугеACC сказал несколько слов. Leaving the room said a masterNOM to his servantACC a few words.
В своём замке баронNOM князяACC встретил любезно и с большими почестями. At his castle meat the baronNOM the dukeACC with grace and high honor.
Однажды пригласил эвенкNOM вождяACC поговорить о его пропавшем отце. Once invited the evenc (Eskimo)NOM the chiefACC to talk about his father who disappeared.
Очень часто палачNOM судьюACC видел только перед исполнением приговора. Very often saw executionerNOM the judgeACC right before the execution of the sentence.
Некоторые думают, что воспитывает школаNOM семьюACC и наоборот. Some think that educated schoolNOM familyACC and vise versa.
Всегда чувствует птицаNOM зверяACC в лесу или в поле. Always senses birdNOM animalACC in the forest and in the field.
В наше время копирует сценаNOM улицуACC или наоборот, трудно разобраться.
In our time whether copies stageNOM streetACC or vis versa hard to understand.
Он не знал вкючает точкаNOM линиюACC в этой фигуре или нет. He did not know if included pointNOM lineACC in this figure or not.
Еле-еле удерживала стенаNOM крышуACC от распада в разрушенном доме. Hardly supported wallNOM roofACC from falling apart in the demolished building.
В книге воспитывает геройNOM армиюACC через череду жизненных ситуаций. In the book educates charachterNOM armyACC through a series of live situations.

Он верил, что прекратит наука войну и старался всех в этом убедить. He believed that will stop scienceNOM warACC and tried to persuade everybody.
По ходу действия замечает гостьNOM кошкуACC и выходит из комнаты. During the story notices guestNOM catACC and leaves the room.
В доке загораживала лодкаNOM доскуACC брошенную у мостка. In the dock blocked boatNOM logACC left by the bridge.
В коридоре прикрывала сумкаNOM шапкуACC лежащую на стуле. In the hall covered bagNOM hatACC on the table.
В этой сказке пригласила цифраNOM буквуACC померяться силами. In this tale invited numberNOM letterACC to test who is stronger.
По легенде просит волнаNOM скалуACC спрятать её от ветра. According to the legend asks waveNOM cliffACC to hide it from the wind.
В кухне догнала мышкаNOM крысуACC и первая схватила сыр. In the kitchen raced mouseNOM ratACC and first took the cheese.
У малыша достаёт ножкаNOM ручкуACC очень легко, не как у взрослых. As a baby touches footNOM handACC very easy not as an adult.
Все считали, что продолжила пьесаNOM книгуACC очень удачно. Everybody believed that continued playNOM bookACC very successfully.
В сарае заслоняла трубаNOM печкуACC в углу у стены. In the shed blocked chimneyNOM ovenACC in the corner by the wall.
Все видели, что задела бомбаNOM плитуACC во дворе разрушенного дома. Everybody saw that touched bombNOM blockACC in the yard of the broken house.

Из-за несогласованности прервала паузаNOM песнюACC в прямом эфире. Due to the lack of coordination interrupted PauseNOM songACC in the air.
Как-то раз дразнила палкаNOM веткуACC на опушке леса. Once teased stickNOM branchACC on the meadow of the forest.
В тот вечер остановила толпаNOM бандуACC на площади перед банком. That evening stopped crowdNOM gangACC in the square by the bank.
На яхте соединяла кухняNOM каютуACC с выходом на палубу. At the yacht connected kitchenNOM sleeping room ACC with the exit to the deck.
Издали заметил юношаNOM оленяACC застывшего за кустом. From afar noticed young manNOM deerACC hiding in the bush.
Было слышно, как задела ложкаNOM чашкуACC и покатилась по столу. It could be heard how touched spoonNOM cupACC and rolled on the table.
В темноте осветила лампаNOM свечуACC на окне и стул в углу. In the darkness light up lampNOM candleACC in the window and a chair in the corner.
С моря загораживала башняNOM соснуACC на горе у леса. From the sea blocked towerNOM pine treeACC on the mountain by the forest.
На фоне плаща оттеняла шляпаNOM лентуACC бирюзового цвета. With the cloak as a background contrasted hatNOM ribbonACC of teal color.
Он понимал, что усиливала суетаNOM злобуACC и надо было уединиться. He realized that increased commotionNOM hatredACC and he had to withdraw.
В избе отгораживала лавкаNOM койкуACC от занавешенного окна. In the house separated benchNOM cotACC from the blinded window.

Было видно, что жалеет вдоваNOM воякуACC и помогает чем может. It was obvious that took pity widowNOM warriorACC and helped the best he/she could.
При голосовании поддержала ЛитваNOM КореюACC на последней встрече. During voting supported LithuaniaNOM KoreaACC at the last meeting.
В зоопарке рассматривает чайкаNOM галкуACC с заметним удивлением. At the Zoo examines see gullNOM robinACC with noticeable surprise.
При крушении задела пушкаNOM мачтуACC и скатилась с палубы. During shipwreck touched canonNOM pollACC and rolled off the deck.
В открытом море обошла шхунаNOM акулуACC и скрылась из виду. In the open sea passed boatNOM sharkACC and disappeared from sight.
В чулане загораживала метлаNOM щёткуACC и совок за ящиком. In the closet blocked broomNOM swifferACC and a shovel behind the box.
Хорошо дополняет грушаNOM ягодуACC и лимон на натюрморте. Very well complemented pearNOM berryACC and lemon on a picture.
Ранней весной отгородила балкаNOM поймуACC после разлива реки. Early spring separated ditchNOM shallow waterACC after the ice melted on the river.
В новой декорации заменяет шпагаNOM саблюACC на левой стене. In the new decoration replace swardNOM daggerACC on the left wall.
Все услышали как задела флягаNOM финкуACC упав со стола. Everybody heard that touched fluskNOM knifeACC as it fell off the table.
В спальне прикрыла майкаNOM кепкуACC на краю кровати. In the bedroom covered undershirtNOM hatACC at the edge of the bed.

Над камином дополняла каскаNOM маскуACC с синим пером. Above the fireplace complemented hatNOM maskACC with the blue feather.
После бури искала пчелаNOM маткуACC у разрушенного улья. After the storm looked beeNOM queen beeACC by the broken beehive.
Упав с ветки задела почкаNOM шишкуACC лежавшую на земле. Falling off the branch touched budNOM pine coneACC lying on the ground.
С берега отделяла виллаNOM горкуACC от леса. From the shore separated villaNOM hillACC from the forest.
На востоке соединяла сопкаNOM бухтуACC с полуостровом. On the east connected mountainNOM lagunaACC with the semi-island.
После обвала поддерживала глыбаNOM вышкуACC довольно долго. After the slide supported rockNOM towerACC for quite sometime.
Из-за беспорядка загородила мискаNOM банкуACC на столе. Due to the mess covered plateNOM jarACC on the table.
На столе закрыла афишаNOM картуACC в стопке бумаг. At the table covered announcementNOM mapACC at the pile of papers.
На поляне отгородила шахтаNOM тропуACC от обрыва. At the field separated a mineNOM pathACC from the cliff.
В кабинете закрывала рамкаNOM папкуACC на столе. In the study blocked frameNOM folderACC on the table.
На севере отгородила аллеяNOM речкуACC от шоссе. In the north divided alleyNOM riverACC from the highway.

Уже давно поддерживает элитаNOM фирмуACC благодаря хорошим связям. For a while supports eliteNOM companyACC due to good communication.
В новой квартире разделяла кухняNOM ваннуACC и коридор расширяя жилую комнату. In the new apartment divided kitchenNOM bathroomACC and hallway widening the living room.
Кое-где покрывала глинаNOM землюACC в этой части тундры. In some spots covered clayNOM groundACC in this part of tundra.

APPENDIX B:

STIMULI USED IN EXPERIMENT 2

Stimuli are created from the base sentence (VSO) by switching positions of the arguments (VOS) and by providing different previews.

В толпе заметила корреспондентkaNOM разведчицуACC о которой писали все газеты.

In the crowd noticed journalistNOM spyACC about whom all newspapers wrote.

/ В толпе заметила разведчицаNOM корреспонденткуACC о которой писали все газеты.

In the crowd noticed spyNOM journalistACC about whom all newspapers wrote.

VSO: Object target – identical preview

В толпе заметила корреспондентка разведчиц**у** о которой писали все газеты.

VSO: Object target – morphologically related preview

В толпе заметила корреспондентка разведчиц**а** о которой писали все газеты.

VSO: Object target – nonword preview

В толпе заметила корреспондентка разведчиц**д** о которой писали все газеты.

VSO: Subject target – identical preview

В толпе заметила разведчиц**а** корреспондентку о которой писали все газеты.

VSO: Subject target – morphologically related preview

В толпе заметила разведчиц**у** корреспондентку о которой писали все газеты.

VSO: Subject target – nonword preview

В толпе заметила разведчиц**д** корреспондентку о которой писали все газеты.

The rest of the stimuli are given in the base (SVO) form.

Каждый день слушал полководецNOM повелителяACC чинно и благостно. Every day listened commanderNOM rulerACC with poise and awe
Однако запомнил оперативникNOM нарушителяACC четко и ясно. In particular remembered the detectiveNOM the transgressorACC clearly and in detail.
В чера утром спросил программистNOM пользователяACC о новой функции. Yesterday asked the programmerNOM the userACC about the new function.
Об опасном выезде предупредил фельдмаршалNOM телохранителяACC задолго до него. About a dangerous trip warned the chief commanderNOM the bodyguardACC well in advance.
За вклад в общее дело благодарил артиллеристNOM изобретателяACC перед всеми. To the contribution into the common success thanked the cannon specialistNOM the inventorACC in front of everybody.
В итоге настиг бомбардировщикаNOM истребителяACC поздно вечером. In the end caught up the bomberNOM the fighterACC plane only late at night.
Тогда выслушал сослуживецNOM надзирателяACC тихо без споров. Then listened the co-workerNOM the prison guardACC quietly without arguing.
Нередко стимулирует капиталист NOM потребителяACC через рыночные отношения. Often stimulate the capitalist NOM the consumerACC through the market relations.
Днем пригласил подпоковник NOM производителяACC осмотреть установку. During the day invited the lieutenant cornel NOM the manufacturerACC to examine the missile.
На обратном пути узнал соотечественник NOM предпринимателяACC только в

поезде. On the way back recognized the compatriot NOM the entrepreneurACC only on the train.
Неделю назад увидел корреспондент NOM исследователяACC первый раз. Week ago saw journalistNOM researcherACC first time with moment.
В заключение отметила администрацияNOM корпорациюACC за помощь в проведении мероприятия. At the end noted administrationNOM corporationACC for help in the organizing the envent.
Кроме того благодарила ассоциацияNOM прокуратуруACC за оказанную помощь. Besides thanked associationNOM defence attorneyACC for help.
В перерыве поздравила руководительницаNOM переводчицуACC с днем рождения. During break congratulated managerNOM translatorACC with her birthday.
Оказывается что сфотографировала племянницаNOM преподавательницуACC уже после выпуска. It turns out took picture neiceNOM teacherACC after graduation.
За столом заметила посетительницаNOM официанткуACC в серой кофточке. At the table noticed visitorNOM waitressACC in gray shirt.
После соревнований встретила победительницаNOM соотечественницуACC с большой радостью. After competition meat winnerNOM compatriotACC with great joy.
Вечером подвезла родственницаNOM незнакомкуACC по пути домой. In the evening gave ride relativeNOM strangerACC on the way home.
Однако накормила комсомолкаNOM крестьянкуACC без всяких распросов.

It turns out fed comsomol memberNOM peasantACC without questioning.
Затем попросила продавщицаNOM покупательницуACC задержаться не надолго. Then asked sellerNOM customerACC wait a little.
Обернувшись увидел администраторNOM избирател**я**ACC краем глаза. When turn back saw administratorNOM voterACC in the periphery.
На вокзале спросила собеседницаNOM путешественниц**у**ACC о расписании поездов. At the railway station asked interlocutorNOM travelerACC about the train schedule.
В комнате загораживала перегородкаNOM аппаратур**у**ACC и выход в коридор. In the room covered screenNOM apparatusACC and the exit to the corridor.
Вскоре засёк пулемётчикNOM наблюдател**я**ACC высоко на горе. Soon spotted shooterNOM watcherACC high on the mountain.
Вместе со всеми поздравлял композиторNOM исполнител**я**ACC стоя на цыпочках. Together with everybody congratulated composerNOM performerACC standing on his tippie toes.
За поддержку отметил губернаторNOM победител**я**ACC самым первым. For support noted governorNOM winnerACC first.
За покупку поблагодарил коммерсантNOM покупател**я**ACC лично сам. For the purchase thanked enterpreneurNOM buyerACC in person.
Почему ругает бездельникNOM преподавател**я**ACC ясно было всем. Why resented slothNOM instructorACC was clear to everybody.
На третий день встретил заведующийNOM посетител**я**ACC прямо в фойе. On the third day meat supervisorNOM visitorACC right in the hall.

Очень резко критиковала контрразведкаNOM спецслужбуACC на страницах газет. Very heavily criticized military intelligenceNOM federal buroACC on the pages of the newspapers.
В тот день прождал архитекторNOM следователяACC очень долго. That day waited architectNOM detectiveACC quite awile.
Два дня назад предупредил администраторNOM руководителяACC о нехватке средств. Two days ago warned administratorNOM managerACC about the lack of funds.
Однажды встречает американкаNOM англичанкуACC на показе мод. Once meat American womanNOM British womanACC at a fashion show.
В итоге нашёл трактористNOM председателяACC поздно вечером. Finally found tractor driverNOM kolhos chairACC late at night.
Об этом спросила официанткаNOM учительницуACC в кафе "Росинка". About this asked waitressNOM teacherACC at the café"Rosinka"
После всех событий закрыла комендатураNOM организациюACC очень быстро. After all events closed committeeNOM organizationACC very quickly.
А у вас заменила статистикаNOM литературуACC в вашем отчёте. With you replaced statisticsNOM literatureACC in your report.
Как в сказке не поймет бездельницаNOM труженницуACC никогда, так и в жизни бывает. As it is in fairytales that the lazy personNOM never understand a worker beeACC it is te same in the real life.
По просьбе директора вызвала заведующаяNOM секретаршуACC сразу после обеда. At the director's request called supervisorNOM secretaryACC right after lunch.

В том бою заменила автоматчицаNOM пулемётчицуACC в женской бригаде. In that battle replaced a gun fighterNOM a gun machine operatorACC in the women’s brigade.
Ближе к вечеру спросила телеграфисткаNOM шифровальщицуACC о последнем сообщении с фронта. Later in the day asked operatorNOM stenographerACC about the latest news from the front.
Пока ждала повелительницаNOM прислужницуACC разразилась сильная гроза. While waited rullerNOM maidACC a heavy storm broke.
Но тут неожиданно поддержала интеллигенцияNOM демонстрациюACC вопреки опросам общественного мнения. But suddenly supported intelligentsiaNOM demonstrationACC despite all the public polls.
Он считал что портила физиономияNOM фотографиюACC которая и так была не в самой лучшей форме. He thought that spoiled appearanceNOM pictureACC that was not in the best shape.
В наше время производит цивилизацияNOM информациюACC или наоборот понять трудно. These days produces civilizationNOM informationACC or vise versa hard to understand.
После испытаний совсем изменила инструкцияNOM эксплуатациюACC этого прибора. After testing completely changed instructionNOM usageACC of this machine.
Почти неделю искала телеграммаNOM экспедициюACC по разным округам. Almost a week searched telegramNOM expeditionACC through different districts.
Вопрос о том как дополняет психологияNOM математикуACC был его любимым коньком. A question about how completes psychologyNOM mathematicsACC was his favorite topic.

В пригороде заменяет электричкаNOM автомашинуACC в зависимости от изменений в доходе. In the suburbs replaces trainNOM carACC depending on the change in the income.
В комнате закривала телогрейкаNOM скульптуруACC лежащую у стены. In the room covered a coatNOM a sculptureACC laying by the wall.
После авто-шоу пригласила автомобилисткаNOM мотоциклисткуACC к себе в гости. After the autoshow invited a car driverNOM a motocycle riderACC over for a visit.
Он считал что помогла публикацияNOM диссертацииACC в самый критический момент./ He thought that helped publicationNOM dissertatioACCn at a most critical moment.
После встречи поблагодарила исполнительницаNOM журналисткуACC за хороший приём. After the meeting thanked performerNOM journalistACC for a good reception.
Только вчера спросила исследовательницаNOM лаборанткуACC о новом приборе. Only yesterday asked researcherNOM lab assistantACC about the new apparatus.
Почему хвалила радиостанцияNOM организациюACC осталось тайной для всех. Why praised radio station NOM organizationACC remained a mystery for all.
На саммите обвинила ВеликобританияNOM БелоруссиюACC в нарушении соглашения. At the summit accused Great BritainNOM BelorussiaACC of breaching the agreement.
Намного улучшила композиция постановку в последней версии. Significantly improved compositionNOM productionACC in the last iteration.
В октябре рекомендовала декларацияNOM конституциюACC предложенную новым правительством.

In October recommended declarationNOM constitutionACC offered by the new government.
Он верил, что предотвратила командировкаNOM катастрофуACC изменившую бы всю его жизнь. He believed that stopped business tripNOM catastrophyACC that could change his whole life.

APPENDIX C:

STIMULI USED IN EXPERIMENT 3

Stimuli are created from the base sentence (SVO) by switching positions of the arguments (OVS) and by providing different previews.

Так уж заведено что председательNOM представляетSG спонсораACC на последнем учредительном собрании года.

It is a custom that the chairNOM introduces sponsorACC at the last executive meeting of the year.

/Так уж заведено что председателяACC представляетSG спонсорNOM на последнем учредительном собрании года.

It is a custom that the sponsorACC introduces the chairNOM at the last executive meeting of the year.

SVO: identical preview

Так уж заведено что председатель представля**е**т спонсора на последнем учредительном собрании года.

SVO: morphologically related preview

Так уж заведено что председатель представля**ю**т спонсора на последнем учредительном собрании года.

SVO: nonword preview

Так уж заведено что председатель представля**д**т спонсора на последнем учредительном собрании года.

OVS: identical preview

Так уж заведено что председателя представля**е**т спонсор на последнем учредительном собрании года.

OVS: morphologically related preview

Так уж заведено что председателя представля**ю**т спонсор на последнем учредительном собрании года.

OVS: nonword preview

Так уж заведено что председателя представля**д**т спонсор на последнем учредительном собрании года.

The rest of the stimuli are given in the base (SVO) form.

В конце лекции профессорNOM показываетSG студентуACC свои любимые произведения искусства. At the end of the lecture professorNOM shows to studentACC his favorite masterpieces.
После стольких лет командирNOM вспоминаетSG бойцаACC с теплотой и болью в сердце. After many years the commanderNOM remembers the solderACC with warmth and sorrow in his heart.
Редко бывает что ведущийNOM предлагает игрокуACC сделать перерыв. It happens seldom that the hostNOM offers the playerACC to take a break.
У нас в семье бабушкаNOM напоминает внукуACC у кого когда день рождения. In our family grandmotherNOM reminds her grandchildACC whose birthday is when.
Чаще всего гидNOM останавливает работникаACC из-за сильного шума в зале. More often then anything the tour guideNOM stops the workerACC of the museum due to high level of noise.
Как всегда ИвановNOM усмехается ПетровуACC из-за того что случилось с Сидоровыми. As usual IvanovNOM smiles PetrovACC because of what happened to Sidorovs
Часто когда тренерNOM поддерживает спортсменаACC то и сборы проходят лучше. Often when the coach NOM supports the athleteACC the training goes better.
Всего за три дня братNOM устраиваетеструACC в общежитие от железной дороги. Only in three days brotherNOM found a place for sisterACC in the dorms for the railroad workers.

Каждый раз бригадирNOM препятствует рабочемуACC когда поднимается вопрос о штрафах. Every time the lead workerNOM puts obstacles for the workerACC when the question of fees come to be discussed.
По сценарию ВалентинаNOM спрашивает ВасилисуACC о том что произошло. According to the script ValentinaNOM asks VasilisaACC about what happened.
Перед банкетом банкирNOM представляет финансистаACC своим друзьям. Before the reception bankerNOM introduces financial specialistACC to his friends.
По обычаю женихNOM показывает невестуACC всем родственникам. Accordign to customs groomNOM showes brideACC to all relatives.
Бывает часто что сеседкаNOM использует соседкуACC даже не подозревая этого. It happens often that neighborNOM uses neighborACC without suspecting it.
По сюжету бабушкаNOM обнаруживает внучкуACC спящей на диване. According to the story grandmotherNOM found granddaughterACC sleeping on the sofa.
Не молодой фотографNOM напоминает клиентаACC его близкому родственнику. Not young photographerNOM reminds clientACC to his close relative.
Очень часто ВаняNOM предлагает ДимеACC помочь с домашним заданием. Often VanyaNOM offersDimaACC help with homework.
Между лекциями студентNOM заговаривает студентаACC так что оба уже ничего не помнят. Between seminars studentNOM talks to studentACC so much that both remember nothing.
После собрания сотрудникNOM останавливает руководителяACC обсудить последний

пункт. After the meeting workerNOM stops supervisorACC to discuss the last point.
Было не ясно начальникNOM испытывает подчиненногоACC или наоборот. It was not clear whether the supervisorNOM tests the workerACC or vise versa.
Очень часто моя соседкаNOM принимает подругуACC у себя в гостях. Often my neighborNOM accepts friendACC for a visit.
Оказывается даже дедушкаNOM определяет внукаACC по манере стучаться в дверь. It turns out even grandfatherNOM recognizes the grandsonACC by the way he knocks on the door.
По регламенту председательNOM утверждает министраACC когда нет согласия. According to the rules the chairNOM appoints the ministerACC when there is no agreement.
Было видно как посетительNOM рассматривает часовогоACC от скуки или просто так. It was noticeable that the visitorNOM stares at the guardACC from boredom or just so.
Как оказалось физикNOM интересует химикаACC в связи с общим проэктом. As it turns out physicistNOM interested chemistACC due to common project.
Интересно когда ученикNOM заставляет учителяACC задуматься на уроке или после. It is interesting when studentNOM makes teacherACC pause during lecture or afterwards.
Когда соседNOM ненавидит соседаACC это хуже чем пожар. When neighborNOM hates neighborACC it is worse then a fire.
В трудную минуту другNOM поддерживает другаACC советом или добрым словом. Durign hard times friendNOM supports friendACC with advice or kind word.
У нас всегда начальникNOM предупреждает заместителяACC о приезде инспекции.

At our word the supervisorNOM always warns his assistentACC about the visit of inspetion.
Редко бывает что водительNOM раслядывает пассажираACC в такси из-за спешки. Seldom driverNOM examines passengerACC in the taxi due to rushing.
В пропаже продавецNOM подозревает кассираACC так как тот ушёл последним. In the theft sellerNOM suspects cashierACC because he was the last to leave.
В нашей семье папаNOM пропускает мамуACC а иногда наоборот. In our family fatherNOM lets motherACC go first, but sometimes vis versa.
Как оказалось сестраNOM обеспечивает братаACC после смерти родителей. It turns out sisterNOM supports brotherACC after the death of parents.
По доброте своей заместительNOM освобождает помощникаACC от ночных дежурств. Because of his kindness the assistant managerNOM releases the assistantACC from night shifts.
Как всегда дядяNOM поддерживает тётюACC в трудные минуты. As usual uncleNOM supports antACC in difficult times.
После бенефиса дирижёрNOM сопровождает певицуACC на торжественный приём. After the benefit the conductorNOM accompanies singerACC to the honor reception.
Особым знаком звязнойNOM предупреждает разведчикаACC об опасности. With a special sign messengerNOM warns the spyACC about the danger.
Егор считал, что художникNOM изображает комедиантаACC довольно похоже. Egor thought that painterNOM shows comedianACC with great resemblance.
Лена слышала , как племянницаNOM благодарит знакомуюACC за помощь. Lena heard that nieceNOM thanked acquaintanceACC for help.
Ольга считала, что ФёдорNOM удерживает ЛюбовьACC всеми правдами и неправдами.

Olga thought that FedorNOM keepsLyubovACC with truth and lies.
В третьей серии ЕленаNOM отправляет ИгоряACC навестить больную мать. In the third episode ElenaNOM send IgorACC to visit sick mother.
Только инструкторNOM записывает попечителяACC по договорённости. Only instructorNOM registers quardianACC according to the agreement.
Тётя вспомнила как племянникNOM изображает племянницуACC очень похоже. Ant remembered how nephewNOM copies neiceACC very well.
В романе партизанNOM перехватывает разведчикаACC до провала явки. In the novel the partisanNOM stops the spyACC before the jerpadizing of the meeting place.
На этот раз инструкторNOM задерживает летчикаACC перед вылетом. This time the instrictorNOM stops the pilotACC before the flight.
Часто бывает, что товарищNOM рекомендует товарищуACC книгу для чтения. It happens often that friendNOM recommends friendACC a book to read.
В комнате тумбочкаNOM прикрывает занавескуACC возле окна. In the room a nightstandNOM covers the blindsACC near the window.
Ему казалось, что продавецNOM раздражает туристаACC назойливым разговором. He thought that the sellerNOM irritates the touristACC with constant chatter.
В современной семье женаNOM обеспечивает мужаACC и наоборот. In the modern family a wifeNOM supports husbandACC and vise versa.
После разговора медсестраNOM уговаривает больногоACC успокоиться.
After the conversation nurseNOM persuades patientACC to calm down.
В разговоре жилецNOM успокаивает хозяйкуACC за чашкой чая.

In a conversation a renterNOM calms down landladyACC during tea.
Тактичная подругаNOM переспрашивает знакомуюACC после вечеринки. Tactful friendNOM asks acquaintanceACC after the party.
Неспеша крестьянинNOM приветствует соседаACC по привычке снимая шляпу. Without rushing peasantNOM greets neighbourACC customarily lifting hat.
На картине колхозникNOM привлекает колхозницуACC к сбору урожая. On the painting a kolhos workerNOM attracts kolhos worker womanACC to collect hearvest.
В метро рабочийNOM пропускает студентаACC задержавшись у входа. In the subway a workerNOM misses studentACC by being delayed by the entrance.
Когда старшийNOM обманывает младшегоACC то к добру это не приводит. When olderNOM cheets youngerACC it does not lead to anything good.
В рассказе солдатNOM освобождает рабочегоACC от повинности. In the story soldierNOM releases workerACC from the dues.
В уличной гонке мотоциклистNOM преследует мотоциклистаACC чтобы померяться силами. In a street race a motorcyclistNOM chases motorcyclistACC to test their powers.
Как всегда комитетNOM организует комиссиюACC по расследованию. As always committeeNOM organizes comissionACC for investigation