ABSTRACT

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The aim of this dissertation is to investigate the contribution of lexical factors that affect second language (L2) lexical access, such as size of L2 mental lexicon, lexical frequency, and number of competitors. It introduces and explores an additional L2-specific dimension that plays a differential role in L2 lexical access, which is the degree of familiarity with the L2 lexical item, in particular, familiarity with its phonological form as it maps onto its meaning. The current thesis focuses on this factor's main consequence, which is the underspecification of the phonological representation of less-known words in the L2 mental lexicon. The combination of traditional lexical factors with the proposed L2-specific lexical factor makes it possible to propose an L2-specific model that accounts for the interactions not found in L1 lexical access mechanisms. The Second Language Lexical Access Model (SLLAM) proposed in the dissertation incorporates L2 specific factors, such as the underspecification of phonological representations and the proficiency-defined size of the mental lexicon, and makes predictions about the process of lexical access in L2. The dissertation compares lexical access mechanisms in three groups of subjects, two of which are L2 learners of Russian at different stages of acquisition (Intermediate learners and Advanced learners), and uses novel empirical evidence from five behavioral experiments: lexical decision task without priming, lexical decision task with phonological priming, lexical decision task with semantic priming, lexical decision task with pseudo-semantic priming, and a translation task. The results of the experiments are discussed in light of the proposed SLLAM model. The dissertation argues that the majority of the observed results can be accommodated by the assumptions made by SLLAM, compatible with the postulated underspecification at the lexical level of L2 phonological representations. Moreover, the study concludes that some of the L2-specific lexical access mechanisms, commonly attributed to a lack of semantic links within the lexicon, may be more parsimoniously explained as resulting from phonological underspecification as well.

PHONOLOGICAL FORM IN L2 LEXICAL ACCESS: FRIEND OR FOE?

by

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CHAPTER 1: Mental lexicon in L1 and L2 speakers

There have been some advances in the research related to the semantic aspect of L2 lexical entries—in particular, how comparable these entries are in late L2 learners and bilinguals to those of native speakers (Grosjean, 1998; Kroll & DeGroot, 1997; Kroll & Steward, 1994). However, the picture is far from complete. While the representational issues of non-native language phonemes and phonological categories have been explored in depth in a number of psycholinguistic studies (Dupoux et al., 1999; Kazanina, Phillips, & Idsardi, 2006; Pallier et al., 2001, 2003; among others), their impact on L2 lexical access has been relatively underresearched (however, see Imai, Walley & Flege, 2005; Pallier, Colomé, Sebastián-Gallés, 2001; Sebastián-Gallés & Soto-Faraco, 1999; Sekine, 2006). Even less is known about the L2 mental lexicon as a system. If L2 speakers are characterized as having a smaller lexicon size and incomplete representations of form, meaning, and the mappings between form and meaning, then we might expect that the L2 lexicon would differ from an L1 lexicon in how individual lexical units relate to each other, including phonological and semantic associates. The issue that comes to the forefront of the current investigation is what impact the familiarity with lexical items, in particular, the degree of confidence in the phonological make-up of an individual L2 word, has on lexical access.

The current study claims that L2 lexical access has its own properties that set it apart from L1. The Second Language Lexical Access Model (SLLAM) that I am proposing here is predominantly based on assumptions that have to do with the limitations of the L2 mental lexicon. First of all, unlike L2 learners, L1 speakers have a distinct benefit of word knowledge, which is reflected in more fine-grained phonological, semantic, and morphological representations of the words. In addition, L1 speakers' lexicon has strong associative connections between lexical entries, which are based on these detailed representations, and which are lacking in L2. Taking these observations into account, SLLAM claims that a different set of factors governs L2 lexical access compared to L1 lexical access. More precisely, if for L1 auditory processing the main contributing factors are lexical frequency and the size of the competitor set, for L2 processing these factors play less of a role, because the magnitude of the influence is also reduced as a consequence of a smaller lexicon.

The most important assumption that SLLAM makes is that L2 learners do not have high confidence in the phonological representation of the L2 word. This assumption is quite transparent: less input and less experience with the language overall leads to lexical representations that are not sufficiently detailed, at least in terms of relevant phonological information. As a consequence, L2 learners possess a high tolerance for ambiguity and lack of certainty during lexical access. They are somewhat accustomed to not being able to identify all of a word's segments, and during lexical access they rely on the selection of the 'closest match' to what they hear or see, rather than on the 'exact match' as a native speaker typically would. It is hypothesized that high tolerance for 'noise' during processing allows L2 learners to complete lexical access with a higher success rate than they would have if the lexicon operated with native-like criteria for access. In addition, L2 learners do not have strong phonological connections between words. This is expected, because not having a distinct representation leads to fuzzy connections between representations as well. What this means for L2 lexical access is that without discrete phonological representations, the words are unable to fully engage in lexical competition, typical for native access, and this lack of lexical competition is actually beneficial for the completion of non-native lexical access. As the model suggests, one of the main consequences of the reduced competition for L2 lexical access is in the greater influence of the pre-lexical properties of the lexicon on lexical access, or the overall pre-lexical activation, primarily manifested in what is usually referred to as phonotactic probabilities. The combined influence of all similar-sounding words boosts pre-lexical activation in order for the word to be selected. At the same time, pre-lexical activation does not necessarily translate into lexical activation, which creates lexical competition. What we seem to observe in L2 access, especially with less-known words, is that lexical access takes place without inhibiting influences from other similar-sounding words, allowing for pre-lexical phonological activation to exert an additional facilitating influence.

These two specific properties of L2 lexical access—the underspecified phonological representations with weaker connections within the competitor set and the lack of lexical competition that results—form the basis for the hypotheses tested in this thesis.

More generally, the goal of the dissertation is to address the following research questions: Do L2 learners operate with fuzzy representations during lexical access? Do fuzzy representations affect L2 lexical access? Do fuzzy representations contribute differently to L2 lexical access at different stages of proficiency?

Before we outline the properties of SLLAM in more detail, we will review some of the contemporary views as well as recent developments in the study of L1 lexical access relevant for this study. In particular, two aspects will be considered: the mental lexicon as a set of distinct representations, and the mental lexicon as an interactive system. Further, we will examine the non-native lexicon along the same dimensions. More specifically, we will consider the following issues and how they are viewed with respect to L1 and L2 lexical processing: (1) what phonological properties of the word are significant for lexical access, and (2) how those phonological properties affect the completion of lexical access.

1.1 L1 Mental Lexicon

1.1.1 Phonological representations

It has been accepted for a few decades now that the mental lexicon resembles a network with interconnected nodes without a strict hierarchical structure connecting words based on semantic, phonological, linguistic, associative and other linguistic and non-linguistic factors (Collins & Loftus, 1975). However, the phonological form of the lexical entry plays a very distinct role—an access code role. While the number of levels of phonological representations (phoneme, syllable, word, suprasegmental elements, such as word stress, etc.) are still widely debated (for review see Cutler, 2008), without the form, there is no proper access to the meaning, which is the most critical objective of any type of communication.

It is also apparent that the influence of phonology on the mental lexicon is not unidirectional. Phonological information can interact with semantic and morphological information (e.g., Bozic et al., 2007; Feldman & Soltano, 1999; Marlen-Wilson et al, 1994; Marslen-Wilson & Tyler, 1998; Rastle et al., 2000, 2004; Marslen-Wilson, Bozic & Randall, 2008; Smolka, Komlósi, & Rösler, 2009), and, as a result, contribute differently to the outcome of lexical access under different conditions.

The role of phonology in mental representations and processing has been investigated in L1 acquisition. Studies with infants have suggested that by the end of the first year, the phonological perception of the child is tuned, for the most part, to its native language, and while for approximately the first six months infants are 'universal listeners' and are able to distinguish all of the phonetic contrasts in any language, this ability is short-lived, since the focus shifts to important distinctions that are present in the native language, and the child learns to ignore the unimportant ones (Kuhl et al., 1992, Maye et al., 2002, Newport & Aslin, 2004, Saffran et al., 1996).

At the same time, phonological representations at the lexical level also undergo a developmental change. According to Walley's Lexical Restructuring Model (LRM) (2007), infants start off with a 'holistic' type of phonological representation of a word, but as they acquire more experience with the language, they begin to identify and encode more distinct features of the word form, which are consequently reflected in the mental representation of that particular word, first, as larger chunks, such as syllables, and only later as phonemes. It has been suggested that the process of refinement of phonological representations is observable in infants as young as 6 months of age (Kuhl, Williams, Lacerda, Stevens & Lindblom, 1992) when they develop perceptual prototypes based on contrastive phonology to better accommodate the new language needs (e.g., Jusczyk, 1993; Werker & Desjardins, 1995). The latter process is caused by the necessity to differentiate between a growing number of similar-sounding words entering the mental lexicon, with such 'holistic' representations becoming insufficient for the specification of lexical entries. In the course of development, the child is forced to attend to (and, consequently, encode) phonological form in more detail in order to be able to uniquely identify the word in his input (Charles-Luce & Luce, 1990, 1995; Jusczyk, 1986; Mills et al., 2004, Walley, 1993).

Additional support for a special status of phonological representations comes from L1 word association studies (Brown & Berko, 1960; Ervin, 1961; Entwisle, 1966; Palermo, 1971). The participants were given a list of words and asked to produce a word that is most closely associated with the target. In following the tradition of word association tasks used in psychological tests (Kent & Rosanoff, 1910), the associations were classified as belonging to three groups: clang associations (phonologically related to the stimulus word, e.g., random – phantom), paradigmatic associations (same grammatical category as the stimulus, e.g., random – disorganized), and syntagmatic associations (sequential, or phrasal, order, e.g., random – number). It was reported that younger monolingual children tend to produce a lot of clang and syntagmatic associations, while older children and adult L1 speakers are likely to produce a higher proportion of paradigmatic responses. The change in response type is viewed as a developmental shift, usually referred to as a syntagmatic-paradigmatic shift, which is brought about by greater experience with the language. In short, while expanding the mental lexicon, the child accumulates more knowledge about linear relationship between words, as, for example, between the words in a phrase or a sentence (e.g., 'black + cat', 'black + coat', etc.). These regularities are easy to attend to, since they co-occur repeatedly in similar contexts. A more advanced ability is to be able to identify and classify language components that are related 'paradigmatically', or 'vertically', as a part of the same paradigm or part of speech (e.g., 'black', 'white', 'red' – are colors; 'long', 'wide', 'short' – are sizes, etc.). This ability requires a more extensive analytical approach to language, where co-occurrence is not sufficient to identify relations, but what is required is a deeper understanding of words' meanings. Indeed, a deeper and richer understanding of words and their meaning leads to a major restructuring of the lexicon, where syntactic connections give way to semantic links, which form the basis of the paradigmatic structure of the mental lexicon.

While older studies, such as the ones we just discussed, are interested in evaluating the structure of the mental lexicon, more recent studies focus on problems of lexical access. While it is quite difficult to establish the structure of the mental lexicon, one can enlist the resources available within the psycholinguistic models of lexical access. Therefore, lexical access can be seen as a hypothetical window that reveals hidden paths and connections between entries of the mental lexicon. The two concepts are very interconnected in what they reveal about our mental processes and representations. Although there used to be a strict divide between the perception of the mental lexicon as a static structure and the perception of lexical access as a dynamic, temporally-distributed interactive process, the strict distinction does not seem to hold anymore, since the mental lexicon exhibits many of the properties attributable to a dynamic interactive system, rather then to a solidified, static structure. Therefore, it seems reasonable to assume that certain properties of lexical access can provide us with insight about properties of the mental lexicon. And the converse is also true, because, on the one hand, representational properties define the characteristics of procedural manipulations of these representations, and on the other, it is through the dynamic interactive processing of the system that these representations are formed in the first place. It is most likely that the properties of lexical access are reflections of the organizational structure of the mental lexicon. More importantly, we should keep this point in mind in order to unify the evidence from various experimental paradigms that concerns representational storage, on the one hand, and its retrieval, on the other, since most of the current issues in L1 mental lexicon studies related to the interaction between the lexicon and its phonological properties, are primarily examined by means of lexical access modeling.

1.1.2 Phonological interactions

The current state of psycholinguistic theory offers a wide variety of models of lexical access that can accurately predict, albeit some more accurately than others, a number of psycholinguistic phenomena in auditory speech perception. Among the most prominent ones are the logogen model (Morton, 1969, 1979), TRACE (McClelland & Elman, 1986), Cohort theory (Marslen-Wilson, 1987), Neighborhood Activation Model (NAM, Luce and Pisoni, 1998), and Shortlist (Norris, 1994)[1]. Each of the models comes with a certain set of predictions, as well as limitations. However, it is possible to outline the characteristics that are more generally accepted across the models, and with some minor generalizations they can serve as guidelines to gain an understanding of the lexical access mechanisms in their most basic form.

Most models have adopted an activation metaphor, which seems to capture the dynamicity of the mental process, as well as mimic a plausible architecture of the neurobiological substrate. Here, in very general terms (in order to accommodate a number of points of contention between the models), is how the processing of auditory input can be represented in terms of the activation metaphor. During processing of the auditory stream, sensory information initiates activation of the appropriate linguistic segments (which vary depending on the selected model) that are compatible with the auditory input. When the activation spreads to the lexical level, goodness-of-fit criteria guide the activation towards the most compatible candidates, which compete with each other for final selection. The choice is made based on the relationship between the levels of activation of the individual candidates. As can be seen from

[1] Due to the focus of the study, the models under consideration were restricted to auditory speech perception.

this brief outline, there are three main components identified in auditory processing: initial activation, competition, and selection. However, this is as far as most models agree.

One of the widely debated points related to speech comprehension modeling to date is what should be considered as a set of competitors. As mentioned above, during lexical access, a number of word candidates compete for selection. However, depending on what is considered to be a 'competitor', the number of competing candidates and their lexical properties can vary significantly from model to model, affecting the outcome of lexical access predicted by the model to a different degree. The cohort model in its original version made a strong claim that the competitor list is a function of the amount of auditory input accumulated by the system up to a certain point. In other words, depending on the initial phoneme(s), all words that start with the same phoneme(s) are activated—this is the cohort—and become involved in lexical competition. With more input, the list of competitors narrows down until only one word remains[2]. According to Marslen-Wilson (1987), the idea of cohort membership is a direct reflection of left-to-right processing, typical of auditory speech perception. Therefore, a critical requirement for the cohort members is to

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[2] This point of final disambiguation may or may not be the end of the word. For some words, disambiguation happens before the entire word is heard, and is usually called a 'uniqueness' point (for nonwords, an 'isolation' point).

share an initial phoneme or phonemes as a defining property of the competitor set.

A different approach to identifying competitors is proposed by Neighborhood Activation Model (NAM, Luce and Pisoni, 1998), which is also shared by the TRACE and Shortlist models. The competitor set is usually referred to as a 'similarity neighborhood' (Luce and Pisoni, 1998), or just 'neighborhood', similar to Coltheart's orthographic neighborhood N (Coltheart et al., 1977). The neighborhood inclusion criteria are based on the following parameter: the word can be considered a part of the neighborhood if it can be transformed into the target word by addition, deletion, or substitution of a single phoneme. NAM predicts that (at least) two main properties of lexical neighborhoods affect performance: neighborhood density and neighborhood frequency measures. As demonstrated by Luce and Pisoni (1998), the number of competing lexical entries (neighborhood size) during lexical access as well as their relative frequencies can predict the speed and success of lexical access. Extending the finding of Coltheart et al. (1977), Luce and Pisoni (1998) found that the time it takes to decide whether what was heard is a real word or not is related to the number of real words in the neighborhood. More precisely, NAM predicts that words occurring in highly dense neighborhoods with a lot of similar-sounding neighbors would be recognized less accurately and less quickly than words occurring in sparse or less confusable neighborhoods (Luce and

Pisoni, 1998; Goldinger, Luce, & Pisone, 1989; Luce, Pisoni, & Goldinger, 1990; Segui & Grainger, 1990).

Another consequence of neighborhood organization of the lexicon is the neighborhood frequency effect, which postulates that the effect of neighborhood size on the speed and accuracy of retrieval of the stimulus-word would be mediated by the frequency of individual neighbors. In other words, in addition to the fact that lexical access is affected by the *number* of the neighbors, the *frequency* of neighbors in the neighborhood also matters: high-frequency words are likely to reduce identification performance, while low-frequency words will produce no sizeable influence (Luce, Pisoni, & Goldinger, 1990).

While both types of competitor sets—cohort and neighborhood—have received plausible empirical support, the discussion of which competitor set is more predictive of lexical access is still an ongoing debate. Some researchers propose that these two sets have proven to be modality dependent, with the cohort-type set being more predictive for auditory input, and neighborhood-type sets for visual (e.g., Andrews, 1989; Coltheart et al., 1977). Another argument in favor of predominant differences rather than similarities has to do with the differences in their timing of influence on word recognition. As demonstrated by Mirman et al. (2010), the effects of neighborhood size are also observable in auditory speech recognition; however, these effects are not manifested right away. Due to the fact that the similarity parameter of neighborhood membership is more associated with global, or holistic, similarity and is not constrained by the location of occurrence, neighborhood density has a greater effect on the selection process, rather than activation of the group, dominated by the cohort influence. Based on this finding, it can be assumed that neighborhoods and cohorts are two different entities with different properties and that they affect lexical access independently of each other.

Others claim, however, that despite the different criteria for membership, there is a great degree of overlap in words being included in both types of competitor sets. Additionally, both sets have the same basic statistical properties that lexical access is sensitive to, such as low modes at very low text frequencies, as well as a long low tail that extends into the high text frequencies for larger set of competitors (Bard & Shillcock, 1993), and attempts were made to develop a measure that incorporates both membership criteria (e.g., Bailey & Hahn, 2001; Goldrick et al. 2010; Vitevitch, 2002; Vitevitch et al., 2004).

Despite such an acute interest in the topic, the debate over the competitor set type is still ongoing, and there is no clear indication of whether one should be preferred over the other. However, some additional considerations regarding this issue will be offered later in the discussion of L2-specific processing.

Another layer of complexity in interpreting phonologically-based interactions between the entries of the mental lexicon comes from priming experiments.[3] Until recently, form-related (phonological or orthographic) priming did not receive as much attention as semantic priming, perhaps due to the fact that the predictions were very complex due to interactions of different factors, and, as a consequence, the results of such studies have been mixed and hard to interpret. According to the predictions of the Cohort theory (Marslen-Wilson, 1987), early phonological information activates a list of word candidates that begin with the same phonological sequence. With more input, the candidates that do not match the continuation of the acoustic sequence get dropped off the list (deactivated, or inhibited) until only one winner remains. Following the Cohort theory, the prime will spread the activation to the words with a similar-sounding onset, providing an advantage to the activation of the target, thus, facilitating its retrieval. The outcome of the priming LDT did not align with that prediction. In a number of cases, no beneficial effect of phonological overlap was reported, creating a challenge for the spreading activation metaphor within the cohort model. When an additional number of studies to further investigate this phenomenon were carried out, the picture became even more convoluted. As was discovered later, the direction of the effect was largely explained by the location of the overlap and the mismatch. The phonological overlap in final position (offset) was generally found to produce a

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[3] Priming is a psycholinguistic phenomenon, which was originally observed in a lexical decision task (LDT) with a prime-target design. A LDT with priming consists of two words related in meaning (e.g., space—planet), which are presented in an immediate sequence. The time it takes to recognize the second word ('target') is less than if the first word ('prime') is not semantically related (e.g., space—finger) (Meyer & Schvaneveldt, 1971, 1976).

facilitatory effect (e.g., Chéreau et al., 2007; Damian & Bowers, 2009; Dufour & Peereman, 2009) however, other outcomes were also reported, e.g., no effect (Damian & Bowers, 2009), and even inhibitory effect when the contribution of orthography was controlled for (Ziegler & Muneaux, 2007). A significant advance in investigating this issue was made by Slowiaczek and Hamburger (1992) and Hamburger and Slowiaczek (1996), who argued that the initial phonological overlap can produce facilitation in a 1-phoneme overlap condition, no effect in the 2-phoneme overlap, and inhibition in a 3-phoneme overlap condition. In light of their findings, they proposed that two distinct mechanisms occur during auditory word recognition: pre-lexical facilitation and lexical inhibition.

The facilitatory effect in the 1-phoneme overlap condition was later challenged by Goldinger et al. (Goldinger, 1999; see also Pitt & Shoaf, 2002), who suggested that a low percentage of unrelated pairs in Slowiaczek & Hamburger's (1992) study lead to a strategic response bias and was not representative of any mechanisms related to speech processing. A follow-up study by Hamburger and Slowiaczek (1996) addressed the concern raised by Goldinger and his colleagues. In order to eliminate the possibility of subject response bias due to an adoption of a strategy, they changed the interstimulus interval (ISI) from short (50 ms) to long (500 ms) as well as reduced the proportion of the related pairs from 75% to 21%. The manipulations resulted in the elimination of the 1-phoneme facilitating priming effect, while the inhibition in a high overlap condition persisted.

These results raise the question of whether the facilitation effect, observed in 1-phoneme condition, is a true manifestation of the pre-lexical facilitation. If the facilitatory effect can be induced by the strategies, then it might not reflect the processing mechanisms per se, but rather an expectation bias. At the same time, there are other studies that demonstrate the effect of facilitation under certain conditions. For example, Radeau et al. (1995) reported facilitation at a short ISI (20 ms) in a lexical decision task, when a higher frequency word primed a lower frequency word with initial overlap. In a different study, Dufour and Peereman (2004) found facilitation in nested priming with French words. Nested priming is when the prime completely overlaps with the target and is 'nested' in the target. The source of facilitation was explained by the absence of mismatching acoustic information between the prime and the target (*ver* 'worm' primed *vertige* 'vertigo'). In contrast, the mismatch between the offset of the words prevented facilitation and resulted in inhibition (*verger* 'orchard' inhibited *vertige* 'vertigo'), which was a predicted outcome of the competition between similar-sounding words. The results of both studies suggest that competition among the candidates is the main factor that introduces inhibition to lexical access of the phonologically-primed target.

Some of the studies that followed confirmed the lexical status of high-overlap inhibition, providing two pieces of evidence that speak in favor of the competition between words. First, the lexical nature of the process is indirectly supported by the data from nonword experiments, where only word primes produced the inhibition effect, while nonwords produced facilitation, which is hypothesized to be caused by pre-lexical activation (Monsell & Hirsh, 1998; Spinelli et al., 2001). Second, the interpretation of the inhibition effect as a reflection of lexical competition is also supported by studies where lexical frequency and neighborhood density/neighborhood frequency were manipulated. For example, Goldinger and colleagues demonstrated that both neighborhood density and item frequency influenced target identification accuracy (Goldinger et al., 1989). They conducted an auditory priming experiment with phonologically-related[4] words, and the participants were asked to identify the target presented in white noise (Experiments 1a and 1b). Accuracy analyses (no RT data was analyzed) showed that when subjects were presented with low-frequency targets from dense neighborhoods, performance was the worst, especially if the prime was also a low-frequency word (see also Luce & Pisoni, 1998; Ziegler et al., 2003). A similar finding regarding frequency was reported by Radeau, Morais, & Segui (1995), who found inhibition in the response latencies (albeit weak) during a shadowing task for the onset overlap in the low-frequency condition.

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[4] Goldinger and colleagues did not use lexical items with a specific phonological overlap, but rather primes and targets which were matched up based on 'acoustic-phonetic similarity', calculated based on phonological confusion matrices for individual phonemes. Due to the method of constructing the material, the authors themselves avoided referring to the priming relationship between the prime and the target as 'phonological' and call it 'phonetic'.

Some researchers believe that neighborhood effects, and the neighborhood density effect in particular, are in fact disguised frequency effects. The neighborhood effects are likely to be a confound which follows from the organization of the neighborhoods themselves and the frequencies of neighborhood members found in natural languages. For example, Bard (1990) suggests, "high-density neighborhoods, which contain many lexemes, have more opportunities than low-density neighborhoods to contain an unusually high-frequency item which will compete strongly with the target" (Bard, 1990: 200). Therefore, low-density neighborhoods will not be able to generate sufficient competition solely due to the fact that most of the neighborhood members are of low-frequency themselves.

Although the evidence from L1 priming studies is still largely inconsistent, in general, a high-degree of phonological overlap in the initial position produces inhibition, which is sensitive to word frequency and neighborhood size and is hypothesized to reflect lexical competition among the candidates. This explanation provides a theoretical groundwork for inhibition by recognizing the role of phonological factors in lexical access: the greater the similarity between competing items, the harder it is to settle on one entry. However, what is still left unexplained is the source of facilitation, seen in the minimal overlap (1 phoneme) condition, reported by Hamburger and Slowiaczek (1996). If any similarity between lexical entries leads to competition, then inhibition should be predicted in this condition as well. However, it was not the case, and the dissociation was attributed to pre-lexical facilitation. More precisely, facilitation occurs when "phoneme units partially activate lexical units consistent with the phoneme" (Slowiaczek & Hamburger, 1992: 1240). What remained unexplained was the nature of pre-lexical activation. In particular, how can the lexical entries be 'partially activated' without presenting competition to the other words, and, more importantly, what is the source of facilitation in pre-lexical activation?

It is possible that the level of pre-lexical activation is controlled by knowledge of phonotactic probabilities. Phonotactics refers to statistical generalizations about what sequences of phonemes (or syllables) are more or less frequent in the language, and in which position in a word they are most likely to occur.

Recall, that according to NAM (Luce and Pisoni, 1998) spoken words that sound like many other words (i.e., words in dense similarity neighborhoods) should be recognized more slowly and less accurately, than words with few similar sounding words (i.e., words in sparse similarity neighborhoods). However, the results of the Vitevitch and Luce (1998) study appeared to be in partial conflict with predictions by NAM. The shadowing task demonstrated that while the words followed the predicted outcome, the nonwords showed a reversed pattern: high probability/density nonwords were repeated more quickly than low probability/density nonwords. To account for the proposed dissociation, Vitevitch and Luce, independently of Slowiaczek & Hamburger's (1992) finding, suggested that two levels of representation and processing—one lexical and one sublexical—are responsible for differential effects (Vitevitch & Luce, 1998), arguing that the effect observed in nonwords is attributed to the absence of strong lexical competition associated with word stimuli. Not being affected by the competing word candidates at a lexical level, higher activation levels of sublexical units (associated with higher language-specific probabilities of certain combinations of phonemes) afford an advantage to high-probability nonwords (Vitevitch & Luce, 1998; Vitevitch et al., 1999). Consequently, whereas the effects of similarity neighborhoods may arise from competition among *lexical* representations, facilitatory effects of probabilistic phonotactics might reflect differences among activation levels of *sublexical* representations (c.f. 'pre-lexical' phonemic level in Slowiaczek & Hamburger's claim).

As plausible as the concept of phonotactics appears to be, there are a number of concerns that need to be addressed. First, Vitevitch & Luce failed to replicate their results with disyllabic words (Vitevitch & Luce, 1999, experiment 5), which presents a major concern for generalizability of the results to a more realistic mental lexicon (for extensive criticism, see Almeida, 2009). Lipinski & Gupta (2005) attempt to replicate Vitevitch and Luce's finding using the same stimulus set and report the same pattern of inhibition for nonwords as well, thus, challenging the sublexical status of phonotactics, which contrast with the lexical status of the stimulus word. Second (and the authors readily admit to it themselves), words in high-density neighborhoods tend to have high-probability phonotactic patterns, whereas words in low-density neighborhoods are typically composed of less frequent segments and sequences of segments (Landauer & Streeter, 1973). Under these circumstances, it is rather problematic to test the prediction of dissociated influences of neighborhood density and phonotactics independently. Since phonotactic probabilities are so closely related to the competitor set size—a lexical measure—a direct reliable estimate of phonotactic influence is very evasive. There were some promising developments in the neurological measures of phonotactics (Pylkkänen et al., 2002; Stockall et al., 2004), but the results turned out to be difficult to replicate (Almeida, 2009). Therefore, the question of whether phonotactics has any measurable influence on lexical access remains an open question.

If we consider the role of phonotactic probabilities plausible, then what is the source of their influence on lexical access? Slowiaczek and Hamburger's model assumes that while there is a distinction between the pre-lexical and lexical level of processing, there is also some sort of interaction between them. As was pointed out earlier, they support the idea of the 'partial activation' of lexical units, which is counterintuitive: if there is activation at the lexical level, even partial, then lexical competition should manifest itself. In addition, the connection between this claim and the experimental evidence they provide is rather speculative. However, more solid support for the idea of partial lexical activation was provided by Gaskell & Marslen-Wilson (1997) in the simulations of lexical access within the distributed model of speech perception. Gaskell and Marslen-Wilson extended the idea originally proposed in Smolensky (1986) that during auditory processing, the system is capable of producing lexical 'blends' that incorporate features of the activated entries, including their phonological form and individual meanings of the candidates. This claim fits well with the concept of 'partial activation' of lexical entries without lexical access, providing theoretical motivation for the simultaneous influences of pre-lexical and lexical levels of processing. It is quite plausible that this is exactly where the phonotactic probabilities can produce an effect on the activation of lexical entries: since the lexical blends incorporate the features of real existing words, the phonotactic probabilities of the language will also be operational at this level of processing. Therefore, phonotactic probabilities can be seen as the reflection of the partial activation of lexical entries through the emergence of lexical blends at the pre-lexical stage of lexical access.

As far as the dissociation between phonological and lexical levels of processing is concerned, the idea of blends eliminates the necessity of distinguishing between purely phonological and purely lexical influences, because they are not distinct during auditory processing. The only definite stage in processing, which remains intact, is the identification of one word with its unique meaning and other properties at the lexical access stage. This being said, the idea of lexical access as an isolated point in time does not negate previous influences of the lexicon: the blends that are produced during processing are greatly affected by the properties of the words that are stored in the mental lexicon, both in terms of form and meaning. On the other hand, partial activation is not sufficient for lexical access (Gaskell & Marslen-Wilson, 1997), since the main criteria for lexical access is the access of the unique word meaning, but it does not occur until only one lexical entry is identified. All this evidence points in the direction that while pre-lexical and lexical stages of processing can be identified, influence of lexical factors can be observed well before lexical access is complete.

In general, what comes out of the quite extensive body of L1 research is that while some aspects of L1 phonological representations and phonological influences are well documented, there are still a lot of unresolved issues that persist. There is some solid evidence for the existence of two sequential stages of processing during auditory speech perception––pre-lexical and lexical.

At the lexical stage of processing, the main factors that have been identified, the effects of competitor set size and competitor frequencies, are quite consistent throughout different methodologies. While the mechanisms of lexical competition have been rather carefully studied and documented, the nature of the influences at the pre-lexical stage is yet to be well understood.

The only generally agreed-upon type of influence at the pre-lexical stage of processing is the effect of phonotactic probabilities. However, the purely pre-lexical (phonology-based) nature of phonotactic probabilities has also been questioned. Somewhat unexpectedly, what becomes evident is that the pre-lexical stage of processing does not eliminate the possibility of lexical influences even before lexical access is complete. Conversely, both phonological and lexical influences affect lexical access mechanisms at the pre-lexical stage of processing, interacting with each other. The interactive nature of pre-lexical phonological influences and the lexicon are supported by the existence of partial lexical activation, which incorporates phonological as well as lexicon-level influences. The concept of partial lexical activation and its properties offer a promising explanation to a number of observed phenomena.

With that in mind, consider whether the same properties of L1 lexical access previously discussed can be applied to L2 lexical access, and examine whether they have the same impact on its outcome.

1.2 L2 Mental lexicon

1.2.1 Representational differences

It is a well-known fact that a newly learned language does not mirror the organization of the existing L1 lexical storage if only in terms of its quantitative dimensions alone, accounting for part of the differences between L1 and L2 processing. Two crucial dimensions that set the L2 lexicon apart from its L1 counterpart are its size, on the one hand, and the status of lexical frequency, partly a consequence of the limited size, on the other.

As far as the size of the lexicon is concerned, it is quite expected that less extensive experience with the language, especially with L2 input, will result in a smaller lexicon with fewer lexical entries. Conversely, it is also expected that more advanced learners have larger vocabularies. What follows from this observation is that the size of the L2 lexicon can be viewed as a function of proficiency—the higher the proficiency, the greater the size of the lexicon. Moreover, smaller lexicons are also characterized by differences in their representation of lexical frequency when compared to a fully developed L1 lexicon (e.g., Ellis, 2002). There is evidence that suggests that attributes of a lexical entry such as frequency are quite sensitive to personal experience with the language, which is even more variable in L2 learners. L2 learners in an immersion experience may encounter lots of L2 words, but they may not take them in unless they reach a threshold of frequency of occurrence or meet some other criteria, like subjective importance, that allows them to start internalizing the lexical entry. More importantly, the effects of less extensive non-native input and limitations on intake are manifested in restricted range effects and the under-representation of low-frequency words (Aizawa, 2006; Milton, 2009). What this means is that being the product of an impoverished input, the L2 lexicon displays a dissociation from the L1 in its statistical properties, which leads to a shift in the L2 frequency ranges: words that are typically high frequency in the L1 lexicon will have significantly lower frequency in their L2 counterpart.

These two characteristics of L2 mental lexicon – smaller size and shifted frequency ranges - are quite well accepted in the current SLA literature. Unfortunately, the quantitative dimensions alone cannot account for the magnitude of difficulties that L2 learners encounter during non-native communication. Even without the complexities of morphology, syntax and pragmatics, simple comprehension of a word in auditory input can present a significant challenge.

1.2.2 Differences in processing interactions

Another aspect of the mental lexicon that contributes to difficulties in non-native communication is how efficiently the lexical entries can be accessed. Efficiency is key for easy, automated access, and can only be achieved by a systematic reorganization of the items as more information is integrated into the lexicon. If there are no associative connections between words, they remain a list of foreign words difficult to utilize for communication. Thus a dynamic system of integration is essential. However, the organizational pattern that results from this integration may not resemble the pattern found in L1, and there are several factors that are responsible for this qualitative dissociation.

The original idea of the L2 lexicon being qualitatively different from the L1 lexicon was proposed by Meara (1978, 1983, 1984) as a result of a word association study with monolingual and L2 learners of French. Based on a number of consecutive word association studies with L1 and L2 learners and comparing the two, Meara concluded that, first, the connections between words in the L2 mental lexicon are less predictable than the connections in the lexicon of native speakers; second, that the semantic links between words tend to differ greatly from those of a native speaker; and third, phonological links between words tend to play a much more prominent organizing role in the L2 mental lexicon than they do for the native speakers. Additionally, there is evidence that monolingual adult speakers tend to give clang or syntagmatic responses when presented with unfamiliar words (e.g., Stolz & Tiffany, 1972; Wolter, 2001; Fitzpatrick, 2006). The latter finding aligns well with the proposal that the L2 lexicon might differ from native-like lexical associations not only due to the fact that L2 learners already possess an established system of semantic connections in their L1 (Jiang, 2000, 2002, but also due to their limited exposure to L2, which leads to a smaller lexicon and fewer known words (Verhallen & Schoonen, 1993, 1998; Vermeer, 2001; Wolter, 2001). However, strong phonological links between lexical entries may in some cases persist even for well-known L2 items (Wolter, 2001: 60), which is being manifested in the fact that in some cases non-native speakers attend more strongly to the form rather than to the semantic associations of the word. This observation is also in line with Walley's (2007)

Lexical Restructuring Model discussed earlier, indicating a similar pattern for a developing L1 lexicon.

1.2.3 Interaction between phonology and lexicon

There is a large body of research that provides empirical evidence for the difference in the ability of L2 learners to adequately acquire non-native phonology as a primary reason for the lack of native-like performance (Best, 1994, 1995; Best, McRoberts, & Goodell, 2001; Flege, Munro, & Fox, 1994; Flege, 1995; Flege et al., 1996; Ingram & Park, 1998; Kuhl & Iverson, 1995; Sheldon & Strange, 1982; Strange, 1995). The bulk of the studies argue that L2 learners may have both production and perception intelligibility deficits for certain phonological contrasts of the target language, which leads to inadequate identification of the phoneme and, consequently, breakdown in lexical access. A common example is the lack of ability of Japanese learners of English to distinguish between English /r/ and /l/ phonemes, which are both conflated into a single Japanese phoneme /l/ (Goto, 1971; McClelland, Thomas, McCandliss, & Fiez, 1999). This underspecified distinction between the two phonemes can lead to erroneous retrieval of 'liver', when the actual word is 'river'. This example demonstrates that dissociation at a phonemic level can produce lexical effects, which is a true testament to the interaction between phonology and lexicon.

Among the first attempts to investigate the interaction of phonology and higher-level lexical knowledge in this vein is a study by Pallier, Colomé, &

Sebastián-Gallés (2001), who presented two groups of Spanish-Catalan and Catalan-Spanish bilinguals with words that differed in one target vowel which is also part of a critical minimal-pair manipulation (present in Catalan, but absent in Spanish) in a medium-term priming lexical decision experiment. The results showed that Spanish-dominant bilinguals, unlike Catalan-dominant bilinguals, exhibited repetition priming for words with minimal pairs, indicating that they processed these words as homophones, and not as two different words, as Catalan-dominant bilinguals did. While they investigated the interaction of phonological and lexical factors during L2 lexical access, the focus of the study remained on the phonological domain, strengthening the claim about the abstract status of phonological representations.

Although quite innovative and very fruitful for phonological theory, this direct method of relating phonemic representations to the outcome of lexical access has not proved to be very illuminating for the theory of the lexicon, since only a one-to-one dependency is explored—between the phoneme and the word that it is incorporated in, while many other connections between these and other lexical entries are not taken into account. Moreover, important lexical factors, such as frequency of occurrence or morphological complexity, were not controlled.

A more indirect way of exploring phonological influences within the L2 lexicon was undertaken by Bradlow and colleagues (Bradlow & Pisoni, 1999; see also Bradlow & Bent, 2002), who looked into such properties of the auditory signal as speaker and rate variability and the contributions of frequency and competitor sets (i.e., lexical neighborhoods). Of particular interest are the results of Bradlow & Pisoni's (1999) study, where two groups – native English speakers and non-native English speakers – were compared in the accuracy of identification of two types of English words—'hard' and 'easy.' The so-called 'hard' words were low-frequency words from dense, high-frequency neighborhoods, while 'easy' words were high-frequency words from sparse, low-frequency neighborhood. In other words, 'hard' lexical items had many competing neighbors, therefore, lexical access was hypothesized to be more challenging, causing a higher error rate, while responses to 'easy' words that do not have such high-pressure competition from their neighbors should have higher accuracy. Bradlow and Pisoni found, as predicted, that native speakers were less accurate in identifying 'hard' words than 'easy' words. L2 learners showed the same pattern, but with a much greater magnitude of difference in the accuracy rate. Even when familiarity with the items was controlled, the magnitude of the effect did not significantly suffer. The findings were interpreted to suggest that non-native word recognition may be compromised when fine phonetic discrimination at the phonemic level is required, as is the case with identifying a word that has a lot of high-frequency neighbors that differ from the target only in one phoneme. However, it is difficult to agree with the conclusion of the study. While the results do suggest the representational deficit of phonemic contrasts, the contribution of frequency and neighborhood properties of the words to the observed results suggest a lexical effect as well. Competing neighbors do not necessarily involve difficult L2 phonological contrasts, therefore, the neighborhood effect cannot be interpreted as solely a reflection of the deficit at the phonological level of processing. What appears plausible is that the difficult phonological contrast only reinforces the already present effect of neighborhood competition and causes a greater confusion among competing neighbors, which are already difficult to identify. This is not the interpretation of the study that was offered by the authors.

Sekine (2006) conducted a more extensive study of English auditory perception to account for the results of Bradlow & Pisoni, where she introduced the following refinement of the methodology and design: (1) the L1 background was controlled (Chinese, Korean, & Japanese L1); (2) the phonological inventories of L1 and L2 were compared to account for easy/hard phonemic contracts; and (3) the position of perceptual difficulty was controlled. According to the initial predictions, the non-native data showed that not having a minimal pair contrast in the L1 significantly affected the ability to correctly perceive the word in auditory input. More importantly, it was confirmed that this factor interacted with the word's *R index*[5]. Despite the fact that some phonemic contrasts are very difficult to hear for certain L1 groups, the words containing them were successfully identified under the condition that they were of high frequency and/or high relative frequency. On the other hand, phonological factors alone did not account for all errors, especially in the low *R* minimal pair condition and in the condition with words that did not contain 'L2 difficult' contrasts. Perhaps more fine-grained lexical measures (instead of the conflated *R* index) as well as evidence of subjective frequency or familiarity could have proven to be more productive in identifying the source of this additional influence.

In another study, the original finding of Bradlow & Pisoni (1999) has received a different treatment by Imai, Walley & Flege (2005), who compared the performance of L1 Spanish learners of English in their auditory perception of accented speech, also controlling for frequency of the stimuli and their lexical density. They hypothesized that L1 speakers of Spanish would benefit from hearing Spanish-accented stimuli to accommodate for a strong L1 influence on their phonological representations, which they did, but only for the items in dense phonological neighborhoods. In addition, when the L1 Spanish group was divided into low and high- proficiency groups, it was found that high-

[5] The study used an index of 'difficulty' of lexical access termed 'relative frequency' *R*, developed by Luce & Pisoni (1998), which is calculated as the target word's log-transformed frequency divided by the sum of all the log-transformed frequencies of its neighbors and the log-transformed frequency of the target word.

proficiency group performed as well as the control group, but this similarity was limited to stimuli from sparse neighborhoods only[6]. The results suggest that when the words belong to a dense neighborhood, a more detailed phonological representation is required for lexical access. In the case of sparse neighborhoods, Spanish-accented speech did not impair lexical access of English native speakers to the same degree as was the case with the dense neighborhoods, because the competition from the neighbors was manageable for the correct identification of a word. Conversely, when the word belonged to the dense neighborhood, the fact that the phonological detail was missing in the Spanish-accented speech further delayed lexical access, which was already impacted by strong neighborhood competition.

Despite a number of confounds related to biases in the duration of the stimuli[7] and the null effect of corpus frequency, differences between the performance of native and high-proficiency Spanish speakers in their accuracy of word identification from dense neighborhoods were observed. These results are a strong indication of the validity of Imai et al.'s argument in favor of the contributing effect of phonological detail to lexical access (for criticism, see Li et al., 2011). The outcome of the study suggests that when the word does not have a

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[6] The frequency effect was only significant when a 'subjective frequency' measure was utilized in the reanalysis. Subjective frequency was obtained from a pilot group of participants who were asked to provide estimates for the relative frequency with which the test words were spoken and/or heard on a 7-point scale (1 'least familiar'-7 'most familiar').

[7] Words from dense neighborhoods were significantly shorter than words from sparse neighborhoods.

detailed phonological representation, the effect of lexical competition is intensified by the number of competing lexical entries. In addition to Sekine's finding of a substantial effect of categorical phonemic distinction on the outcome of lexical access, the study by Imai et al. point in the direction of a more global type of influence, which cannot be equated with the lack of phonemic granularity in L2 perception, such as mistaking *fish* for *feet*. Sekine's finding for the 'non-minimal pair' condition also invites a similar interpretation. These recent findings, in particular, the earlier-underestimated influence of lexical representations on processing of word phonology, have motivated the present study.

CHAPTER 2: L2-specific mechanisms

As was demonstrated both in L1 child language acquisition and L2 adult acquisition, with increased proficiency the lexicon gets larger, simultaneously establishing deeper, more stable connections among the lexical entries. A more sophisticated L2 lexicon resembles a monolingual lexicon more closely, which is likely to result in more native-like processing as well. This being said, even very advanced L2 speakers exhibit processing idiosyncrasies that cannot be explained by L1 influences alone (e.g., Hyltenstam & Abrahamsson, 2000, 2008). This statement, in turn, attests to the fact that a certain number of differences between L1 and L2 processing still remain. The focus of the present study is not on L1 transfer, but rather on the properties of the immature L2 lexicon, more specifically, on the features of the L2 lexicon that contribute to non-native like properties of lexical access. While an extensive body of research provides convincing evidence for the pervasive nature of these differences, the source of these differences, at least the ones related to lexical access, has yet to be identified.

Based on the previous discussion, it appears plausible that L2 lexical access has its own specific properties that set it apart from the L1. The present proposal makes an attempt to gain a better understanding of what factors in addition to L1 transfer contribute to L2 learners' inability to attain native-like performance and demonstrate L1 functional capabilities during auditory lexical access. More precisely, we propose that L2 learners suffer from a representation deficit, which is manifested in the underspecified phonological representation of the word as a whole, especially of words that are not very well-known. The underspecified representations lead to the fact that some similar-sounding words are highly confusable. In addition to the fact that many words in the L2 lexicon do not have detailed phonological representations, the phonological connections between them also possess non-native properties, such as weak phonological links between the lexical entries, and, in particular, between members of the competitor set. The uncertainty in lexical selection between similar-sounding words prompts L2 learners to utilize a different processing mechanism, which ultimately leads to attenuated lexical competition. These assumptions motivated the Second Language Lexical Access Model (SLLAM) that takes into account the representational deficit and weak lexical competition to make testable predictions about L2 processing differences during lexical access.

The current study tests the main assumptions of SLLAM, in particular, weaker competition during lexical selection, on the one hand, and the underspecification of moderately-known lexical entries, on the other. These two assumptions are closely related, because weaker competition is, in part, a consequence of the underspecification phenomenon I am proposing. This is not to say that phonological underspecification is solely responsible for weaker competition in the L2 lexicon, because another L2-specific feature of the non-native lexicon—weaker connections between lexical entries—also contributes to the decline in competition strength. Due to both sources—weaker connections between the entries and underspecification in their phonological representation—the L2 lexical access mechanism, according to SLLAM, does not assume a strong lexical competition between words, and therefore, the effect of reduced competition is predicted. Weaker competition, in turn, is hypothesized to lead to a greater influence of pre-lexical properties of the L2 lexicon on lexical access. In order to test the model, three types of experiments are proposed: a translation task, a simple auditory lexical decision task (LDT) and an auditory lexical decision task with priming that will manipulate semantic and phonological relatedness between the words.

Before we discuss more concrete predictions of the study, let us consider some empirical evidence that provides some initial motivation for this model.

2.1 Theoretical Motivation

To test the extent to which advanced L2 learners are affected by competition between semantically- and phonologically-related words, Gor, Cook, & Jackson (2010) conducted a primed LDT experiment with Russian word and nonword stimuli. Three groups of proficient American learners of Russian at different proficiency levels (2, 2+, and 3 on the ILR scale[8]) and a group of

[8] According to the ACTFL proficiency scale, a more widespread global rating scale used in academia, ILR levels of 2 and 2+ correspond to ACTFL-Advanced and refers to students who

Russian native controls performed a lexical decision task, listening to pairs of stimuli (primes and targets), and responding only to the targets (i.e., the second auditorily presented word in each stimulus pair). The primes and targets were paired within the same frequency ranges, high and low, and both error rates and reaction times (RT) to the targets were collected. The authors report that in semantic priming, native speakers showed robust facilitation RT effects in both frequency ranges, as did the L2 learners with increasing magnitude of the priming effect with ascending proficiency levels. In phonological priming, native speakers showed the expected inhibition effects in high-frequency items with a 3-phoneme overlap, while L2 learners showed the emergence of similar effects only at levels 2+ and 3. The pattern for low-frequency items was more surprising. While the inhibition was attenuated for native speakers, L2 learners showed outright facilitation in phonological priming, which increased with ascending proficiency levels. The authors offered two potential explanations. One explanation has to do with the slower speed of access in L2 speakers and the other one with the fact that L2 speakers operate with fuzzy representations. The first explanation was based on the contrast between the speed of L1 and L2 lexical access. It was suggested that native speakers had a significant advantage over L2 learners in terms of processing speed, and, therefore, the Inter-Stimulus Interval (ISI) allowed native speakers enough time to successfully access the

have a limited working proficiency, while ILR 3 or above correspond to the ACTFL-Superior level and refers to students who have general professional proficiency and beyond (Stryker & Leaver, 1997: 24).

prime prior to the presentation of the target, which may not have been the case for the L2 speakers.

As monolingual research has suggested, interference during access in priming experiments is caused by the completed lexical selection of the prime, which results in suppressed activation or decay of all other potential candidates activated during the time-course of the auditory input (post-lexical inhibition), while the activation of phonological information can result in a more rapid access (pre-lexical/sublexical facilitation). Due to slower processing speed, L2 learners have time to activate only the phonological code of the prime, which facilitates the processing of the related target, but do not reach full access of the prime in time to inhibit the target. This prediction is also in line with monolingual research—if the prime is not fully accessed, then it would be treated as a nonword, providing conditions for facilitation of lexical access (as in Spinelli et al., 2001, and Monsell & Hirsch, 1998, in conditions with nonword primes).

To further investigate the validity of the 'processing speed' hypothesis, proposed in Gor et al. (2010), a follow-up study was conducted (Cook & Gor, in preparation). The study included both an auditory priming task, in which the ISI was manipulated (350, 500, and 650 ms) to explore the processing differences between L1 and L2 lexical access, as well as a translation task to control familiarity with the stimulus words, both primes and targets. The priming task consisted of three blocks that comprised phonological, semantic, and repetition priming. It was discovered that when the words are well-known, the ISI manipulation proved to be excessive, and L2 learners demonstrated the same inhibitory effect as did the native controls even at shorter ISIs, which was originally hypothesized to be not sufficiently long for adequate L2 lexical access. Therefore, the initial hypothesis about slower processing in L2 was not supported, suggesting that L1 and L2 learners demonstrate comparable speed of lexical access, at least at the activation stage, when the words are very well known. However, as partial support for the 'speed hypothesis,' the facilitatory priming effect in the phonological condition was replicated with unknown real word primes at a later ISI (500 ms), partially justifying the initial prediction of slower speed, but this only applied to unknown words. Unknown words, in this case, also act as nonwords and activate only the phonological code without lexical access without presenting competition to the target, therefore, the effect of facilitation was expected in the absence of lexical competition.

The original Gor et al. (2010) study offered another possible explanation for the unexpected facilitation in the L2 group, namely that L2 lexical access differs from L1 lexical access because it relies less on the semantic component and is facilitated by phonological associations instead due to the fuzziness of representations[9]. The validation of this proposal was unexpectedly found by Cook & Gor (in preparation). An error analysis, conducted on the results of the translation task, revealed an interesting pattern. When the translations given by the participants were evaluated, it became apparent that some translations referred to a different Russian word, and not the one given on the list. The pattern of substitution errors were classified into four main types: form-related error, semantic association error, false cognate, and unknown type of substitution. Form-related errors included those substitutions that were given to the word that shared form-related information (which could be either orthographic or phonological), i.e., initial syllable (e.g., *забота – задание* /zabota/—/zadan'ija/, Eng. 'care'—'assignment'), rhyme (*повесть – зависть* /povist'/—/zavist'/, Eng. 'novel'—'envy'), or both (e.g., *крыльцо – крыло* /krɨlo/—/krɨl'tso/, Eng. 'porch'—'wing'). Semantic association substitutions were translations that were close in meaning to the target word, but were not the correct translation (e.g., *горький – кислый* /gor'k'ij/ – /k'islɨj/, Eng. 'bitter' translated as 'sour'). The false cognate category included translations where the participant associated an unrelated (or very distantly related) word in English

[9] By claiming a primacy of phonology over semantics in the L2 lexicon, we do not assume that phonological connections between words are comparatively stronger, especially, if compared to ones found in the L1 lexicon. Quite to the contrary: Admitting the fact that L2 learners deal with limited accessibility to semantics due to L1 influence and other preventive factors, the phonological basis for organization becomes a default for the system. This being said, phonological connections in L1 are still much stronger and more powerful compared to L2, but so are the semantic links. Without reliable semantic connections, phonology comes to dominate the L2 lexicon organization, which is not the case for the native lexicon.

that shared a similar phonological form with the Russian word (e.g. *патрон* /patron/, Eng. 'bullet'/'patron'). And lastly, if the connection between the substitution and the word in question could not be established, the substitution was classified as 'unknown relationship' (e.g., *состав – место*, /sastaf/ – /m'esta/, Eng. 'composition' – 'place'. When the averages of the substitution errors in each category were compared, we discovered that the majority of substitutions fell into the phonologically-related category (58%). What this result directly points to is that L2 learners often misinterpret the surface form of a word in favor of a different word, as indicated by the translation errors. Recall, in Sekine (2006) an indication of a similar pattern of 'misheard' words was reported in an identification task with a greater chance of the word being misidentified in favor of a higher-frequency neighbor. Although in our study we did not evaluate the frequency direction of substitutions, it is possible that the preference for a higher-frequency competitor would have been observed. All in all, what the translation task showed is that the phonological makeup of a word plays a very prominent role in L2 lexical access, prevailing over the semantic associates.

If we consider this finding together with additional evidence from previous studies, in particular, those of Pallier et al. (2001) and Imai et al. (2006), a new picture of L2 lexical representations emerges. As was demonstrated by Pallier et al. (2001), Spanish-dominant bilinguals were 'mishearing' the Catalan sound in a Spanish word as a Spanish sound, demonstrating the facilitatory priming effect of repetition. Similarly, in Imai et al. (2005) low-proficiency Spanish learners of English perceived English words with a Spanish accent as accurately as the same words spoken by a native speaker of English. In order to account for these results, it should be assumed that the phonological or orthographic form of the word does not have a definite and distinct representation in the L2 lexicon. More precisely, L2 lexical entries suffer from inconcrete phonological representations, such that when a lexical item has neighbors that are very similar in their phonological make-up, the difference between them can be blurred and one word can be substituted for another based on the formal properties, such as the onset consonant cluster or a rhyme syllable, or both.

The 'vagueness' of the phonological make-up of the word can also explain the reversal of the repetition priming effect at ISI 650 (Cook & Gor, in preparation): while at ISI 350 and ISI 500 a facilitatory effect took place, ISI 650 was marked by an inhibitory effect, which parallels the effect observed in the phonological priming condition with real words at the same ISI. It is suggested that the underspecification of the phonological form does not allow the L2 learner to retain phonological information to provide the activation boost to the repeated word if the interval is longer than what allows for the auditory trace to be maintained in memory. If this occurs, repetition priming takes the course of phonological priming, where a partial dissociation between the prime and the target leads to inhibition.

There has been a lot of interest lately in the issues of phonemic categorization and identification in L2 learners of different language backgrounds. While the findings about the differences at the phonemic level during L2 processing are not novel, this is one of the factors that could lead to non-native phonological representations at the lexical level. In other words, this 'phonological noise' places an additional burden on processing; however, this is not the only factor. It is plausible that if L2 processing is accustomed to tolerating a certain degree of inconsistent mapping in terms of phonological representations at a phonemic level, it might be biased to skip over some of the features at this level of processing. This is when low-resolution phonological representations of words as sequences of phonemes, now at the lexical level, come into play: the lexical access channels cannot sustain the memory traces of a representation that is not specified in detail. As it was reported in Cook and Gor (in preparation), L2 participants were likely (58% of all translation errors) to provide a translation of a similar-sounding word (e.g., *крыло* /krɨlo/, Eng. wing—*крыльцо* /krɨl'tso/, Eng. porch) and rate it as a highly familiar lexeme. The difference between the words with phonologically-related translations went beyond the difference in a certain phonemic contrast alone, but, in some cases, the confused words had a different number of syllables (*глоток – плот*,

/glatok/—/plot/, Eng. ‘swallow’—‘raft’), included a different-sounding coda (e.g., *охотник – выходной*, /axotn'ik/—/vɨxadnoj/, Eng. 'hunter'—'day-off'), or had a stress shift (e.g., сосна—соска, /sasna/—/soska/, Eng. 'pine tree'—'pacifier'). These types of differences between the two L2 words could be explained by the lack of fine detail in the phonological encoding of the entry.

Given the above data, we operate under the assumption that L2 learners do not have complete specification in their phonological representation of the lexical entry. This is not to say that it is inaccurate––the phonology may be represented quite adequately for the functioning of the lexicon. For example, if the L2 learner is only familiar with the word *feet*, there is no reason to code the possible difference in the quality of the vowel in order to differentiate it from the word *fit*. A similar proposal has also been made in respect to the L1 lexicon. Lahiri and Marslen-Wilson (1991) suggest that when certain features are not distinctive in the native language, L1 speakers’ perception of the words with this feature used inappropriately remain unaffected, similarly to what we saw in bilingual speakers in the case with their weaker language in Pallier et al. (2001). This is an important finding both with respect to L1 and L2 lexical access, because it demonstrates a high tolerance in the system towards comprehension of mispronounced or otherwise distorted auditory input. Underspecification, therefore, is an important component of speech recognition, which is operational not only in L2 performance, but also in L1. Without postulating this fact, phenomenon such as comprehension of mildly-accented speech should cause a break-down in recognition, but this is not the case (Coenen, Zwitserloot, & Bölte, 2001; Hay, Pierrehumbert, & Beckman, 2004), because there is no mismatch between the surface speech information and the underlying representation, if the representation itself does not impose rigid constraints on the input.

However, in applying the idea of underspecification to L2 learners, we will adopt a much more liberal interpretation of the term, contrary to its the traditional use where it would solely assume a lack of detail in regard to the specification of a phonemic feature, as, for example, the lack of distinction of nasality feature in English vowels, discussed in Lahiri & Marslen-Wilson (1991). Native speakers deal with aspects of the language, such as redundancy, reduction and high-level variability, in an efficient way, because they have a distinct prototype of what the word should sound like. With L2 speakers the situation is different—they do not have a clear representation to match the input to, and, consequently, tend to accept matches that have few similar features. In other words, for L2 learners the underspecification is much more crude, and can be manifested in missing phonemes, substitutions for a target phoneme with a low confusability rating (for example, [ʃ] misanalyzed for [z]), and even omitted or added syllables. Conversely to the limitations that originate from the underrepresentation of certain phonemic contrasts, SLLAM can account for L2 limitations at various levels of representations, whether they are motivated by phonological considerations or not. The variation at other levels, however, is much more widespread and the outcome is significantly less predictable, than the corresponding phenomenon occurring in L1 speech. Coming from the point of view of difficult phonemic contrasts, there is no overt phonemic difficulty that makes the learners encode *fish*, as opposed to *feet,* but for some reason this type of substitution occurs on a regular basis.

Interestingly, similar observations have been made in connection with child L1 development, discussed previously. Yet, the most convincing L1 evidence to date comes from a phonological priming study with infants (Mani & Plunkett, 2008). Two groups of infants (18- and 24- month olds) were presented with a visual prime, which was followed by the visual presentation of two pictures side-by-side and 50 ms later they heard the label for one of the two pictures. In half the trials (primed trials), the heard label began with the same consonant as the unheard label for the prime image. For instance, in a primed trial, infants were presented with an image of a bed in silence for 1.5s, followed by the simultaneous presentation of a boot and a fork. 50ms after the images of a boot and a fork appeared on the screen, infants heard the word boot. In the other half of the trials (unrelated trials), the heard label was phonologically unrelated to the label for the prime image. Two measures—latency and a proportion of target looking (PTL)—were obtained. PTL was calculated using the following formula: PTL = T / (T + D), where T stands for time infants spent looking at the target, and D stands for time infants spent looking at the distractor. Mani and Plunkett found that infants were faster to recognize an auditorily-presented word (latency measure) after having been shown a picture of a phonologically-related target, indicating the facilitating priming effect. Also, 18-month old infants exhibited only pre-lexical facilitation and no lexical competition, reflected in PTL. In contrast, 24-month olds showed evidence of lexical competition proportional to the cohort size of the priming pair (a proportion of target looking (PTL) measure): after the stimulus was heard, the cohort, initiated during the acoustic sequence of the target, was affecting lexical access with an influence proportional to its size. These results primarily mean that at 18-months, infants do not experience any lexical competition that would slow down the processing of the target, but quite the opposite—unlike adults, they experience the benefit of phonological relatedness (latency measure). At the same time, at a later age of 24 months the size of the competitor set starts to matter as well, or at least the presence of other similar-sounding words is being acknowledged (PTL measure). The results of this study confirmed Walley's (2006) Lexical Restructuring Model by clearly demonstrating a progression from a vague phonological representation to a more defined, high-resolution representation of the word in a developing lexicon. It is quite possible that L2 lexicon development follows a similar pattern.

The proposal about L2 learners operating with low-resolution phonological representations can provide an insight into the more fine-grained mechanisms of L2 lexical access. If our assumption is true, phonological facilitation would indicate that accurate phonological information in the L2 lexicon cannot be sustained over time due to the fact that it is not there to begin with. If the L2 learner cannot confidently identify the word, then trying to recall it would present a major challenge, which is likely to lead to failure in access.

This explanation fits very well with the data reported in Gor et al. (2010). One of the results that presented a challenge was the increasing magnitude of facilitation with increasing ILR proficiency levels. Another challenge was to explain the fact that overall latencies also increased with proficiency, which was counterintuitive. These two pieces of data taken together can be accommodated by the mechanism we are proposing. It is possible that due to a larger lexicon, the selection process takes longer, because the target word has a greater cohort size, which means that the L2 learner has to sort through more similar-sounding words. In comparison to L1 processing, an L2 learner's ability to reach a decision is slower and less efficient, because the phonological representations are fuzzy and do not provide for clear-cut and quick decision-making. This increased number of similar-sounding words (the cohort size) slows the selection process down and potentially leads to latencies that increase with proficiency. As for the increase in the magnitude of facilitation, it could also be seen as a consequence of the increased cohort sizes. Initially, the L1 cohorts in children are formed by predominantly high-frequency words (Zevin & Seidenberg, 2002), and as the lexicon grows, more and more lower frequency words are incorporated. This fact has a major significance for the mechanism discussed here, because the changes in size result in both a benefit and a drawback—the benefit of having a larger lexicon with increased overall pre-lexical activation, and the drawback of having more lexical entries to sort through with more similarities to attend to. It is the greater influence of the lexicon at the pre-lexical stage of processing through 'lexical blends' that is potentially responsible for the facilitation of access to the target. The reason for this is primarily the fact that the contribution of the 'cohort blends' is proportionate to the size of the competitors, i.e. represents their cumulative strength. According to our claim, many lesser-known words remain at the partial activation stage and do not participate (or only participate weakly) in the lexical competition, because the L2 speaker is unable to accurately identify them. Consequently, instead of preventing access to other competing words, they contribute to the overall activation at the pre-lexical stage of processing, where phonotactic probabilities have the largest influence on the outcome. If this is the case, then the state of the processing system at that particular moment allows for faster activation of any other word in the cohort (e.g., the target in a priming experiment). For the L2 processor, this word (e.g., the prime in a priming experiment) is not a competitor, but more of an accessory, or a 'friend'. What needs to be kept in mind, however, is that the key to the observed result is not simply in the size of the lexicon, but the fact that low-frequency entries are not phonologically detailed enough to participate in competition with the higher-frequency item. Underspecification, in this case, results only in partial activation of the word. Therefore, instead of preventing fast access of the target (as is the case with native speakers), similar-sounding words 'enhance' access to the target due to their fuzzy phonological representations in the L2 lexical store and pre-activation of the phonological form shared by the cohort. Or, to put it simply, the 'foe' turns into a 'friend'.

An important point here is the fact that both L1 and L2 speakers experience the partial activation stage during processing. What is different is the degree to which activation affects the final selection of the word, which also ties in with the phonological underspecification of the lexical form. For L1 speakers the state of partial activation is transient and is quickly overcome when the word in question is uniquely identified. It is possible that it can only be a part of the pre-lexical stage of processing. It appears that for L2 speakers the situation is slightly different. Since the words that are not well-known for the L2 speaker lack phonological specification (which affects direct access to the meaning), its unique identification (required for lexical access in L1) might not occur. This is not to say that lexical access does not occur either, but it is likely that in L2 processing the criteria for lexical access are less stringent. There is no need to select a 'perfect' match as in L1. As long as the best candidates are narrowed down and one highly-likely candidate is selected, lexical access to the word can take place. However, what it also means is that the other candidates remain activated, if only partially. This consequence is crucial for the mechanism we are proposing—without underspecification, the facilitating influence of the similar-sounding competitors cannot be achieved.

Despite preliminary evidence in favor of low-resolution representations, at this point the proposal is still a suggestion and requires direct experimental evidence. The first step towards verifying the proposed claim should be outlining a possible mechanism that can account for the possibility of a facilitating effect that is proportionate to the L2 learner's language proficiency. As we hypothesize, this would support the claim of vague phonological representations. Then more straightforward, testable predictions can be made.

This point is especially important, considering that there is an alternative possibility, which does not assume a representational deficit. The other cause for the previously reported results could be attributed to the lack of phonological associations between the words. What we mean by this is that L2 learners can potentially be lacking in the ability to incorporate the phonological representation into the mental lexicon infrastructure. In the L1 lexicon, connections based on the phonology of the words are the basis for associations between similar-sounding words. In terms of lexical access, whereas similarity of phonological form at the pre-lexical stage can benefit access initially, it ultimately results in increased competition between lexical items. If we assume that L2 speakers do not have these integrative and, at the same time, interactive connections between words, then the differences that are observed could be attributable to the lack of phonological connections, and not to the low specificity of the representation, as we suggest. The main prediction for L2 performance would be that words not integrated into the lexicon will display a reduced competition effect, or no effect at all. This could be tested in a simple lexical decision experiment, where if the size of the competitor set is manipulated, the outcome could either produce the behavior, prompted by the lack of stable phonological connections (no effect of the competitor size), or typical L1 behavior (inhibitory effect of competitors). Although this proposal is not very plausible, we will attempt to examine this issue more closely in the experimental part of the study.

In summary, to investigate L2-specfic influences on the lexical access outcomes, we propose the following framework. Smaller lexicons with weaker phonological connections between competitors, on the one hand, and the underspecification of moderately-known lexical entries, on the other, differentially affect lexical access. The underspecified phonological representations of L2 lexical entries lead to greater influences of lexical properties of the competitor set during the pre-lexical stage of processing. Similarly to L1, these influences originate from the generation of blended lexical representations with resulting partial lexical activation of the competitors. As a result of this processing mechanism, certain phonological properties of pre-activated words receive greater activation, and this activation is usually described by phonotactic probabilities. However, for the L1 speaker this stage is short-lived, because the processing advances to the lexical stage, where competition from highly activated neighbors slows down processing and eliminates the original advantage of activation of high-probability phonological components. As for L2 learners, due to underspecified phonological representations and the high tolerance of L2 learners for phonological 'noise', this is not the case, and competition between lexical entries is greatly reduced. Along with the lack of competition between the members of the competitor set, which is hypothesized to reduce the duration of lexical access, sustained pre-lexical activation carries over to the lexical stage and provides conditions for a facilitated access during a phonological priming experiment. These assumptions form the basis of the Second Language Lexical Access Model—SLLAM. A detailed discussion of the proposed model is offered in the next section.

2.2 L2-specific Mechanisms of Lexical Access

In this section, I will discuss the properties of the lexicon from two perspectives – from a representational perspective and from an interactional perspective. The former will discuss the properties of the phonological representations of lexical entries as independent entries, while the latter will discuss the properties of these representations as part of an integrated system and will be mainly concerned with the connections between lexical entries within the lexicon.

In order to explore representational and interactional accounts of the L2 lexicon, we will assume the following attributes of the general processing mechanism. Although these attributes do not perfectly match any of the existing auditory speech perception models, we will not introduce any new mechanisms and will adhere to the properties that have been previously agreed upon in the majority of the existing models of lexical access:

1) The system of auditory speech perception is sensitive to the lexical frequency of the input; in following parallel distributed models, lexical frequency is reflected in the resting level of activation for each lexical entry.
2) There are at least two stages of processing a word's phonological information, the phonological level, that is the initial contact of the auditory information with the system which is responsible for, but is not limited to, phonemic identification and syllabic structure identification. Most of the processing preceding lexical access happens at this level, which is the *pre-lexical* level of processing. The second level is the *lexical* level, where the best-fitting candidates from the mental lexicon are matched to the outcomes of pre-lexical processing.

3) There are several lexical candidates that are competing for selection, but only one will come out a winner based on its higher relative activation compared to other candidates. As a result of the lexical access of this word, its phonological, morphological, syntactic and semantic properties are uniquely isolated and identified.

Now that the properties are outlined, let us hypothesize what the behavior of the auditory speech perception mechanism with the proposed parameters will be during the processing of the signal by an L1 speaker in a lexical decision experiment (see Figures 1 and 3 for a graphic representation of the hypothesized activation during L1 processing of the prime *curtain* and of the target *curve,* respectively). As mentioned earlier, there are two important stages that need to be kept in mind when assessing auditory processing: the pre-lexical stage and the lexical stage. In further discussion, I will continue to refer to the phonological processing stage leading up to and during lexical access as 'pre-lexical stage of processing'; however, I need to clarify how this term will be understood in the framework of this dissertation. The term itself can lead to an incorrect assumption that all phonological processing happens prior to lexical access and, by doing so, it creates an impression of a certain limit, where phonological processing stops and lexical access begins. This is not the understanding of lexical access that I will adopt here. On the contrary, I believe that the interpretation of lexical access as sequential is unwarranted. While it is

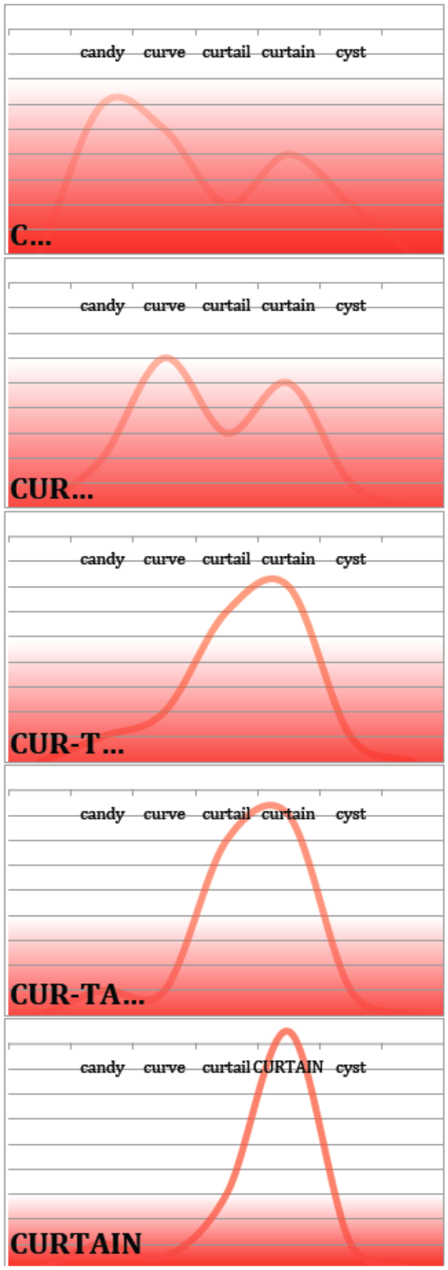


Figure 1. Hypothesized activation sequence in native speakers during processing of the prime

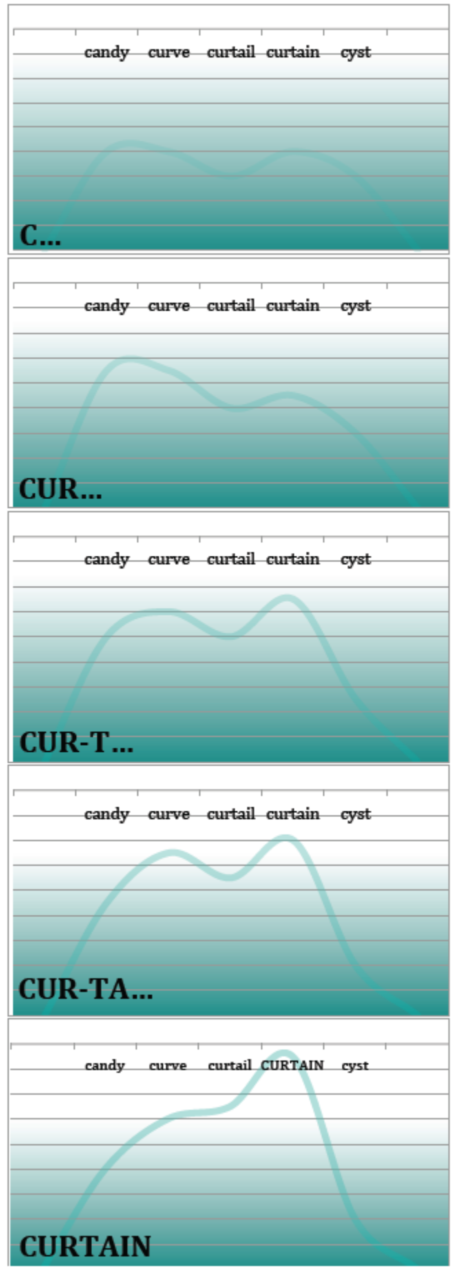
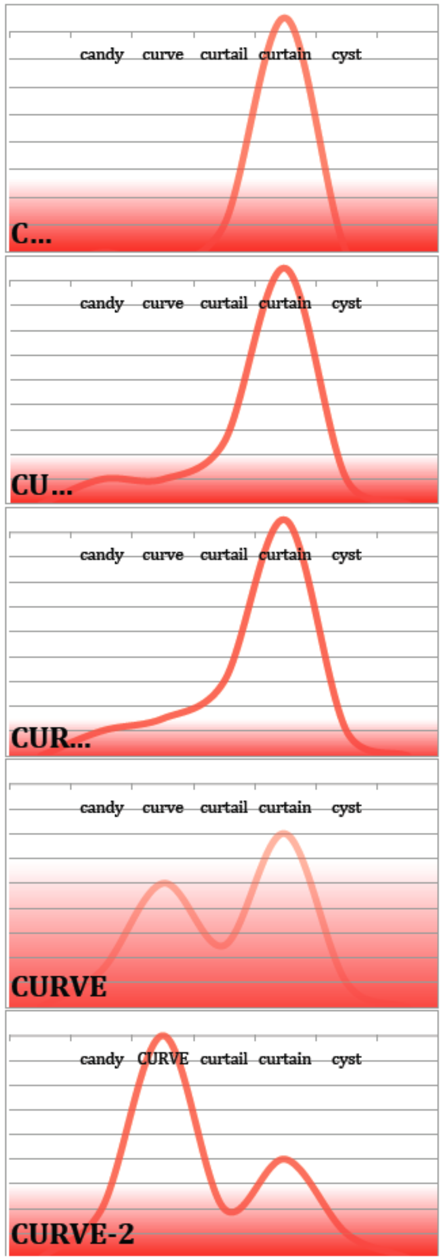


Figure 2. Hypothesized activation sequence in L2 speakers during processing of the prime

Note: The line of the graph represents the lexical activation with the degree of boldness reflecting the degree of certainty in identifying the word, while the background color reflects the overall activation of the system at the pre-lexical level.



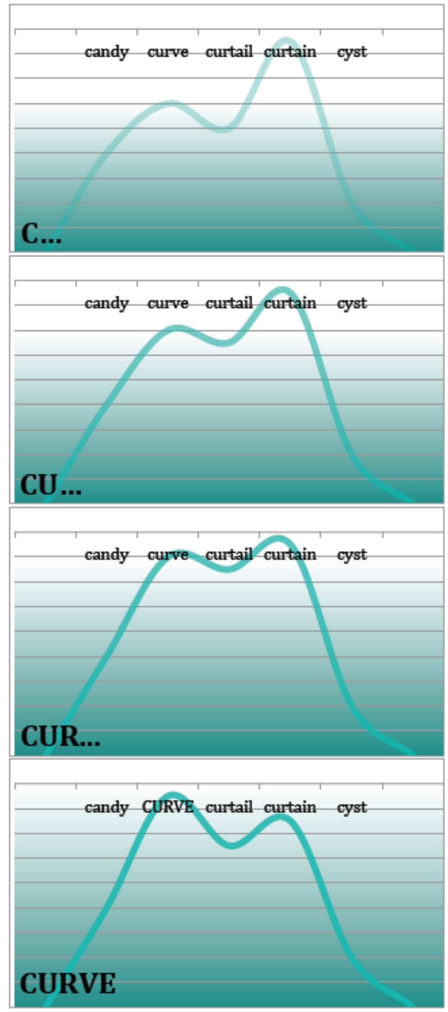


Figure 3. Hypothesized activation sequence in native speakers during processing of the target

Figure 4. Hypothesized activation sequence in L2 speakers during processing of the target

highly plausible that the initial processing of auditory information is predominantly phonological, when the selection of the contenders narrows down to several best-matched candidates, partial lexical access also becomes a possibility. At the same time, partial activation of semantics of several candidates cannot be considered 'lexical access' per se, because in the end, only one word receives the benefit of full semantic access. Up to this point, both processing routes—phonological pre-lexical processing and semantics-based lexical access—are likely to occur in parallel, with a greater influence of phonological factors at the initial stage of processing, and a much greater influence of lexical factors associated with the activation of meaning, during the stage of lexical access. By adopting this interpretation of the term 'pre-lexical', we intend to follow its conventional use to refer to the phonological processing route during lexical access; at the same time, I would like to stress that it will be used without an assumption of the sequential nature of the phonological and lexical processing routes during lexical access. Therefore, 'pre-lexical' in this text is close in meaning to sublexical, a less common term.

During the pre-lexical stage, the initial processing of phonological input takes place. Recall Smolensky's (1989) proposal, which states that even before lexical access is complete, the processing mechanisms produce so-called 'lexical blends' that incorporate representational segments of all the lexical members competing for selection. However, while the lexicon has not yet been accessed in order to retrieve the one single complete set of lexical properties, several lexical entries receive 'partial activation'. As a result, they produce strong cumulative activation to the segments that are shared by the pre-activated lexical entries. The rest of the activation (of the non-overlapping segments), creates phonological 'noise' and blurs the more prominent shared activation. Therefore, 'partial lexical activation' produces two consequences for the outcome of lexical access. On the one hand, partial activation provides a distinct benefit to the more typical phonological elements and sequences, projecting a strong focused activation to those segments. This outcome can be interpreted as the basis for the phonotactic probabilities. On the other hand, partial activation also implies that a number of distracting phonological sequences are being activated, which creates phonological 'noise' that impedes lexical access. What it also means is that the more possible lexical matches there are, the less is the certainty in uniquely identifying the word. It can be implied that these two consequences are in conflict with each other: the greater the number of competing lexical entries and the greater the overall activation in the processor, the less certainty there is in identifying a one single match and the less chances there are in completing lexical access. With more input, the degree of distracting pre-lexical activation drops, as does the overall activation at the pre-lexical level, and the number of the potential word matches to the input is reduced. Therefore, reduced activation at a pre-lexical level leads to increased certainty in selecting a matching lexical entry. In other words, for successful lexical access, the level of pre-lexical activation needs to be low (reduced phonological 'noise' from lexical blends) and the level of lexical activation should be high (high certainty of the match between the input and the existing phonological representation or representations). When those conditions are met, the best possible matches to the input at this point compete for selection.

Take as an example the word *curtain* being processed; a word from a relatively large set of competitors (see Figure 1). When the initial syllable of the word is heard (*cur-*), it is first processed by the phonological level (/kər/). Upon identification of the onset sequence, the words starting with /kər/ are partially activated (the cohort) (e.g., *curfew, curl, curling, cursor, curtain*, *curtail, curve*, etc.). Notice that at this point pre-lexical phonological activation is at its highest, since many words are pre-activated and the irrelevant information imposes a burden on the phonological system, creating a lot of 'noise'. As the additional incoming auditory information gets processed at the phonological level (the second syllable –*tain* of the word *curtain*), the activation spreads to the lexical level and boosts the already pre-activated matching word *curtain*, reducing pre-lexical activation. At the same time, the inhibition gets passed on to the cohort members that are not a match to the activation of the second syllable /tən/ at the phonological level. As a result, only one lexical member remains activated—*curtain*. The competing group of words gets rapidly deactivated, and, according to some recent MEG findings (Pylkkänen et al., forthcoming), there is enough evidence to assume that the activation drops below the resting level. In this scenario there are at least two dominating influences that we should acknowledge: the main frequency effect of the word and its competitor set density effect. As for frequency, the word *curtain* (13 instances per million, i.p.m., Francis & Kucera, 1971) is relatively low in frequency, and in comparison to more frequent words, e.g., *summer* (134 i.p.m.) or *name* (294 i.p.m.) will have a lower resting activation, thus requiring a longer activation period, and, therefore, its recognition will be slightly delayed. As for the competitor frequency effect, *curtain* has only one higher frequency competitor – *curve* (45 i.p.m.), which would be considered to be the most powerful contender. When the hearer attempts to retrieve the word *curtain*, the word that dominates the competitor set in terms of frequency (Bard & Shillock, 1992) *curve* will interfere with processing, causing a relative slow-down in reaction time compared to the case when the most frequent member of the competitor set is being retrieved.

Now let us consider the system's behavior during a phonological priming lexical decision task. For illustration purposes, let us use a priming pair *curtain* – *curve* (Figure 3). The word *curtain* has been processed in a similar fashion as described above, but without a button press (Figure 1). Recall that after the identification of the prime (*curtain*), the cohort members are suppressed below their resting level, which means that the activation of any of the words-competitors would require a more robust activation and, possibly, a longer time for the activation to surpass the threshold of lexical selection. However, the initial activation does not suffer. When the higher frequency target *curve* is presented, during pre-lexical processing, the previously activated phonological sequence /kər/ gets more robust activation due to the fact that it was 'primed' before, facilitating the initial processing of the word form. The pre-lexical activation also remains low, because the system is made to believe that the incoming input will be a match to just heard *curtain*, but not *curve*. However, when the phonological processing advances further and initiates partial activation of the competing entries, the same cohort of words gets moderately reactivated, but the activation of the competitors the second time around is not the same as it was during the first pass: the resting activation of the words is different. In order for the word *curve* to be selected, the activation level needs to be first brought up to the resting level, because this lexical item has experienced strong inhibition from the main competitor—*curtain*—a few hundred milliseconds prior, and this inhibition is still strong enough to resist reactivation. At this moment the uncertainty in the match of the input to the representation drastically increases, because the processor needs to reconsider other options, available in the cohort, producing great 'noise' in phonological activation. Consequently, additional time is necessary in order to resolve the conflict and narrow down selection for successful lexical access to occur, resulting in longer decision times and higher error rates associated with its identification. In other words, a strong inhibition effect is observed. The performance of target retrieval under priming conditions is predicated on the fact that the previous competitor set activation has just experienced a strong deactivation.

Now let us consider the performance of the model that we have outlined in an L2 speaker, taking into consideration the representational differences, such as the fuzziness of the phonological representations in the non-native mental lexicon and weak competition at the lexical level (see Figures 2 and 4 for a graphic representation of the hypothesized activation during L2 processing of the prime *curtain* and of the target *curve,* respectively).

Let us assume that during a simple lexical decision experiment, the same two factors influence the outcome of L2 processing as in L1 processing: the frequency effect and the competitor set density effect. In our example, the identification of word *curtain* is predicted to be slightly delayed in native processing due to relatively low frequency of occurrence (a main frequency effect). It is expected that the overall decision time will be higher for L2 learners (a common effect in non-native processing), and the magnitude of the frequency effect will be attenuated due to a smaller lexicon and distorted frequency counts. However, what makes L2 processing mechanisms differ is lack of definitiveness. The underlying phonological representation of the words is 'vague' or 'approximate', and this leads to considerable fluctuation in the system in order to identify the best match. Since L2 comprehension mechanisms can tolerate a high degree of underspecification, the system can avoid making an 'all-or-none' decision by providing an activation boost to a single entry and deactivating the rest with the risk that the input was not identified correctly. It is even more plausible that due to such low specificity, all candidates will remain partially activated, and the lack of competition is due to the fact that most of the candidates had such weak partial activation that they did not trigger the activation at the lexical level at all, so their contribution to inhibition is irrelevant. If this is the case, as a result of this mechanism a strong activation at the pre-lexical level is observed, a consequence of underspecification of form as well as the higher tolerance of the processor for 'phonological noise'. The lexical decision is being facilitated as a function of the increased pre-lexical activation, primarily due to the positive contribution of cumulative activation to the overlapping segments. At this point what makes the L2 mechanism different from the L1 processing is that L2 speakers still have a lot of fuzziness in their phonological representations of words, and a lot more irrelevant lexical entries get partially activated, some very vaguely related. In addition, 'cove', 'corridor', 'kernel' could also be activated. The inability of L2 speakers to use well spelled-out representations (because they are not there to begin with) produces a much greater pre-lexical activation for multiple words to compensate for this uncertainty, which means that more similar-sounding words are pre-activated in a larger cohort and less in the smaller cohort. This behavior can provide explanatory power to the greater effect of phonotactics in L2 rather than in L1 processing, which is counterintuitive. The magnitude of facilitation is directly related to the subjective similarity of the target word to the other words in the lexicon, when greater facilitation is produced by the greater number of similar-sounding words. In the case of L2 learners, the degree of familiarity with the word determines how detailed the phonological form of the word is in the lexicon. Consequently, if the word is not well-known and its phonological representation is fuzzy, more words will be similar to this subjective, or individualized, representation, therefore, its competitor set will also expand as a consequence. This observation can be interpreted as an indirect reflection of the pre-lexical competitor set effect in L2 processing, where the underspecification of L2 lexical items allows for a greater influence of the pre-lexical stage of processing on lexical access.

When this limitation of L2 processing is applied to the phonological priming manipulation, a different set of predictions can be made. Generally, the ability to identify a word is highly affected by the hearer's ability to manipulate the activation of the competitor set. During the processing of the target, the reactivation of the competitor set is unavoidable, since both members of the priming pair—the prime and the target—belong to the same set. However, unlike the L1 processing sequence, the activation of the prime does not produce any measurable competition at the lexical level, only an increased overall activation at the pre-lexical level that was generated by partial activation of the words-competitors, but did not result in lexical activation. Recall that during L1 processing, the activation of the competitors the second time around (i.e., during processing of the target) is greatly influenced by the altered resting activation of the words, which requires time to dissipate and overcome the inhibition which resulted from the selection of the winner. Therefore, a delay in processing is observed. But for L2 speakers the activation of the competitors at the lexical level of target identification is suppressed once again. As suggested by SLLAM, when the target is presented for identification, any member of the competitor set has already been partially pre-activated without experiencing any inhibition associated with lexical competition, and, consequently, has a higher activation level than its resting level. As a result, the pre-activated connections at the phonological level allow for an L2 processing advantage (in relative terms). However, what one should also consider is that at this point in processing the contribution of the competitor set size might manifest itself. As was reported in Gor et al. (2010), the magnitude of facilitation in L2 learners during auditory phonological priming increased as a function of proficiency. This finding primarily indicates that since proficiency is highly correlated with both awareness of non-native phonotactic probabilities and the size of the lexicon, the larger the number of competitors in the set, the greater the magnitude of facilitation. This can mean one of two things. First, the source of facilitation stems from a greater mastery of the language and is a manifestation of phonotactic probabilities without lexical competition. Although probable, this proposal is not very plausible. If mastery of the language is sufficiently high to be able to form a probabilistic mechanism for predicting phonotactic probabilities, the effect of competition should also be observed. With successful lexical access, the competing candidates require more time for lexical access, and thus neutralize the processing advantage that comes from pre-lexical activation. In this case L2 lexical access will approach native-like performance and will likely result in inhibition. It is not very likely that the effect of phonotactic probabilities in L2 learners will outweigh the effect of lexical competition, because it does not do so in L1 learners under similar circumstances.

The second explanation suggests that the number of words in the set allows for a greater pre-activation at the phonological level from partial activation, which would result in an even more robust facilitation. The second explanation would relate to the size of the lexicon directly, more precisely, to the number of pre-activated lexical candidates. The key in this explanation is the fact that the potential competitors are only partially activated and, therefore, are unable to compete against each other. If the greater proficiency means more words in the lexicon, it would also mean that more phonologically-related words are pre-activated, therefore, there should be an effect of the competitor set size—facilitation of a greater magnitude is expected for higher proficiency learners with larger lexicons, compared to a magnitude of facilitation for less-proficient learners with smaller lexicons. We are leaning towards the second explanation. As was also observed in Gor et al. (2010), the overall latencies in the matched phonological condition exhibited an upward progression as a function of proficiency. While at first the outcome was rather puzzling, since a more sophisticated L2 lexicon resembles a monolingual lexicon more closely, making it possible to hypothesize that the processing will also show more resemblance to L1 lexical access, this was not the case. The explanation that incorporates the assumption about partial lexical activation, however, can accommodate the results about the reversal of the cohort influence in L2 speakers.

While the hypothesis about the impact of cohort/neighborhood factors was not directly addressed by the two previous studies, the data already collected in these experiments can give a preliminary idea of whether the competitor size is in fact an important contributing factor to L2 lexical access and whether the hypothesized model fits L2 behavior. We decided to isolate the items that would fit the criteria of the proposed study along the competitor set dimensions. Since the critical manipulation in the matched phonological condition had to do with the initial overlap, and the priming experiments were auditory, a cohort seemed to be a more natural measure to use for controlling the competitor set size. As a result, we ended up with 8 items from the high frequency range based on Sharoff's corpus data (around 100-200 occurrences per million), with half of the items falling into the 'large cohort' group and the other half into the 'small cohort' group (See Table 1). Also, we decided to focus on only two proficiency ranges—ILR 2 and ILR 3—to maximize the proficiency gap between the two groups. Based on some preliminary findings about the size of the lexicon of American learners of Russian at certain proficiency ranges (discussed in more detail in the next chapter), we calculated the following lexical parameters of the words: the cohort size for a particular proficiency level, similar to N size, or neighborhood density, for lexical neighborhoods (a function of the size of the L2 vocabulary), the average frequency of the cohort (cohort frequency), and the relative sum of frequencies of all cohort members at this particular proficiency level. As was mentioned before, all cohort measures are highly consistent across the proficiency levels and have a high correspondence to the L1 lexicon measures, so that words from big cohorts also remain classified as belonging to big cohorts even at lower proficiency. The same applies to words from small cohorts. By verifying the composition and average frequencies of the cohorts at each proficiency level, we confirmed that there were no major inconsistencies in the classification of the items, i.e., that words that are classified as members of the small cohort for lower L2 proficiency group are also members of the small cohort for higher L2 proficiency groups.

Further, we compared the latencies of responses to those items in phonologically matched and unmatched conditions with initial overlap. The words in the unmatched condition were hypothesized to behave similarly to what we have hypothesized for a simple LDT experiment. The prime will not present any competition for the target, so it is reasonable to assume that the phonological influence of the prime will be negligible and can be dismissed. In this case, we predicted that if words are not well known to the participants (ILR 2 group), they cannot fully participate in competition, since they are still underspecified in terms of their phonological make-up. However, the learners can benefit from the knowledge of other words that have the same onset at the pre-lexical stage. If it is a highly probable combination, then it would imply that there are many words that start with the same initial sequence, i.e., the target

Table 1
Summary of item parameters used in the reanalysis

Item	Corpus Freq	Corpus Cohort	ILR 2 subset Freq	ILR 2 subset Cohort	ILR 2 subset Mean Freq	ILR 3 subset Freq	ILR 3 subset Cohort	ILR 3 subset Mean Freq
Large cohort								
Голый /golɨj/ *naked*	97.26	272	53.28	23	340.52	53.28	32	255.75
Короткий /karotk'ij/ *short*	202	743	149.69	36	92.705	149.69	64	84.04
Острый /ostrɨj/ *sharp*	126.34	239	74.44	9	112.72	74.44	14	110.60
Страх /strɑx/ fear	185.16	49	114.77	9	154.17	114.77	15	106.89
Mean	152.69	325.75	98.04	19.25	175.03	98.04	31.25	139.32
Small cohort								
Край /krɑj/ *region*	200.77	79	165.53	5	105.02	165.53	6	86.06
Плохо /ploxa/ *poorly*	187.18	38	111.05	2	115.98	111.05	4	76.16
Слабый /slabɨj/ *weak*	132.03	40	98.26	1	98.26	98.26	2	66.66
Стул /stul/ *chair*	129.34	29	67.27	2	81.53	67.27	3	66.54
Mean	162.33	46.5	110.52	2.5	100.19	110.52	3.75	73.85

as well as other cohorts) will be responded to more quickly than words from smaller, less populated cohorts, and this is exactly what we see for the lower word would belong to a big cohort. Therefore, targets from sizeable cohorts (and ‘sizeable’ implies a relative comparison to the size of their lexicon proficiency group (Figure 5). In other words, pre-lexical activation is correlated to the number of words in the cohort through probabilities. As far as the higher proficiency group, its behavior is quite comparable to the native controls—they exhibit a delay in accessing words from larger cohorts due to increased competition, similarly to the native speakers. The critical difference between the two proficiency groups is in their degree of certainty about the phonological form of the words. While the higher proficiency group (ILR 3) has resolved the ambiguity in the form of the target and its competitors, the lower proficiency group (ILR 2) is still working towards adequate specification.

The second point of interest was to compare the latencies of the responses in the phonologically-matched condition, where we would expect to see the most profound manifestation of L2 advantage based on overall pre-lexical activation (Figure 6). What makes this situation especially interesting is that the pre-lexical activation that carries over from the processing of the prime to the processing of the target without lexical competition, does not incur inhibition. Returning to the predictions of our model, the lack of complete lexical activation at the prime level and, as a result, no lexical competition allows for phonological priming to affect the L2 decision on the target in a different way. For native processing we observe a delay due to increased competition from the prime word, as well as the other

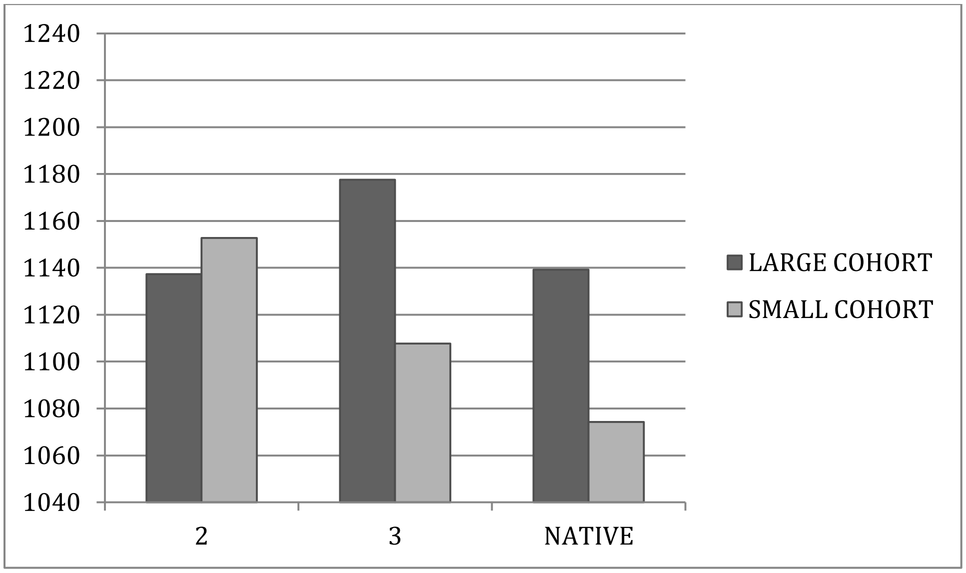


Figure 5. Mean latencies in the unprimed LDT condition, by Group

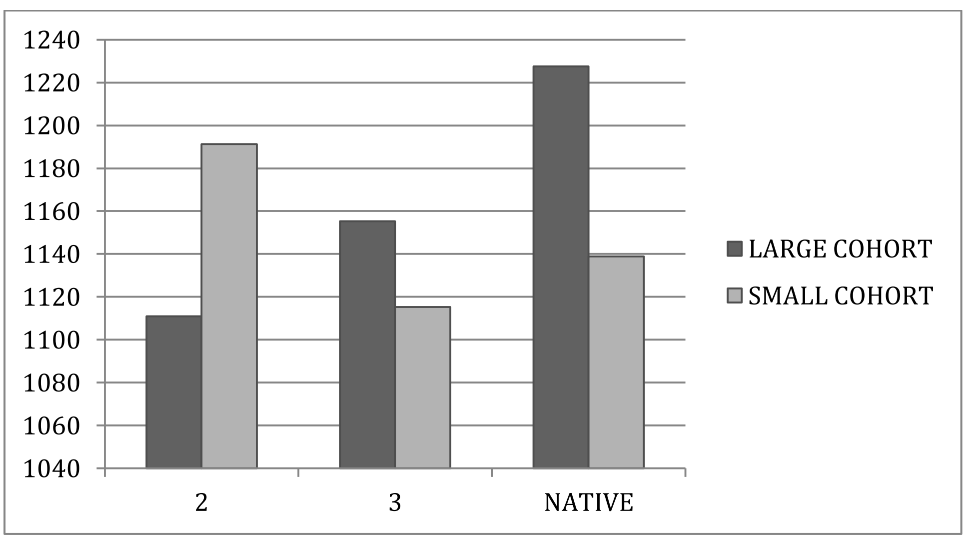


Figure 6. Mean latencies in the primed LDT condition, by Group

members of the competitor set. However, L2 speakers do not experience the pressure of competition to the same extent as L1 speakers do—the activation levels of the L2 words are weaker, their number is also limited, and, more importantly, the prime itself is not a strong competitor due to the vagueness in representation. Intuitively, these factors would be expected to affect lexical behavior negatively, since weaker lexical activation and underspecification of phonological representations are characteristic of a lower level proficiency lexicon. However, the opposite seems to be true: weaker activation links allow for the overall activation of the phonological system to remain strong and to avoid being neutralized by lexical competition. Consequently, facilitation in the auditory processing network is produced for an onset-related target. If the degree of facilitation is related to the magnitude of pre-lexical activation and, indirectly, to the size of the cohort/competitor size, then faster latencies are expected for words with higher phonotactic probabilities onset (larger cohorts) and longer latencies for words with less probable onsets (smaller cohorts), and this is what the reanalyzed data shows. The lower proficiency group still lacks detail in the phonological encoding of the stored words, and, therefore, shows a considerable facilitating effect of a large cohort, relying, for the most part, on the 'wordlikeness' of the input. According to SLLAM, the fact that they are able to match neither prime nor target to the exact entry in the lexicon is a direct consequence of the underspecification of the phonological form in the lexical store. However, the implicit improvement in lexical access is apparent in higher proficiency level L2 speakers, whose performance parallels that of the native speakers and results in inhibition. Strong competition from a larger cohort drastically slows down the decision latency for both the ILR 3 and the native control group. This fact demonstrates that greater familiarity with the words allows non-native speakers to compensate for the limitations of their processing system, such as weaker connections between entries and difficulties in perception of non-native sounds. Although the magnitude of the difference is not the same, higher proficiency learners are definitely more similar in their linguistic behavior to native speakers than to lower proficiency learners, at least with respect to phonological processing.

The Second Language Lexical Access Model (SLLAM) that we are proposing here seems to fit rather well with the body of empirical evidence collected up to date, including the reanalysis of our own data discussed above. The evidence suggests that one major modification of the L1 auditory processing model accounts for a number of phenomena in L2 lexical access. A severe impairment of phonological representations of words that goes beyond difficulties in representations of discrete phonemic distinctions at the lexical level (Lahiri & Marslen-Wilson, 1991; Pallier et al., 2001; Imai et al, 2005; Sekine, 2006), can explain L2 phonological behavior as well as several other idiosyncrasies of L2 lexical access, such as the overall increase in latencies with increased L2 proficiency.

CHAPTER 3. Methodology

3.1 Introduction

Before going into the methodology of the study, I would like to restate the main consideration at hand. The research question that motivated the study concerns the factors that are involved in lexical access for non-native speakers, more precisely, what lexical and non-lexical factors associated with phonology are involved in the auditory speech perception of L2 learners and whether any of these factors can account for the lack of native-like mechanisms in their processing of auditory input.

3.2 Research hypotheses

In the previous section, I outlined the theoretical motivation for the L2-specific psycholinguistic model of lexical access. In the present chapter, I plan to explore how lexical parameters of Russian words such as lexical frequency and competitor set size affect non-native lexical access in two L2 groups at different stages of acquisition, which are the Advanced group and the Intermediate group. The Advanced group included L2 learners of higher proficiency and the Intermediate group included L2 learners of lower proficiency. The present study attempts to further identify the contributions of various factors to the outcome of auditory speech processing in non-native speakers of Russian and discuss the validity of the predictions of the model I have proposed, SLLAM. More specifically, the study addresses the following research questions in relation to the proposed model:

RQ1: Do L2 learners operate with fuzzy representations during lexical access?

RQ2: Do fuzzy representations affect L2 lexical access?

RQ3: Do fuzzy representations contribute differently to L2 lexical access at different stages of proficiency?

Before I outline the design and methodology of the study, the hypotheses motivated by the main research questions will be discussed.

Hypothesis #1: *L2 speakers operate with impaired phonological representations of words that lead to confusion in form-meaning mappings of L2 lexical entries.*

This is one of the main hypotheses of the current study, which was motivated by the first research question about the existence of underspecified phonological information in the L2 lexicon. The current hypothesis sets out to provide further empirical support for the lack of specification in phonological representations in L2 learners. The present study was designed to show that unlike native speakers of Russian, who also experience accidental misidentification of words, even advanced adult learners of Russian do not have adequate phonological representations for some Russian words, especially if they are of lower lexical frequency. Moreover, these fuzzy representations are much more severe and are not limited to 'difficult' phonemic contrasts in the L2.

The underspecification of phonological information in L2 lexical representations can be manifested in two ways—in the phonological representation itself and in the form-meaning mapping between the underspecified form and its meaning. When we think of the underspecification in phonological form, first we have to take into account that L2 learners' ability to encode L2 phonological information is impaired. This encoding deficit is primarily manifested in the 'difficult' phonemic contrasts, which do not exist in learners' L1. Additionally, L2 learners are not very familiar with the combinatorial possibilities of the language at the lexical level, such as what are legal and illegal phonological combinations, which phonological sequences are allowed in certain positions and which are not, etc., the very basic phonotactic properties of the language that are still in the process of developing. Keeping in mind that due to a limited number of words familiar to the L2 learner, there is no immediate need to encode them in fine detail, the encoding deficit and lack of phonotactic sensitivity also contribute to the underspecification\\ in the representation of the lexical entries. These three factors taken together lead to a phonological representation with insufficient detail. However, if the lexicon is small enough and there is no conflict between the existing entries in terms of their phonological make-up, the L2 underspecified representation can function similarly to a fully-specified representation in L1 lexicon.

This leads us to the second assumption about the nature of the underspecified representations, which is manifested in the form-to-meaning mapping between the underspecified representation and the semantic component of the L2 word. If the formal properties of the phonological representation are only an approximation of the true phonological form of the L2 word, then this entry's connections to its semantics might also be lacking in detail. What I mean by that is that the lack of a distinct phonological form of the word leads to unstable and, consequently, weak links to the meaning. For example, let us assume that the L2 learner does not have a distinct phonological representation of the word *pretzel.* At the same time, the word *pretzel* has some phonological segments, which make it smiliar to the word *pencil*. It is possible that when hearing an unfamiliar word like *pretzel,* an L2 learner would attempt to match the word he is hearing to the existing representation of the word *pencil.* Having an encoding deficit, what he hears might be characterized as a phonological blend of *pretzel* with *pencil*. In this case, it is not unlikely that the word *pencil* is being accessed instead of the intended *pretzel.* We should also assume that by acquiring the new word with a new meaning, which will be the case for the word *pretzel* at a later stage of L2 acquisition, the semantic links between the word *pencil* and its meaning will undergo changes, during which progressively more often the correct semantic link to the word *pretzel* will be assigned. Therefore, what we can say about the early stage of word acquisition is that the semantic link to the correct meaning is more likely to be assigned incorrectly, thus displaying a weak form-to-meaning mapping.

These two implications of underspecified phonological representations were addressed using both on-line and off-line measures. I will address the underspecification as a phonological phenomenon in more details in Hypotheses

#2-5. The current hypothesis primarily focuses on exploring the manifestation of underspecification in the form-to-meaning mappings in the L2 lexicon.

To test the form-to-meaning manifestation of the phonological underspecification I conducted two experiments—a translation task (an off-line measure) and a pseudo-semantic priming task (an on-line measure). Both tasks have their own benefits. First, they create two different kinds of demands on the subjects, depending on the modality. The translation task emphasizes accuracy, while the priming experiment explores the processing component with less of a focus on accuracy. Another important factor assessed by the translation task is the form-meaning dimension, which is intended to provide definitive evidence of L2 learners' familiarity with the words used in the experiments. Based on SLLAM, the critical differences in L2 processing lie in the fact that the competing lexical entries remain only partially activated, without participating in lexical completion. In order to confirm the fact of lexical access, which assumes access to meaning, the translation experiment seems to be an adequate measure to establish whether lexical access in fact took place and whether the form was linked to a unique meaning.

In addition, I will explore the possibility of whether the vague phonological form of a word can lead to confusion between two existing words and result in accessing a different meaning. By showing that it can, I argue that while the form is vague, the higher tolerance of 'noise' at the phonological level can still result in lexical access, albeit incorrect access. In order to test this prediction, a pseudo-semantic priming task will be conducted in conjunction with the traditional semantic priming that will establish a baseline effect. In the pseudo-semantic condition, the lower proficiency L2 learners will be more quick to accept a high frequency pseudo-target for a true semantically-related target, thus showing a facilitation effect typical for semantic priming. High proficiency L2 learners, having more detailed representations of the phonological form of the word, should be more sensitive to the mismatch between the semantically-related target and the pseudo-semantic target, and woul\d be more likely to identify the mismatch between the expected semantic target and the presented pseudo-semantic target. However, what we would also expect to see in this case is the evidence of competition, typical for phonological priming. By presenting participants with a pseudo-semantic target, the intention is to evoke phonological competition between the expected semantic target and the actual word, which is being presented. By design, these two words are phonological competitors within the same cohort. Since the predicted outcome of lexical competition is a delay in latencies, we would also expect a delay in the high-frequency range for the Advanced speakers, because more-proficient speakers would be highly familiar with the words from this frequency range. However, the pattern of results in the low-frequency condition for more proficient L2 learners will be similar to the pattern of responses of the lower proficiency L2 group in the high-frequency condition, displaying semantic priming facilitation.

The two tasks—the auditory translation task and the LDT with pseudo-semantic priming—combined should be able to provide a full view of the underspecification phenomena I intend to exemplify.

The following two hypotheses—Hypothesis #2 and Hypothesis#3—are aligned to address the second research question about the role that phonological underspecification plays during L2 lexical access.

Hypothesis #2: *Underspecified phonological representations facilitate L2 lexical access as a function of lexical competitor set size.*

As we have proposed earlier, the lack of certainty about the phonological form of an L2 word is hypothesized to produce no competition between the candidates for selection, primarily, due to the fact that the rest of the candidates also have relatively weak activation. However, according to the proposed model, L2 learners exhibit a pre-lexical effect of cohort size, which is manifested in faster and more accurate performance in lexical access of words from large competitor sets. Moreover, the magnitude of facilitation is associated with greater activation of phonotactically-probable segments at the phonological level and, consequently, with a larger lexical competitor size.

While Hypotheses 4 and 5 address the question of cohort influence at the lexical level, which is typically manifested in the inhibitory influence of lexical competition proportionate to the competitor set size, the present hypothesis, Hypothesis 2, addresses the pre-lexical influence of the cohort size, typically manifested in the facilitatory influence of the competitor set size.

The current hypothesis will be tested in an LDT with phonological priming. According to the assumptions of SLLAM, when the words are not well-known to the L2 learner, lexical access proceeds without competition among members of the competitor set. The primary reason for this is the fact that lexical access of a less-known word results in the inhibition of the competitors of a much smaller magnitude. Therefore, if this assumption is true, when the word is not well-known and is presented as a prime, then access of the target will be facilitated proportionately to the competitor set size. Accordingly, the following predictions are made: a target from a large competitor set will be accessed faster than a target from a small competitor set when primed by the phonologically-related prime. This will be true for the L2 learners of lower proficiency in the high frequency condition and for the L2 learners of higher proficiency in the low-frequency condition. Assuming that the effect of lexical competition is no longer observable in these frequency ranges, the magnitude of facilitation will be modulated by the competitor set size.

Hypothesis #3: *Facilitation in L2 lexical access originates at the pre-lexical level of processing.*

Considering the pre-lexical facilitating contribution of phonotactics, SLLAM also assumes that the facilitating influence of the competitor set size has a pre-lexical origin. Therefore, we hypothesize that if the level of pre-lexical activation affects lexical access, words that are completely unknown to the learner would produce the same benefits of partial activation during a lexical decision experiment. The degree of facilitation will vary as a function of the competitor set size, which is being partially activated before lexical access (or lack thereof), with greater membership providing more facilitation.

Hypothesis 3 is an extension of the previous hypothesis about the facilitatory effect of the cohort at a pre-lexical level, with the present hypothesis highlighting the source of the facilitation rather than the general contribution to lexical access, which is the facilitation of access. This hypothesis postulates that with the absence of a highly operational phonotactic mechanism in L2 learners, there is only one plausible source of facilitation—the pre-lexical competitor set influence. To test the pre-lexical status of facilitation, the performance of L1 and L2 speakers in known-word and unknown-word conditions will be compared. More specifically, the results of the LDT with phonological priming will be analyzed in conjuncture with the translation task, which would allow us to identify the trials with primes that are known and were correctly translated in the translation experiment and the trials with primes that are unknown and were incorrectly translated. Following the predictions of SLLAM, the primes that are unknown will perform a similar function to the nonwords. Like nonwords, the unknown words will lead to partial activation of the known competitor set, and depending on whether the competitor set is large or small, the accuracy and speed of lexical access will be affected accordingly. Therefore, the L2 learners are expected to experience a greater benefit from unknown words that activate large cohorts than from unknown words that activate small cohorts. Consequently, we would expect this to be the case in the high frequency condition for L2 learners of lower proficiency and in the low-frequency condition for the L2 learners of higher proficiency.

The two remaining hypotheses—Hypothesis #4 and Hypothesis #5—address the third research question about the role of proficiency in the influence of phonological underspecification on L2 lexical access, designed to focus on the developmental tendencies in the mechanisms of L2 lexical access. Hypothesis #4 targets the gradual nature of development, while Hypothesis #5 is more concerned about whether the attainment of fully-specified phonological representation is possible by L2 learners.

Hypothesis #4: *With an increase in proficiency, the underlying processing of L2 auditory input experiences a gradual shift towards native-like processing.*

This proposal is not novel, and as I discussed earlier, greater experience with the L2 leads to more lexical entries and, therefore, a more sophisticated lexicon. An indirect consequence of this observation is the dissociation between the phonological makeup of well-known and less-known words. In order to show a developmental tendency, the performance on a task involving two frequency ranges will be conducted. Even if the word is well known, which primarily means that a unique form is associated with a unique (to an extent) meaning, the form might still be not quite discrete and suffer from fuzziness. Of course, for less-known words, the degree of uncertainty about the form will be even greater.

The hypothesis will be tested in a simple Lexical Decision task (LDT) by comparing the performance of the L2 group of higher proficiency across two frequency ranges, high and low, and in two cohort conditions, large and small. It is predicted that only well-known words, i.e., words from a high frequency condition, will be accessed in a native-like fashion and will display a similar effect to the L1 group effect. Therefore, both the high proficiency L2 group and the L1 speakers will display an inhibitory effect of the large cohort of approximately the same magnitude in the high frequency condition. In the low-frequency condition, L1 speakers will also display an inhibitory influence of the large cohort, while the high proficiency L2 speakers will not. This result will indicate that depending of the degree of familiarity with the word, its processing will continuously approach native-like status: the higher the familiarity with the word, the more native-like lexical access it will produce. Therefore, the results of the high proficiency L2 group will be comparable to the L1 performance only in the high frequency condition, where in the low-frequency condition the performance of the two groups will be different.

Hypothesis #5: *The L2 lexical entries are sufficiently integrated into the phonological competitor sets, provided that they have enough specification.*

As suggested earlier, an alternative possibility can explain the divergence of L2 behavior during lexical access from the native performance. If we accept that L2 representations are not subject to underspecification, we have to consider the relational explanation, which assumes that the phonological entries are not integrated into the mental lexicon with sufficient links between the related items––phonological, as well as semantic, morphological, etc. Of course, the strength of the connections as well as the number will be of a different magnitude, however, what interests us is whether those connections play the same organizational function as in the L1 lexicon. The present hypothesis primarily intends to identify the contribution of the phonological connections between the members of the cohort to the outcome of L2 lexical access.

This hypothesis will be tested in a simple LDT task. We will compare the performance between the two L2 groups of different proficiency. According to the model I am proposing, the degree of integration of the word into a competitor set size relies heavily on the amount of detail included in the phonological representation of the word. Under the assumption that a word from a large cohort will experience greater competition than a word from a small cohort, L2 learners are expected to demonstrate inhibition during lexical access of words from large cohorts, as opposed to words from small cohorts, provided that the words are well known to the L2 learners. If L2 learners performing an LDT are not sensitive to cohort size and do not show an inhibitory effect of the competition, this is an indication that the connections at the lexical level are weak. Conversely, if they display competition effects, it suggests that the words are integrated into the competitor set and are subject to lexical competition from its members. It is predicted that the L2 group of higher proficiency will demonstrate strong competition effects with high-frequency words, which will be manifested in the inhibitory influence of the cohort size, while with low-frequency words the effect of competition will be attenuated. A similar pattern of results is predicted for the L2 group of lower proficiency: high frequency words are still not sufficiently known to the learners at this stage of acquisition, and, therefore, the effect of competition will also be reduced and resemble the effect of the L2 group of higher proficiency with the words from lower frequency range, i.e., no competition effect in response to the words from large cohorts will be observed.

In order to address the research questions and the proposed hypotheses, five experiments were conducted: a Lexical Decision Task (LDT), an LDT with phonological priming, an LDT with semantic priming, an LDT with pseudo-semantic priming, and a translation task. Each of the experiments is designed to address one or a combination of the proposed hypotheses.

3.3 Materials

3.3.1 Selection: Frequency-related measures

All experiments used Russian words that are selected from two frequency ranges – high (HF, approximately 130-500 instances per million) and low (LF, approximately 30-100 instances per million). The words for all experiments were selected from different grammatical categories, but the majority of them belong to the noun, verb, and adjective classes. The stimuli varied in phonological length (4-10 phonemes) and syllabic length (1-4 syllables). Nonwords were created from existing real Russian words by manipulating the first syllable. Care was taken to control the means for each parameter of interest across conditions.

Two additional L2-specific frequency parameters were calculated – the size of the L2 lexicon and the size of the L2 cohort for the words used in the experiment for each proficiency level. Based on previous findings (Bell, MA thesis; Cook, unpublished data; Solovyeva, unpublished data), the number of lexical entries in L2 Russian at different proficiency levels can be approximated based on the L1 corpus estimates. For example, an intermediate learner of Russian, whose proficiency level corresponds to our Intermediate group, was expected to be familiar with the words that are of higher corpus frequency (above the cut-off point of around 110 occurrences per million), which roughly corresponds to the first 1,000 most frequent words in the corpus. Advanced Russian learners, who were assigned to the Advanced L2 group, were expected to be familiar with more words, with the cut-off point dropping to around 30 occurrences per million. This vocabulary size was expected to roughly correspond to the first 3,000 most frequent words in the corpus. I have mentioned earlier that great variability in lexical access is tied to lexical factors, such as frequency of the target, the number of competitors, and their frequency. The estimate of lexicon size, typical of a language learner of a certain proficiency, allowed us to estimate the other two missing properties of the L2 mental lexicon, that, to our knowledge, have not been accounted for in previous studies—the size of the L2 lexicon and the L2 proficiency-dependent competitor set size measure. Because the relative differences in the size of the lexicon could play a qualitative difference in lexical access, the quantitative aspects of the lexicon composition become an extremely important factor that needs to be rigorously controlled for.

3.3.2 Selection: Competitor-related measures

Since there is no overwhelming evidence in favor of one index of competitor sets vs. the other, we will assume that for auditory input the cohort measure appears to be the most promising. The special status of the onset was confirmed in a number of studies (Marslen-Wilson, 1996; Bailey & Hahn, 2001; Vitevitch et al., 2002, 2004; Benki, 2003; Dufour, 2004; Goldrick et al., 2010), however, our main reason for this preference is the fact that auditory speech is processed sequentially (Magnuson, Mirman, & Strauss, 2007), suggesting that the onset will be processed before the rest of the word, imposing a greater constraint on the availability of competitors with a match in the initial sequence, rather than later in the word. In addition, Russian is a language with extremely rich inflectional morphology. Therefore, the length of the same word can fluctuate significantly, even within a regular inflectional paradigm. For example, the Russian word *lozhka*, Eng. spoon, in the singular Nominative case, has 5 phonemes, in the singular Instrumental case *lozhkoj* has 6 phonemes, and in the plural Instrumental case *lozhkami* has 7 phonemes. Needless to say, if the length of the word were a critical measure for the competitor set membership, as it is in the neighborhood model, it would prove to be inefficient if only due to the inflectional variations.

Calculating cohort measures presented a major challenge, because to our knowledge there was no available corpus of spoken Russian that would have allowed us to obtain such measures. In order to obtain the necessary counts, the first 3,000 most frequent words in Sharoff's corpus were transcribed phonologically by a trained linguist, who is a native speaker of Russian, following the pronunciation standards of Russian by using a modified version of 'Klatesse' (Vitevitch & Luce, 2004). The corpus was transcribed in such a way that each phoneme corresponded to one letter/symbol in the transcription, which would allow for an adequate count of probabilities of phoneme co-occurrence. More precisely, it would eliminate the confound of representing phonemes that cannot be transcribed using Romanized alphabet without resorting to two-letter or three-letter combination, as, for example, using "sh" for the Russian grapheme *ш* or "shch" for a Russian grapheme *щ*. This allowed for the phonological transcription to be computer-readable. The transcription was then verified for accuracy by a second native speaker of Russian, also a trained linguist.

All cohort measures were calculated manually. The cohort size calculations were based on the initial syllable overlap (Magnuson et al., 2003) with at least a 3-phoneme overlap. An attempt was made to avoid words with an initial vowel and to limit our selection to words starting with a CCV or CVC syllable structure for consistency across conditions. It is important to point out that while there are few morphologically simple words in Russian, especially with zero endings, the material was controlled for morphological complexity and words with derivational prefixes were avoided.

The two phonotactic probabilities measures—the whole-word phonotactic probability index and the first-3 phoneme phonotactic probability index—were calculated for two lexicon subsets of the two L2 proficiency groups, with the help of the Language Independent Neighborhood Generator of University of Alberta (LINGUA, Westbury, Hollis, & Shaoul, 2007). For a summary of the stimuli parameters see Table 2.

Table 2
Means for the stimuli across conditions for LDT and LDT with phonological priming

Mean	Large cohort	Small cohort	*F*	*p*
Cohort size (Intermediate groups)	9.35	2.2	10.5	0.002
Cohort size (Advanced group)	28.1	5.35	32.33	<0.001
Frequency of the prime	107.57	105.86	0.01	0.917
Frequency of the target	167.22	218.93	1.11	0.296
Phonotactic probability index, whole word	647.12	212.85	27.86	< 0.001
Phonotactic probability index, first 3 phonemes	662.71	336.58	14.1	< 0.001
Average length in phonemes, prime	6.925	6.55	5.34	0.023
Average length in phonemes, target	6.9	6.425	1.23	0.271

Every attempt was made to counterbalance the material; however, because the selection of the stimuli was highly constrained by the L2 lexicon size (a 1,000 word limit for the Intermediate group and a 3,000 word limit for the Advanced group), the possibilities were limited. In addition, due to the nature of the experiment, none of the words could be repeated on one presentation list, which was another major limitation in our freedom of selecting the stimuli. Most of the requirements for the materials were met, except for the length of phonemes in the prime, which differed significantly across large cohort and small cohort condition (p = 0.023). This statistic, however, was not expected to present a major challenge for interpreting the results, since the same set of primes and targets were used across presentation lists, and when one prime word appeared in the matched experimental condition, on another list it was in the unmatched condition. This design should prevent any differences in results that can be attributed to the length of the stimuli. Distribution plots with the length of words in phonemes, as well as frequency and cohort size, can be found in Appendix A.

In addition, I was interested in how the cohort measure compares to the measures of phonotactic probabilities (Table 3). As reported previously in studies of phonotactic probabilities (Landauer & Streeter, 1973; Vitevitch & Luce, 1999), there is usually a high correlation between the competitor set size, cohort in our case, and the phonotactic probabilities. The proposal also found support in our testing material. The size of the cohort for the low-frequency item set was highly correlated with the 3-phoneme phonotactic probability index in both primes and targets ($R^2 = 0.617$ and $R^2 = 0.483$, $p < 0.01$ for prime and target respectively). The cohort size in high-frequency items correlated only with 3-phoneme phonotactic probability index of the prime ($R^2 = 0.265$, $p < 0.05$), but not of the target ($R^2 = 0.202$, $p > 0.05$). This result could be explained by the nature of the cohorts in the high frequency condition. Since in large cohorts the number of members is large, it is expected that the initial overlap will be consistently of higher frequency and, consequently, have a higher phonotactic probability index. At the same time, in order to differentiate between the numerous words with a high-frequency onset, it is plausible that there will be more variation at the end of the words, to make the differentiation of the words with high frequency overlap easier. In other words, the more similar the beginning of the word is, the more different the end of the word should be.

Concerning whole-word phonotactics independently of the cohort measures, there was also a statistically significant correlation between the 3-phoneme and the whole-word phonotactics indices, which was unexpected. It does not necessarily follow that the whole-word phonotactic probability can be reduced to the probability of the first 3-phoneme, but it does suggest that the beginning of the word significantly contributes to the whole-word phonotactic probabilities index. Therefore, this observation provides empirical support in favor of the cohort construct, at least to the degree that cohorts are a valid measure of statistical frequency of phonological units and sublexical elements of the words in a given language.

Table 3
Correlation between the cohort measures and phonotactic probability indices

	Cohort density, HF	Cohort density, LF	Phonotactic prob., prime	Phonotactic prob., first 3 prime	Phonotactic prob., target	Phonotactic prob., first 3 target
Cohort density, HF	1	.522**	0.007	.265*	0.052	0.202
Cohort density, LF	.522**	1	0.119	.617**	0.011	.483**
Phonotactic prob., prime	0.007	0.119	1	.340**	.240*	0.141
Phonotactic, prob., first 3 prime	.265*	.617**	.340**	1	-0.004	.623**
Phonotactic prob., target	0.052	0.011	.240*	-0.004	1	.248*
Phonotactic, prob., first 3 target	0.202	.483**	0.141	.623**	.248*	1

Note. ** - significant at $p < 0.01$; * - significant at $p < 0.05$

3.4 General procedure

The study consisted of three parts, corresponding to three tasks: a simple Lexical Decision Task (LDT), an LDT with priming, and a translation task. Within the priming LDT there were 3 experiments: phonological priming, semantic priming and pseudo-semantic priming.

Participants for the study were recruited at US universities, which have a Russian language program. Flyers advertising the study were posted on bulletin boards on university campuses; electronic copies of the flyer were distributed via mailing lists among students majoring in Russian with the permission of the department (see Appendix B for a sample of the flyer). Native speakers of Russian were recruited through personal contacts.

Prior to participation, all interested candidates contacted the administrator via email expressing the desire to participate. They were provided with an invitation to anonymously fill out a screening questionnaire via Google survey tool (https://docs.google.com), which included information about their language learning background and a screening proficiency C-test "Present day Mowgli" with 40 test items. After the candidates submitted the screening proficiency form, they were contacted with an invitation to participate in the experiment as a part of the Intermediate or the Advanced test group depending on their proficiency and language experience.

There were two ways that participants could participate in the study—in person or remotely via the remote DMDX option (http://psy1.psych.arizona.edu/~jforster/dmdx/help/dmdxhremotetestingoverview.htm). The same testing software and delivery sequence was used in both methods. A testing bundle was emailed to each participant, who chose to participate remotely, for installation on his or her personal computer[10]. They received an IRB-approved consent form, a testing module with detailed instructions for its installation, a

[10] Only computers with Windows platform were suitable for the experiment. All participants were informed about this limitation prior to participation.

copy of the instructions for the general testing procedure, and a copy of the answer sheet for the translation task. All participants received detailed explanation of importance of a quiet testing area, a required use of headphones during testing, and the need for an Internet connection.

Each participant took the test individually on a computer with headphones in a quiet room. Before they began, participants familiarized themselves with the purpose of the experiment and provided written consent to participate by signing the IRB form. The participant initiated the testing sequence when ready. The behavioral data were automatically emailed to the administrator at the end of each block from the computer of the test-taker (with their prior consent). The participant was responsible for delivering the filled-out answer sheets and a consent form to the administrator via post or email after the completion of the study.

If the person chose to participate in person, the study was conducted by the administrator. The same testing method and delivery of the results as described above was used. The only difference was that the administrator was physically present during testing. All participants were paid for their participation.

First, an LDT block was administered, which lasted for about 10 minutes for the Intermediate group and 20 minutes for the Advanced and the Native control groups. When finished, the participant was offered a break at his/her discretion (about 5-10 minutes). Then, the second block was administered (about

30 minutes for the Intermediate group and 1 hour for the Advanced and Native control groups). Upon completion of Part 2, the participant was also offered a short break (5-10 minutes). After the break the final part—Part 3—was administered (excluding the Native group), which was a translation task. The approximate duration of the study was about 1.5 hours for the Intermediate and Native groups and about 3 hours for the Advanced group.

3.5 Participants

Sixty-eight paid volunteers took part in the experiment: 48 adult American learners of Russian (9 female), and 20 adult native Russian controls (11 female). For the purpose of the experiment, all L2 participants were assigned to one of the two proficiency ranges: Intermediate or Advanced. The same participants took part in all three blocks of the study.

The age of L2 learners was from 20-32 years (M = 23.95) in the advanced group and 18-32 years (M = 24.3) in the Intermediate group. The age range for the participants in the Native control group was 19-34 (M = 23). All L2 participants in the Advanced group spent a considerable amount of time in Russian-speaking countries (M = 1.68 years), as opposed to the Intermediate group participants, whose immersion experience was limited (M = 0.43 years). It is worth mentioning that due to the specific background of many participants in the Advanced group, duration of classroom instruction is not a reliable measure of proficiency. Due to the specifics of the language program, the majority of the

Table 4
Language background and biographical information by participant group

Group		Advanced	Intermediate	Native
Gender				
	Male	16	15	9
	Female	4	5	11
Age (in years)				
	Mean	23.95	24.3	23
	Min	20	18	19
	Max	32	32	34
	SD	3.6	5.2	4.2
Age of Acquisition (AOA, in years)				
	Mean	20.15	21	
	Min	14	12	
	Max	30	30	
	SD	4.5	5.9	
Classroom instruction (in years)				
	Mean	2.38	2.84	
	Min	0	0.2	
	Max	5	4	
	SD	1.5	2.0	
Immersion (in years)				
	Mean	1.68	0.43	
	Min	0.5	0	
	Max	2	1.2	
	SD	0.49	0.38	

participants in the Advanced group were a part of during the time of testing, Russian language learners do not get extensive classroom instruction before a long-term immersion program in the Russian-speaking country, but can choose to continue classroom instruction upon completion of the immersion program.

Therefore, the participants from this particular program achieve a high level of proficiency prior to the bulk of their classroom instruction. Refer to Table 4 for more-detailed background information on L2 participants.

In order to pre-screen the participants in terms of their level of Russian language proficiency, a C-test (Klein-Braley, 1981) was constructed based on the story "Modern day Mowgli", which was adopted for testing purposes by the author from a Russian language textbook (Niznik et al., 2009). A C-test is assumed to be a reliable measure of global language proficiency (Eckes & Grotjahn, 2006; Dörnyei & Katona, 1992). It has been suggested that while C-tests are usually used to measure overall language proficiency, they can also be successfully used in vocabulary research as a measure of vocabulary size (Singleton & Little, 1991; Singleton & Singleton, 1998; Singleton, 1999). Therefore, a C-test was chosen as a screening measure for the purposes of the study.

According to the specification of the test, the second sentence of the story remained unchanged, and starting with the first sentence every other word was partially deleted. The deletion was done according to the prescribed methodology: if the word has an even number of letters, the split is done in the middle and the beginning half of the word is presented to the test-taker; if the word has an uneven number of letters, then the beginning half is preserved plus one additional letter, and this combination is presented to the test-taker. The story ended up having 40 partially-deleted words. The scoring was done on a 3-point scoring scale for each testing item. Three points were assigned for a correct answer; two points were assigned for a correct vocabulary item, but in an incorrect form, resulting from an incorrect inflection (number, person, gender, tense and mood errors); one point was assigned for a correct vocabulary item in a default form, i.e., uninflected; and zero points were assigned for an incomplete or incorrect vocabulary item. The ceiling accuracy score was 120 points (40 x 3 points per item). The decision on the proficiency assignment was predominantly made based on the results of the C-test; however, other background information was also an important factor, such as length of study and length of immersion. As can be seen in Figure 6, the majority of the Advanced participants scored above a 100 point mark on the C-test (M = 107.143 points), while the participants in the Intermediate group showed much greater variability, with scores distributed over a larger range (M = 76.79 points). In addition, the participants provided self-assessment data on their abilities in Speaking, Writing, Pronunciation and their estimate of their L2 lexicon size (Figure 7). All these factors were taken into account for the group assignment. For example, if the prospective participant had a significant immersion experience and high self-assessment scores, but had a borderline score on the C-test, they were assigned to the Advanced group. At the same time, if the participant achieved a border-line score, but did not have significant Russian language immersion experience (< 0.5 years), he or she was assigned to the Intermediate group.

Also, seven participants from the Advanced group and one participant from the Intermediate group were removed due to proficiency limitations. In order to compare the consistency of accuracy scores within each group, a K-means cluster test was conducted with the intention of identifying any inconsistencies, using the three accuracy measures previously identified – the C-test score, ab accuracy score for HF items, and an accuracy translation score for HF items. The predetermined number of clusters was 5. Most of the Advanced, Intermediate and Native participants clustered together, while one intermediate learner formed a separate cluster, which was an indication that this participant was an outlier and should not be included in the sample. On the other hand, eight of the Advanced speakers clustered with the Native group, which was also an indication that their scores were in many ways very similar to the scores produced by the Native group. These participants were performing at a proficiency level, which is beyond the Advanced level. Therefore, in order to maintain the internal consistency of the Advanced group, we excluded seven that displayed the greatest distance from the mean of the Advanced group in the three proficiency measures. In order to retain the necessary sample size for comparison, one out of the eight participants in the Advanced group was retained. The final sample size for the study was N=20 for the Advanced group and N=20 for the Intermediate group.

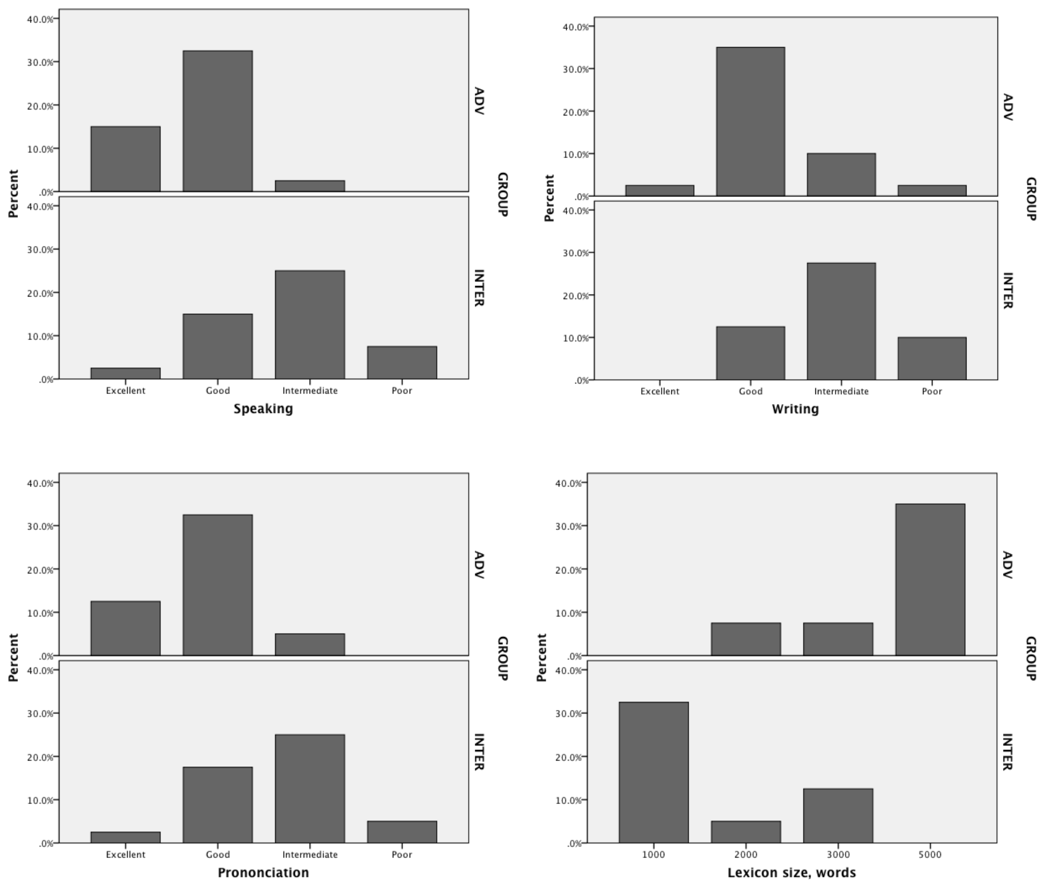


Figure 7. The distribution of self-assessment measures by L2 speakers by the language skill: Speaking, Writing, Pronunciation, and Lexicon Size

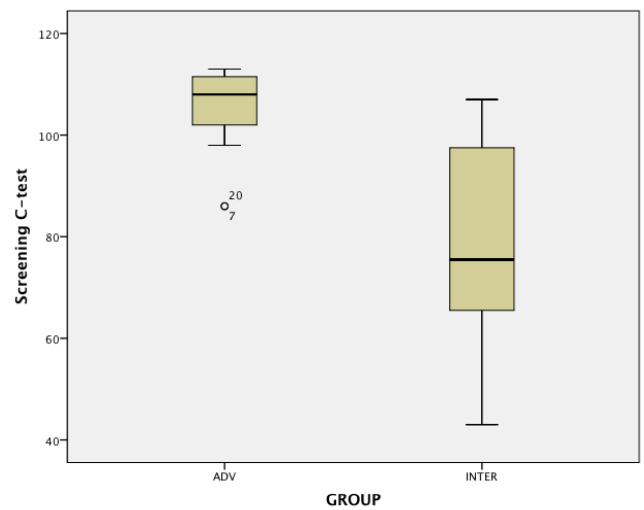


Figure 8. Distribution of scores on C-test

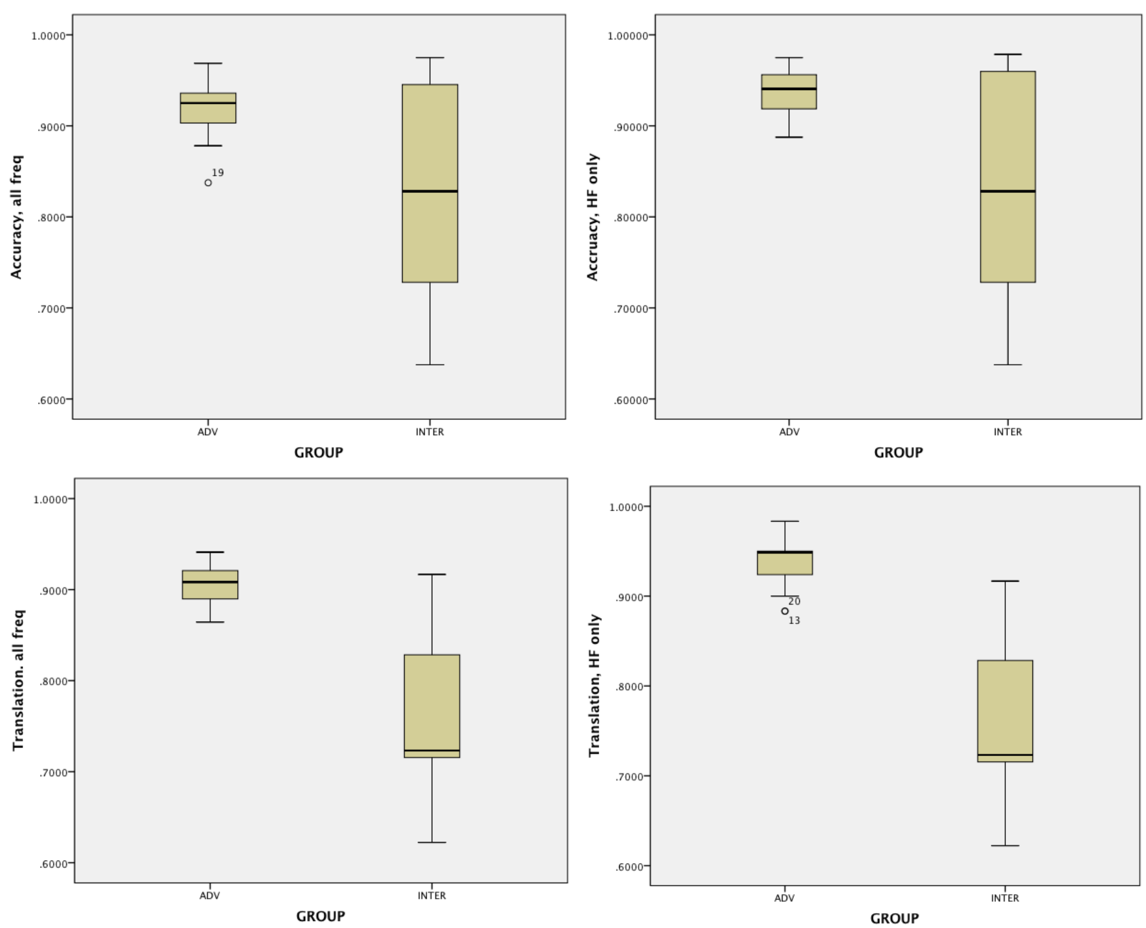


Figure 9. Distribution of average scores in the behavioral data (accuracy of correct responses in primed LDT, all frequency ranges and high-frequency range (HF) only) and in the translation task (correct translation accuracy, all frequency ranges and high-frequency only)

To evaluate the predictive power of the C-test used in this study, I conducted a bivariate correlation (Spearman's *rho*) to compare proficiency related measures from the behavioral data and from the translation data (see Figure 9). Due to the fact that Intermediate learners were only exposed to High frequency items, it was decided to add another accuracy parameter—accuracy in the high frequency range, since this is the only range that both Advanced and Intermediate groups were tested on. As shown in Table 5, the C-test did show high correlations with both the behavioral data and the translation data, with higher order correlations being in the latter. The data, therefore, suggests that all three measure of proficiency tap into the same general language proficiency, and that the C-test used in the study was in fact a reliable measure of the global language proficiency.

Table 5
Correlations between accuracy measures and C-test, Spearman's rho

	C-test	Accuracy, all	Accuracy, HF‡	Translation, all	Translation, HF
C-test	1	0.353*	0.333*	0.701**	0.819**
Accuracy, all	0.353*	1	0.947**	0.182	0.226
Accuracy, HF	0.333*	0.947**	1	0.172	0.228
Translation, all	0.701**	0.182	0.172	1	0.846**
Translation, HF	0.819**	0.226	0.228	0.846**	1

Note. * - significant at $p < 0.05$; ** - significant at $p < 0.01$
‡HF – High-frequency range

3.6 Summary

In this chapter we have outlined the rationale for the main hypotheses and the design of the study. We have presented some data validation of the item parameters, as well as of the participants' proficiency estimates. The individual predictions for each experiment in light of the proposed hypotheses will be discussed in Chapters 4, 5, 6 and 7.

CHAPTER 4: Experiment 1: Lexical Decision Task (LDT)

As can be recalled from the previous chapter, all participants took part in three experiments, one of which was a simple Lexical Decision Task (LDT).

The goal of this chapter is to detail the results of the LDT task and to outline the observed patterns, which could further inform the analysis of the priming section of the study. I will start with outlining the rationale for this task, and then I will provide the details of the methodology. Lastly, I will discuss the results.

4.1 Predictions

The purpose of the LDT task was to establish a baseline for the cohort effects, if they, in fact, exist and compare how cohort membership affects the outcome of lexical access in different proficiency groups. In doing so, the task addressed the hypothesis about the shift in processing strategies that the L2 learners employ during lexical access towards native-like processing (*Hypothesis #4*). As mentioned earlier, the uncertainty in the phonological makeup of the word reduces the effect of lexical competition. An indirect consequence of this observation is the dissociation between the phonological makeup of well-known words, for which lexical cohort competition will be present, and less-known words, for which the role of the cohort will disappear.

To test this hypothesis we compared the processing of high- and low-frequency words by the Advanced L2 group in a simple LDT experiment. We expect to demonstrate that in the high-frequency condition the L2 learners are predicted to behave similarly to L1 learners, due to the fact that their experience with high-frequency words approaches that of L1 speakers, and L2 learners at this point are confident in both the form and the meaning of those words. However, in the low-frequency condition, the words will be processed by different underlying mechanisms, because fuzziness gets in the way of discrete identification, which is no longer the case for high-frequency words.

The second hypothesis addressed by the LDT task has to do with the question of whether the L2 lexical entries are capable of being integrated into the phonological competitor sets *(Hypothesis #5).* If we accept that L2 representations are not subject to underspecification, we have to consider a relational explanation, which assumes that phonological entries are not integrated into the mental lexicon with sufficient links between related items––phonological, semantic, morphological, etc. Of course, the strength of the connections as well as the number will be of a different magnitude, however, what interests us is whether those connections play the same organizational function as in L1 lexicon. Primarily, this hypothesis intends to isolate the contribution of the phonological connections between the members of the cohort to the outcome of L2 lexical access. By using two frequency ranges (High and Low) and two L2 proficiency groups (Advanced and Intermediate), we intend to demonstrate that the processing shift is not a consequence of higher proficiency vs. low proficiency, which entails general changes in phonological processing, but is rather a consequence of how well the words are known to the L2 learner. To demonstrate this, we predict that if the words are well known (the High frequency condition for the Advanced L2 group), the underlying processing of these entries will follows the L1 processing route. More specifically, inhibition of a greater magnitude from the members of a large cohort will be observed due to lexical competition. However, if the words are only moderately-known (the High frequency condition for the Intermediate group and the Low-frequency condition for the Advanced group), the processing of these words will demonstrate a different tendency, that contrasts with the results in the High frequency condition for the advanced L2 group. More specifically, there will be no inhibition effect observed due to lexical competition for words from large cohorts.

4.2 Stimuli

All stimuli were selected according to the criteria outlined in Chapter 4. The present task included 160 stimuli, of which 80 were real words and 80 were nonwords. The words were representative of 4 conditions: 20 words in High frequency/Large cohort condition, 20 words in Low-frequency/Large cohort condition, 20 words in High frequency/Small cohort condition and 20 words in Low-frequency/Small cohorts. Participants in the Advanced and Native groups were exposed to all 160 items. The Intermediate group was exposed to a subset of the task, which consisted of 40 High frequency words in Large and Small cohort conditions and 40 nonwords.

All auditory stimuli were recorded in a sound attenuated room by a female native speaker of Russian into a digital recorder at a sampling rate of 44.1 kHz, and saved in a 16-bit mono WAVE format. The stimuli were subsequently edited into individual sound files in PRAAT.

4.3 Method

Stimulus presentation and experiment control was carried out by the DMDX program (Forster & Forster, 2003). Subjects were instructed to decide whether each stimulus item was a real word or not (lexical decision), and to respond as quickly and accurately as possible using an appropriate button on the computer keyboard (right Control key for 'YES' and left Control key for 'NO'). The test stimuli were always played in their entirety, and subjects were given 4000 ms from the onset of presentation to respond. If no response was given, the next trial was advanced without a button press. Accuracy and reaction times from the onset of stimulus presentation were recorded.

4.4 Results

One set of analyses was conducted on the LDT results with the data on high-frequency words and was intended to compare the outcomes in terms of accuracy and reaction time (RT) among the three participant groups – Advanced L2 learners, Intermediate L2 learners and Russian Native controls. The second set of analyses focused on the developmental tendency within the Advanced group, members of which were tested on both the high-frequency items (similarly to the Intermediate group) and the low-frequency items (unlike the Intermediate group).

No items were excluded from all analyses. In the RT analyses, the responses with RTs lower than 300 ms were excluded, because these reflect RTs that are too fast for normal processing. Responses with long RTs were excluded if they exceeded a three standard deviation cutoff. These trimming procedures excluded a total of 0.9% of the data from the RT analysis. Finally, RTs for incorrect answers were also excluded.

The results will be presented in the following order. First, the accuracy and RT results will be discussed for the High-frequency condition for Advanced, Intermediate and Native groups (section 4.4.1). Then the accuracy and RT data will be discussed for the Advanced and Native groups in High-frequency and Low-frequency conditions (section 4.4.2).

4.4.1 Advanced, Intermediate and Native groups: High-frequency

To examine the effects of the cohort in the Intermediate group in comparison to the Advanced group, we conducted two sets of repeated measures ANOVAs (one for accuracy and one for RT) with Group (Intermediate, Advanced, and Native) as a between-subject variable and Cohort (Large and Small) as a repeated measure.

Accuracy data. The analysis was first performed with subjects as a random variable and then with items as a random variable. The main effect of Group was significant in both analyses ($F_1(2, 57) = 20.24$, $p < 0.001$; $F_2(2, 37) = 10.64$, $p < 0.001$), while the main effect of Cohort was not ($F_1(1, 57) = 1.03$, $p = 0.314$; $F_2(1, 38) = 0.299$, $p < 0.587$). However, in the by-subject analysis the interaction Group x Cohort also reached statistical significance (F1 $(2, 57) = 3.18$, $p < 0.05$), which was not the case in the by-item analysis (F2 $(2, 37) = 0.97$, $p = 0.391$). The Tukey HSD post hoc analysis for the main effect of Group showed that the Intermediate group was significantly less accurate in making a word/nonword judgment in general ($p < 0.001$), while the Advanced group did not differ in their accuracy from the Native control group. While both Advanced and Native speaker groups exhibit a ceiling effect, which could explain the lack of the Cohort effect, the Intermediate group does not. Although in both cohort conditions the accuracy in the Intermediate group is rather high ($M = 0.90$ for Large cohort and $M = 0.86$ for Small cohort), the accuracy is higher in the Large cohort condition, which is the opposite of the expected cohort effect. Recall that for native lexical access due to greater competition from the numerous members of the cohort, accuracy is expected to diminish. What we encounter in the Intermediate group is that the cohort influence works in the opposite direction, as was predicted for words that are less-known to the L2 learners.

Table 6
Mean accuracy scores in LDT task: High-frequency condition

	Large cohort		Small cohort		Effect size
Group	Mean	SD	Mean	SD	
Advanced	0.96	0.05	0.97	0.05	0.01
Intermediate	0.9	0.06	0.86	0.12	-0.04
Native	0.97	0.05	0.98	0.03	0.01

Note. * - significant at $p < 0.05$; ** - significant at $p < 0.01$

A post hoc paired t-test was conducted to explore whether the difference was significant. The outcome showed that it was not ($p < 0.074$), however there is a marginally significant trend in the predicted direction.

RT data. A similar set of analyses was performed for the latency data. The main effect of Group was significant in both analyses ($F_1(2, 57) = 17.27$, $p < 0.001$; $F_2(2, 76) = 108.33$, $p < 0.001$), and the main effect of Cohort was significant only in the by-subject analysis ($F_1(1, 58) = 19.15$, $p < 0.001$), while in the by-item analysis it only approached significance (F_2 $(2, 76) = 2.99$, $p = 0.056$). The interaction between the main effects, Group x Cohort size, reached significance only in the by-subject analysis ($F_1(2, 57) = 10.22$, $p < 0.001$), but not in the by-item analysis ($F_2(2, 76) = 2.99$, $p = 0.056$). According to the results of the Tukey HSD post hoc analysis, as predicted, the latencies in the responses of the Intermediate group participants were significantly longer than the latencies of the two other groups ($p < 0.001$).

Table 7
Mean RTs in the LDT task: High-frequency condition

	Large cohort		Small cohort		Effect size
Group	Mean	SD	Mean	SD	
Advanced	966.35	65.99	922.75	71.76	-43.60**
Intermediate	1061.07	140.78	1070.48	139.03	9.41
Native	890.82	89.36	859.04	102.15	-31.78**

Note. * - significant at $p < 0.05$; ** - significant at $p < 0.01$

To further explore a significant interaction, we conducted three paired t-test post hoc comparisons (with Bonferroni adjustment) within each experimental group between the Large and the Small cohort conditions (Figure 10). The difference between the conditions was highly significant in both Advanced and Native groups (both $p < 0.001$), but was not in the Intermediate group ($p = 0.38$). As expected, the shortest latencies were demonstrated by the Native group in the responses to the words from the small cohorts ($M = 859.04$ ms), while the responses to the words from the large cohort took longer ($M = 890.82$). The pattern of the results in the Advanced group is very similar – shorter response latencies were observed for words from the small cohorts ($M = 922.35$) and longer latencies for words from the large cohorts ($M = 966.35$). As for the Intermediate learners, the pattern of responses shared by Native and Advanced groups is not replicated in their responses. More so, there is a slight reversal of the direction of the effect.

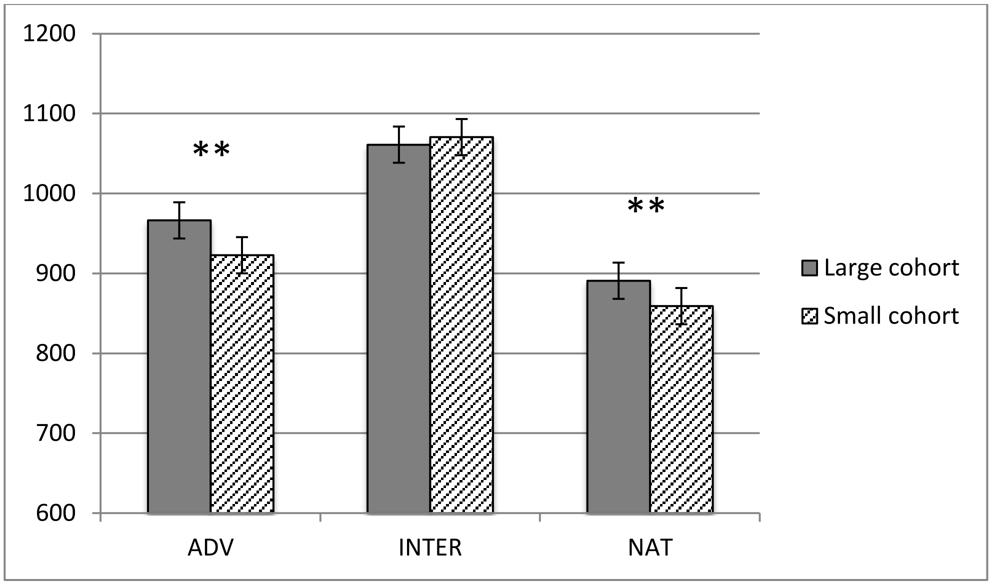


Figure 10. Mean RTs in LDT task, High-frequency condition

Discussion. The results of these experiments demonstrate that the inhibitory effect of the large cohort was replicated in the native speaker group. In addition, high proficiency learners also demonstrated predicted native-like behavior in response to words from Large cohorts, demonstrating a significant delay in lexical access, which was a predicted consequence of strong lexical competition among the members of the cohort. As for the Intermediate group, they do not appear to be sensitive to the cohort manipulation and the cohort effect was not observed in this group.

4.4.2 Advanced and Native groups: High- and Low-frequency

By looking at the cohort effect in a lower frequency range we hope to see the difference between how the advanced speakers access highly familiar words and how they access words that are less known to them. If such a difference does in fact exist then it would provide sufficient evidence to exclude the possibility of the sudden qualitative shift in L2 lexical access developmentally.

Accuracy data. To explore this possibility further we conducted two sets of ANOVA analyses with a repeated measures design. The first set of ANOVAs was performed on the accuracy data (by subject and by item) with Group (Advanced and Native) as a between-subjects variable and Frequency (High and Low) and Cohort size (Large and Small) as the within-subject variables. The analyses showed a statistically significant main effect of Group ($F_1(1, 38) = 18.64$, $p < 0.001$; $F_2(1, 76) = 8.81$, $p < 0.01$), a significant main effect of Frequency ($F_1(1, 38) = 27.426$, $p < 0.001$; $F_2(1, 76) = 7.07$, $p < 0.01$), but no main effect of Cohort in either by subject or by item analyses ($F_1(1, 38) = 1.76$, $p = 0.193$; $F_2(1,76) = 0.338$, $p = 0.526$). However, there was an interaction of Frequency x Cohort that was statistically significant in the by-subject analysis ($F_1(1, 38) = 5.59$, $p < 0.05$; $F_2(1, 76) = 0.012$, $p = 0.20$). Other effects and interactions were not statistically significant.

The difference between the means for the Native group is comparable to the difference in the high frequency condition for both groups (0.01 difference across conditions). At the same time, the difference in the performance of the Advance group in the two cohort conditions with low-frequency words is much greater (*diff* = 0.425). Four paired t-tests at the adjusted alpha level of $p = 0.013$ show that the difference between the cohort conditions in the Advanced group was only marginally significant (p = 0.032). All other contrasts were not statistically significant.

Table 8
Mean accuracy scores in the LDT task, High- and Low-frequency conditions

	Large cohort		Small cohort		Effect size
Group	Mean	SD	Mean	SD	
High frequency					
Advanced	0.96	0.05	0.97	0.05	0.01
Native	0.97	0.05	0.98	0.03	0.01
Low frequency					
Advanced	0.91	0.07	0.87	0.07	-0.04*
Native	0.98	0.04	0.97	0.04	-0.01

Note. * - significant at p = 0.013 (Bonferroni adjusted alpha level)

RT data. Then, the latency data were also analyzed in a repeated measures ANOVA with two groups (Advanced and Native) as a between-subjects variable and crossed factors Frequency (High and Low) and Cohort (Large and Small) as within-subject repeated measures. All main effects were statistically significant, at least in the by-subject analysis (Group: $F_1(1, 38) = 11.74$, $p < 0.001$, $F_2(1, 76) = 148.89$, $p < 0.001$; Frequency: $F_1(1, 38) = 4.5$, $p < 0.05$, $F_2(1, 76) = 0.49$, $p = 0.486$; Cohort: $F_1(1, 38) = 6.24$, $p < 0.05$, $F_2(1, 76) = 0.732$, $p = 0.395$). Frequency x Group interaction was statistically significant in both analyses ($F_1(1, 38) = 14.14$, p <

0.001; $F_2(1, 76) = 6.69$, $p < 0.05$). Also, in by-subject analysis Frequency x Cohort interaction was statistically significant ($F_1(1, 38) = 39.42$, $p < 0.001$; $F_2(1, 76) = 0.732$, $p = 0.395$), as well as the three-way interaction Group x Frequency x Cohort ($F_1(1, 38) = 4.59$, $p < 0.05$; $F_2(1, 76) = 0.027$, $p = 0.149$). The rest of the interactions failed to reach the significance threshold.

Table 9
Mean RTs in the LDT task, High- and Low-frequency conditions

	Large cohort		Small cohort		Effect size
Group	Mean	SD	Mean	SD	
High frequency					
Advanced	966.35	65.992	922.75	71.756	-43.60**
Native	890.82	89.359	859.04	102.153	-31.78**
Low frequency					
Advanced	937.94	70.92	967.57	82.307	29.63**
Native	843.37	100.966	847.53	91.12	4.16

Note. * - significant at $p < 0.05$; ** - significant at $p < 0.01$

Discussion. The latency data confirms the pattern of results observed in the accuracy data. Similarly to the previously reported results on accuracy, a reversal of the cohort effect is observed in the low-frequency condition, especially pronounced in the Advanced group. In the High frequency condition the latencies of the Advanced speakers mirror those of the Native speakers (*diff* =

43.6 ms and *diff* = 31.79 ms for Advanced and Native groups respectively) with words from large cohorts being responded to slower than the words from the small cohorts, which is an expected statistically-significant native-like effect. However, in the Low-frequency condition words from small cohorts seem to be experiencing longer latencies, while the words from large cohort are responded to almost as quickly as the high frequency words from small cohorts. It appears that Advanced learners benefit more from the large cohort in the low-frequency condition (*diff* = 29.63 ms), while the Native group shows no preference (*diff* = 4.174 ms). A pair-wise comparison of latencies of the Advanced group in response to the low-frequency words from large cohorts to words from the small cohorts was statistically significant ($p < 0.01$) (see Figure 11).

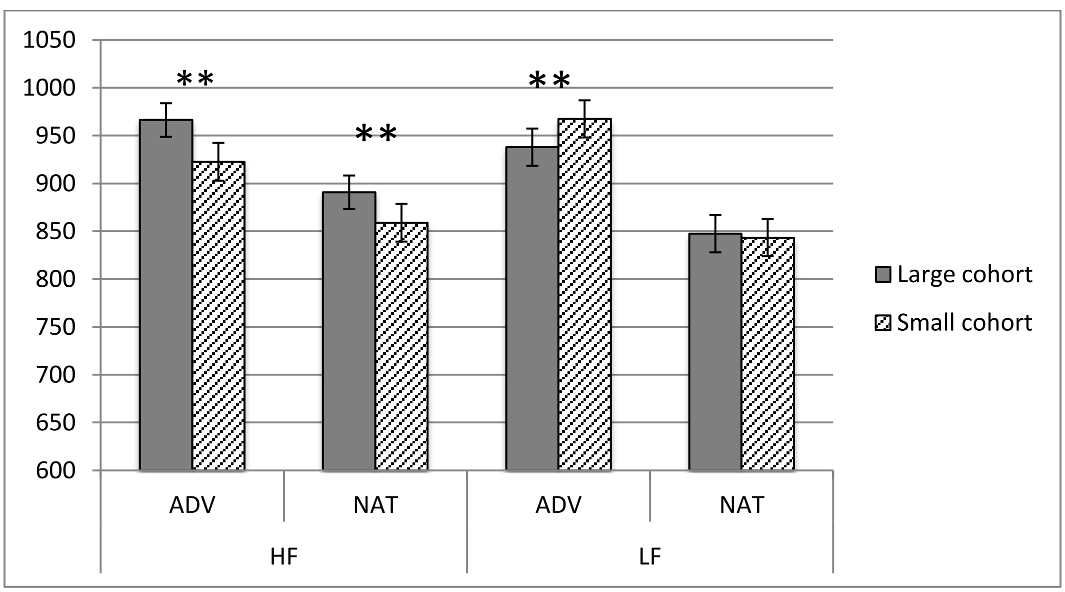


Figure 11. Mean RTs in LDT task, High-frequency and Low-frequency conditions

4.5 General discussion

The results of the experiment have confirmed most of the predictions put forth earlier in Chapter 3.

We will begin the discussion with *Hypothesis #5*, since the analysis relevant to this hypothesis was presented first. It states that L2 lexical entries are sufficiently integrated into the phonological competitor sets, provided that they have enough specification. The present hypothesis was addressed by comparing the performance of the two L2 groups at different stages of acquisition in the high-frequency condition. As was predicted, high proficiency L2 learners are more familiar with high-frequency words than low-proficiency L2 learners; therefore, the effect of competition that we observed is more pronounced in the group of higher proficiency, with larger cohorts producing significantly more competition. As for the lower-proficiency group, the words from the high-frequency range are not well-known to this group of L2 learners, and therefore, the cohort size was not expected to produce an effect on the lexical access, at least not by introducing lexical competition, which is only expected in the L1 and Advanced groups. As opposed to the Advanced group, the Intermediate learners displayed virtually no effect of cohort either at the lexical level nor at the pre-lexical level. As was suggested, given that the words do not have detailed phonological representations, they are unable to compete with the other cohort members. Without detailed specifications, the lexical entries are not fully-integrated into the competitor sets, which was the mechanism that we attempted to exemplify in the current experiment.

If we only consider the results of the L2 learners of higher proficiency and the L2 learners of lower proficiency with the high-frequency words, what is still a plausible explanation is that the influence of cohort is an 'all or nothing' type of influence, which is the point to be addressed in Hypothesis #4. Intermediate learners do not yet have it, but Advanced learners do, and they apply it across the board to all of the words in the L2 lexicon. Presumably, this could be a result of an ongoing qualitative 'cohort' shift in the development of the lexicon, which affects the direction of the cohort influence from facilitation to native-like inhibition. If we assume that this shift happens at once, before the cohort shift occurs, all learners just learn new words and accumulate them into their L2 word bank without any further organization. At this stage, the words exist in the lexicon as individual entries and are not integrated into the mental lexicon via phonological, semantic or morphological links. Then something triggers the cohort shift, perhaps, there might be a quantitative aspect of the lexicon size that imposes a phonological organization on words in it. From this moment on, all lexical entries alike experience the consequence of phonological organization, manifested in the cohort effects.

To see if this (unlikely) proposal about a sudden qualitative shift is true, we suggested exploring cohort influence as a function of lexical frequency within the same group of L2 learners, addressing *Hypothesis #4*. In addition to comparing the 'state of the system' in two proficiency groups cross-sectionally and exploring the role language proficiency plays in the processing of high frequency words, it appeared to be more beneficial to see whether there is a stable phonological influence across different frequency ranges within the same L2 lexicon. According to our hypothesis, the influence of the phonological organization of the system, which is manifested in the cohort effects, stems from the degree of familiarity with the lexical item and is not a result of a major qualitative shift. What was clearly demonstrated in the data of the L2 learners of higher proficiency, at a higher level of proficiency, lexical access resembles native-like processing more closely. More proficient L2 learners demonstrated native-like effects in lexical access of high-frequency words, which they know very well; the access happens more quickly for words from a small cohort, while the words from large cohorts take longer. According to the prediction, competition from the other members of the cohort at the lexical level causes a greater delay if the cohort has more members. Both high proficiency L2 speakers and L1 speakers have demonstrated statistically significant differences in the latencies during lexical access of words from large cohorts and of words from small cohorts.

With the words of lower frequency, however, L2 learners do not seem to experience the same inhibitory effect of large cohort size. This suggests that lexical access of a lower-frequency word does not experience as much competition from the cohort members, as a higher-frequency word would. What we observe in the low-frequency condition is the statistically-significant reversal of the cohort effect for the L2 learners—the pre-lexical influences dominate the outcome of the lexical access, overcoming lexical competition and allowing for a more efficient lexical access of words from larger cohorts.

As expected, the effect of the cohort size is not the same throughout the frequency ranges, which is reflected in the significant interaction between Cohort and Frequency variables. Indeed, the influence of the phonological organization exerts an opposite influence on the lexical access of high- and low- frequency words. Interestingly, the pattern displayed by the more advanced group in the high frequency condition is rather similar to the pattern of the performance of the L1 group, and mirrors the accuracy data in the low-frequency condition. However, we see a slightly different picture in RT data in the Low-frequency condition. While L2 speakers still show a significantly better performance in the large cohort condition, the L1 group maintains the preference for small cohorts, although very minor, demonstrating attenuated latencies. It is important to mention that according to the results of this experiment, L1 learners also tend to experience the reduced effects of competition with items of lower frequency, as seen in the reduced cohort effect for this group in low-frequency condition. As will be seen in the Chapter 5, this result does not appear to be an artifact of the task and needs to be addressed in more detail.

Therefore, in line with the predictions of *Hypothesis #4*, the results of the high proficiency L2 group were comparable to the L1 performance only in the high frequency condition, whereas in the low-frequency condition the performance of the group was different, with L2 learners of higher proficiency exhibiting strong reversal effect of the cohort influence from inhibition in the high-frequency condition to facilitation in the low-frequency condition. If we postulate the sudden change in the processing route, then we will have to assume that since the more advanced L2 learners have developed a more sophisticated processing mechanism, they would have to utilize it for lexical access of all words, irrespective of specification. However, our data seem to point in a different direction. Our results indicate that the shift in the processing mechanisms does not happen at once, but rather displays a developmental trend, affecting words with varying degrees of specification to a different extent. More specifically, the changes that are observed in the behavior of L2 learners during lexical access might not be a consequence of any profound transformation of the processing mechanisms, but rather be different only on the surface and not necessarily qualitatively different. These differences could be potentially explained as a consequence of a quantitative shift—a shift in the balance of two opposing influences exerted by pre-lexical facilitation and lexical inhibition. If we assume a gradual strengthening of the lexical competition along the continuum of the better-known words to less-known words, then at some point, lexical competition will outweigh the magnitude of pre-lexical facilitation, and it will be manifested in inhibition in L2 lexical access. The results of the experiment are compatible with this proposal.

CHAPTER 5: Experiment 2: Lexical Decision Task (LDT) with priming

As can be recalled from Chapter 3, all participants took part in three tasks, one of which was a Lexical Decision Task (LDT) with priming. The LDT with priming included 3 independent experiments: a Phonological priming LDT, a Semantic priming LDT, and a Pseudo-semantic priming LDT. Although the purpose of each experiment was different, the stimuli from different priming conditions were presented in the same block. This was done intentionally to prevent the participants from developing a strategy that can accommodate one particular type of priming and produce strategically-biased results. Mixing different types of primed pairs together provided an opportunity to obtain bias-free data.

In this chapter, we will review the predictions and the results of the three experiments, which were a part of the Priming LDT task. First, we will consider Phonological priming, then we will look at Semantic priming and conclude with Pseudo-semantic priming.

5.1 Phonological priming

5.1.1 Predictions

The phonological priming LDT will partially address the hypothesis that underspecified phonological representations facilitate L2 lexical access as a function of lexical competitor set size *(Hypothesis #2).*

According to the model we are proposing here, the lack of certainty about the phonological form of the L2 word is hypothesized to produce no competition between the candidates for selection. Moreover, the magnitude of facilitation is associated with a greater activation of phonotactically-probable segments at the phonological level. If we consider the same mechanism in the priming paradigm, then the magnitude of facilitation should be greater than in a simple LDT task, since there will be an additional boost in the activation of the target from the previous partial activation of the prime's cohort, which is not the case with native processing, where strong competition from other cohort members prevents quick reactivation.

To assess the influence of partial activation of the competitor set during pre-lexical processing of the prime on the processing of the target, the results in an LDT with phonological priming across cohort conditions will be compared. In the phonological priming task, we expect to see an additional contribution of pre-lexical activation (as a result of partial activation of the competitors). Namely, a target from a large competitor set will be accessed faster than a from a small competitor set when primed by the phonologically-related prime. This will be true for L2 learners of lower proficiency in the high frequency condition and for the L2 learners of higher proficiency in the low-frequency condition with the magnitude of facilitation varying as a function of the pre-lexical activation of the competitor set size.

The phonological priming LDT will also address the hypothesis about the source of facilitation, which is hypothesized to originate at the pre-lexical level of processing *(Hypothesis #3).* We hypothesize that if the level of pre-lexical activation affects lexical access, words that are not known to the learner, similarly to nonwords, will produce a significant pre-lexical activation of the cohort and will pass it on to the target. Consequently, the target would also experience the benefits of partial activation during a lexical decision experiment. The degree of facilitation will vary as a function of the competitor set size, with competitors being partially activated before lexical access, with greater membership providing more facilitation. This hypothesis will be addressed by comparing the performance of L2 learners with words that they know well and the words that they do not know in an LDT with phonological priming. Recall that by using the data from the translation experiment we are able to identify which words are well known and which are not well-known to each individual participant, allowing for such comparison. In the condition with words that the L2 learners know well, a lexical effect of the cohort influence will be observed with worse performance in the large cohort condition. In the condition with words that the L2 learners do not know, the cohort effect will be reversed and worse performance will be observed in the small cohort instead.

5.1.2 Stimuli

The experimental stimuli were selected according to the procedure described in Chapter 3. The test consisted of 320 items, half of which were real words and the other half—nonwords. Out of 160 word targets, 80 were created for the phonological priming condition. Items in the matched condition had an initial phonological overlap between the prime and the target. Phonological overlap here is defined along the same parameters as cohort membership: the overlap is imperative of at least three initial phonemes (CVC or CCV). As shown in Tables 10 and 11, the task included 40 related and 40 unrelated pairs in the phonological condition with frequency (HF and LF) and cohort size (Large and Small) orthogonally crossed (10 items per condition), another 40 related pairs in the repetition condition, when the prime and the target were identical, 20 in the semantic and 20 in the pseudo-semantic condition. Only real words were used as primes. Two presentation lists were constructed with the same stimuli. The presentation lists varied along the matched/unmatched condition. For example, if one target appeared in List A in the phonologically matched condition, then in List B it would appear in the unmatched condition.

5.1.3 Method

The stimulus presentation and experiment control were carried out by the DMDX program. A single trial in a short-lag priming experiment consisted of an aurally-presented pair of lexical items with the first member of the pair being a 'prime' and the second member—a 'target'. Audio stimuli were presented at an Interstimulus Interval (ISI) of 320 ms (the same interval as previously used in

Table 10

Conditions and examples of stimuli used in LDT with priming

	Large cohort Frequency		**Small cohort Frequency**			**Large cohort**	**Small cohort**
	high	**low**	**high**	**low**			
Semantic priming							
matched	10		10		matched		
prime	**корова**		**золото**		prime		
target	**молоко**		**метал**		target		
prime	/karova/		/zolata/		prime		
target	/malako/		/m'ital/		target		
prime	cow		gold		prime		
target	milk		metal		target		
unmatched	10		10		unmatched	20	20
prime	**дело**		**цирк**		prime	**дело**	**цирк**
target	**молоко**		**сено**		target	**макАлый**	**хобЕй**
prime	/d'ela/		/tsɨrk/		prime	/d'ela/	/tsɨrk/
target	/malako/		/m'ital/		target	/makalɨj/	/xab'ej/
prime	action		circus		prime	action	circus
target	milk		metal		target	—	—
Pseudosemantic priming							
matched	10		10				
prime	**корова**		**золото**				
target	**молоток**		**метать**				
prime	/karova/		/zolata/				
target	/malatok/		/m'itat'/				
prime	cow		gold				
target	hammer		throw				
unmatched	10		10		unmatched	20	20
prime	**дело**		**цирк**		prime	**дело**	**цирк**
target	**молоток**		**метать**		target	**мольтО**	**мерчАть**
prime	/d'ela/		/tsɨrk/		prime	/d'ela/	/tsɨrk/
target	/malatok/		/m'itat'/		target	/mal'to/	/m'irchat'/
prime	action		circus		prime	action	circus
target	hammer		throw		target	—	—
Repetition priming							
matched	10	10	10	10			
prime	**корова**	**корабль**	**цена**	**шишка**			
target	**корова**	**корабль**	**цена**	**шишка**			
prime	/karova/	/karabl'/	/tsɨna/	/shɨshka/			
target	/karova/	/karabl'/	/tsɨna/	/shɨshka/			
prime	cow	ship	price	pinecone			
target	cow	ship	price	pinecone			
unmatched	10	10	10	10	unmatched	40	40
prime	**правило**	**почва**	**хвалить**	**пароль**	prime	**корова**	**шишка**
target	**корова**	**корабль**	**цена**	**шишка**	target	**плОтень**	**фурдА**
prime	/prav'ila/	/pochva/	/xval'it'/	/parol'/	prime	/karova/	
target	/karova/	/karabl'/	/tsɨna/	/shɨshka/	target	/plot'in'/	/furda/
prime	rule	ship	praise	password	prime	cow	pinecone
target	cow	ship	price	pinecone	target	—	—

Table 11
Conditions and examples of stimuli used in LDT with priming (continued)

	Large cohort Frequency high	Large cohort Frequency low	Small cohort Frequency high	Small cohort Frequency low		Large cohort	Small cohort
Phonological priming							
matched	10	10	10	10	matched	20	20
prime	**корова**	**король**	**зонт**	**череда**	prime	**корова**	**череда**
target	**коробка**	**конвой**	**золото**	**черепаха**	target	**корДок**	**черевИть**
prime	/karova/	/karol'/	/zont/	/chir'ida/	prime	/karova/	/chir'ida/
target	/karopka/	/kanvoj/	/zolata/	/chir'ipaxa/	target	/kardok/	/chir'ivit'/
prime	cow	king	umbrella	sequence	prime	cow	sequence
target	box	escort	gold	turtle	target	—	—
unmatched	10	10	10	10	unmatched	20	20
prime	**сеть**	**обои**	**шина**	**зеркало**	prime	**сеть**	**шина**
target	**коробка**	**конвой**	**золото**	**черепаха**	target	**кордОк**	**черевИть**
prime	/s'et'/	/aboji/	/shɨna/	/z'erkala/	prime	/s'et'/	/shɨna/
target	/karopka/	/kanvoj/	/zolata/	/chir'ipaxa/	target	/kardok/	/chir'ivit'/
prime	net	wallpaper	tire	mirror	prime	net	tire
target	box	escort	gold	turtle	target	—	—

Gor et al., 2010), which was measured from the offset of the prime to the onset of the target. Participants were instructed to decide whether the presented target is a real Russian word or not by pressing an appropriate button on the computer keyboard (right Control key for 'YES' and left Control key for 'NO'). Auditory stimuli were always played in their entirety, and subjects were given 4000 ms from the onset of presentation to respond. If no response was given, the next trial was advanced without a button press. Reaction time (RT) and accuracy were digitally recorded for further analysis.

No items were excluded from all analyses. In the RT analyses, the responses with RTs lower than 300 ms were excluded, because these reflect RTs that are too fast for normal processing. Responses with long RTs were excluded if they exceeded a 3 standard deviation cutoff. These trimming procedures excluded a total of 1.8 % of the data from the RT analysis. Finally, RTs to incorrect answers were also excluded.

The results will be presented in the following order. In section 5.1.4.1 we will discuss the analysis for the High frequency condition for Advanced, Intermediate and Native groups. Section 5.1.4.2 will discuss the results for the Advanced and Native groups in the High frequency and Low-frequency conditions. Then we will discuss the priming effect analysis (Section 5.1.4.3). In the two last sections we will present a reanalysis of the data in light of the translation data (5.1.4.4 and 5.1.4.5).

5.1.4 Results

5.1.4.1 Advanced, Intermediate and Native groups: High frequency

Accuracy. In order to explore the influence of phonological relatedness on lexical access during phonological priming, the data were analyzed in the following way. Similarly to the previous analyses, two by-subject analyses, one for accuracy data and another one for reaction time data, were conducted. For the accuracy data, the repeated measures ANOVA with Group (Advanced, Intermediate and Native) as a between-subjects factor, and Priming (Primed and Unprimed) as a within-subject factor showed only a statistically significant effect of Group ($F_1(2, 57) = 17.88$, $p < 0.001$). The Intermediate group was less accurate across all conditions, while the accuracy of responses in the Advanced and

Native group patterned together and exhibited a ceiling effect. All other effects and interactions were not significant.

A Tukey HSD post hoc comparison was conducted to explore the main effect of Group and confirmed the prediction that the accuracy difference was significant—between the Intermediate and the Advanced group ($p < 0.01$) and between the Intermediate and the Native group ($p < 0.001$).

Also, three a priori comparisons between the Matched and Unmatched condition within each group were conducted by means of the paired t-test at a Bonferroni adjusted alpha level of 0.017 (0.5/3). None of the contrasts were significantly different from each other (see Table 12). As was the case with the simple LDT, L2 learners of higher proficiency and L1 speakers display ceiling effects of accuracy; consequently, the effect of priming is not manifested in the accuracy data.

Table 12
Mean accuracy in the Phonological LDT task: High-frequency condition

	Primed		Unprimed		Effect Size
Group	Mean	SD	Mean	SD	
Advanced	0.96	0.036	0.96	0.046	0.00
Intermediate	0.87	0.092	0.85	0.115	-0.02
Native	0.95	0.050	0.96	0.058	0.00

Note. * = $p < 0.013$ 9Bonferroni adjusted alpha level)

Table 13
Mean RTs in the Phonological LDT task: High-frequency condition

	Primed		Unprimed		Effect Size
Group	Mean	SD	Mean	SD	
Advanced	948.21	82.628	935.30	82.083	-12.91
Intermediate	1063.01	157.677	1072.05	166.519	9.04
Native	912.16	99.058	892.20	110.730	-19.95*

Note. * = $p < 0.013$ (Bonferroni-adjusted alpha level)

RT data. The same analyses were conducted for the RT data. The main effect of Group ($F_1(2, 57) = 11.13$, $p < 0.001$) was again significant. Neither the main effect of Priming ($F_1(1, 57) = 1.33$, $p = 0.253$) nor the interaction of Group x Priming was statistically significant ($F_1(2, 57) = 1.36$, $p = 0.264$). A Tukey HSD post hoc comparison of the main between-subject effects showed that the Intermediate group was significantly slower than both the Advanced and Native groups ($p < 0.001$), but the contrast between the Advanced and the Native group was not statistically significant (p = 0. 284).

Also, three a priori comparisons between the Matched and Unmatched conditions within each group were conducted by means of the paired t-test at a Bonferroni adjusted alpha level of 0.017 (0.5/3). Only the contrast Between the Matched and Unmatched condition in the Native group was marginally significant ($p = 0.019$).

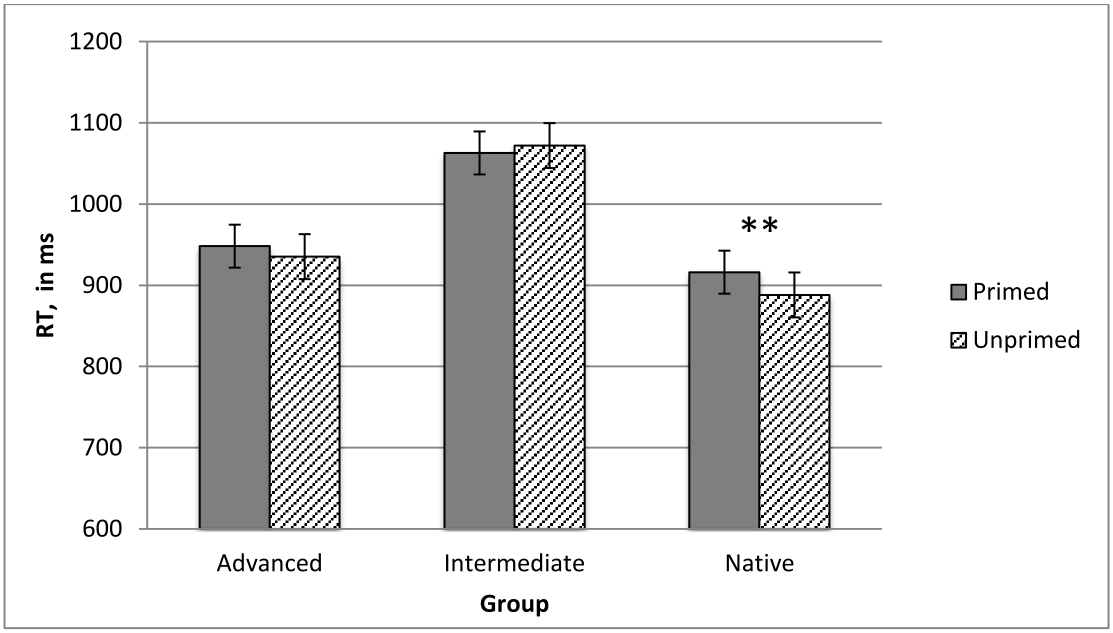


Figure 12. Mean RTs in the Phonological LDT task, High frequency

Discussion. As can be seen in Table 13, the Advanced and Native groups display a similar pattern, exhibiting reduced latencies in response to the items in the Unmatched condition, compared to the Matched condition. The Intermediate group, on the other hand, showed a slight facilitation in the Matched condition compared to the Unmatched condition—lexical access after the presentation of the phonologically-related prime happens slightly faster. Although the contrast was not statistically significant, the direction of the results goes against the pattern of response latencies, observed in the Advanced and the Intermediate groups, and is in contrast to the expected native-like effect. On the other hand, the direction of the effect suggests a reduced role of lexical competition at lower levels of L2 proficiency. As was hypothesized, attenuated competition allows for greater pre-lexical influences on the speed of lexical access. As the data on the Intermediate group shows, the benefit of pre-lexical activation is not strong, however, the fact that even a small facilitation manifests itself is an indication of the fact that the effect of lexical competition is greatly attenuated.

5.1.4.2 Advanced and Native groups: High and Low frequency

In order to evaluate the contribution of phonological relatedness within one group of L2 learners, the data were analyzed in the following way. Similarly to the previous analyses, two analyses, one for accuracy data and another one for reaction time data, were conducted.

Accuracy. For the accuracy data, the repeated measures ANOVA with Group (Advanced and Native) as a between-subjects factor, and Frequency (High and Low) and Priming (Primed and Unprimed) as a within-subject factor showed a significant main effect of Frequency ($F_1(1, 38) = 12.03$, $p < 0.001$) and a significant interaction of Group x Frequency ($F_1(1, 38) = 11.65$, $p < 0.01$). The main effect of Group was not statistically significant ($F_1(1, 38) = 3.09$, $p = 0.087$). All other effects and interactions were not significant. As can be seen in Table 14, both groups had a very high accuracy rate, which would explain the lack of the main effect of Group. At the same time, the significant difference in the interaction of Group x Frequency indicates that Advanced learners were still behind the Native group in accuracy, which is exemplified in a lower accuracy rate in the Low-frequency condition. As far as the priming effect is concerned, it appears that the fact that both groups were very close to ceiling in accuracy might have prevented the manifestation of the priming effects. Therefore, it appears that the accuracy data for these groups are not sensitive to the priming effect to the same extent as the latency data are.

Table 14
Mean RTs in the Phonological LDT task: High- and Low-frequency conditions

	Primed		Unprimed		Effect Size
Group	Mean	SD	Mean	SD	
High frequency					
Advanced	0.96	0.036	0.96	0.046	0.00
Native	0.95	0.050	0.96	0.058	0.00
Low frequency					
Advanced	0.90	0.110	0.90	0.079	-0.01
Native	0.95	0.071	0.95	0.057	0.00

Discussion. The accuracy data demonstrates that both groups of participants—L1 and L2—were equally familiar with the words in the high-frequency condition, which is reflected in the high accuracy rate for both groups. Although the accuracy is not quite at the highest possible score, the slight drop in accuracy could be attributed to fatigue, inattentiveness, or erroneous button presses, which are a common side effect of the lexical decision experiments. The accuracy data in the Low-frequency condition are more informative. If we compare the results in the Native group between the Primed and Unprimed conditions, there is no decline in accuracy due to the condition. This is not the case for the L2 learners group. Unlike native speakers, L2 participants demonstrated a drop in accuracy, which could be attributed to their lack of familiarity with some of the words of lower frequency. The results of the experiment are in line with the predictions that were put forward for the proficiency of the Advanced group. Recall that L2 learners of higher proficiency are expected to exhibit native-like accuracy in the high frequency range, while the words in the Low-frequency conditions are still expected to present a great deal of difficulty. The data clearly demonstrate that this was the case.

In terms of the priming manipulation, the results of the accuracy analysis are slightly unexpected. We did not expect to see a null result of the priming manipulation. However, it is not unlikely that the ceiling effect in accuracy did not allow the priming effect to be manifested, at least in the High frequency condition. At the same time, if the prediction about the differential influence of the cohort effect applies to the data, it is possible that making conclusions about the magnitude of the priming effect is premature and warrants further investigation, incorporating the cohort variable.

RT data. The same analysis was conducted for the RT data by means of a repeated measures ANOVA with Group (Advanced and Native) as a between-subjects factor, and Frequency (High and Low) and Priming (Primed and Unprimed) as a within-subject factor. The analysis showed significant main effects of Group ($F_1(1, 38) = 4.23$, $p < 0.05$), Frequency ($F_1(1, 38) = 10.78$, $p < 0.01$) and Priming ($F_1(1, 38) = 5.65$, $p < 0.05$). In addition, the interaction between

Frequency and Group ($F_1(1, 38) = 8.60$, $p < 0.01$) was also highly significant. The remaining main effects and interactions were not statistically significant.

Also, four a priori hypotheses for comparisons between the Matched and the Unmatched condition within each Frequency range for Advanced and Native groups were conducted by means of a paired t-test at a Bonferroni adjusted alpha level of 0.013 (0.5/4). Although the contrast in the High frequency condition for the Native group closely approached the significance threshold, none of the contrasts were statistically significant (Native group: $p = 0.019$ and $p = 0.227$; Advanced group: $p = 0.471$ and $p = 0.942$ for High- and Low-frequency conditions respectively) (see Table 15).

Table 15
Mean RTs in Phonological LDT task: High- and Low-frequency conditions

	Primed		Unprimed		Effect Size
Group	Mean	SD	Mean	SD	
High frequency					
Advanced	948.21	82.628	935.30	82.083	-12.91
Native	912.16	99.058	892.20	110.730	-19.95
Low frequency					
Advanced	988.05	136.732	986.00	105.384	-2.05
Native	915.11	115.202	904.36	103.800	-10.74

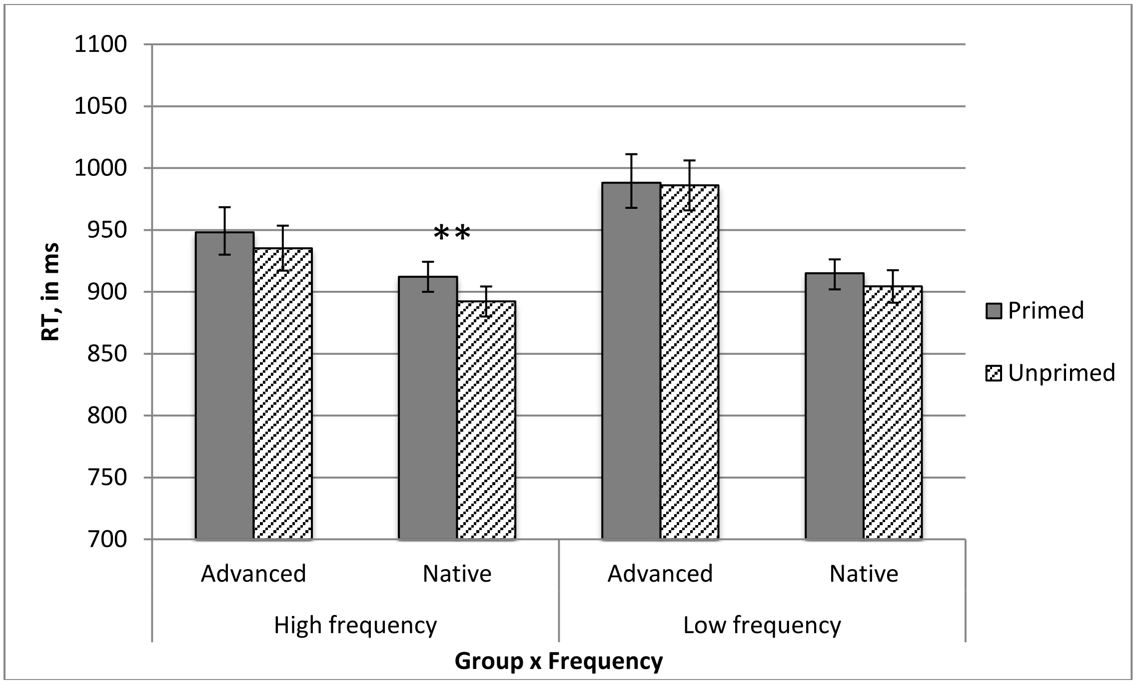


Figure 13. Mean RTs in the Phonological LDT task, High- and Low-frequency conditions

Discussion. The latency data parallel the results of the accuracy data. As expected, the Advanced group was significantly slower than the Native group in general and especially in the Low-frequency condition. As discussed earlier, both groups display inhibition in the phonologically-matched condition with high-frequency words. It is important to point out that the inhibitory effect of the phonologically-related prime also persists for native speakers of Russian with words of lower frequency. Although the priming effect is reduced, and the variability in the responses increased, the pattern of responses still shows that lexical access of L1 words is delayed after the presentation of a phonologically-related prime. At the same time, the fact that L1 speakers experience a reduction in the magnitude of the priming effect also suggests that it might not necessarily be a reflection of the cohort influences per se. The fact that frequency modulates the effect size might in part be explained by the frequency effect of individual items, which join in the competition for lexical selection. When the prime and the target both come from the lower end of the frequency range, it is possible that the cohort influences are not as strong, since the pre-lexical facilitation of the cohort has to stand up against the high-frequency cohort members' competition in addition to competition from the prime. It is plausible that the degree of competition that the target experiences is not comparable across cohorts in different frequency ranges, since the contribution of the cohort influence will also be reduced as a reflection of the frequency status of the members of the cohort. We will return to the question of the cohort in different frequency ranges in Chapter 7.

As for the L2 groups, the contrast between the Matched and Unmatched conditions was not statistically significant; however, it is worth mentioning that the direction of the phonological influence of the prime in the High frequency condition patterns in the native-like direction: when the word is followed by a phonologically-related prime, a delay in lexical access is observed. At the same time, it appears that L2 learners are affected by the frequency manipulation to a greater degree than native speakers. In the Low-frequency condition, the effect of phonological priming in the L2 group is close to null, potentially indicating that the mechanisms involved in lexical access of less-known L2 words are different from the ones applied to better-known L2 words. According to our prediction, the degree of familiarity with lexical items is a critical component of L2 lexical access, and in order to make more informed conclusions, it is important to consider the contribution of the familiarity variable.

In addition, and this applies to both L1 and L2 groups, the magnitude of the priming effect in phonological priming is smaller than reported in previous studies (Gor et al., 2010; Cook & Gor, in preparation). One thing that makes the present study different from the previous ones is that the material was carefully selected to represent two cohort groups—large and small, which has potentially introduced an additional dimension that previous studies did not have. If, as was previously hypothesized, lexical access latencies depend on the size of the cohort, then a combination of the cohort effects can reduce the overall inhibitory trend, typical for L1 phonological priming. In order to explore this possibility further, the analyses that will follow will include the cohort variable as one of the factors. By isolating the contribution of the cohort size to the phonological priming effect, it will be possible to identify the source of the interaction.

In the next section we will compare the cohort effects in two L2 groups to explore a developmental tendency in lexical access of words with a different degree of specification in L2 learners' lexicon. Since Intermediate learners were only tested on the High-frequency items, the comparison will be limited to the High-frequency condition.

5.1.4.3 Advanced, Intermediate and Native groups: Priming effect in High-frequency condition

To investigate a priming effect we focused on the RT data, since it is more appropriate for the research questions we need to address. Although accuracy data can be very informative, in our case it appears that it is subject to ceiling effects, especially in the Advanced and Native groups, consequently, the conclusions might not necessarily be justified. Latency data, on the other hand, does not have such a limitation and even with 100% accuracy it can provide helpful information about the time course of lexical access.

RT data. To address the question about the different contribution of the cohort sizes, on the one hand, and the priming condition, on the other, we conducted a by-subject and a by-item analysis to compare the priming effect in each Cohort condition across the two L2 groups—Intermediate and Advanced.

The priming effect was calculated in the following way:

PRIMING EFFECT = RT in UNMATCHED condition – RT in MATCHED condition

Here we will follow the convention, adopted by priming studies with a semantic relationship between the prime and the target. The positive value of the priming effect should be interpreted as a facilitation of the priming condition compared to the unprimed condition; consequently, a negative value should be interpreted as an inhibition of the primed condition compared to the unprimed condition.

Table 16
Mean RTs in Phonological LDT task: Priming effect in High-frequency condition

	Primed		Unprimed		Effect size
Group	Mean	SD	Mean	SD	
Advanced	14.87	85.976	-40.77	100.528	-55.64*
Native	40.05	80.930	-22.14	146.559	-62.19

Note. * = $p < 0.025$ (Bonferroni-adjusted alpha level)

The results of the repeated measures ANOVA with Group (Advanced and Intermediate) as a between-subject factor and the Cohort effect (Large and Small) as repeated measure, revealed a statistically-significant effect of Cohort size in by-subject analysis ($F_1(1, 38) = 7.05$, $p < 0.01$, $F_2(1, 38) = 1.23$, $p = 0.231$) and a statistically-significant effect of Group in the by-item analysis ($F_1(1, 38) = 0.743$, $p = 0.394$; $F_2(1, 38) = 101.98$, $p < 0.001$). All other effects and interactions were not significant. Means by Group and Cohort size are reported in Table 16. In order to test the original hypothesis about the cohort size effect in a priming paradigm in each of the experimental groups three a priory contrasts between the effect sizes in a Large cohort condition and a Small cohort condition at a Bonferroni adjusted alpha of 0.025 (0.5/2) were carried out. The difference in latencies in the Advanced group was statistically significant, but not in the Intermediate group ($p = 0.025$ and p =0.119 for Advanced and Intermediate groups respectively).

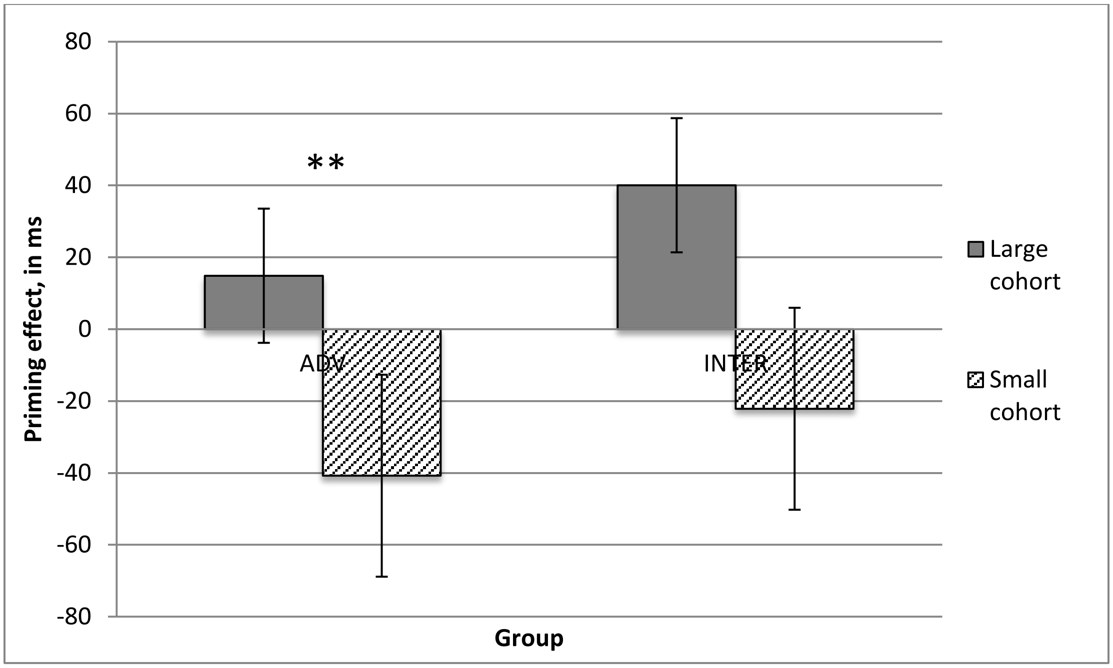


Figure 14. Priming effect (RT) in the Phonological priming LDT, High frequency condition

Graphic representation of means by Group and Cohort size are reported in Figure 14.

Discussion. As we can see, both the Advanced and the Intermediate group do, in fact, benefit from the matched condition with words from the Large cohort. As predicted, due to the greater influence of cohort size and a weaker contribution of competition from the prime, the decision on the target is made faster when the cohort has been previously activated. Both L2 groups (the Intermediate group to a greater degree) do not experience as much competition at a lexical level and take advantage of the pre-lexical activation of the words. The analysis confirmed that the lexical access of words from Large cohorts is different from the lexical access of words from the Small cohort at least for one of the two L2 groups. It is somewhat surprising that the contrast between the cohort conditions did not reach statistical significance in the Intermediate group. As can be seen in Figure 14, both groups demonstrate a very similar tendency and an effect of a very similar magnitude, however, the greater variability of responses in the Intermediate group might have prevented the effect from reaching statistical significance. At the same time, the comparison of priming effect has uncovered a distinct tendency in the performance of both groups – phonological priming of the word from a large cohort induces facilitated access, while phonological priming of the word from a small cohort inhibits access. This is a very interesting observation, especially considering a similar magnitude of difference between the reaction times versus words from large cohorts to words from small cohorts across groups. This result suggests that the outcome of lexical access in L2 learners of higher proficiency can be seen as an interaction of two processes—pre-lexical facilitation of the joint cohort activation and lexical level competition. Based on the observed results, it can be suggested that both processes have an impact on lexical access at various stages of proficiency. More importantly, the outcome of this experiment demonstrates that there is a strong pre-lexical activation for words from both types of cohorts regardless of proficiency. However, the determining factor for the facilitation or inhibition in lexical access is not the size of the cohort per se, but the degree of familiarity with the lexical item in this cohort. If the word is well-known, as is the case for the higher-proficiency L2 learners, the lexical access of the word creates the pressure of lexical competition, which counteracts the facilitation effect of pre-lexical facilitation. Larger cohorts produce lexical competition of a greater magnitude as well as a pre-lexical facilitation of a greater magnitude, while smaller cohorts are unable to do so. Consequently, what we see is the dominance of the competition effects in the small cohorts.

This is a very important finding, providing support for one of the most important assumptions of SLLAM about the pre-lexical contribution of the cohort set. As the experiment clearly shows, the interaction of pre-lexical activation of the cohort with its lexical influence at the stage of lexical competition can lead to different outcomes, depending on how strongly these two factors contribute to lexical access.

Thus far, we have only taken into consideration the behavioral data, without having confirmed whether we can assertively speak about lexical access in L2 learners. As we have suggested, another aspect of the phenomenon we are investigating has to do with confirming the source of the facilitation, observed with less-known words. By examining the translation data, we will be able to address directly the predictions in *Hypothesis #3* about the pre-lexical level of cohort influence.

5.1.4.4 Advanced and Intermediate groups: High-frequency condition with Familiarity variable

One of the central hypotheses of this study has to do with the fuzziness of the phonological representations in the L2 mental lexicon. If we assume that the acquisition of lexical items is a gradual process and that it takes some time to perfect the usage of a particular L2 word, then it can be assumed that at early stages of acquisition the words in the mental lexicon lack specification. We have also suggested that as long as the phonological representation of the word is not highly detailed, the word will not be an effective competitor when it comes to lexical competition. In this case the mechanism of lexical access will follow a different route, and, as was demonstrated earlier, will allow for a much greater influence of the pre-lexical factors during lexical competition. The model that we are proposing here is based on the claim that various degrees of familiarity with the word will affect the outcome of the lexical access differently. We have demonstrated by the behavioral data that there is in fact a facilitatory effect of the larger competitor set. However, the question of whether this facilitation emerges as a consequence of the lack of detailed specification in its phonological form remains open. By exploring the behavioral data together with the data from the translation experiment, we will be able to support this claim.

After the paper and pencil translation task was scored, the data were merged with the behavioral data, so that it was possible to identify the words that are known to each individual test taker on an item-by-item basis. All data were classified into four categories. The first category included individual responses to items with both words known to the participant (prime and target). The second group comprised of items with neither prime nor target known to the participant. The third group included the items where only the prime was known and the target was unknown, while the fourth group included items where only the target was known. For further analysis we focused on two groups of items based on the familiarity criteria—when both items were known and when only the target was known. This choice was made based on the following grounds. While RT analyses required the use of trials that have the correct judgment on the lexicality of the item, we opted not to use the trials when the participant made the correct decision on the button press, but was not able to translate the same word correctly on the translation task. The ultimate judgment of the learner's familiarity with the word is an accurate translation, so this leaves open the questions whether the buttonpress was accidental or whether the participant actually thought he/she knew the word. Since we cannot claim for certain that the button press was justified, the choice was made not to pursue the analysis of these trials. Therefore, the trials with a correct behavioral response, but an incorrect translation were excluded from further analyses. These data included responses with unknown primes and targets, as well as the unknown targets.

The prediction for the experiment goes as follows: if the prime is well-known, then during lexical competition it will be a highly competitive candidate, which would be reactivated with the target cohort and will delay the response to the target, or at least, will get in the way of pre-lexical facilitation. If the word is not well-known, as is the case in the condition where only the target is known, but not the prime, a lack of lexical access will not counteract the pre-lexical activation, allowing for facilitated access of the target. In addition, the facilitatory effect is a consequence of pre-lexical activation of the 'fuzzy' contenders; the difference in the degree of facilitation will be modulated by the size of the cohort: if the words are from a large cohort, then the prime will facilitate access to the target to a greater degree, than if the words are from a small cohort. We explored the results of the matched phonological condition of the primed LDT experiment in conjunction with the translation data, first, in the High frequency condition to compare the results of the Intermediate and Advanced groups, and then for the Advanced group alone with the lexical frequency of items as one of the factors.

Data treatment. Data analysis was carried out on a small sub-set of data due to the fact that assignment of the items to the conditions based on familiarity with the word could not have been controlled prior to the experiment, and, therefore, was not a part of the design. Care was taken to include lexical items that would potentially produce a comparable amount of data in both conditions, however, the outcome was largely dependent on the proficiency level of the participants. This was the case in our experiment. Since higher proficiency implies greater lexicon size and greater familiarity with the words, the amount of data in the two conditions of interest was uneven. Due to the proficiency of the Advanced group being higher than expected, the majority of the words in both the High and Low-frequency ranges were known to the participants (as indicated by accurate translation), which greatly reduced the counts for the items with unknown primes. In addition, the analysis was only conducted on the items, which appeared in the Matched conditions. The unmatched condition does not provide a good baseline for the investigation of the cohort effect since the words in the Unmatched condition also experience the cohort influence, however, these are the effects of different cohorts. A better comparison is between the Matched conditions in different Frequency and/or group conditions, because it will provide a clear benefit/detriment of the pre-activation of the same cohort. Consequently, all trials in the Unmatched condition were also excluded from the analysis. The counts of items used in the analyses can be found in Table 17.

Although the experimental design warrants the use of the repeated measures analysis, for this reduced data set this presented a challenge. A number of the participants did not have data in all of the conditions, therefore, the data set was incomplete for this purpose. I opted not to exclude cases listwise due to already limited amount of data and used ANOVA without repeated measures as an analysis of choice.

RT data. For the RT data in the High-frequency condition a by-subject and by-item two-way ANOVA with Group (Advanced and Intermediate) as a between-subjects variable and Cohort size (High and Low) and Familiarity (Both known and Target known) as within-subject were conducted. In the by-subject analysis, a statistically significant effect of Group ($F_1(1, 114) = 14.77$, $p < 0.001$) and a marginally significant interaction Group x Familiarity were observed ($F_1(1, 114) = 3.43$, $p = 0.067$). There was also a trend in the direction of a statistically significant result in the Cohort condition ($F_1(1, 114) = 1.838$, $p = 0.178$). In the by-item analysis, only the main effect of Group ($F_2(1, 113) = 24.06$, $p < 0.001$) was statistically significant.

To test a priori hypotheses, four pair-wise comparisons were carried out between the two Familiarity conditions for each group in each cohort size at a Bonferroni adjusted alpha level of 0.013 (0.05/4). The results confirmed that the difference between the conditions in the Large cohort for the Advanced group is statistically significant ($p = 0.009$), while the difference in the Small cohort – was significant only marginally ($p = 0.049$). Neither of the contrasts have reached the statistically significant threshold in the Intermediate group ($p = 0.498$ in Large cohort and $p = 0.373$ in the Small cohort). See Table 18 for the descriptive statistics.

Table 17
Count of trials, retained for the analysis with Familiarity variable

GROUP		Cohort	BOTH KNOWN	PRIME UNKNOWN
Advanced group				
	High frequency	Large	*362*	*20*
		Small	*368*	*8*
	Low frequency	Large	*279*	*70*
		Small	*278*	*60*
TOTAL, Advanced group			*1287*	*158*
Intermediate group				
	High frequency	Large	*177*	*95*
		Small	*193*	*67*
TOTAL, Intermediate group			*370*	*162*

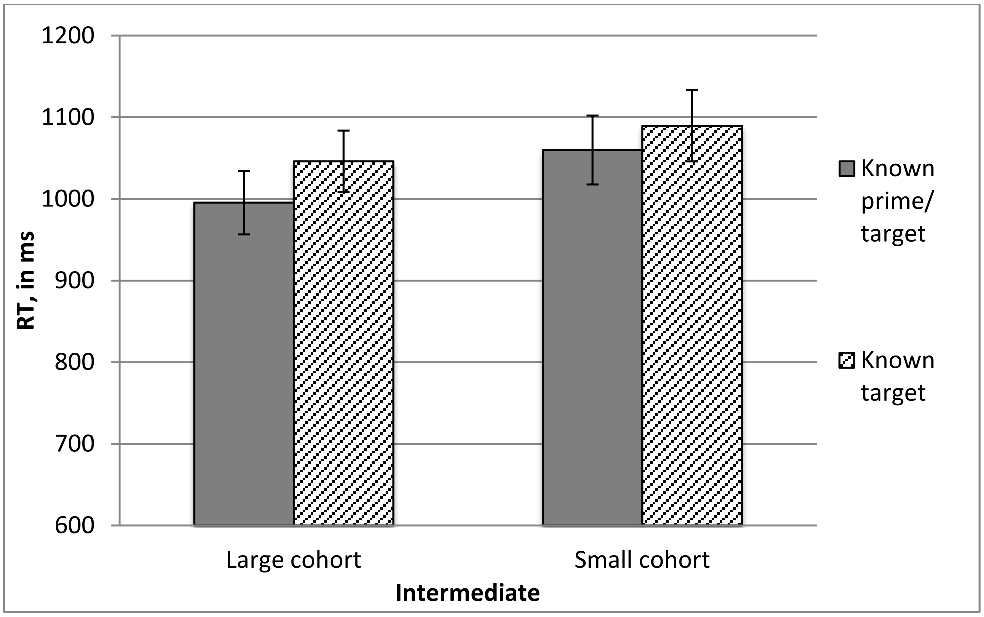


Figure 15. Priming effect (RT) in the Intermediate group by the Cohort size

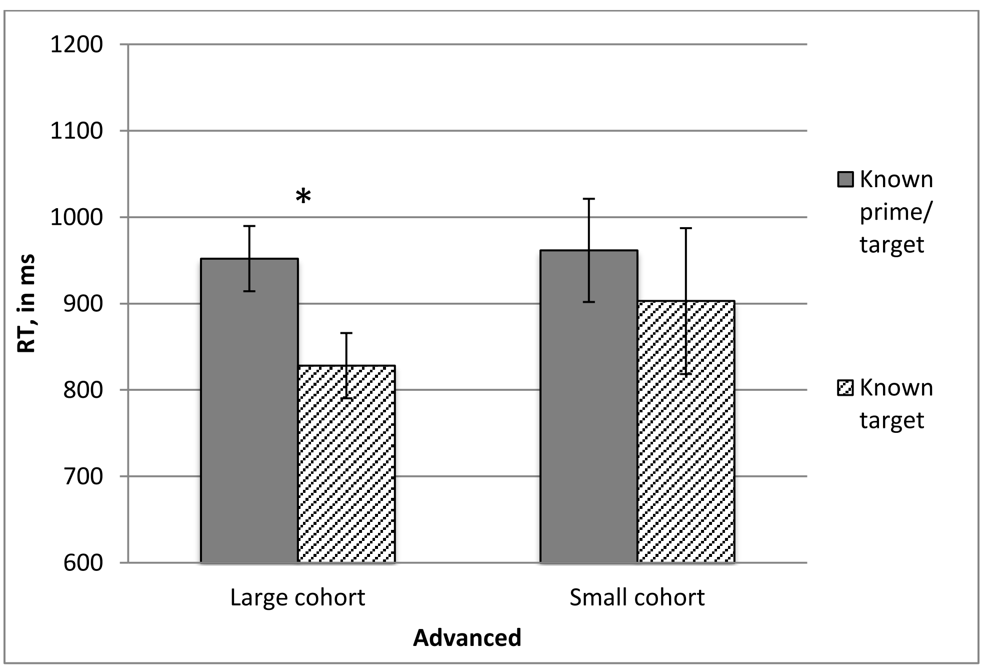


Figure 16. Priming effect (RT) in the Advanced group by the Cohort size

Table 18
Mean RTs in Phonological priming LDT with Familiarity variable: High-frequency condition

	Large cohort				Small cohort				Large cohort	Small cohort
	Both known		Prime unknown		Both known		Prime unknown		Effect size	Effect size
	Mean	SE	Mean	SE	Mean	SE	Mean	SE		
Advanced	952.16	36.47	828.25	57.67	1010.82	25.79	1050.37	37.42	-123.91*	39.55
Intermediate	995.35	38.75	1046.0	42.23	1059.97	38.75	1089.67	43.61	50.65	29.70

Note. * - significant at $p < 0.013$ (Bonferroni-adjusted alpha level).

Discussion. According to the results in Figures 15 and 16, the two groups exhibit a different pattern in their responses. The Advanced group displays a strong influence of the competitor prime. When the prime is known, then the effect of the cohort is attenuated (M = 952.15 in the Large cohort condition and M = 961.67 in the Small cohort condition). To the contrary, when the prime is not known, then the facilitative trend of the cohort manifests itself – the targets from the Large cohorts are responded to faster (M = 828.25) than the words from the Small cohorts (M = 903.00). As we have hypothesized, this occurs due to lack of competition from the prime, which is unknown. The absence of competition implies that all cohort-induced pre-lexical activation is still at play and allows for an easier access to the related word when the prime is presented for identification. The results seem to align with the proposed reasoning and provide support for the pre-lexical nature of cohort effects.

As for the Intermediate group the results do not contradict the pattern in the Advanced group, but, rather, enhance our understanding of the variations in lexical access as a function of proficiency. The main difference between the Advanced and the Intermediate group is in their degree of familiarity with the L2 words. As was hypothesized, the Intermediate group still experiences a lack of specificity in their phonological representations of lexical items. Therefore, it is possible that the difference in the processing of words that they do know as opposed to the words they do not know is diminished. It can be argued that that all words and non-words that remotely adhere to the phonotactics of the language occupy a continuum in the mental lexicon of a beginning learner. Some phonological strings sound a lot like words and there is potentially a meaning attached to it (although, not necessarily correctly identified). Others might actually be words, but since they could differ in their phonological form from other words that the learner has been exposed to, they could be identified as non-words, solely due to their formal qualities. The words in this continuum, as the learner progresses, will eventually gain more detail and at the later stages of proficiency there is a definite semantic component attached to the phonological string. In that respect, learners of advanced proficiency are probably more likely to approach lexical decision tasks from the perspective of meaning, and not just form. On the other hand, Intermediate learners are not yet proficient learners of the language. They are limited in the number of words they know, and they are especially limited in the number of words they know well. It is not surprising that while the connections between form and meaning are still rather weak in a beginning L2 lexicon, the default processing strategy for lexical access (and lexical decision tasks in particular) will be to rely on the phonological form and to try to identify the likelihood of the phonological string being a true L2 word. From this point of view, we should not expect to see a drastic difference in the performance of the Intermediate group in the conditions with the words they know and the words they do not know. In line with the hypothesis about attenuated lexical competition at the lower levels of proficiency, both types of primes – known and unknown – will exert a similar effect on the outcome of lexical decision. Neither one will be an effective prime for an intermediate learner, since there is a lack of confidence in the phonological make-up of the word, and even if the prime is selected for access, it is too weak to inhibit the pre-lexical activation it has received. The pre-lexical activation will still maintain its facilitative influence and in both cases the access will be facilitated.

As far as the cohort influence is concerned, although the Cohort x Group interaction did not achieve a statistically significant status, there is a strong trend in the predicted direction. It should be kept in mind that the magnitude of the effect depends on the amount of data, and the lack of statistical significance might not be an indication of the lack of interaction, but rather a consequence of the small sample due to the unanticipated overall high proficiency in the Advanced group. This remains a limitation for the current study and should be addressed in further research.

5.1.4.5 Advanced group: High- and Low-frequency condition with Familiarity variable

RT data. For the RT data in the Advanced group condition by-subject and by-item one-way ANOVAs with Frequency (High and Low), Cohort size (High and Low) and Familiarity (Both known and Target known) were conducted. The analyses have shown a statistically significant effect of Cohort in the by-subject and marginally significant in the by-item analysis ($F_1(1, 150) = 14.652$, $p < 0.001$, $F_2(1, 104) = 3.19$, $p = 0.077$). Both analyses also revealed a statistically significant interaction of Cohort x Familiarity ($F_1(1, 150) = 8.39$, $p < 0.01$; $F_2(1, 104) = 4.657$, $p < 0.05$). In addition, the by-items analysis indicated that the difference between items in the Low and High frequency conditions was significant ($F_1(1, 150) = 0.84$, $p = 0.359$, $F_2(1, 104) = 6.8$, $p < 0.05$). Descriptive statistics and effect size are reported in Table 19.

To test a priori hypotheses, two additional pair-wise comparisons were carried out between the two Familiarity conditions for each Cohort size in each Frequency range at a Bonferroni adjusted alpha level of 0.013 (0.05/4). As we have reported earlier, the difference in the High frequency condition proved to be statistically significant, however, we need to evaluate the difference between the Familiarity conditions in the Low-frequency range. According to the analysis, the difference between the latencies in the Large frequency condition was not statistically significant ($p = 0.341$), while the difference in the Small cohort condition was significant only marginally ($p = 0.039$).

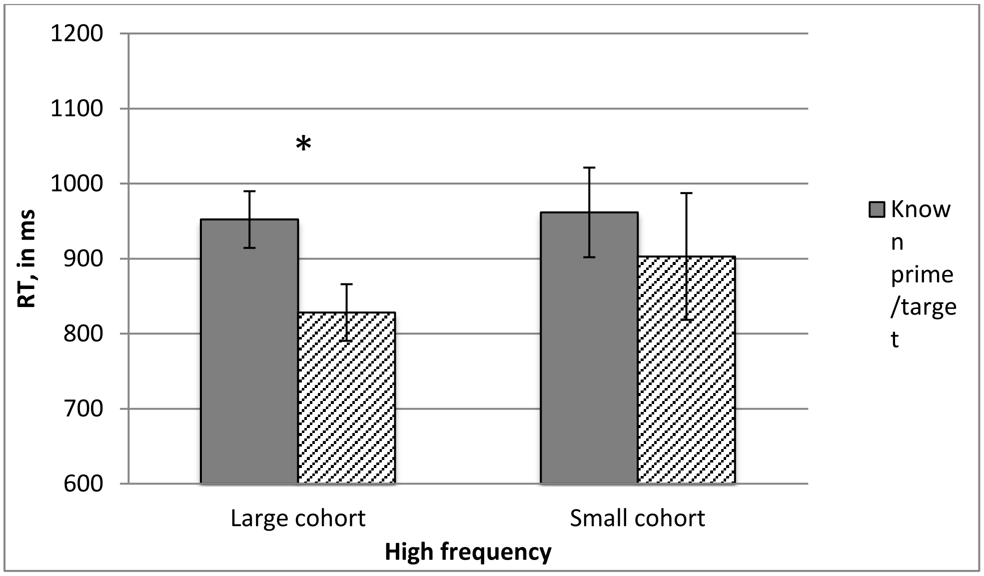


Figure 17. Priming effect (RT) in Phonological priming LDT in the Advanced group: High-frequency condition

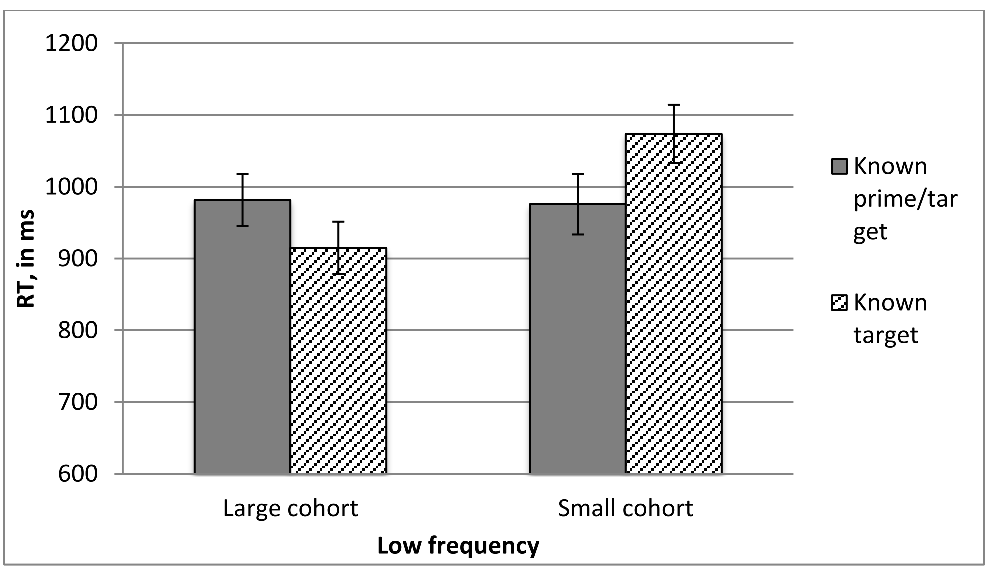


Figure 18. Priming effect (RT) in Phonological priming LDT in the Advanced group: Low-frequency condition

Table 19
Mean RTs in Phonological priming LDT with Familiarity variable: High- and Low-frequency conditions

	Large cohort				Small cohort				Large cohort	Small cohort
	Both known		Prime unknown		Both known		Prime unknown		Effect size	Effect size
	Mean	SE	Mean	SE	Mean	SE	Mean	SE		
High frequency	952.16	36.476	828.25	57.674	1010.82	25.793	1050.37	37.424	-123.91*	39.55
Low frequency	981.66	36.476	914.93	42.119	975.65	36.476	1073.56	40.782	-66.72	97.91

Note. * - significant at $p < 0.013$ (Bonferroni adjusted alpha level).

In order to address the significant interaction of Cohort x Familiarity, we conducted a Tukey HSD post hoc analysis for the means. The analysis confirmed that when the High frequency prime is unknown to the learner, a target from the large cohort is responded to significantly faster than a target from a small cohort ($p < 0.05$) and also faster than the unknown word from a Low-frequency range ($p < 0.01$). All other contrasts were not statistically significant.

Discussion. The pattern of the observed results lies in line with our predictions. Indeed, the Advanced learners tend to experience significant pressure of lexical competition from the prime, when the word is well known to them. This is what we see in the Known Familiarity condition. At the same time, when the prime is not well known, competition from the prime is not strong enough to counteract the pre-lexical activation of the prime, and the time course of the lexical decision is reduced. This effect is observed in both the High- and Low-frequency condition, with it being slightly less pronounced in the latter.

It is also important to look at the results from the point of view of the cohort contribution. As the results clearly indicate, when the factor of the lexical competitor is taken out of the mechanism, lexical access shows a robust effect of pre-lexical cohort activation, leading to facilitation. This can be seen across both frequency ranges. Targets are responded to significantly faster in the Large cohort condition than in the Small cohort condition with the help of pre-lexical activation.

It is quite possible that we are not only dealing with large cohort size facilitation, but also with small cohort size inhibition, which has to do with phonotactic probabilities. The effect of phonotactic probability, traditionally observed in lexical access, has to do with the statistical prognosis of what a word in a language should or should not sound like. This ability results from a rather extensive experience with the language and is a result of complex generalization and abstraction. While we can safely assume that native speaker of the language possesses this knowledge, it would be a stretch to attribute this ability to an L2 learner, especially at the early stages of acquisition. It is highly unlikely that a beginning or intermediate L2 leaner would have enough exposure to the language to form this complex database. And it is also unlikely that he could form an abstraction of all the possible phonological strings. Of course, infants do it easily, but for adults it is a long and pain-staking process, which might never lead to native-like perception or lexical access.

If it is not phonotactic probabilities that facilitate access, then it has to be the pre-lexical cohort activation, which has not been successfully resolved in favor of the winning competitor. The results seem to point in that direction.

This explanation, however, could be challenged by the results in the Small cohort condition when we compare the results of the two Familiarity conditions. What can be seen is that when the prime does not participate in lexical completion, the latencies for some reason become longer. These results are even more pronounced in the Low-frequency condition. The presentation of a successful competitor from the Small cohort, the prime, does not seem to delay its access. In keeping with the prediction, the effective competitor should always delay lexical access, because during reactivation the suppressed competitor, which also happens to be the prime, needs some time to come back to the baseline and then it can again be a strong competitor for selection. The time difference in reactivation is usually reflected in the delayed latencies for phonologically-matched stimuli. This exactly what we see in the Large cohort condition. However, the mechanism does not seem to follow the predicted route in the Small cohort condition.

There is one possible explanation that we can offer. What makes the small cohort different from the large cohort is the frequency factor. As pointed out by Bard (1990), competitor sets with a lot of competitors tend to include at least one highly frequent member, which is not the case with the smaller competitor sets. The latter can consist exclusively of lower-frequency members. By design, all small cohorts used in the high frequency condition include at least two high frequency members – the prime and the target. However, the small cohorts in the low-frequency condition do not include high frequency words, even as 'latent' competitors. According to the design of the experiment, in all conditions, a lower frequency word of the priming pair serves as a prime and is presented first. Let us consider what happens in the high frequency condition. First, a prime is presented, which is of slightly lower frequency, but nevertheless one of the top 1,000 most frequently-used words according to the corpus data. When the target is presented, the prime has already been successfully recognized, since it is a well-known word for the Advanced speakers of Russian, and it strongly competes with the prime. If we set aside the frequency difference between the prime and the target used for the purpose of the priming manipulation, both words are extremely strong competitors to each other. It is quite possible that the high frequency membership of both prime and target is the primary source of the inhibition effect. As we have discussed, the small competitor sets are not capable of producing enough pre-lexical facilitation to make an impact on the outcome of lexical access, especially when it involves competition among high-frequency words. On the other hand, the priming pair itself in the low-frequency condition consists of only low-frequency words.

Since the cohort is small and mostly consists of low-frequency words, in order for the prime to be selected, inhibition does not need to be of the same extent as it would be in the large cohort with multiple strong competitors. Consequently, when the target appears, the only competition that it receives is from the previous activation of the prime. However, when there are only a few competitors to select from and they are all of low frequency, they do not experience strong inhibition as a consequence of prime access, thus they can be easily reactivated, and the target is selected without significant competition from the prime.

Thus far we have attempted to illustrate how the frequency status of the priming pair can account for the lack of lexical competition when both words are of lower frequency. What still remains to be explained is why the Advanced group shows inhibition in the case when the prime word is unknown to them. It has been assumed that when the size of the competitor set is small, the contribution of the cohort can be negligible. At the same time, the factor that comes to the forefront is the relation between the members of the priming pair. The previous discussion also suggested that in a pair that consists of lower frequency words, they do not compete with each other to the same degree as high-frequency words. The only part of the mechanism that remains intact between the high and low-frequency words, and which could be potentially critical for this argument, is the possibility of reactivation of the competitors. For the Large cohort this means reactivating a large number of competitors, the ones of higher frequency first, then ones of lower frequency to follow till a match is found. The same process occurs in competitor sets of all sizes, but the word is found quicker in sets that (1) have less members and (2) have members that are less frequent. Having higher frequency members seems to be the justification for the general cohort-size effects, which is predicated on lexical level competition. On the other hand, the size of the cohort can play an important role, because the effectiveness of reactivation hinges on the size of the competitor set. Reactivating the target that was activated during the previous search will be more effective if the competitor set is small. For the native speakers, and we have demonstrated this in our experimental section, the contribution of competition and the speed of reactivation seem to work in opposite directions and cancel out the effect, because when the native speaker hears the target that was previously considered during the selection of the prime, lexical decision is performed quicker. However, the delay in accessing the known target after an unknown prime by L2 learners might have to do with the lack of distinction in phonological representation. In previously discussed work by Mani and Plunket (2008), as well as by Walley (1993, 2007), L1 language acquisition starts with very generalized representations of words, that more closely resemble a lexical blend, in Smolensky's terminology. It is only with the need to make a distinction between the two words, that these words receive more detailed specification, which results in the more detailed and accurate representation. We have hypothesized that the same process occurs in the L2 learners and, similarly to L1 acquisition, there is a trend for adding more detailed phonological detail to the already existing fuzzy representations. What we assume might have occurred during the priming with the unknown low-frequency prime is that the learners were, so to speak, 'caught off guard'. Imagine that the learner hears a real word 'CLAMOR' (for clarity of the argument I will use an English example) as a prime and then hears a word 'GLAMOR' as a target. Since the original phonological sequence was so close to the word, which is more familiar to the learner, the presentation of the target will produce a 'confusion' effect and is likely to cause a delay in processing. The words sound differently acoustically and this difference is registered with the audio processor (especially since the leaner hears them in sequence and has a chance to compare the traces in immediate memory), but only one word exists in the lexicon. This sequence puzzles the leaners and it s quite possible that the delay in processing is caused by an attempt to identify which of the words the speaker actually knows. Although this explanation seems highly hypothetical, some concrete evidence to support this claim is presented in the analysis of the translation results, discussed in the next section.

5.2 Semantic priming

5.2.1 Predictions

As was previously suggested, semantic links do not play a major role in the organization of the L2 lexicon, as they do in the native lexicon. The source of weaker semantic priming effects are not quite clear yet. It is not plausible that semantic relations are absent in the L2 lexicon, because there is already an established network of connections in the L1 that can subserve the needs of the new lexicon. At the same time, these links do not function in a native-like manner. The meanings of the words in the L1 lexicon are not very useful to the speaker without the ability to map these meanings onto the lexical units of the new language. And this is exactly what makes access to lexical meaning difficult. Without a proper form that automatically activates a large number of various semantic and other connections in the lexicon, semantic links are unable to function as they do in the native-like lexicon. The L2 lexicon needs to build that network of connections to approach the functionality of the first language. In the present experiment we intend to address the question of whether the main source of the attenuated semantic priming has to do with the weakness of the links between lexical items or whether the source of this effect stems from the lack of detail in the phonological representations of L2 words.

The main goal of the LDT task with semantic priming is to provide an on-line measure of lexical access and to examine whether the impaired phonological representations lead to confusion in form-meaning mappings of L2 lexical entries (*Hypothesis #1*). This is one of the main hypotheses of the study, and the semantic priming experiment sets out to provide further empirical support for the lack of specification in phonological representations in L2 learners. The present study was designed to show that unlike native speakers of Russian, who also experience accidental misidentification of words, even advanced adult learners of Russian do not have adequate phonological representations of some Russian words, especially if they are of lower lexical frequency. Moreover, these deviations go beyond difficulties with phonemic contrasts.

Based on SLLAM, the critical differences in L2 processing lie in the fact that the competing lexical entries remain only partially activated, without participating in lexical competition. In order to confirm completed lexical access, which assumes access to meaning, a translation experiment is an adequate measure to evaluate this aspect, in particular, to determine whether the lexical access in fact took place and the form was linked to a unique meaning.

In order to address this question, we conducted two experiments that can help to dissociate the contribution of the phonological form, on the one hand, and the strength of the semantic links, on the other. These are the semantic priming LDT and the pseudo-semantic priming LDT. First, the analyses and discussion of the semantic priming task is presented.

5.2.2 Stimuli

Experimental stimuli were selected according to the procedure described in Chapter 4 and followed the same selection criteria with the exception of the cohort measure. Due to the nature of the task, the cohort measure was irrelevant. The semantic priming section consisted of 40 items, 20 items in the HF and 20 in LF condition. Half of the item in each frequency range appeared in a semantic condition in one presentation list and in the pseudo-semantic on another. The priming pairs in the semantic condition were counterbalances with the unmatched trials, which were described in the phonological priming section, and nonword trials were added (see section 6.1.2 for a more detailed stimuli description of the entire priming LDT experiment).

5.2.3 Method

The method is the same as in LDT with phonological priming.

5.2.4 Results

5.2.4.1 Advanced, Intermediate and Native groups: High frequency

Accuracy. To assess the results of the experiment, two sets of analyses, by-subject and by-item, for each of the two outcome variables, accuracy and RT, were carried out. In the High-frequency condition the repeated measures ANOVA for accuracy with Group (Advanced, Intermediate and Native) as between-subject and Priming (Primed and Unprimed) as a within-subject conditions showed statistically significant main effects of Group ($F_1(2, 57) = 35.58$, $p < 0.001$, $F_2(2, 37) = 22.84$, $p < 0.001$), Priming ($F_1(1, 57) = 6.74$, $p < 0.01$, $F_2(1, 38) = 10.56$, $p < 0.01$) and a statistically significant interaction of the main effects Group x Priming ($F_1(2, 57) = 11.43$, $p < 0.001$, $F_2(2, 39) = 12.03$, $p < 0.001$) (see Table 20). As confirmed by the Tukey HSD post hoc, the Intermediate group was significantly less accurate than the Advanced and the Native speakers ($p < 0.001$), and also significantly less accurate in the matched condition than in the unmatched ($p < 0.001$), which was not predicted. A more common effect of semantic priming on accuracy is to enhance the accuracy, and not to reduce it. This effect still remains difficult to interpret.

Table 20
Mean accuracy scores in Semantic priming LDT: High-frequency condition

	primed		unprimed		effect size
Group	Mean	SD	Mean	SD	
Advanced	0.975	0.06	0.962	0.05	-0.01
Intermediate	0.539	0.41	0.853	0.11	0.31 **
Native	0.995	0.02	0.956	0.06	-0.04

Note. **-significance at $p < 0.01$; * - significant at $p < 0.05$

RT data. For the reaction time analysis only the words that were correctly translated in the translation task were used. Similarly to the phonological priming with Familiarity as a variable, in order to arrive at a meaningful conclusion about the priming mechanism, the trials where the lexical decision was made at random were excluded.

The same analyses, as for the accuracy data, were carried out for the RT data. In the repeated measures analysis for three Groups (Advanced, Intermediate and Native) with Priming (Primed and Unprimed) as a within-subjects condition, a statistically significant main effect of Group was observed ($F_1(2, 57) = 13.56$, $p < 0.001$, $F_2(2\ 37) = 37.19$, $p < 0.001$), as well as the main effect of Priming ($F_1(1, 57) =$

17.06, $p < 0.001$, $F_2(1, 37) = 15.41$, $p < 0.001$). The main interaction was not statistically significant (see Figure 19). Similarly to the accuracy data, the Intermediate group demonstrated the worst performance of the three groups (see Table 21). As confirmed by the Tukey HSD post hoc analysis, the difference between the Primed and Unprimed conditions was statistically significant in Advanced and Native groups (both $p < 0.001$), but not in the Intermediate group ($p = 0.091$). However, all groups seem to benefit from the priming conditions, even the Intermediate group. The trend in the Intermediate groups indicates that semantic connections in their L2 lexicon are beginning to emerge, however, they are not strong enough to produce a significant effect like we see in the Advanced group.

Table 21
Mean RTs in Semantic priming LDT: High-frequency condition

	Primed		Unprimed		Effect size
Group	Mean	SD	Mean	SD	
Advanced	864.84	76.969	935.26	82.063	70.42 **
Intermediate	1014.01	250.043	1071.97	166.515	57.96
Native	798.97	85.236	902.78	97.565	103.81**

Note. ** - significant at $p < 0.01$; * - significant at $p < 0.05$

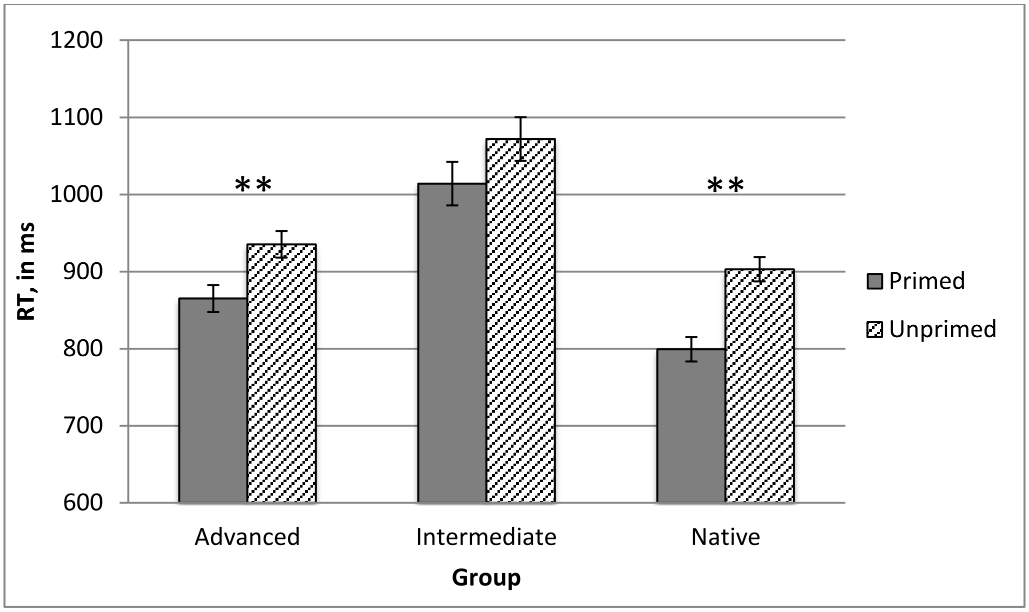


Figure 19. Mean RTs in the Semantic priming LDT: High-frequency condition

5.2.4.2 Advanced and Native groups: High and Low frequency

Accuracy. In the analyses with the addition of a low-frequency condition, the repeated measures ANOVA for accuracy with Group (Advanced and Native) as between-subjects and Priming (Primed and Unprimed) and Frequency (High and Low) as a within-subjects condition showed statistically significant main effects of Group ($F_1(1, 37) = 9.98$, $p < 0.01$, $F_2(1, 76) = 7.82$, $p < 0.01$), Priming ($F_1(1, 37) = 11.39$, $p < 0.01$, $F_2(1, 76) = 8.25$, $p < 0.01$), and Frequency ($F_1(1, 37) = 15.95$, $p < 0.001$, $F_2(1, 76) = 5.07$, $p < 0.05$). Group x Priming interaction was statistically significant only in the by-subject ($F_1(1, 37) = 9.94$, $p < 0.01$, $F_2(1, 76) = 0.98$, $p = 0.323$), while Group x Frequency interaction was only significant in the by-item analysis (F1 (1, 37) = 1.99, $p = 0.166$; F2 (1,76) = 5.49, $p < 0.05$). See Table 22 for descriptive statistics.

Table 22
Mean accuracy scores in Semantic priming LDT: High- and Low-frequency conditions

	Primed		Unprimed		Effect size
Group	Mean	SD	Mean	SD	
High frequency					
Advanced	0.98	0.055	0.96	0.046	-0.01
Native	0.99	0.023	0.96	0.060	-0.04
Low frequency					
Advanced	0.92	0.074	0.90	0.079	-0.03
Native	0.99	0.025	0.95	0.059	-0.04

Note. ** - significant at $p < 0.01$; * - significant at $p < 0.05$

RT data. As in the previous analysis of RT in the High-frequency condition, for the reaction time analysis, only the words that were correctly translated in the translation task were used. In order to analyze the reaction time variable in the low-frequency condition, the repeated measures ANOVA with Group (Advanced and Native) as between-subjects and Priming (Primed and Unprimed) and Frequency (High and Low) as a within-subjects condition was carried out. The results showed statistically significant main effects of Group ($F_1(1, 38) = 6.93$, $p < 0.01$; $F_2(1, 76) = 58.34$, $p < 0.001$), Priming ($F_1(1, 38) = 0.045$, $p = 0.833$; $F_1(1, 76) = 94.77$, $p < 0.001$), and Frequency ($F_1(1, 38) = 287.44$, $p < 0.001$; $F_1(1, 76) = 0.01$, $p = 0.940$). In addition, statistically significant interaction of Priming x Frequency ($F_1(1, 38) = 10.98$, $p < 0.01$; $F_2(1, 76) = 4.05$, $p < 0.05$), Group x Priming ($F_1(1, 38) = 5.43$, $p < 0.05$; $F_2(1, 76) = 1.33$, $p = 0.253$), and Group x Frequency ($F_1(1, 38) = 2.51$, $p = 0.122$; $F_2(1, 76) = 4.40$, $p < 0.05$). Only a three-way interaction of Group x Frequency x Prime was not statistically significant. A post hoc Tukey HSD confirmed that all contrasts in the priming condition within each Frequency condition were statistically significant ($p < 0.001$). The descriptive statistics are reported in Table 23.

Table 23
Mean RTs in the Semantic priming LDT: High- and Low-frequency conditions

	Primed		Unprimed		Effect size
Group	Mean	SD	Mean	SD	
High frequency					
Advanced	862.08	83.028	943.08	70.899	80.99 **
Native	798.25	75.906	905.63	64.177	107.38 **
Low frequency					
Advanced	853.11	71.522	988.54	64.689	135.43 **
Native	756.29	55.869	907.44	54.244	151.15 **

Note. ** - significant at $p < 0.01$; * - significant at $p < 0.05$

Discussion. Based on the analyses, the picture is rather clear (see Figure 20). Both the Advanced and the Native group display a robust semantic priming effect, which is especially visible in the RT data. As we have seen in other accuracy data in previous experiments, the Advanced group seemed to display ceiling effects. Therefore, it is not surprising that the accuracy data have little variation as a function of the priming manipulation. The same applies to the Native group. In the RT data, however, the priming effect is not only robust, but also consistent across the two frequency ranges. The situation is also interesting with the

Intermediate group. According to the accuracy data, the Intermediate group experiences serious problems in making lexical judgments when the prime and target are semantically related. As we can see, the accuracy rate in the matched group drops to almost 50% correct, which is at chance. It seems to be improbable that the priming effect is so profound that it breaks down lexical access completely. Although the conclusion might be justified, the RT data shows the opposite pattern, a more universal one. Even though the contrast between the priming conditions in the Intermediate group did not reach statistical significance, the pattern appears to be trending in the right direction – faster access in the matched condition and slower access in the unmatched condition. One plausible explanation that can account for the diverging results could have to do with the words that were used as test material. Since the lexicon of the Intermediate learner is still rather small, there is a greater chance of them not knowing a particular word, than, for example, for Advanced learner. Perhaps, then the selection of the lexical items in this particular condition negatively affected the accuracy. At the same time, the words that they did know showed a strong priming effect, as expected.

To conclude, the result of the semantic manipulation is a robust priming effect, which was equally strong across conditions and frequency ranges for the Advanced and Native group. An important conclusion that follows from the results of the Advanced group is that whether the phonological representations are fuzzy or not, it is possible to establish strong semantic links even if the words are not well-known, as is the case in the Low-frequency words.

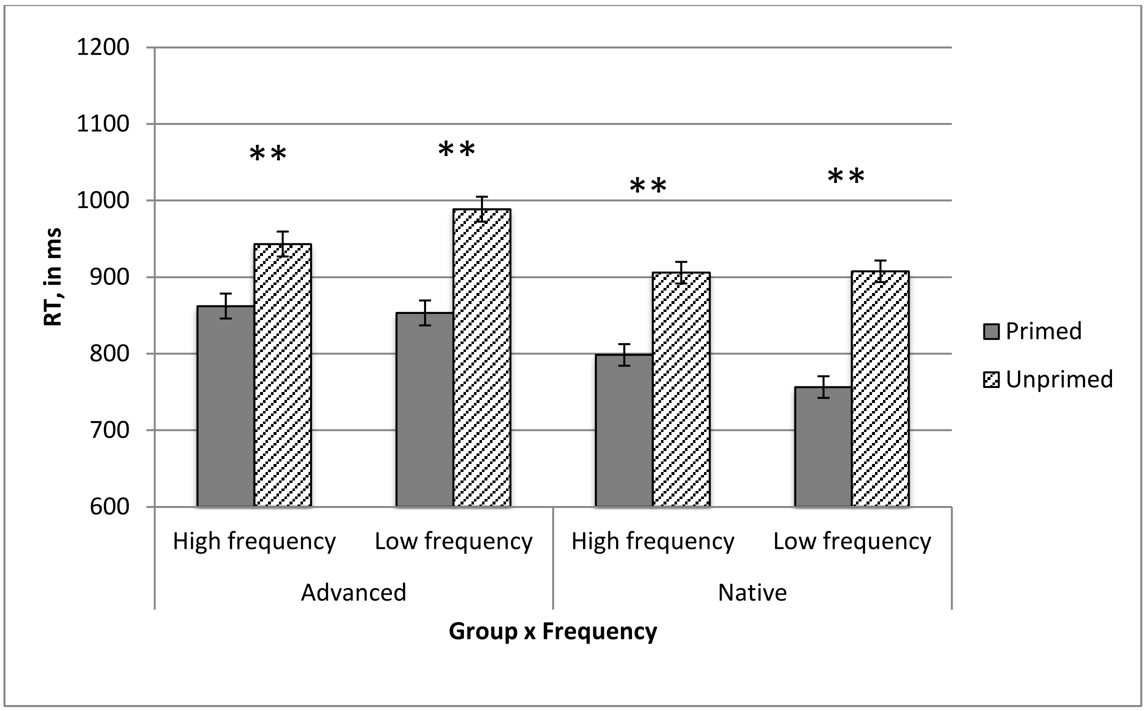


Figure 20. Mean RTs in Semantic priming LDT: High- and Low-frequency conditions

The Intermediate group, however, displayed some idiosyncratic results in the accuracy data, but in the RT date they followed the same expected facilitation pattern in the matched condition as the rest of the groups. The fact that a large variability of responses prevented the difference between the conditions from reaching a statistically significant contrast in the Intermediate group shows that while there is an emerging trend for establishing a semantic network in the lexicon, the network is not yet functioning in an automatic fashion. Moreover, it is highly sensitive to individual lexical items and is prone to lexical break down.

We will discuss further the L2 issues associated with semantic priming in the next section, where we will attempt to evaluate the strength of the connections among items that have similar-sounding forms.

5.3 Pseudo-semantic priming

5.3.1 Prediction

This part of the study aims to identify the role that the phonological form plays in lexical access in L2 learners. The "traditional" semantic priming experiment discussed previously demonstrated that even Intermediate learners can exhibit strong priming effects when the task is constructed with words that they know. The conclusion that can be drawn from this is that the degree of familiarity with a lexical item is the key to successful lexical access, and the familiarity hinges on two main assumptions. First, there should be an accurate representation of form, in the case of auditory lexical access, this is a representation of the phonological string. Second, this form should activate the unique meaning associated with it. When those two components come together, successful lexical access can be expected. From the perspective of the priming paradigm, the semantic priming effect is achieved when the core lexical meaning of the prime is activated. However, this is not sufficient to produce a semantic priming effect. Additionally, the prime word needs to activate other words that are closely related to it either in meaning or by association. Therefore, when the semantic priming effect is observed, the result can be taken as positive evidence for support of at least two facts – (1) lexical access of the prime took place with the correct meaning being accessed; and (2) the network of semantically related words was activated during lexical access. If we follow this reasoning, the fact that the correct phonological form is accessed is really not a part of the mechanism. For example, the learner hears the word *молоток* /malatok/ 'hammer', and he is not sure whether he heard the word he knows *молоко* /malako/ 'milk' or something else. Both words sound very much alike, but for the learner the task at hand is not to differentiate between the two words, but to try to identify what he heard to the best of his ability, so that the meaning becomes available. Since he does not know the word *молоток* /malatok/ 'hammer', he identifies it as the closest phonological match *молоко* /malako/ 'milk'. As a result the word is confused with another one based on the similarity of the phonological forms. This scenario is only possible if neither words have a detailed phonological representation, or if there is an imbalance between them in terms of frequency and, thus, availability in lexical access. Sekine (2006) reported that the lower frequency words in her experiment had a tendency to be identified as similar-sounding higher frequency words. However, this outcome might be more a result of the acquisition sequence, rather than the frequency effect per se. Typically, words of higher frequency are learned before words of lower frequency, therefore, the former are better known to the learner. Regardless of the source, the critical difference between the two words that are confusable is the fact that one has a more detailed representation than the other, so that the pattern of substitution will follow from the less-known word to the better-known word. It is also plausible that if the learner is not able to make a distinction between the forms of two similar-sounding words in the mental lexicon, both phonological forms will be linked to the same meaning. This assumption goes along with the fuzziness hypothesis that is postulated in SLLAM. If the learner operates with underspecified phonological representations, we can assume that the two similar-sounding words are not sufficiently isolated from each other in terms of form and the fine distinctions between them have not been accurately represented. Therefore, under certain circumstances inadequate phonological representations can trigger the lexical meaning of the competitor and the wrong lexical meaning could be erroneously accessed. This is exactly the effect that pseudo-priming experiment is designed to reproduce. If our assumption is true, then the leaners will tend to confuse the pseudo-related target with the actual semantically related word.

The following predictions are made. In the High-frequency condition, the lower proficiency L2 learners will be more likely to accept a pseudo-target for a true semantically-related target, thus, exhibiting facilitation, common to semantic priming manipulation. High proficiency L2 learners, having more detailed representations of the phonological form of the word, will be more sensitive to the mismatch between the semantically-related target and the pseudo-semantic target, and would be more likely to process the pair as unrelated. Therefore, there will be no difference between the performance on pseudo-related targets and unrelated target. However, the pattern of results in the Low-frequency condition for more proficient L2 learners will be similar to the pattern of responses of the lower proficiency L2 group in the High-frequency condition, displaying semantic priming facilitation.

Together with the results of the semantic priming experiment, the pseudo-semantic priming experiment will provide evidence for the status of phonological representations in the L2 lexicon and the strength of semantic associations between them.

5.3.2 Stimuli

These were the same stimuli used in semantic priming, however, the target was replaced with a similar-sounding word of lower frequency. The same 20 primes were used as in the semantic priming condition (10 matched pairs in the High-frequency condition and 10 matched pairs in the Low-frequency condition). Each participant heard the prime only once during the experiment, and whether the prime appeared in the semantic condition or in the pseudo-semantic conditions depended on the presentation list. For example, in the true semantic condition the word pair *корова – молоко* /karova/ - /malako/, Eng. 'cow'-'milk' is presented, while in the pseudo-semantic condition the pair *корова – молоток* /karova/ - /malatok/, Eng. 'cow'-'hammer', is presented instead of a true semantically-related pair. The participant only hears /malatok/, if the priming pair is a pseudo-semantically related pair, or /malako/ if the target is a true semantically-related word.

The material for the experiment was constructed by using words that are moderately known to the speaker—well enough for the lexical meaning to be accessed, but not enough to be able to accurately access the correct phonological representation in the mental lexicon. The words for the pseudo-semantic priming condition were selected based on their phonological similarity to the semantically-related target. Pseudo-semantic pairs were pilot-tested on two Russian language learners prior to the study. The pilot-testers were not participants of the present study. Items that performed the best, were retained for the use in the experiment.

5.3.3 Results

Two sets of analyses, by-subject and by-item, for each of the two outcome variables, accuracy and RT, were carried out.

5.3.3.1 Advanced, Intermediate and Native groups: High frequency

Accuracy. In the accuracy analysis for items, the repeated measures ANOVA with Group (Advanced, Intermediate and Native) as a between-subject, and Priming (Primed and Unprimed) as a within-subject condition showed statistically significant main effects of Group ($F_1(1, 57) = 31.48$, $p < 0.001$; $F_2(1, 37) = 7.54$, $p < 0.01$), Priming ($F_1(1, 57) = 105.01$, $p < 0.001$; $F_2(1, 38) = 28.44$, $p < 0.001$) and a statistically significant interaction of the main effects Group x Priming ($F_1(1, 57) =$

13.89, $p < 0.001$; $F_2(1, 37) = 2.44$, $p = 0.101$) in the by-subject analysis. Both Advanced learners and Native speakers showed celling accuracy with a slight preference in the unmatched condition. I conducted a Tukey HSD post hoc analysis to verify whether the difference was statistically significant, which it was not. The result can be attributed to the ceiling accuracy effect, which does not allow a lot of variation, as expected. However, the task did not perform as predicted in the Intermediate group. Based on the assumption, we predicted that the accuracy scores would be significantly higher in the matched condition than in the unmatched condition. The rationale for this prediction was as follows: if the Intermediate learner is not able to match the phonological string to what he hears due to the lack of adequate representation of this word, he will erroneously access the meaning of the word that was his higher frequency competitor. In this case the increase in accuracy should be seen compared to the unmatched condition. However, this is not what we observed. On the contrary, we see a drastic drop in accuracy (from $M = 0.853$ in the unmatched condition to $M = 0.549$ in the matched condition). As the post hoc analysis indicated, the contrast between the two priming conditions in the Intermediate group was statistically significant. If we consider these results alone, then it can be suggested that the Intermediate learners are able to identify the 'trap' and the reduced accuracy attests to the fact that they are putting extra effort into identifying the pseudo-semantic target and are not as successful in doing so. At the same time, it is important to recall the results in the true semantic priming experiment, where the accuracy pattern is identical. The Intermediate learners' accuracy seems to suffer as much in the true semantic priming condition as it does in the pseudo-semantic condition. While the reason for such behavior requires further exploration which lies outside of the scope of this study, the fact remains that the pattern of accuracy results for true semantic priming and the pattern of results for pseudo semantic priming in Intermediate learners is virtually identical. This observation suggests that, as previously thought, Intermediate learners seem to access both the semantic and the pseudo-semantic targets via a similar route. What the accuracy data is not able to show is whether the access of the primed meaning takes place at all, or if access fails altogether regardless of the condition. I will return to this point in the discussion of the RT data.

Table 24
Mean accuracy scores in Pseudo-semantic LDT: High-frequency condition

	Primed		Unprimed		Effect size
Group	Mean	SD	Mean	SD	
Advanced	0.808	0.12	0.962	0.05	0.15
Intermediate	0.550	0.18	0.853	0.11	0.30 **
Native	0.874	0.11	0.956	0.06	0.08

Note. ** - significant at $p < 0.01$; * - significant at $p < 0.05$

Table 25
Mean RTs in Pseudo-semantic LDT: High-frequency condition

	Primed		Unprimed		Effect size
Group	Mean	SD	Mean	SD	
Advanced	1019.579	36.03	935.262	27.07	-84.32**
Intermediate	1129.003	42.63	1071.967	38.27	-57.04
Native	911.421	31.30	902.782	23.12	-8.64

Note. ** - significant at $p < 0.01$; * - significant at $p < 0.05$

RT data. For the RT analysis only the items that were correctly translated were retained. Then the data was analyzed in the repeated measures ANOVA with Group (Advanced, Intermediate, and Native) as a between-subject, and Priming (Primed and Unprimed), as a within-subject, variable. The analyses produced statistically significant main effects of Group ($F_1(1, 57) = 10.27$, $p < 0.001$; $F_2(1, 37) = 7.54$, $p < 0.01$), Priming ($F_1(1, 57) = 22.69$, $p < 0.001$; $F_1(1, 37) = 26.44$, $p < 0.001$), as well as the statistically significant interaction of the main effects in the by-subject analysis ($F_1(1, 57) = 4.45$, $p < 0.05$; $F_2(2, 37) = 2.44$, $p = 0.101$). A Tukey HSD post hoc analysis showed that the contrast between the primed and the unprimed condition was significant ($p < 0.01$) in the Advanced group, but not in the Intermediate or Native group (see Table 25 for descriptive statistics).

Discussion. The results of the experiment in the Advanced group are not quite what we had predicted (see Figure 21). Recall that in the High frequency condition Advanced L2 speakers were expected to exhibit native-like behavior and to show no effect of priming: assuming that they possess a high level of mastery in lexical access of items in the higher range of corpus frequency, Advanced L2 speakers should have identified the target as an incorrect semantic match. This result was observed only in part. Indeed, the Advanced learners noticed the mismatch, however, they did not move quickly past it. The delay in latencies potentially indicates that there is still some confusion about the phonological form of the word, and that the L2 learners cannot dismiss the mismatch between what they heard and what they expected to hear as irrelevant. It is plausible that the delay in the decision suggests an attempt to disambiguate the phonological form from the 'semantic' competitor. Therefore, the significant delay in decision latencies suggest that even well-known high frequency words can present a recognition challenge for L2 speakers, which, in turn, points to a certain degree of underspecification of phonological representations persisting into the advanced stages of acquisition. As for the Intermediate learners, the delay in latencies is also observed in their performance in the pseudo-semantic condition, although it is not as strong as in the Advanced group. The observed pattern of effects suggest that the effect observed in the Advanced group is just emerging in the Intermediate speakers due to their lower lexical control in comparison to the Advanced speakers. However, it should be mentioned that the predicted facilitation effect in the Intermediate learners was not observed, which was an unexpected finding.

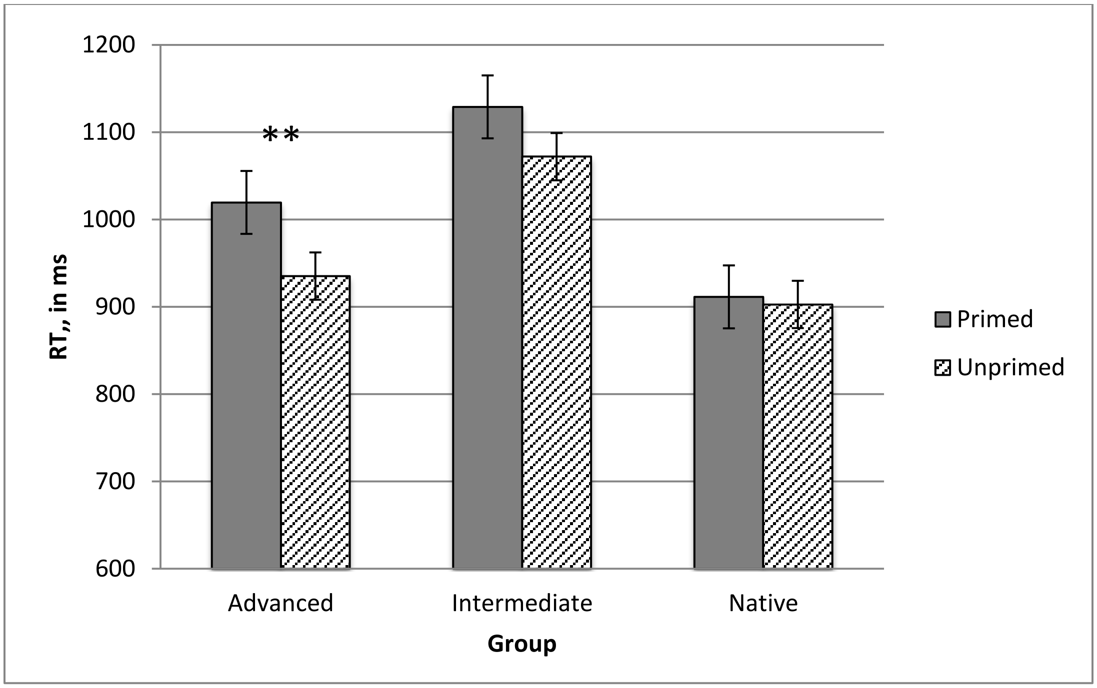


Figure 21. Mean RTs in Pseudo-semantic LDT: High-frequency condition

The Native group predictably does not show any difference in the reaction times between the primed and the unprimed condition. This pattern of results, however, was predicted. Native speakers do not possess a phonological representation with low specificity, and, therefore, they successfully apply the phonological knowledge that they have of the word to identify it. For the Native speaker, 'hammer' is very unlikely to be confused with 'milk', so the combination of words in the pseudo priming pair, 'cow'—'hammer', approached the relationship of the unmatched words. Consequently, the lack of difference in the RTs of the Native group is a result of appropriate lexical access of the pseudo prime without having confused it with the true semantic prime.

5.3.3.2 Advanced and Native groups: High and Low frequency

Accuracy. To assess the performance of the Advanced group across the two frequency ranges, the additional two sets of analyses for accuracy, by-subject and by-item, were carried out. For the high and low-frequency items combined, the repeated measures ANOVA with Group (Advanced and Native) as between-subjects and Priming (Primed and Unprimed), and Frequency (High and Low) as a within-subjects condition for accuracy showed statistically significant main effects of Group ($F_1(1, 38) = 10.88$, $p < 0.01$, $F_2(1, 76) = 4.44$, $p < 0.05$), Priming ($F_1(1, 38) = 115.01$, $p < 0.001$; $F_2(1, 76) = 22.17$, $p < 0.001$), and Frequency ($F_1(1, 38) = 12.91$, $p < 0.001$; $F_2(1, 76) = 4.43$, $p < 0.05$). The interaction effects were not statistically significant. The Advanced and Native groups showed a similar pattern of results with a reduced accuracy rate in the pseudo condition. The drop in accuracy can be interpreted as an indication of the difficulties in accessing the pseudo-prime as compared to the unmatched condition. Based on these results, we can conclude that Advanced L2 speakers do notice the mismatch between the true semantic match and the pseudo match. As confirmed by the Tukey HSD post hoc analysis, the contrast between the primed and the unprimed condition was statistically significant in both groups in the low-frequency condition ($p < 0.01$), but not in the high frequency condition.

Discussion. The results align with the prediction that in the High-frequency condition; both groups have a high degree of familiarity with the pseudo target, and, as the accuracy data suggest, it does not present difficulty in terms of identification. The learners are proficient enough to correctly differentiate the pseudo target from a true semantically-matched target, and thus, correctly identify the lexical item. In the Low-frequency condition, the pseudo target starts to impact the decision accuracy to a greater degree. The fact that the pseudo target is more 'confusable' with the true semantic target leads to more errors in this condition. Overall, the distribution of error rates across groups and conditions demonstrates that pseudo-semantic priming is an effective priming technique, and its effects can be observed in the accuracy data in the predicted direction.

Table 26
Mean accuracy scores in Pseudo-semantic LDT: High-and Low-frequency conditions

	Primed		Unprimed		Effect size
Group	Mean	SD	Mean	SD	
High frequency					
Advanced	0.81	0.120	0.96	0.046	0.15
Native	0.87	0.107	0.96	0.058	0.08
Low frequency					
Advanced	0.71	0.161	0.90	0.079	0.19 **
Native	0.78	0.125	0.95	0.057	0.17 **

Note. ** - significant at $p < 0.01$; * - significant at $p < 0.05$

RT data. In order to compare the results of the Advanced group across the two frequency ranges, the repeated measures ANOVA with Group (Advanced and Native) as a between-subject variable and Priming (Primed and Unprimed) and Frequency (High and Low) as within-subject variables were carried out. The analyses produced a statistically significant main effects of Group ($F_1(1, 38)$ =

6.65, $p < 0.05$; $F_2(1, 76) = 4.44$, $p < 0.05$), and in the by-item analysis the effect of Priming ($F_1(1, 38) = 2.42$, $p = 0.128$; $F_2(1, 76) = 22.17$, $p < 0.001$) and Frequency ($F_1(1, 38) = 0.82$, $p = 0.372$; $F_2(1, 76) = 4.43$, $p < 0.05$). The interactions Group x Priming ($F_1(1, 38) = 9.22$, $p < 0.01$; $F_2(1, 76) = 1.31$, $p = 0.257$) and Priming x Frequency ($F_1(1, 38) = 17.72$, $p < 0.001$, $F_2(1, 38) = 1.56$, $p = 0.215$) were only statistically significant in the by-subject analyses. The contrasts in the Low-frequency condition were not statistically significant (See Table 27 for summary of the effects).

The RT data for the Advanced group in the High-frequency condition showed that pseudo-semantic priming can confuse even highly-proficient L2 learners, which was observed in the accuracy data. The results in the low-frequency condition show a significant reduction in the effect between the primed and the unprimed condition compared to the high-frequency condition. Contrary to the RT data in the High-frequency condition, the Advanced group does not show any significant processing difficulties of the pseudo-targets from the low-frequency condition, but not for the same reasons as the Native speakers. For the L2 learners the change in the effect indicates that pseudo targets from the Low-frequency condition no longer delay the decision latencies, which is indicative of the less detailed phonological representations of the words in this frequency range. Unlike Native speakers, who do not experience any confusion due to great familiarity with the word, L2 speakers are insensitive to the mismatch. One of the possibilities is that the form of the expected word, not being clearly defined in terms of its phonological composition, is a good candidate for potential confusion. The discrepancy of form between what is heard and the projected word by the L2 speaker based on the semantic priming relation, is not different enough to produce a delay in response latencies, comparable to what was seen in the case of the Advanced group's performance in the High-frequency condition.

Discussion. Overall, the RT data in the pseudo-semantic priming experiment has demonstrated a consistent pattern of responses. They indicate that L2 learners are not sufficiently sensitive to the mismatch, and when the prime builds their expectations of a 'confusable' target, they are willing to accept it. This result primarily suggests that the degree of detail in an L2 learner's phonological representation interacts with the semantic priming manipulation. When the

Table 27
Mean RTs in Pseudo-semantic LDT: High- and Low-frequency conditions

	Primed		Unprimed		Effect size
Group	Mean	SD	Mean	SD	
High frequency					
Advanced	1019.58	110.575	935.26	82.063	-84.32 **
Native	911.42	128.245	902.78	97.565	-8.64
Low frequency					
Advanced	975.09	126.924	986.04	105.391	10.96
Native	872.66	111.422	904.93	102.117	32.27

Note. ** - significant at $p < 0.01$; * - significant at $p < 0.05$

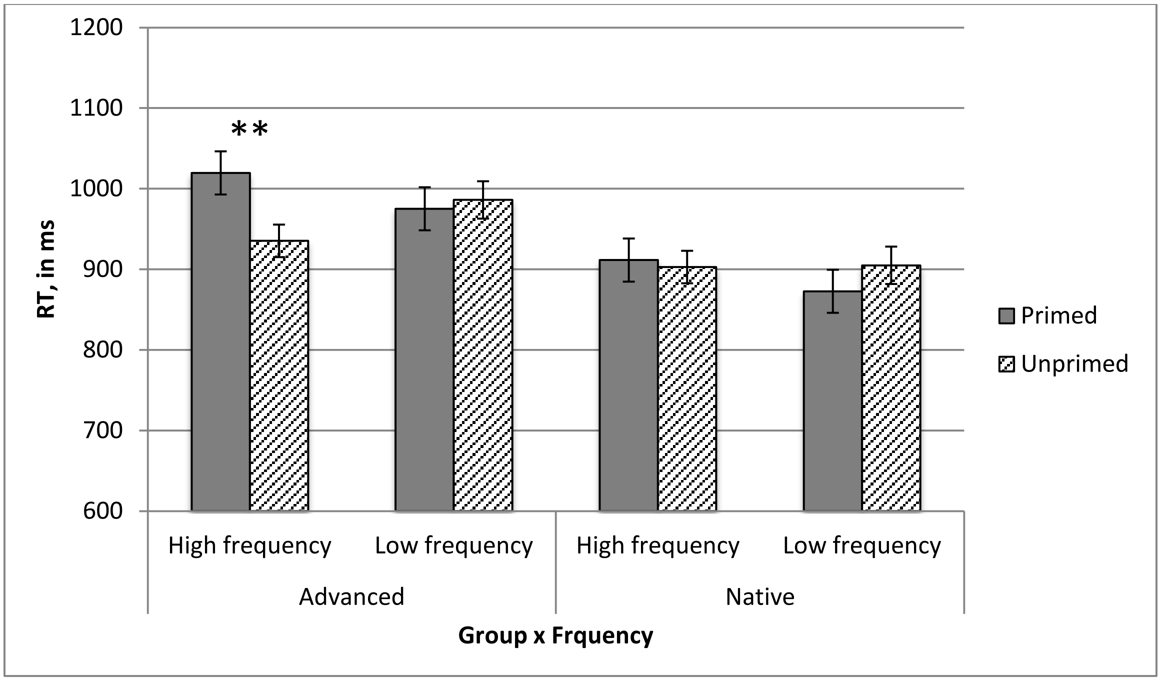


Figure 22. Mean RTs in Pseudo-semantic LDT: High- and Low-frequency conditions

representation is solid, the delay in the response latency reflects the post-access checking mechanism to make sure that the correct word has been identified. In this case the effect of semantic priming does not have a great impact on the outcome of the decisions, since L2 learners are confident in the phonological form of the word and lexical access accurately occurs for the correct word. At the same time, if the representations are fuzzy, then the semantic priming biases the decision toward the true semantic target, in a way encouraging the mistake. Under those circumstances the learner is more likely to confuse the pseudo-target with the true target.

The results of the pseudo-semantic priming provide convincing data about the state of the phonological representations in the L2 lexicon. As suggested in *Hypothesis #1*, due to the underspecification in the phonological representations, L2 learners tend to confuse words based on their formal similarity. The results of the pseudo-semantic experiment suggest that even at high levels of proficiency phonological representations are not detailed enough. Therefore, L2 learners are not sensitive to some phonological information, which needs to be encoded in the lexical entry for proper identification. As the inhibitory effect in the pseudo-priming condition with High-frequency words indicated, Advanced speakers were still experiencing 'confusion' when the presented target was not a complete match to the expected semantically-related target. The same tendency could also be observed in the Intermediate group. Intermediate learners also noticed the mismatch, however, due to weaker control over the L2 lexicon, lexical access is not delayed to the same extent as in the Advanced group. What is important is that both L2 groups experience 'false' recognition of the L2 lexical entry, because their phonological representations are vague enough to accommodate both items in terms of phonological makeup. Although the L2 group of lower proficiency did not exhibit facilitation with the High-frequency pseudo-targets, the fact that the mismatch has registered with them, but did not significantly delay lexical access, indicates that the distinction between the two targets—pseudo-semantic and semantic—is still fuzzy. Therefore, it can be concluded that pseudo-semantic priming has provided strong support in favor of underspecified phonological representations in L2 lexicon, as stated in *Hypothesis #1*.

CHAPTER 6: Experiment 3: Auditory Translation Task

6.1 Introduction

The last experiment, which I will discuss, is the Translation task. First I will outline the predictions and the methodology of the experiment, then I will discuss the results.

6.2 Predictions

The translation task was designed to perform two functions. The first function was to provide a reliable measure for establishing the degree of familiarity of L2 learners with the words used in the study. By cross-referencing the behavioral data with the translation data, we were able to argue in favor of several hypotheses that pertain to reaction time measures. The second function of the translation task was to obtain qualitative evidence of the confidence in the translation decision that each individual learner provides. In a way, the translation task is a means to gain insight into the small section of the mental lexicon that we are dealing with in this study and to get a better understanding of how form relates to the meaning in the L2 system.

The predictions for the auditory translation test relate to substitution errors in translation. Both groups of L2 learners are expected to produce a greater number of phonologically-related substitutions as opposed to substitution of any other type. This outcome will indicate that phonological links play an important role in lexical access.

6.3 Stimuli

The stimuli for the translation task were the same stimuli used in LDT with priming in phonological, semantic and pseudo-semantic conditions. Advanced learners had to translate 240 words, while Intermediate learners were only translating 120 High-frequency words. Both primes and targets were included for translation.

6.4 Method

Stimulus presentation and experiment control was carried out by the DMDX program. Before the start of the experiment participants were given an answer sheet with numbered lines for each item. The experiment required the participants to write down on the answer sheet the Russian word that was presented to them aurally and to provide an English translation. Then they were asked to evaluate how confident they were that this was the correct translation of the Russian word they just heard. Participants were provided with a 3-point rating scale on the answer sheet. The numerical answers corresponded to the following statements: (3) I know this word very well; (2) I think I know this word; (1) I do not know this word. The audio stimuli were computer-delivered at a fixed pace for all participants. Each trial consisted of an auditory stimulus presentation immediately followed by a 10 points count-down spaced 1,000 ms apart for a total of 9,000 ms. Then a message "Prepare for the next item – item #..."

appeared on the screen for 3,000 ms. This message was followed by a blank screen for 200 ms and the next audio presentation was initiated. Participants were not able to replay the stimuli or to go back and to the previous trial. Upon completion of the block, the answer sheets were collected by the administrator for scoring.

6.5 Results

The results of the task were hand-scored for appropriateness of the translation by a native speaker of Russian. For the purpose of the error substitution analysis, only incorrect translation attempts were retained. All errors due to omitting an answer were excluded. Overall, 329 substitution errors were retained (see Table 28). All errors were classified based on the type of substitution—phonological, semantic, false cognates and substitution with an unidentified relation. Phonological substitutions included form-related substitutions that were given to the word that shared form-related information, e.g. *крыльцо – крыло* /krɨlo/ – /krɨl'tso/, Eng. 'porch' – 'wing'. The semantic association substitutions were translations that were close in meaning to the word on the list, but were not the correct translation (e.g., *горький – кислый* /gor'ki'j/ – /k'islɨj/, Eng. 'bitter' – 'sour'). The false cognate included translations, where the participant tried to associate an unrelated word in English that shared a similar phonological form with the Russian word (e.g. *пример* /pr'im'er/, Eng. 'example'/'premier'). And lastly, if the connection between the translation substitution and the word in question could not be established, the substitution was classified as ‘unknown relationship’ (e.g., *возраст – ?*, /vozrast/ – /?/, Eng. ‘age’ – ‘exposure’. Further, all phonological errors were classified based on the location of the overlap with the overlap occurring in the initial or final position, or based on whole-word similarity. The following criteria were used for classifying form-related substitutions. If the word was to be split into halves and there was overlap only with initial half of the intended word, then the substitution was classified as having an initial phonological overlap; if the overlap was limited to the final half of the intended word, then the word was classified as having a final overlap. If the similarity between the words spanned across both halves, or at least extended beyond one of the halves, then the word was classified in the ‘body’ category. For example, the substitution *сосна-состав*/sasna/—/sastaf/, ‘pine’—’composition’, was assigned to the initial overlap category, *трубка – пробка* /trupka/—/propka/, Eng. ‘pipe’—’cork, traffic jam,’ to the final overlap category and *крыльцо – крыло* /krɨlo/—/krɨl'tso/, Eng. ‘porch’—’wing’ was assigned to the body overlap category (see Table 29).

In order to address the hypothesis about the predominance of form-related factors in the pattern of substitution errors, the data were analyzed by comparing the means in a chi-square test, which concluded that the proportion did not vary significantly across groups ($\chi^2(1, N = 6) = 4.24$, $p = 0.126$), but the occurrence of phonologically-related errors was higher than expected compared

Table 28
Distribution of substitution errors across Group, Substitution error type and Confidence ratings

Group	Confidence rating	Phonologically-related error	Semantically-related error	False cognate	Unknown relation
Advanced group					
	3 (well-known)	103	14	11	1
	2 (moderately known)	55	17	12	4
	1 (unknown)	14	2	4	
Intermediate group					
	3 (well-known)	23	5	1	1
	2 (moderately known)	26	12	3	2
	1 (unknown)	4		1	1

Table 29
Distribution of phonological substitution errors across Group and Confidence ratings

Type of phonological overlap	Confidence rating		
Advanced group	3 (well-known)	2 (moderately-known)	1 (unknown)
Initial overlap	41	25	4
Final overlap	11	4	4
Body overlap	30	21	4
Intermediate group	3 (well-known)	2 (moderately-known)	1 (unknown)
Initial overlap	13	19	1
Final overlap	5	0	2
Body overlap	5	6	1

to the other types of errors ($\chi^2(4, N = 6) = 0.89$, $p > 0.05$). I also analyzed the error data in terms of the location of the overlap using a chi-square test. The observed pattern of substitution was not statistically significant between the initial, final or body condition ($\chi^2(4, N = 6) = 6.00$, $p = 0.199$). It seems that an analysis of substitution errors lacks explanatory power to provide the answer that we were after, and, therefore, is not an optimal tool for exploring subtle aspects of lexical access. However, it did provide a great amount of qualitative data that reveals some aspects of processing that the behavioral studies did not.

Discussion. Indeed, both groups have made more form-related errors than all errors of other types combined. What is also interesting is that the same pattern can be observed regardless of the confidence rating the learner provides. In fact, advanced learners committed more substitution errors based on phonology when they rated their confidence in translation the highest (3). This result indicates that L2 learners are often misinterpreting the surface form of the word as a different word, as indicated by the translation errors. It can be assumed that the phonological, and possibly, orthographic form of the word, is not likely to have a definite and distinct representation in the L2 lexicon. When a lexical item has lexical competitors that are very similar in their phonological make-up, the difference between them can be blurred and one word can be substituted for another just based on formal properties, such as the onset consonant cluster or a rhyme syllable. Form-meaning mappings are fluid in L2 learners, and two forms and two meanings can be aggregated into one entity with weak semantic, as well as phonological connections in the lexicon. The results definitely point in the direction that the formal properties of the words are not stable and quite likely lack phonological specification, which is the main source of the form-related substitution errors.

This proposal could also provide a reasonable explanation for the attenuated semantic effects generally attributed to early stages of L2 acquisition. Since access to the meaning lies through the phonological access code, if the code is not accurate, the activation of the meaning could also be impaired. All of the evidence seems to point in this direction.

Another interesting observation from the substitution error results has to do with the pseudo-semantic priming discussed previously. Recall that instead of some words in the semantically-related trials, the participants heard a 'pseudo-semantically related' word. The 'pseudo' semantic target has a significant phonological overlap with the actual phonological target and, as we predicted could have been mistaken for it. After I classified the substitution errors, I isolated the substitution errors that occurred in the pseudo-semantic condition and reviewed them from the point of view of the particular word that was actually presented to the participants. Since only one of the potentially confusable words was actually a part of the testing material in a particular list, the information could be easily obtained. For example, in the pseudo-semantic condition the word pair *корова – молоток* /karova/ - /malatok/, Eng. 'cow'-

‘hammer’, is presented instead of *корова – молоко* /karova/ - /malako/, Eng. ‘cow’-‘milk’, which is a true semantically-related pair. The participant only hears /malatok/, but not /malako/ in any of the other conditions, so the probability of activating the actual semantically-related word would be only possible if the pseudo-prime gets confused with the actual semantic candidate. As was discovered, 24 out of 31 (77.42%) in the Advanced group and 8 out 12 (67 %) ‘confusion’ errors in the Intermediate group occurred when the ‘pseudo’ prime was heard in the semantic condition. In other words, the learner only hears ‘cow’-‘hammer’, but when he needs to translate ‘hammer’, it is being translated as ‘milk’. The most surprising part was that the translation task was the last task in a sequence of the study, which means that some participants heard the ‘pseudo’-primed pair that they needed to translate at least several minutes, or even an hour, ago. Keep in mind that during the translation task the words were presented in a random order and not in the priming sequence, therefore, the priming effect cannot stem from the translation task presentation order. Nevertheless, the priming effect from the previously completed LDT with priming manifests itself in the translation task.

This observation plays a very important role in presenting the argument in favor of the fuzziness of phonological representations, stated in Hypothesis # 1. First of all, it is important to say that by conducting the pseudo-priming experiment we managed to manipulate the direction of the errors the learner normally commits on a random basis. Showing that the error pattern can be brought about by an experimental design lends support to the fuzziness argument. Secondly, these results suggest that even when the phonological form is not a match to the existing representation, this does not lead to a breakdown in lexical access. It appears that a vague idea of what the word sounds like is sufficient to complete lexical access to the best of the learner's knowledge about the form and the meaning of the word. In order to access the meaning, a clear phonological representation is not a necessity, but it benefits the learner at more advanced stages of proficiency. However, at the beginning stages of acquisition, an approximate idea of the form seems to be sufficient.

CHAPTER 7: Conclusion

7.1 Introduction

The general goal of this dissertation was to examine the contribution of lexical factors, such as lexical frequency and the size of the competitor sets, as well as some L2-specific parameters (the size of the lexicon which is proportionate to the stage of L2 acquisition) to the outcome of L2 lexical access. I have also put forth an L2-specific model of lexical access, the Second Language Lexical Access model (SLLAM), which takes into consideration the degree of the individual learner's familiarity with a particular lexical item. One of the main assumptions that SLLAM makes is that the lack of familiarity with the lexical item and, consequently, underspecification in its phonological representation, forces lexical access to take a different route. The L2 processing route is characterized by greater pre-lexical influences as opposed to pressure from lexical competition, typical for L1 access, and testing these proposals was the main focus of the dissertation. In this conclusion, I seek to summarize the major findings of the empirical research of this dissertation, draw connections and thus highlight their relevance for the approaches tested, and discuss some limitations of the current study as well as plans for future research.

7.2 Summary of major findings

First I will summarize the findings in light of the research questions, formulated in Chapter 3. Then I will discuss how the empirical findings align with the proposed hypotheses.

Hypothesis #1: *L2 speakers operate with impaired phonological representations that lead to confusion in form-meaning mappings of L2 lexical entries.*

Since this is the central hypothesis of the study, it was explored by several tasks, LDTs with both semantic and pseudo-semantic priming and the translation task. For the most part, the results of the study aligned with the predictions. As expected, L2 learners in the Intermediate group showed predicted, albeit weak, semantic priming effects in words that they were familiar with, which was expected to be the case with words from the high-frequency range. The learners in the Advanced group demonstrated equally strong semantic priming effects in both frequency ranges and their performance, which, in general, closely approached that of the Native control group. These observations were true for both accuracy and latency measures. These results suggest two things. First, that the degree of the semantic priming effect is modulated by familiarity with the lexical items, which is not a novel finding. However, if the word is well-known, then the degree of the priming effect is observable even in the Intermediate learner group and is similar to that of the Advanced learners. At the same time, the fact that the word is translated correctly does not necessarily mean that the phonological form of this word is stored in a detailed representation. The results observed in the LDT with phonological priming as well as in the LDT with pseudo-semantic priming seem to point in the same direction.

Pseudo-semantic priming was a novel task, which was designed specifically for the present study and seemed to adequately address the predictions put forth. Indeed, Intermediate learners notice the mismatch between the pseudo target and the true-semantic target, but were, nevertheless, inclined to accept the word as a true semantically-related target. This was not the case for the more proficient learners, who, similarly to the L1 speakers, noticed the mismatch in the phonological form, which was evident in the significant delay in their reaction times. The inhibition effect was predicted for the more proficient L2 learners, since the task not only induces a certain semantically-related expectancy for the target, but also creates an opportunity for lexical-level competition between the true semantic target, which is expected, and the pseudo-semantic target, which is heard. The expected lexical item becomes, in a way, a competitor to the actual target they hear, and some time is required to identify the target under the pressure of competition. More generally, what these results suggest is that L2 learners are capable of making associative connections based on the words that they know; however, if the representation of the word lacks specificity, L2 learners of lower proficiency have a higher tolerance for phonological 'noise'. The aspects of the word that do not match up with their internal representation do not prevent lexical access. Moreover, an automatic processing strategy allows for the word to be integrated into the semantic links within the lexicon even though it is not fully-functional according to native standards. More generally, it allows L2 learners to access the meaning of the word even if the words are lacking in terms of phonological detail.

Additional evidence was provided by the translation task in conjunction with the LDT with pseudo-semantic priming, where the priming effect of the pseudo-semantic target was persistent over a significant amount of time of at least 30-40 minutes. Not only were the participants made to believe that they heard the correct semantic pair, but they also retained that semantic association for some time after the priming exposure.

Taken together, these two main findings— about the strength of semantic relations and the learners' high tolerance for phonological 'noise'— mean that words that do not have detailed phonological representation are capable of producing semantic effects, suggesting that lexical items are integrated into the mental lexicon and are a part of the semantic and associative networks despite the underspecification of the phonological form.

At the same time, these L2 form-to-meaning mappings based on underspecified representations are not as strong as they are in the L1 lexicon, because, as the study has exemplified, the connections between the form and the appropriate meaning are still largely inconsistent. What the LDT with pseudo-semantic priming has successfully demonstrated is that even highly proficient L2 speakers can display a 'garden path' effect in accessing the meaning of the true semantic target through the phonological form of the pseudo-semantic target that they actually heard; and that even highly proficient L2 speakers are unable to unambiguously identify the correct form of the word in the input and effectively match it to the appropriate meaning.

All this evidence is a strong indication that L2 learners operate with underspecified phonological representations during lexical access, which also affect form-to-meaning mapping in the L2 lexicon. The results of the experiments also provide support for the first research question.

Hypothesis #2: *Underspecified phonological representations facilitate L2 lexical access as a function of lexical competitor set size.*

The most illustrative support for this hypothesis is the analysis of the priming effect in the LDT with phonological priming, which clearly shows an advantage of the large cohort for the L2 groups. What the inhibition in the high frequency condition for the more proficient L2 learners showed is that when the effect of competing lexical items is present, it neutralizes the facilitating influences of the pre-lexical activation. This is clearly seen in the pattern of results in both L2 groups. In the case of the unprimed LDT, Advanced learners experience strong competition effects from well-known words, which causes a significant delay in reaction times: the bigger the cohort, the greater the number of words there are competing for selection. For comparison, if we look at the priming task, the negative effect of competition seems to be an extremely strong factor, which is competing against pre-lexical facilitation. Although there is a very minor effect of facilitation, we need to take into account the powerful effect of lexical competition leading to longer latencies in response to the items belonging to the large cohorts observed in the unprimed LDT, and we have to assume that the same lexical competition takes place during lexical access in the primed LDT with only one difference – the cohort activation was primed by the previous presentation of the word from the same cohort. What we see in the outcome is a strong interaction between the pre-lexical cohort-related facilitation and the lexical-level competition between lexical entries. The results of the less-proficient group suggest that the explanation of the interaction between the suggested lexical factors, where we observed highly attenuated lexical competition effects, is also at play. The results of lower-proficiency L2 learners showed that without prior activation of the cohort, the search for a word does not take much longer if it is from a large cohort rather than if it is from a small cohort. If there is no pre-activation, both words are accessed with similar speed. In contrast to this result, the cohort difference in primed lexical access is much more obvious. What changes in lexical access in this condition is that the cohort has been pre-activated, and since no strong lexical competition occurred at the point of prime access or at the point of target access, all that remains is the effect of pre-lexical activation. The difference clearly shows how much faster the words from large cohorts are accessed compared to those from small cohorts. This result clearly indicates the processing benefits that large cohorts have for L2 learners.

The second important point that we need to make is that there is a very clear and definitive trend between in the two L2 groups in terms of the phonological influence of the cohort, which shows that pre-lexical activation and lexical competition are not mutually exclusive. It is more accurate to say that the outcome of lexical access in each case is driven by several factors. According to the results of the phonological priming effect analysis, there is a clear difference in the contribution of the competitor set sizes to the outcome of lexical access, more specifically, whether the competitor set size will facilitate or inhibit lexical access. When we consider the results in the L2 group of higher proficiency, the contribution of the large competitor set to the overall mechanism is not as obvious, since the large cohort not only produces pre-lexical activation of a great magnitude, but also creates conditions for a high-pressure competition at the lexical level of processing.

What we observe, and this is also apparent in the results of the less-proficient L2 group, is that the benefit or detriment of lexical factors can be better understood as a sum of influences that can have opposing contributions, and when we say that there is a facilitative trend that does not mean that lexical access in this case does not experience inhibiting influences of some other factor. As the comparison between the Intermediate and Advanced groups demonstrates, both factors—pre-lexical activation and lexical competition—affect the lexical access mechanism in both groups, however, when one factor gains strength, the other experiences a stronger counteraction.

Hypothesis #3: *Facilitation in L2 lexical access originates at the pre-lexical level of processing.*

The main evidence for the role of pre-lexical level of processing comes from the results of the comparison of the Known vs. Unknown primes. In the LDT with phonological priming we discovered that when the prime is known, the target experiences inhibition; at the same time, when the prime is unknown, then the effect of lexical competition is eliminated, and the benefits of the pre-activated cohort activation can be seen in the improvement in performance. In interpreting the results of this experiment, we have assumed that if the word is unknown, lexical access cannot be completed and, therefore, the word acts like a nonword prime. Showing that the same was true for both Advanced and Intermediate groups is a valid indication of the pre-lexical source of facilitation stemming from the partial activation of the cohort, which is independent of the phonotactic probabilities.

Hypothesis #4: *With the increase in proficiency, the underlying processing of L2 auditory input experiences a gradual shift towards native-like processing.*

Evidence in support of this hypothesis comes from the simple LDT experiment, where it was shown that the facilitative effect of pre-lexical activation is not limited to a particular group, but is, in fact ,a graded phenomenon. This was particularly evident when the cohort effects of L2 learners of higher proficiency were compared across two frequency ranges in a LDT with phonological priming, where the interaction between pre-lexical influences and lexical competition was especially transparent. For learners at advanced levels of proficiency, a predicted inhibitory effect was observed in the condition with high frequency words and a facilitative effect of cohort size manifested itself in lexical access of low-frequency words. As expected, the main factor affecting the outcome of competition between pre-lexical activation and lexical level competition is the degree of familiarity/confidence in the phonological form of the lexical item. Although the words can effectively function as part of the L2 semantic network, they do not assume the same role when phonological processing is required. Vagueness of phonological representation prevents the words from competing against other candidates during lexical access. At the same time, having an approximate representation seems to be sufficient to take advantage of the pre-lexical activation of the cohort, which makes access faster and more accurate. In a way, the facilitative function of the cohort can be seen as a compensatory mechanism that facilitates lexical access in the absence of distinct phonological representations.

Hypothesis #5: *L2 lexical entries are sufficiently integrated into phonological competitor sets, provided that they have enough specification.*

This hypothesis seems to follow from the previous one. I believe that we have obtained sufficient evidence to say that a word can become an effective competitor when it reaches the level of full specification of its phonological form. The evidence can be taken from the comparisons of the results in the Advanced group to the results of the Intermediate groups, that show that while the lexical items display a native-like behavior in the high frequency range, where the words are very well known, the behavior in the low-frequency condition resembles more the behavior of the Intermediate group in the high frequency condition. Although several observations were made about the status of the low-frequency cohorts in general, despite these differences, we can say that the degree of confidence in the form of a word is a critical measure for integration of the word in the phonological competitor set.

7.3 Limitations of the study and future research

One of the main limitations of the study is the fact that even if all of the relevant lexical factors, including corpus frequency and cohort size, are held equal, due to the nature of the mental lexicon, it would be very challenging to have a meaningful comparison of the cohort effects across different frequency ranges. As the present study discovered, regardless of the degree of familiarity with L2 words, cohorts consisting exclusively of low-frequency words cannot be equated to cohorts that include high-frequency words. The main reason for this lies in the fact that high frequency words enter into lexical competition among themselves, while low-frequency words have to compete not only against low-frequency competitors of the same frequency status, but also with high-frequency members of the same cohort. And if the high-frequency competition factor is controlled for, this affects the status of the cohort in general. Based on the data from the native control group, it appears that low-frequency cohorts may not contain a high-frequency competitor, affecting the overall frequency of the cohort, which becomes a confound for the low-frequency cohorts in general. In other words, a cohort consisting of low-frequency words is a low-frequency cohort. This observation makes it challenging to interpret some of the predictions relating to cohort effects in the low-frequency condition. The bottom line is that the present study did not succeed in establishing a pure comparison of cohorts, since the status of the cohort is confounded with the frequency of its members. However, we are not aware of any available methodology that would allow for better comparisons of the cohort effect. The search for a more adequate methodology for the study of cohort effects in isolation from frequency effects will be an important direction for studies of cohorts to pursue in the future.

There is one more aspect of the present study that would benefit from improvements, which is controlling for the level of proficiency of the L2 learners. Every attempt was made to recruit a representative homogeneous sample of participants by pre-screening them on their Russian language proficiency, as well as collecting biographic data detailing their language learning experience. However, the diversity in the language learning experience might have been a factor that affected the outcome of the study. The performance of the more proficient group appeared to be very close to native-like, especially in the accuracy measures across tasks, which is an indication that the proficiency of some of the learners in this group was probably beyond what I had anticipated. Perhaps, a different screening procedure, such as an Oral Proficiency Interview (OPI), would have been more appropriate. This being said, OPI testing requires a certified tester and is expensive to administer. We had considered using this method prior to recruitment, but due to budget limitations, this option was not feasible. At the same time, the C-test used in the study seemed to perform the screening function rather well, especially for a quick snapshot type of proficiency test. What could have been done differently is that a high cut-off point on the C-test should have been established to screen out highly-proficient participants. This, however, was a difficult call to make prior to seeing how the participants behaved in each particular task. Regardless of this limitation, the study succeeded in showing some of the major trends that occur developmentally during L2 acquisition, and, perhaps, a higher than expected proficiency for the advanced group was instrumental in exemplifying these trends. This proposal remains to be confirmed by replicating the results of the current study with participants at a slightly lower level of proficiency.

7.4 Conclusion

The present dissertation has attempted to demonstrate the contribution of L2-specific lexical factors, such as lexical frequency and competitor set size as a function of L2 lexicon size at different stages of L2 acquisition, to non-native lexical access. An additional factor—the degree of specification in the phonological representations of L2 words in the non-native lexicon, which is a consequence of L2 learners' familiarity with L2 lexical items—was proposed. Taken together, the L2-specific factors, which relate to the size of the lexicon, and the underspecification in the L2 phonological representations, form the basis for the L2-specific Second Language Lexical Access Model (SLLAM).

The model of lexical access, proposed in this dissertation, makes two main assumptions about L2 lexical access. First, the detail of phonological representations reflect the degree of familiarity of L2 learners with the L2 words: better-known words have more detailed phonological representations in the lexicon, while words that are less-known, suffer from a lack of detail in the phonological representation, or underspecification. The second assumption SLLAM makes is that the fact that L2 learners operate with fuzzy phonological representations during lexical access affects the mechanisms that subserve it. The primary consequence of underspecification is reduced lexical competition. The third, and final, assumption about the specifics of L2 lexical access has to do with the contribution of pre-lexical activation during lexical access. Due to the underspecification of phonological representations, the contribution of pre-lexical factors play a more prominent role in L2 lexical access than it does in L1.

These assumptions made it possible to advance testable predictions, which were able to provide evidence of whether the assumptions of SLLAM were valid in relation to L2-specific mechanisms of lexical access. More specifically, since the assumptions concern pre-lexical activation and lexical competition, an appropriate way of identifying lexical and pre-lexical influences would be through exploring the contribution of lexical competitor sets, or, in our case, cohorts, to L2 lexical access.

The dissertation explored the contribution of competitor set size along three dimensions by posing the following research questions: Do L2 learners operate with fuzzy representations during lexical access? Do fuzzy representations affect L2 lexical access? Do fuzzy representations contribute differently to L2 lexical access at different stages of proficiency?

The first question about the contribution of lexical competition was addressed by two experiments – a simple Lexical Decision Task (LDT) and a Lexical Decision Task with phonological priming. The results of the two experiments demonstrated that the degree of lexical competition that the word experiences from competitors in the same cohort is modulated by the degree of the L2 learners' familiarity with the lexical items. As predicted by SLLAM, at a more advanced stage of acquisition, a better knowledge of L2 words and more fine-grained phonological representations strengthen the ability of the words to compete against each other. More specifically, when I compared the performance of the L2 learners of Russian, who were at intermediate and advanced stages of acquisition, during a simple LDT task, only higher-proficiency L2 learners demonstrated inhibition in response latencies to words from large cohorts, while L2 learners of lower proficiency did not seem to experience any delay in lexical access due to the large number of competitors, a number of which were specially calculated based on the size of the lexicon appropriate for each stage of L2 acquisition. In addition, when the degree of familiarity with the words, obtained in an auditory translation task, was taken into account, the results of the LDT with phonological priming showed a lexical competition effect for words that were accurately translated, indicating a high level of familiarity with these words. Therefore, the study provided positive evidence in support of the contribution of lexical competition to lexical access in L2 learners as a function of competitor set size.

The study also explored the pre-lexical contribution of competitor set size to the outcome of L2 lexical access. Due to the reduced competition effect, discussed earlier, the effects of pre-lexical facilitation were predicted to affect L2 lexical access to a greater degree than L1 lexical access, where lexical competition persists. We hypothesized that learners at the intermediate stage of acquisition would be unable to clearly identify the words that they are attempting to access, which leads to a predominance of pre-lexical influences. The effect of the pre-lexical contribution was explored primarily in the LDT with phonological priming, and we found that intermediate learners tend to experience greater pre-lexical facilitation due to the partial activation of the cohort, especially when the words are not well-known. The analysis of the reaction time measure that incorporated the degree of familiarity with the prime showed that when the prime was not known to the learners, they benefited from the pre-activation in the large cohorts prior to accessing the target from the same cohort, which was true for L2 learners of both groups. This result supported the claim about the pre-lexical level of cohort influence in L2 lexical access.

The study also succeeded in demonstrating the interaction between the cohort contribution at the pre-lexical level and at the level of lexical selection. The analysis of priming effects in the two L2 groups demonstrated that the interaction between the two factors is a graded phenomenon, which influences lexical access in opposite directions. When the competition is strong, the effect of pre-lexical activation is reduced; at the same time, when the effect of lexical competition is reduced, then the pre-lexical activation determines the outcome of lexical access, facilitating it. The data from the LDT with phonological priming corroborated the assumption posed by SLLAM by demonstrating a greater contribution of lexical competition, modulated by the size of the cohort, to lexical access in L2 learners of higher proficiency, and a greater contribution of the cohort's pre-lexical facilitations in the L2 group of lower proficiency.

In addition, the present dissertation explored the underspecification phenomenon not only from the point of view of phonological connections, manifested in the cohort influences, but also from the perspective of the mapping between form and meaning. The LDT studies with and without phonological priming clearly demonstrated the effect of phonological relatedness between L2 words. The question of fuzziness in the form-to-meaning mapping was addressed by three additional experiments—the LDT with semantic priming, the LDT with pseudo-semantic priming, and the Auditory translation task. The LDT with semantic priming illustrated the developing trend in L2 learners of lower proficiency to assign meaning to form and to incorporate lexical items into the semantic and associative network, indicating that lexical access is possible in L2 without fully-specified phonological representations. The results of the pseudo-semantic priming LDT are compatible with the claim about fuzziness of phonological representations by demonstrating a tendency to confuse similar-sounding words as a consequence of a semantic priming manipulation, more prevalent in learners of lower proficiency, and also suggested that the fuzziness extends to form-to-meaning mapping as well. As for the Auditory translation task, it identified several substitution error patterns, which also point in the direction of not only fuzzy representations at the phonological level of lexical representation, but also fuzziness in form-to-meaning mappings. More specifically, L2 learners of both groups showed a statistically significant tendency to erroneously translate the target as another phonologically-related word. All this evidence suggests that underspecification in the phonological form of the L2 word contributes to the weaker associative connections among words in the L2 lexicon, because, as it appears, L2 learners at the early stages of acquisition of a particular vocabulary item tend to use it 'holistically', with the details of representation not being sufficiently encoded to differentiate it from other phonologically- or semantically-related words in the L2 lexicon.

The findings reported in this dissertation could inform future studies in the area of L2 lexical access and L2-specific processing mechanisms, as well as contributes to the general body research of auditory speech perception.

APPENDIX A

Comparison of item parameters for LDT and LDT with phonological priming across Frequency and Cohort conditions

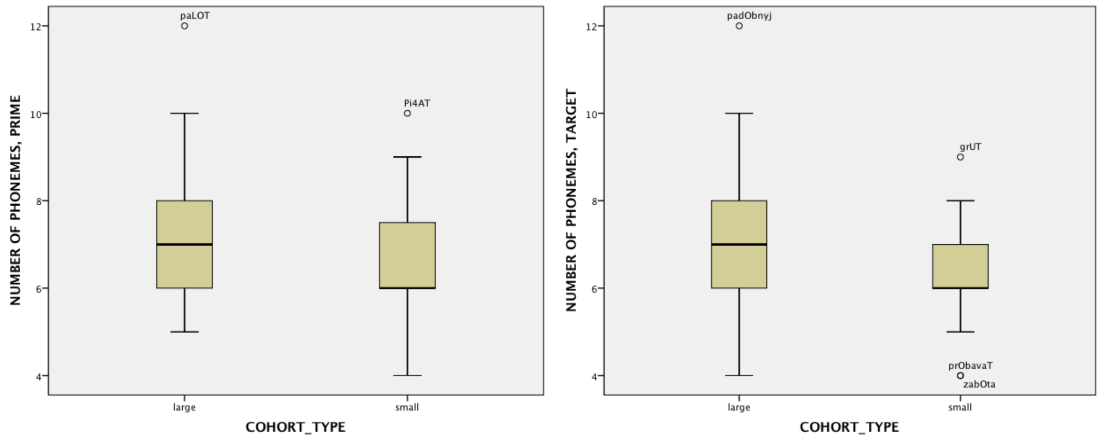


Figure A-1*. Distribution of length in phonemes in Large and Small cohort conditions*

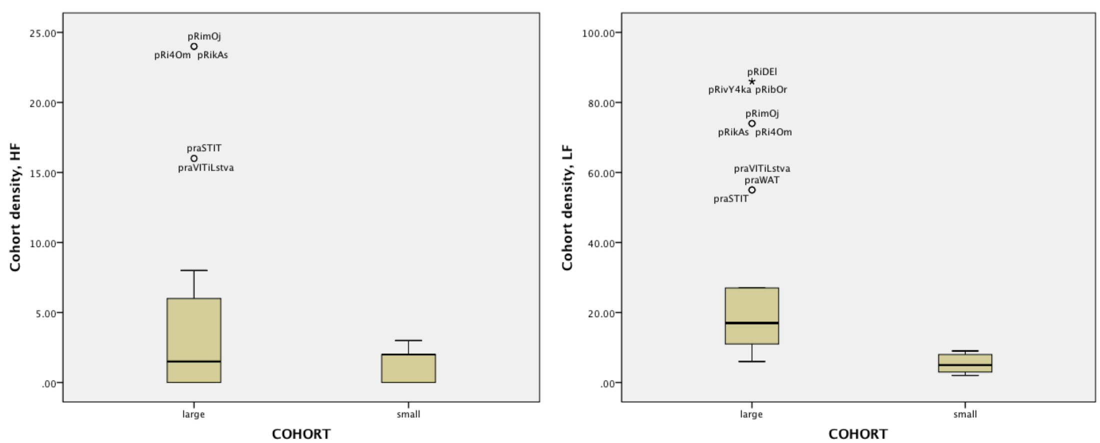


Figure A-2. Cohort density in Large and Small cohort conditions by Frequency condition

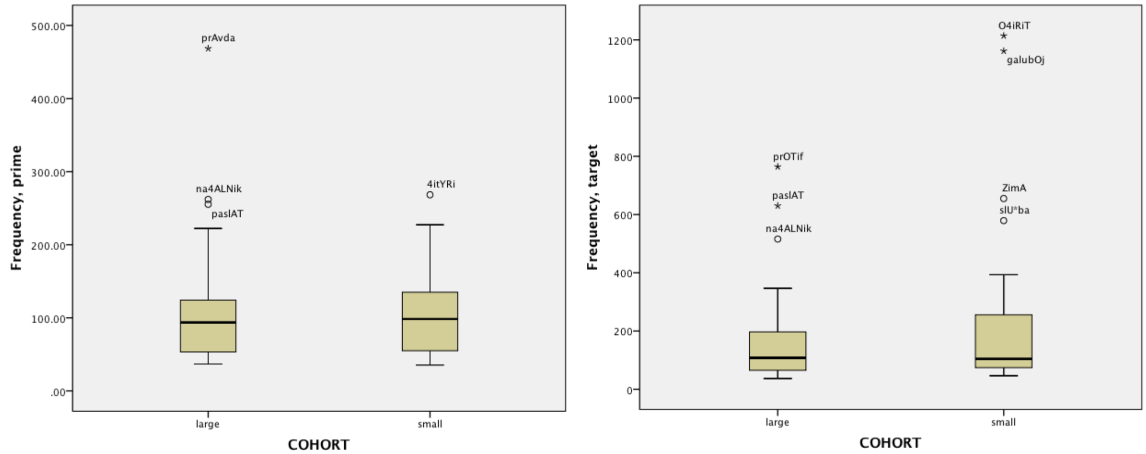


***Figure A-3*.** Frequency in Large and Small cohorts

APPENDIX B

Sample of the recruitment flyer

Second Language Acquisition Program
at University of Maryland

is conducting a study of

Lexical Access in Learners of Russian

...and we invite you to make your contribution! If you are currently learning Russian language or have already reached a high level of proficiency, we invite you to participate in the language study conducted by the department of Second Language Acquisition and Application at the University of Maryland. You do not have to be present to participate, no appointments are necessary and you can participate in this study from the convenience of your own home, or any other quiet location without potential distractions. The study consists of a series of computerized tests and a translation paper-and-pencil task.

We are looking for:

- Russian language learners with *Intermediate level of proficiency* (3-4 semesters of college level Russian courses);
- Russian language learners with *Advanced level of proficiency* (6-7 semester of college level Russian courses AND a semester or more of study abroad in a Russian-speaking country/or equivalent).

Your proficiency for the purpose of the experiment will be estimated by the screening proficiency test and the language background questionnaire, accessible online. Once you have expressed your interest in participating, you will receive a link to it.

The duration of the experiment and the compensation for participating will depend on the group designation. For the Intermediate group, the experiment is expected to last between 1 and 1.5 hours and the compensation is $25; for the Advanced group the experiment is expected to last between 2 and 2.5 hours and the compensation is $50.

If you are interested in participating in the study remotely, you should have:

- access to a PC computer with Vista, XP or Windows 7 with the ability to download files to it (these are temporary files and they will be deleted automatically at the end of the experiment);
- a quiet room with minimum of distractions (home, a quiet corner in a library, etc.);
- access to the printer to print out forms before you start the experiment (10 pages);
- a pair of headphones;
- the computer should be connected to the internet during the experiment;
- you should be able to scan and email OR mail by regular post mail a few pages that you have filled out – the check for your participation will be mailed to you immediately after the paper documents are received (electronically or hard copies).

If you are interested in participation, please, go to:
https://docs.google.com/spreadsheet/viewform?formkey=dG9DaHRwWXNXUjhXTlUwal9pbFNkYmc6MA to fill out a screening questionnaire and a proficiency assessment test.

For more information and to check if you qualify, please, email Svetlana Cook at RussianStudyUMD@gmail.com

This research is being conducted by Kira Gor and Svetlana Cook, Second Language Acquisition, at the University of Maryland, College Park. If you have any questions about the research study itself, please contact at: or Svetlana Cook at Holtzapfel Hall 2111, University of Maryland, College Park, MD 20742

APPENDIX C

Russian language C-test

Маугли наших дней

Когда Джону Себутия было всего четыре года, он убежал из дома в лес и не смог найти дорогу назад. Его на _____ , когда е ___ было дес ____ лет, в стае обе_______ . В т____ же де_____ мальчика прив______ в дет____ приют. Пер____ время о ___ подолгу си______ на од_____ месте и смо______ в пустоту. О__ не м____ есть з__ столом, бр___ еду рук_____ и боль______ кусками подн_______ её к___ рту, пот_______ что боя_____ , что е____ у не___ отберут. Сей_____ ему трид____ лет. О___ играет в футбол, быс_____ бегает, отл______ плавает. Хо___ и с трудом, н___ говорит с другими люд____. До не___ никто и__ Маугли, верну_________ к челов________ жизни, нич_____ не мо____ рассказать о своей жи______ в лесу.

[When John Sebutia was only 4 years old, he ran away from home into the woods and could not find his way back home. He was found when he was 10 year old in the pack of monkeys. Same day he was brought to the orphanage. At the beginning he would spend long hours sitting in one place and blankly staring. He did not know how to eat at the table, he grabbed food with his hands and in big bites brought it up to his mouth, because he was afraid that it will be taken away from him. Now he is 30 years old, he plays soccer, he is a fast runner and a good swimmer. Although with difficulty, but he talks with other people. Before him, nobody of the present day Mawgli, who returned to the civilized life, could not tell anything about their life in the wild.]

APPENDIX D

List of phonologically-transcribed experimental stimuli with frequency and cohort size counts.

Key to the transcription:

Letter	hard/unstressed	soft/stressed
а	a	A
б	b	B
в	v	V
г	g	G
д	d	D
е	e	E
ё		~
ж	*	
з	z	Z
и	i	I
й	j	
к	k	K
л	l	L
м	m	M
н	n	N
о	o	O
п	p	P
р	r	R
с	s	S
т	t	T
у	u	U
ф	f	F
х	h	
ц	&	
ч	4	
ш	w	
щ		W
ы	y	Y
ь		
э	>	<
ю	q	
я	#	

PRIME	TARGET	PRIME FREQ	TARGET FREQ	Priming	Group
dvOje	dvOr	155.78	221.64	phono	BOTH
sREDNij	sREtstva	122.18	181.98	phono	BOTH
MiwAT	MiwOk	115.99	113	phono	BOTH
Ostraf	Ostryj	116.24	126.34	phono	BOTH
gra*daNIn	graNI&a	114.83	130.26	phono	BOTH
galubOj	galavA	132.89	1161.9	phono	BOTH
pOmaW	pOmNiT	227.34	392.91	phono	BOTH
VOzrast	VOzdux	126.16	275.69	phono	BOTH
slU*ba	slU4ij	153.46	579.24	phono	BOTH
4itYRi	4itAT	268.35	315.54	phono	BOTH
ZimA	ZimLA	117.71	655.02	phono	BOTH
dOlGij	dOl*nyj	132.52	130.26	phono	BOTH
trUpka	trUdna	155.9	169.86	phono	BOTH
skOryj	skOLka	224.83	393.4	phono	BOTH
grUT	grUppa	218.95	235.6	phono	BOTH
krAj	krAsnyj	200.77	316.64	phono	BOTH
plOWiT	plOxa	127.07	187.18	phono	BOTH
STiklO	STinA	137.17	317.5	phono	BOTH
kaLI4istva	kaLEna	131.79	162.45	phono	BOTH
O4iRiT	O4iN	211.48	1214.24	phono	BOTH
ViSET	ViSTI	130.26	291.36	phono	BOTH
prO4ije	prOwlyj	117.16	346.45	phono	BOTH
prAvda	prAVila	468.51	137.23	phono	BOTH
kamAnda	kampANIja	114.46	150.09	phono	BOTH
na4ALNik	na4Ala	261.98	515.95	phono	BOTH
prOTif	prOsta	222.32	764.4	phono	BOTH
karOL	karOtKij	125.24	202.55	phono	BOTH
karAbL	karmAn	117.95	216.56	phono	BOTH
astarO*na	astaLnOj	118.69	148.07	phono	BOTH
stakAn	staRIk	111.1	313.64	phono	BOTH
stajAT	staTjA	130.91	116.24	phono	BOTH
strAnna	strAwna	114.83	113.48	phono	BOTH
palu4AT	pala*YT	136.75	191.22	phono	BOTH
paslAT	pasLEDNij	255.37	630.17	phono	BOTH
padObnyj	padNAT	167.23	262.53	phono	BOTH
praSTIT	pradal*AT	145.62	286.83	phono	BOTH
praVITiLstva	prabLEma	123.1	185.41	phono	BOTH
pRi4Om	pRi4Ina	118.38	191.35	phono	BOTH
pRikAs	pRiMEr	112.2	122.12	phono	BOTH
pRimOj	pRirOda	112.2	141.4	phono	BOTH
sLixkA	sLixkA	113.18	113.18	repeat	BOTH
NikagdA	NikagdA	460.92	460.92	repeat	BOTH
praSIT	praSIT	272.69	272.69	repeat	BOTH
pRikrAsnyj	pRikrAsnyj	143.17	143.17	repeat	BOTH
padObnyj	padObnyj	167.23	167.23	repeat	BOTH
palkOvNik	palkOvNik	125.18	125.18	repeat	BOTH
papAST	papAST	208.85	208.85	repeat	BOTH
atkrYtyj	atkrYtyj	156.7	156.7	repeat	BOTH

PRIME	TARGET	PRIME FREQ	TARGET FREQ	Priming	Group
atkUda	atkUda	265.78	265.78	repeat	BOTH
pRivYknuT	pRivYknuT	117.28	117.28	repeat	BOTH
pRE*Nij	pRE*Nij	175.25	175.25	repeat	BOTH
sAmyj	sAmyj	1744.2	1744.2	repeat	BOTH
saznANije	saznANije	145.68	145.68	repeat	BOTH
vzgLAt	vzgLAt	372.41	372.41	repeat	BOTH
kRi4AT	kRi4AT	220.36	220.36	repeat	BOTH
pamO4	pamO4	143.66	143.66	repeat	BOTH
paRAdak	paRAdak	230.76	230.76	repeat	BOTH
pAMiT	pAMiT	173.59	173.59	repeat	BOTH
samaLOt	samaLOt	158.17	158.17	repeat	BOTH
mal4AT	mal4AT	243.68	243.68	repeat	BOTH
sVi4A		37.09	nonce	phono	ADV
abmanUT		37.46	nonce	phono	ADV
subOta		37.52	nonce	phono	ADV
aLEN		38.07	nonce	phono	ADV
glatOk		39.05	nonce	phono	ADV
pustYNa		40.28	nonce	phono	ADV
bRivnO		44.07	nonce	phono	ADV
galOdnyj		46.58	nonce	phono	ADV
ugrOza		49.15	nonce	phono	ADV
braDIT		51.97	nonce	phono	ADV
xalAT		53.01	nonce	phono	ADV
VidrO		55.58	nonce	phono	ADV
pAlka		61.15	nonce	phono	ADV
gaSTINi&a		67.33	nonce	phono	ADV
kLEtka		70.82	nonce	phono	ADV
apAsnaST		75.6	nonce	phono	ADV
xaZAjka		76.33	nonce	phono	ADV
glUpyj		77.19	nonce	phono	ADV
tumAn		77.8	nonce	phono	ADV
mAsla		78.9	nonce	phono	ADV
vREMa		1862.46	nonce	phono	BOTH
DEla		1453.57	nonce	phono	BOTH
*YZN		1317.07	nonce	phono	BOTH
dUmaT		936.4	nonce	phono	BOTH
MEsta		935.42	nonce	phono	BOTH
Li&O		915.59	nonce	phono	BOTH
kA*dyj		844.04	nonce	phono	BOTH
kazAt&a		681.64	nonce	phono	BOTH
NEskaLka		645.71	nonce	phono	BOTH
gOrat		630.59	nonce	phono	BOTH
fSigdA		614.25	nonce	phono	BOTH
vaprOs		510.99	nonce	phono	BOTH
DENGi		493.3	nonce	phono	BOTH
AknO		441.58	nonce	phono	BOTH
kNIga		414.28	nonce	phono	BOTH
Utra		398.3	nonce	phono	BOTH
VE4ir		391.01	nonce	phono	BOTH

PRIME	TARGET	PRIME FREQ	TARGET FREQ	Priming	Group
pOlnyj		362.06	nonce	phono	BOTH
mYsL		351.35	nonce	phono	BOTH
OpWij		350	nonce	phono	BOTH
bajAt&a		338.19	nonce	phono	BOTH
agrOmnyj		298.95	nonce	phono	BOTH
nastajAWij		297.73	nonce	phono	BOTH
inagdA		290.87	nonce	phono	BOTH
Dir*AT		267.37	nonce	phono	BOTH
NiDELa		256.9	nonce	phono	BOTH
igrAT		249.62	nonce	phono	BOTH
Ti*Olyj		247.35	nonce	phono	BOTH
dLInnyj		244.05	nonce	phono	BOTH
DESaT		237.56	nonce	phono	BOTH
SILnyj		225.26	nonce	phono	BOTH
agON		214.36	nonce	phono	BOTH
PisATiL		213.5	nonce	phono	BOTH
RikA		199.36	nonce	phono	BOTH
DEjstVije		193.49	nonce	phono	BOTH
vOlas		189.81	nonce	phono	BOTH
nOMer		188.41	nonce	phono	BOTH
sVAS		181.37	nonce	phono	BOTH
tOlstyj		176.72	nonce	phono	BOTH
WASTje		174.94	nonce	phono	BOTH
butYlka		170.35	nonce	phono	BOTH
Okala		166.74	nonce	phono	BOTH
kUxNa		152.05	nonce	phono	BOTH
kA4istva		147.21	nonce	phono	BOTH
dO4		136.13	nonce	phono	BOTH
dOwT		134.6	nonce	phono	BOTH
ulYpka		133.62	nonce	phono	BOTH
durAK		131.17	nonce	phono	BOTH
sajUs		130.56	nonce	phono	BOTH
lOwaT		128.91	nonce	phono	BOTH
Levyj		128.11	nonce	phono	BOTH
rAdaST		126.46	nonce	phono	BOTH
&ynA		124.99	nonce	phono	BOTH
krYwa		124.44	nonce	phono	BOTH
zErkala		121.69	nonce	phono	BOTH
gaRET		121.01	nonce	phono	BOTH
mNENije		117.89	nonce	phono	BOTH
LESNi&a		117.04	nonce	phono	BOTH
TimnatA		115.93	nonce	phono	BOTH
WikA		113.73	nonce	phono	BOTH
jivLENije	jivrOpa	81.96	82.27	phono	ADV
zabOta	zabOr	55.89	66.72	phono	ADV
paraxOt	paraZIT	40.03	62.07	phono	ADV
paViDEnije	paVErxnaST	71.43	76.82	phono	ADV
abalO4ka	abarOna	40.52	46.46	phono	ADV

PRIME	TARGET	PRIME FREQ	TARGET FREQ	Priming	Group
malaDE&	malakO	58.33	72.78	phono	ADV
partFEL	partREt	43.89	69.29	phono	ADV
patOk	patalOk	61.7	80.98	phono	ADV
sasnA	sastAf	38.07	95.37	phono	ADV
sPirvA	sPiwYT	59.25	93.84	phono	ADV
nasOk	nastrajENije	38.07	84.16	phono	ADV
pakaLENije	pakOj	62.86	83.92	phono	ADV
RiwOtka	RiwAT	36.97	64.94	phono	ADV
naprAViT	naprOTif	61.21	81.66	phono	ADV
prObavaT	prOSba	43.64	58.82	phono	ADV
vazdUwnyj	vazmO*nyj	41.38	85.94	phono	ADV
Pi4AT	Pi4ALnyj	54.17	66.72	phono	ADV
kaL&o	kaLisO	59.74	73.27	phono	ADV
gORKij	gORe	58.58	75.41	phono	ADV
ustAlaST	ustrOjstva	35.44	55.4	phono	ADV
atkrYTije	atkAs	54.23	36.91	phono	ADV
karOpka	kartOwka	53.93	59.5	phono	ADV
karandAw	karaLEva	43.15	59.62	phono	ADV
palagAT	palAtka	73.45	81.59	phono	ADV
staRInnyj	stalOvyj	53.07	61.76	phono	ADV
starUwka	staLI&a	52.21	88.63	phono	ADV
PiREDNij	PiRIat	56.99	96.59	phono	ADV
pRivY4ka	pRijATEL	57.42	79.15	phono	ADV
strakA	stradAT	36.79	62.99	phono	ADV
strOiT	strOga	76.09	76.27	phono	ADV
palasA	paltarA	62.56	80.49	phono	ADV
razBItyj	razMEr	49.58	86.55	phono	ADV
padUwka	padrUga	48.48	60.54	phono	ADV
padvAl	padArak	52.46	70.33	phono	ADV
pastUpak	pasUda	48.66	41.99	phono	ADV
astAtak	astanOfka	63.41	39.97	phono	ADV
paLOT	paLtO	53.62	56.01	phono	ADV
praWAT	pradAT	44.68	66.9	phono	ADV
pRiDEl	pRidMET	74.13	102.34	phono	ADV
pRibOr	pRiVEt	43.95	53.74	phono	ADV
razLI4nyj	razLI4nyj	101.24	101.24	repeat	ADV
rasVEt	rasVEt	39.11	39.11	repeat	ADV
padgatOfka	padgatOfka	43.4	43.4	repeat	ADV
razVEtka	razVEtka	53.07	53.07	repeat	ADV
pakupAT	pakupAT	59.25	59.25	repeat	ADV
palsTI	palsTI	48.17	48.17	repeat	ADV
rastvOr	rastvOr	66.29	66.29	repeat	ADV
pRikLu4ENije	pRikLu4ENije	38.2	38.2	repeat	ADV
prazrA4nyj	prazrA4nyj	56.13	56.13	repeat	ADV
razRiwYT	razRiwYT	80.31	80.31	repeat	ADV
spasObnaST	spasObnaST	75.35	75.35	repeat	ADV
sPIsak	sPIsak	71.68	71.68	repeat	ADV
stOlp	stOlp	55.46	55.46	repeat	ADV

PRIME	TARGET	PRIME FREQ	TARGET FREQ	Priming	Group
zaMEtnyj	zaMEtnyj	40.46	40.46	repeat	ADV
abrazavANije	abrazavANije	85.63	85.63	repeat	ADV
napRi*ENije	napRi*ENije	64.52	64.52	repeat	ADV
sasUt	sasUt	36.6	36.6	repeat	ADV
slAbaST	slAbaST	47.19	47.19	repeat	ADV
zakLu4ENije	zakLu4ENije	40.4	40.4	repeat	ADV
stradANije	stradANije	36.79	36.79	repeat	ADV
kravAT		117.28	nonce	phono	ADV
rYba		120.03	nonce	phono	ADV
jAWik		133.26	nonce	phono	ADV
kREsla		138.52	nonce	phono	ADV
tOnKij		144.58	nonce	phono	ADV
SINij		149.6	nonce	phono	ADV
zalatOj		152.29	nonce	phono	ADV
ladON		155.29	nonce	phono	ADV
rUbL		164.17	nonce	phono	ADV
bumAga		183.45	nonce	phono	ADV
wyrOKij		187.31	nonce	phono	ADV
VETir		209.16	nonce	phono	ADV
vNimANije		252.31	nonce	phono	ADV
kvarTIra		268.04	nonce	phono	ADV
davnO		345.29	nonce	phono	ADV
duwA		402.03	nonce	phono	ADV
kOmnata		420.89	nonce	phono	ADV
snOva		506.09	nonce	phono	ADV
rabOta		675.46	nonce	phono	ADV
nagA		762.75	nonce	phono	ADV
mOkryj		112.26	nonce	phono	ADV
iskUstva		108.96	nonce	phono	ADV
MiravOj		102.34	nonce	phono	ADV
*EnsKij		101.61	nonce	phono	ADV
kLU4		99.83	nonce	phono	ADV
MAxKij		98.86	nonce	phono	ADV
trubA		98.86	nonce	phono	ADV
LINija		97.14	nonce	phono	ADV
atDEl		96.35	nonce	phono	ADV
aBEt		96.28	nonce	phono	ADV
gRAznyj		95.79	nonce	phono	ADV
BiLEt		95.43	nonce	phono	ADV
LIwNij		95.31	nonce	phono	ADV
4EST		95.12	nonce	phono	ADV
sPOsap		94.82	nonce	phono	ADV
awYpka		92.86	nonce	phono	ADV
bEgaT		91.39	nonce	phono	ADV
zlOj		89.12	nonce	phono	ADV
mOkryj		88.76	nonce	phono	ADV
iskUstva		87.16	nonce	phono	ADV

PRIME	TARGET	PRIME FREQ	TARGET FREQ	Priming	Group
*YTeL		86.55	nonce	phono	ADV
PIva		86	nonce	phono	ADV
DivAn		84.9	nonce	phono	ADV
narOdnyj		83.8	nonce	phono	ADV
atRAt		83.12	nonce	phono	ADV
dra*AT		81.59	nonce	phono	ADV
PjAnyj		81.53	nonce	phono	ADV
gustOj		80.74	nonce	phono	ADV
mOst		80.68	nonce	phono	ADV
zvanOk		80.13	nonce	phono	ADV
trUdnyj		79.7	nonce	phono	ADV
PisOK		79.51	nonce	phono	ADV
samNENije		79.45	nonce	phono	ADV
4Esna		78.96	nonce	phono	ADV
NIsKij		78.23	nonce	phono	ADV
PESNa		78.11	nonce	phono	ADV
plATje		77.74	nonce	phono	ADV
&ErkaF		76.51	nonce	phono	ADV
4imadAn		74.43	nonce	phono	ADV
kApLa		73.15	nonce	phono	ADV
sOVeST		72.05	nonce	phono	ADV
axOta		71.86	nonce	phono	ADV
brOF		71.74	nonce	phono	ADV
raSTI		71.74	nonce	phono	ADV
NI*Nij		70.15	nonce	phono	ADV
asnOva		69.96	nonce	phono	ADV
damAwNij		69.9	nonce	phono	ADV
BiSEda		67.33	nonce	phono	ADV
IsTina		66.35	nonce	phono	ADV
bUkva		64.21	nonce	phono	ADV
a*ydANije		62.8	nonce	phono	ADV
pOVeST		62.44	nonce	phono	ADV
bLIska		62.19	nonce	phono	ADV
vzrYf		60.54	nonce	phono	ADV
grOmKij		60.17	nonce	phono	ADV
sabrANije		58.27	nonce	phono	ADV
jUnawa		58.09	nonce	phono	ADV
paSOlak		57.54	nonce	phono	ADV
baradA		57.48	nonce	phono	ADV
aDijAla		56.56	nonce	phono	ADV
stOl		595.89		LDT	BOTH
stOLka		149.54		LDT	BOTH
ViSOlyj		123.22		LDT	BOTH
znAT		2011.33		LDT	BOTH
sabYTije		143.91		LDT	BOTH
sabAka		224.83		LDT	BOTH
slAva		125.24		LDT	BOTH
stArwyj		167.66		LDT	BOTH

PRIME	TARGET	PRIME FREQ	TARGET FREQ	Priming	Group
stAryj		528.25		LDT	BOTH
stAViT		114.4		LDT	BOTH
astAt&a		560.75		LDT	BOTH
strAx		185.16		LDT	BOTH
slAbyj		132.03		LDT	BOTH
fstRETiT		126.65		LDT	BOTH
pala*ENije		181.67		LDT	BOTH
palu4IT		388.81		LDT	BOTH
fstAT		253.35		LDT	BOTH
vajTI		244.54		LDT	BOTH
mal4ANije		56.93		LDT	BOTH
pastAViT		253.84		LDT	BOTH
krOF		258.31		LDT	BOTH
LESNi&a		117.04		LDT	BOTH
pAMiT		173.59		LDT	BOTH
4ilaVEk		2945.47		LDT	BOTH
4islO		164.84		LDT	BOTH
4Istyj		175.92		LDT	BOTH
4Ustva		243.86		LDT	BOTH
asOBinna		262.35		LDT	BOTH
bYstryj		128.97		LDT	BOTH
daLikO		187.24		LDT	BOTH
darOga		458.16		LDT	BOTH
tREbavaT		150.58		LDT	BOTH
udAr		162.7		LDT	BOTH
uslOVije		169.8		LDT	BOTH
xudO*Nik		111.71		LDT	BOTH
xudOj		174.63		LDT	BOTH
zakOn		202.79		LDT	BOTH
slUwaT		343.82		LDT	BOTH
atVEt		229.66		LDT	BOTH
fPiRidI		134.42		LDT	BOTH
pa*Ar		53.5		LDT	ADV
malYw		43.7		LDT	ADV
malaDOw		47.5		LDT	ADV
pajmAT		85.57		LDT	ADV
spakOjnyj		109.69		LDT	ADV
karMIT		55.03		LDT	ADV
paLEznyj		49.09		LDT	ADV
pravadNIk		37.15		LDT	ADV
pRinaSIT		60.05		LDT	ADV
praTIvNik		85.7		LDT	ADV
praVERiT		78.35		LDT	ADV
pRistUpnik		48.6		LDT	ADV
pRiglaSIT		76.33		LDT	ADV
prakLAtyj		55.09		LDT	ADV
pa*ylOj		63.17		LDT	ADV

PRIME	TARGET	PRIME FREQ	TARGET FREQ	Priming	Group
iskAT		239.4		LDT	ADV
platOk		64.82		LDT	ADV
kasTOr		79.76		LDT	ADV
dOlk		74.86		LDT	ADV
sLEtsVije		48.79		LDT	ADV
skAska		58.52		LDT	ADV
mrA4nyj		48.17		LDT	ADV
NE*nyj		50.93		LDT	ADV
kO*anyj		51.66		LDT	ADV
kusOk		109.26		LDT	ADV
Li4ENije		110.06		LDT	ADV
LiDinOj		42.24		LDT	ADV
magU4ij		54.42		LDT	ADV
naSiLENije		93.9		LDT	ADV
nOvaST		48.05		LDT	ADV
Oblaka		65.86		LDT	ADV
pavarOt		55.58		LDT	ADV
rubAwka		68.01		LDT	ADV
sdarOVje		88.14		LDT	ADV
sdANije		107.67		LDT	ADV
SEVir		56.99		LDT	ADV
sLipOj		36.91		LDT	ADV
MiNAT		58.7		LDT	ADV
paBEda		90.59		LDT	ADV
SiRiDIna		64.76		LDT	ADV

BIBLIOGRAPHY

Abrahamsson, N., & Hyltenstam, K. (2009). Age of onset and nativelikeness in a second language: Listener perception versus linguistic scrutiny. *Language Learning, 59 (*2), 249-306.

Aizawa, K. (2006). Rethinking frequency markers for English-Japanese dictionaries. In M. Murata, K. Minamiide, Y. Tono, & S. Ishikawa (Eds.), *English lexicography in Japan* (pp. 108–19). Tokyo: Taishukan.

Almeida, D. (2009). *Form, meaning and context in lexical access: MEG and behavioral evidence*. Unpublished Doctoral dissertation, University of Maryland, College Park, MD.

Andrews, S. (1989). Frequency and neighborhood effects on lexical access: Activation or search? *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 15, 802–814.

Bailey, T., & Hahn, U. (2001). Determinants of Wordlikeness: Phonotactics or Lexical Neighborhoods?. *Journal of Memory and Language, 44,* 4, 568-591.

Bard, E.G. (1990). Competition, lateral inhibition, and frequency: Comments on the chapters of Frauenfelder and Peeters, Marslen-Wilson, and others. In G. T. M. Altmann (Ed.), *Cognitive models of speech processing: Psycholinguistic and computational perspectives* (pp. 185-210). Cambridge: MIT Press.

Bard, E., & Shillcock, R. (1993). Competitor effects during lexical access: Chasing Zipf's tail. In G.Altmann & R. Shillcock (Eds.), *Cognitive models of speech processing* (pp. 235–275). Hove, UK: Erlbaum.

Bell, K. (2005), *Russian vocabulary acquisition by American learners.* Unpublished MA thesis, University of Maryland, College Park, MD.

Benki, J. R. (2003). Quantitative evaluation of lexical status, word frequency, and neighborhood density as context effects in spoken word recognition. *The Journal of the Acoustical Society of America, 113 (*3), 1689-1705.

Best, C. T. (1994). The emergence of native-language infuence in infants: A perceptual assimilation model. In H. Nusbaum, J. Goodman & C. Howard (Eds.), *The transition from speech sounds to spoken words: The development of speech perception* (pp. 167-224). Cambridge, MA: MIT Press.

Best, C. T. (1995). A direct realist view of cross-language speech perception. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 171-203). Timonium, MD: York Press.

Best, C. T., McRoberts, G. W., & Goodell, E. (2001). Discrimination of non-native consonant contrasts varying in perceptual assimilation to the listener's native phonological system. *The Journal of the Acoustical Society of America, 109 (*2), 775-94.

Bradlow, A. R., & Bent, T. (2002). The clear speech effect for non-native listeners. *The Journal of the Acoustical Society of America, 112 (*1), 272-284.

Bradlow, A. R., & Pisoni, D. B. (1999). Recognition of spoken words by native and non-native listeners: Talker-, listener-, and item-related factors. *Journal of the Acoustical Society of America, 106*(4), 2074-2085.

Brown, R. W., & Berko, J. (1960). Psycholinguistic research methods. In P. H. Mussen (Ed.), *Handbook of research methods in child development* (pp. 517-557). New York: Wiley.

Brysbaert, M. (2003). Bilingual visual word recognition: Evidence from masked phonological priming. In S. Kinoshita & S. J. Lupker (Eds.), *Masked priming: State of the Art* (pp. 323-343). Hove, UK: Psychology Press.

Brysbaert, M., Van Dyck, G., & Van De Poel, M. (1999). Visual word recognition in bilinguals: Evidence from masked phonological priming. *Journal of Experimental Psychology: Human Perception and Performance, 25*(1), 137-148.

Burton, M. W. (1992, November). Syllable priming in auditory word recognition. Poster session presented at the 33rd annual meeting of the Psychonomic Society, St. Louis, MO.

Charles-Luce, J., & Luce, P. A. (1990). Similarity neighborhoods of words in young children's lexicons. *Journal of Child Language, 17*(1), 205– 215.

Charles-Luce, J., & Luce, P. A. (1995). An examination of similarity neighborhoods in young children's receptive vocabularies. *Journal of Child Language, 22*, 727– 735.

Chéreau, C., Gaskell, M. G., & Dumay, N. (2007). Reading spoken words: Orthographic effects in auditory priming. *Cognition*, 102, 341–360.

Coenen, E., Zwitserlood, P., & Bolte, J. (2001). Variation and assimilation in German: Consequences for lexical access and representation. *Language and Cognitive Processes, 16 (*5), 535-564.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review, 82 (*6), 407-428.

Coltheart, M., Davelaar, E., Jonasson, J. T., & Besner, D. (1977). Access to the internal lexicon. In S. Dornic (Ed.), *Attention and performance, VI* (pp. 535-556). New York: Academic Press.

Corina, D. P. (1992). Syllable priming and lexical representations: Evidence from experiments and simulations. In Proceedings of the Fourteenth Annual Conference of the Cognitive Science Society (pp. 779-784). Bloomington: Indiana University.

Costa, A., & Sebastian-Gallés, N. (1998). Abstract phonological structure in language production: Evidence from Spanish. *Journal of Experimental Psychology: Learning, Memory and Cognition, 24*, 886–903.

Cutler, A. (2008). *Twenty-first century psycholinguistics: Four cornerstones*. New York: Psychology Press.

Damian, M. F., & Bowers, J. S. (2009). Orthographic effects in rhyme monitoring tasks: Are they automatic? *European Journal of Cognitive Psychology, 22* (1), 106-116.

Dijkstra, T., Roelofs, A., & Fieuws, S. (1995). Orthographic effects on phoneme monitoring. *Canadian Journal of Experimental Psychology, 49*, 264–271.

Dufour, S. & Peereman, R. (2004). Phonological priming in auditory word recognition: initial overlap facilitation effect varies as a function of target word frequency. *Current psychology letters* (Online), 14(3). Retrieved from http://cpl.revues.org/index437.html on December 14, 2009.

Dufour, S., & Peereman, R. (2009). Competition effects in phonological priming : The role of mismatch position between primes and targets. *Journal of Psycholinguistic Research, 38*, 475-490.

Dupoux, E., Kakehi, K., Hirose, Y., Pallier, C., & Mehler, J. (1999). Epenthetic vowels in Japanese: A perceptual illusion? *Journal of Experimental Psychology: Human Perception and Performance, 25*, 1568 –1578.

Eckes, T., & Grotjahn, R. (2006). A closer look at the construct validity of C-tests.

Language Testing, 23, 290-325.

Ellis, N. C. (2002). Frequency effects in language processing: A review with implications for theories of implicit and explicit language acquisition, *Studies in Second Language Acquisition 24*(2), 143–88.

Emmorey, K. D. (1989). Auditory morphological priming in the lexicon. *Language and Cognitive Processes, 4*, 73–92.

Entwisle, D.R. (1966). *Word associations of young children*. Baltimore: Johns Hopkins University Press.

Ervin, S. (1961). Changes with the age in the verbal determinants of word association. *American Journal of Psychology, 74*: 361-372.

Fitzpatrick, T. (2006). Habits and rabbits: Words associations and the L2 lexicon. *EUROSLA Yearbook, 6*: 121-145.

Flege, J. E. (1995). Two Procedures for Training a Novel Second Language Phonetic Contrast. *Applied Psycholinguistics, 16 (*4), 425-42.

Flege, J. E., Munro, M. J., & Fox, R. A. (1994). Auditory and categorical effects on cross-language vowel perception. *The Journal of the Acoustical Society of America, 95 (*6), 3623-3641.

Flege, J. E., Takagi, N., & Mann, V. (1996). Lexical familiarity and English-language experience affect Japanese adults' perception of /l/ and /r/. *The Journal of the Acoustical Society of America, 99 (*2), 1161-1173.

Forster, K. I., & Forster, J. (2003). DMDX: a Windows display program with millisecond accuracy. *Behavior research methods, instruments, & computers*, *35* (1), 116-124.

Foss, D. J. (1982). A discourse on semantic priming. *Cognitive Psychology, 14*(4), 590-607.

Frankish, C. R. (1996). Auditory short-term memory and the perception of speech. In S. E. Gathercole (Ed.), *Models of short-term memory* (pp. 179–208). Hove, UK: Psychology Press.

Gaskell, M. G., & Marslen-Wilson, W. (October 01, 1997). Integrating Form and Meaning: A Distributed Model of Speech Perception. *Language and Cognitive Processes, 12*, 613-656.

Gathercole, S. E. (2006). Nonword repetition and word learning: The nature of the relationship. *Applied Psycholinguistics, 27*, 513–543.

Goldinger, S. D. (1999). Only the Shadower knows: Comment on Hamburger & Slowiaczek (1996). *Psychonomic Bulletin and Review*, *6*, 347-351.

Goldinger, S. D., Luce, P. A., & Pisoni, D. B. (1989). Priming lexical neighbors of spoken words: Effects of competition and inhibition. *Journal of Memory & Language, 28*, 501-518.

Goldrick, M., Rapp, B., & Folk, J. R. (2010). Mrs. Malaprop's neighborhood: Using word errors to reveal neighborhood structure. *Journal of Memory and Language, 62 (*2), 113-134.

Gor, K., Cook, S., & Jackson, S. (2010). Lexical access in highly proficient late L2 learners: Evidence from semantic and phonological auditory priming. Paper presented at *Second Language Research Forum (SLRF*), University of Maryland.

Goto, H. (1971). Auditory perception by normal Japanese adults of the sounds "L" and "R". *Neuropsychologia, 9 (*3), 317-323.

Grainger, J., & Holcomb, P. J. (2009). Watching the word go by: On the time-course of component processes in visual word recognition. *Language and Linguistic Compass, 3,* 128–156.

Grainger, J., Muneaux, M., Farioli, F., & Ziegler, J. (2005). Effects of phonological and orthographic neighborhood density interact in visual word recognition. *Quarterly Journal of Experimental Psychology, 58*A, 981–998.

Grosjean, F. (1998). Studying bilinguals: Methodological and conceptual issues. *Bilingualism: Language and Cognition, 1*, 117–130.

Hallé, P. A., Chéreau, C., & Segui, J. (2000). Where is the /b/ in "absurde" [apsyrd]? It is in French listeners' minds. *Journal of Memory & Language, 43*, 618-639.

Hamburger, M. B., & Slowiaczek, L. M. (1996). Phonological priming reflects lexical competition. *Psychonomic Bulletin & Review, 3*, 520-525.

Hay, J., J. Pierrehumbert, and M. Beckman (2004). Speech perception, well-formedness and the statistics of the lexicon. In J. Local, R. Ogden, and R. Temple (Eds.), *Phonetic Interpretation: Papers in Laboratory Phonology VI*. Cambridge: Cambridge University Press.

Hyltenstam, K. and Abrahamsson, N. (2008) Maturational Constraints in SLA, in The Handbook of Second Language Acquisition (eds C. J. Doughty and M. H. Long), Blackwell Publishing Ltd, Oxford, UK. doi: 10.1002/9780470756492.ch17

Hyltenstam, K., & Abrahamsson, N. (2000). Who can become native-like in a second language? All, some, or none? On the maturational constraints controversy in second language acquisition. *Studia Linguistica, 54 (*2), 150-166.

Imai, S., Walley, A. C., & Flege, J. E. (2005). Lexical frequency and neighborhood density effects on the recognition of native and Spanish-accented words by native English and Spanish listeners. *The Journal of the Acoustical Society of America, 117 (*2), 896-907.

Ingram, J. C., & Park, S. G. (1998). Language, context, and speaker effects in the identification and discrimination of English /r/ and /l/ by Japanese and Korean listeners. *The Journal of the Acoustical Society of America, 103 (*2), 1161-74.

Jiang, N. (2000). Lexical representation and developoment in a second language. *Applied Linguistics, 21*(1), 47-77.

Jiang, N. (2002). Form-meaning mapping in vocabulary acquisition in a second language. *Studies in Second Language Acquisition, 24*, 617-637.

Jusczyk, P. W. (1986). Towards a model for the development of speech perception. In J. Perkell & D. H. Klatt (Eds.), *Invariance and variability in speech processes* (pp. 1-19), Hillsdale, NJ: Erlbaum.

Jusczyk, P. W. (1993) From general to language-specific capacities: the WRAPSA model of how speech perception develops. *Journal of Phonetics, 21*, 3-28.

Kandel, E.R. (2001). The molecular biology of memory storage: a dialogue between genes and synapses. *Science, 294*, 1030–1038.

Katona, L., & Dornyei, Z. (1992). Validation of the C-test amongst Hungarian EFLlearners. Language Testing, 9, 187-206.

Kazanina, N., Phillips, C., & Idsardi, W. (2006). The influence of meaning on the perception of speech sounds. *Proceedings of the National Academy of Sciences, USA, 103,* 11381–11386.

Kent, G. H., & Rosanoff, J. A. (1910). A study of association in insanity. *American Journal of Insanity, 67*, 37-96 & 317-390.

Kovacs, G., & Racsmany, M. (2008). Handling L2 Input in phonological STM: The effect of non-L1 phonetic Segments and non-L1 phonotactics on nonword repetition. *Language Learning, 58*(3), 597–624.

Kroll, J.F. & De Groot, A.M.B. (1997). Lexical and conceptual memory in the bilingual: mapping form to meaning in two languages. In De Groot, A.M.B. and Kroll, J.F., editors, *Tutorials in bilingualism: psycholinguistic perspectives* (pp. 169-199). Mahwah, NJ: Lawrence Erlbaum.

Kroll, J.F. & Stewart, E. (1994). Category interference in translation and picture naming: evidence for asymmetric connections between bilingual memory representations. *Journal of Memory and Language, 33*, 149–74.

Kucera, F., & Francis, W. (1967) Computational Analysis of Present Day American English. Providence: Brown University Press.

Kuhl, P. K., Williams, K. A., Lacerda, F., Stevens, K. N., & Lindblom, B. (1992). language experience alters phonetic perception in infants by 6 months of age. *Science, 255*(5044), 606-608.

Kuhl, P. K., and Iverson, P. (1995). Linguistic experience and the perceptual magnet effect. In W. Strange (Ed.) *Speech Perception and Linguistic Experience: Issues in Cross-Language Research (121-154).* Baltimore, MD: York Press.

Kuhl, P. K., Stevens, E., Hayashi, A., Deguchi, T., Kiritani, S. & Iverson, P. (2006). Infants show a facilitation effect for native language phonetic perception between 6 and 12 months. *Developmental Science, 9*, F13–F21.

Kuhl, P. K. (2004). Early language acquisition: cracking the speech code. *Nature Reviews Neuroscience, 5*, 831–843.

Lahiri, A., & Marslen-Wilson, W. (1991). The mental representation of lexical form: a phonological approach to the recognition lexicon. *Cognition, 38 (*3), 245-294.

Landauer, T. K., & Streeter, L. A. (1973). Structural differences between common and rare words: Failure of equivalence assumptions for theories of word recognition. *Journal of Verbal Learning and Verbal Behavior, 12,* 119–131.

Lenneberg, E. (1967). *Biological foundations of language*. New York, NY: Wiley.

Li, F., Munson, B., Edwards, J., Yoneyama, K., & Hall, K. (2011). Language specificity in the perception of voiceless sibilant fricatives in Japanese and English: Implications for cross-language differences in speech-sound development. *Journal of the Acoustical Society of America, 129 (*2), 999-1011.

Lipinski, J., & Gupta, P. (2005). Does neighborhood density influence repetition latency for nonwords? Separating the effects of density and duration. *Journal of Memory and Language, 52 (*2), 171-192.

Luce, P. A., & Pisoni, D. B. (1998). Recognizing spoken words: The neighborhood activation model. *Ear & Hearing, 19*, 1-36.

Luce, P. A., Pisoni, D. B., & Goldinger, S. D. (1990). Similarity neighborhoods of spoken words. In G. T. M. Altmann (Ed.), *Cognitive models of speech processing: Psycholinguistic and computational perspectives* (pp. 122-147). Cambridge, MA: MIT Press.

Magnuson, J. S., Dixon, J. A., Tanenhaus, M. K., & Aslin, R. N. (January 01, 2007). The Dynamics of Lexical Competition during Spoken Word Recognition. *Cognitive Science, 31,* 1, 133-156.

Magnuson, J. S., Dixon, J., Tanenhaus, M. K., & Aslin, R. N. (2007). The dynamics of lexical competition during spoken word recognition. *Cognitive Science, 31*, 133-156.

Mani, N. & Plunkett, K. (2008). Phonological specificity of consonants and vowels in early lexical representations. *Journal of Memory and Language, 57*, 252-272.

Marslen-Wilson, W. D. (1987). Functional parallelism in spoken word-recognition. *Cognition*, 25, 71-102.

Maye, J., Werker, J., & Gerken, L. (2002). Infant sensitivity to distributional information can affect phonetic discrimination. *Cognition*, 82, B101–B111.

McClelland J. L., Elman J. L. (1986). The TRACE model of speech perception. *Cognitive Psychology, 18*, 1-86.

McClelland, J. L., Fiez, J. A., & McCandliss, B. D., (2002). Teaching the non-native [r]-[l] speech contrast to Japanese adults: training methods, outcomes, and neural basis. *Physiology and Behavior, 77*, 657-662.

McClelland, J. L., Thomas, A. G., McCandliss, B. D., & Fiez, J. A. (1999). Understanding failures of learning: Hebbian learning, competition for representational space, and some preliminary experimental data. *Progress in Brain Research, 121,* 75-80.

Meara, P. (1983). Word associations in a foreign language: A report on the Birkbeck Vocabulary Project. *Nottingham Linguistic Circular, 11*, 29–38.

Meara, P. (1984). The study of lexis in interlanguage. In A. Davies, C. Criper, & A. Howatt (Eds.), *Interlanguage* (pp. 225–235). Edinburgh, Scotland: Edinburgh University Press.

Meara, P. M. (1978). Learners' word associations in French. *Interlanguage Studies Bulletin, 3(*2), 192-211.

Meyer, D. E., & Schvaneveldt, R. W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology, 90*, 227-234.

Meyer, D. E., & Schvaneveldt, R. W. (1976). Meaning, memory structure, and mental processes. *Science, 192*, 27-33.

Mills, D., Prat, C., Zangl, R., Stager, C., Neville, H. & Werker, J.(2004). Language experience and the organization of brain activity to phonetically similar words: ERP evidence from 14- and 20-month-olds. *Journal of Cognitive Neuroscience, 16,* 1452–1464.

Milton, J. (2009). Measuring Second Language Vocabulary acquisition. Second Language Acquisition: 45. London: Multilingual matters.

Mirman, D., Strauss, T. J., Dixon, J. A., & Magnuson, J. S. (2010). Effect of representational distance between meanings on recognition of ambiguous spoken words. *Cognitive Science, 34 (*1), 161-173.

Monsell, S., & Hirsh, K.W. (1998). Competitor priming in spoken word recognition. *Journal of Experimental Psychology: Learning, Memory & Cognition*, *24*, 1495-1520.

Morton, J. (1969). Interaction of information in word recognition. *Psychological Review*, 76, 165–178.

Morton, J. (1979). Facilitation in word recognition: Experiments causing change in the logogen model. In P. A. Kolers, M. E. Wrolstad, & H. Bouma (Eds.), *Processing models of visible language* (pp. 259–268). New York: Plenum.

Newport, E. L., & Aslin, R. N. (2004). Learning at a distance I. Statistical learning of non-adjacent dependencies. *Cognitive Psychology*, 48, 127–62.

Niznik, M., Vinokurova, A., Voroncova, I., Kagan, O., & Cherp, A. (2009). Русский без границ [Russian without borders]. Israel: Russkij Mir.

Norris, D. (1994). Shortlist: A connectionist model of continuous speech recognition. *Cognition, 52*, 189–234.

Palermo, D. S. (1971). Characteristics of word association responses obtained from children in grades one through four. *Developmental Psychology*, 5, 118–123.

Pallier, C., Bosch, L., & Sebastián-Gallés, N. (1997). A limit on behavioral plasticity in speech perception. *Cognition, 64*(3), B9–17.

Pallier, C., Colomé, A., & Sebastián-Gallés, N. (2001). The influence of native–language phonology on lexical access: Exemplar–based versus abstract lexical entries. *Psychological Science, 12*(6), 445–449.

Pallier, C., Dehaene, S., Poline, J.B., LeBihan, D., Argenti, A.M., Dupoux, E., & Mehler, J. (2003). Brain imaging of language plasticity in adopted adults: Can a second language replace the first? *Cerebral Cortex, 13*, 155–161.

Papagno C., & Vallar G. (1992). Phonological short-term memory and the learning of novel words: the effects of phonological similarity and item length. *Quaterly Journal of Experimental Psychology, 44A*, 47–67.

Papagno, C., & Vallar, G. (1995). Verbal short-term memory and vocabulary learning in polyglots. *Quarterly Journal of Experimental Psychology, 48A*, 98-107.

Peereman, R., Dufour, S., & Burt, J. S. (2009). Orthographic influences in spoken word recognition: The consistency effect in semantic and gender categorization tasks. *Psychonomic Bulletin & Review,* 16, 363-368.

Pisoni, D. B., Aslin, R. N., Perey, A. J., & Hennessy, B. L. 1982. Some effects of laboratory training on identification and discrimination of voicing contrasts in stop consonants. *Journal of Experimental Psychology: Human Perception and Performance, 8,* 297–314.

Pitt, M. A. & Shoaf, L. (2002). Revisiting bias effects in word-initial phonological priming. *Journal of Experimental Psychology: Human Perception and Performance,* 28, 1120–1130.

Pylkkänen, L., Stringfellow, A., & Marantz, A. (2002). Neuromagnetic evidence for the timing of lexical activation: an MEG component sensitive to phonotactic probability but not to neighborhood density. *Brain and Language, 81 (1-3), 666-678.*

Radeau, M., Morais, J., & Segui, J. (1995). Phonological priming between monosyllabic spoken words. *Journal of Experimental Psychology: Human Perception and Performance, 21*, 1297-1311.

Saffran, J., Aslin, R., & Newport, E. (1996). Statistical learning by 8-month old infants. *Science*, 274, 1926–1928.

Sebastián-Gallés, N. & Soto-Faraco, S. (1999). On-line processing of native and non-native phonemic contrasts in early bilinguals. *Cognition, 72*, 111-123.

Segui, J., & Grainger, J. (1990). Priming word recognition with orthographic neighbors: Effects of relative prime-target frequency. *Journal of Experimental Psychology: Human Perception and Performance, 16*, 65-76.

Sekine, S. (2006). *The Effects of Phonological and Lexical Factors on L2 Word Recognition: A Cross-linguistic Study*. Unpublished Doctoral dissertation, University of California Los Angeles, LosAngeles, CA.

Sheldon, A., & Strange, W. (1982). The acquisition of /r/ and /l/ by Japanese learners of English: Evidence that speech production can precede speech perception. *Applied Psycholinguistics 3,* 243-261.

Shillcock, R. C., & Bard, E. G. (1993). Modularity and the processing of closed-class words. In: G. T. M. Altmann & R. C. Shillcock (Eds.), *Cognitive models of speech processing: The second sperlonga meeting* (pp. 163–183). Mahwah, NJ: Lawrence Erlbaum Associates.

Singleton, D. (1999). Exploring the second language mental lexicon. Cambridge: Cambridge University Press.

Singleton, D., & Little, D. (1991). The second language lexicon: some evidence from university-level learners of French and German. *Second Language Research,* 7, 62-81.

Singleton, D., & Singleton, E. (1998). The C-test and L2 acquisition/processing research. In J. A. Coleman (Ed.), *University language testing and the C-test* (pp.150-178). Portsmouth: University of Portsmouth.

Slowiaczek, L. M., & Hamburger, M. B. (1992). Prelexical facilitation and lexical interference in auditory word recognition. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *18*, 1239-1250.

Slowiaczek, L. M., Nusbaum, H. C., & Pisoni, D. B. (1987). Phonological priming in auditory word recognition. *Journal of Experimental Psychology: Learning, Memory and Cognition, 13*, 64-75.

Smolensky, P. (1986). Neural and conceptual interpretation of PDP models. In D.E.Rumelhart & J.L. McClelland (Eds), *Parallel distributed processing: Explorations in the microstructure of cognition, Vol. 2: Psychological and biological models*. Cambridge, MA: MIT Press/Bradford Books.

Spinelli, E., Segui, J., & Radeau, M. (2001). Phonological priming in spoken word recognition with bisyllabic targets. *Language & Cognitive Processes, 16*(4), 367-392.

Stockall, L., Stringfellow, A., & Marantz, A. (2004). The precise time course of lexical activation: MEG measurements of the effects of frequency, probability, and density in lexical decision. Brain Lang, 90 (1-3), 88–94.

Stolz, W.S., & Tiffany, J. (1972). The production of 'child-like' word associations by adults to unfamiliar adjectives. *Journal of Verbal Learning and Learning Behavior, 11*, 38-46.

Strange, W. (1995). Cross-language studies of speech perception: A historical review. In W. Strange (Ed.), *Speech perception and linguistic experience: Issues in cross-language research* (pp. 3-48). York: Baltimore.

Stryker, S. B., & Leaver, B. L. (1997). *Content-based instruction in foreign language education: Models and methods.* Washington, D.C: Georgetown University Press.

Taft, M., Castles, A., Davis, C., Lazendic, G., & Nguyen-Hoan M. (2008). Automatic activation of orthography in spoken word recognition: Pseudohomograph priming. *Journal of Memory & Language, 58*, 366-379.

Van Wijnendaele, I., & Brysbaert, M. (2002). Visual word recognition in bilinguals: Phonological priming from the second to the first language. Journal of experimental psychology. *Human perception and performance, 28*(3), 616-627.

Verhallen, M. & Schoonen, R. (1993). Lexical knowledge of monolingual and bilingual children. *Applied Linguistics, 14*, 344 – 363.

Verhallen, M. & Schoonen, R. (1998). Lexical knowledge in L1 and L2 of third and fifth graders. *Applied Linguistics, 19*(4), 452-470.

Vermeer, A. (2001). Breadth and depth of vocabulary in relation to L1/L2 acquisition and frequency of input. *Applied Psycholinguistics, 22*(2), 217-234.

Vitevitch, M. S. (2002). Influence of onset density on spoken-word recognition. *Journal of Experimental Psychology. Human Perception and Performance, 28,* 2, 270-8.

Vitevitch, M. S., Armbruster, J., & Chu, S. (2004). Sublexical and lexical representations in speech production: effects of phonotactic probability and onset density. *Journal of Experimental Psychology. Learning, Memory, and Cognition, 30,* 2, 514-29.

Wolter, B. (2001). Comparing the L1 and L2 mental lexicon: A depth of individual word knowledge model. *Studies in Second Language Acquisition, 23*, 41-69.

Walley, A. (2007). Speech learning, lexical reorganization, and the development of word recognition by native and non-native English speakers. In O.-S. Bohn & M. J. Munro (Eds.), Language experience in second language speech learning: In honor of James Flege (pp. 315-330). John Benjamins Publishing Company.

Walley, A. C. (1993) The role of vocabulary development in children's spoken word recognition and segmentation ability. *Developmental Review*, 13, 256-350.

Werker, J. E. & Desjardins, R. N. (1995) Listening to speech in the 1st year of life: experiential influences on phoneme perception. *Psychological Science, 4*, 76-81.

Westbury, C., Hollis, G. & Shaoul, C. (2007). LINGUA: The Language-Independent Neighbourhood Generator of the University of Alberta. *The Mental Lexicon*, 2:2, 273-286Wolter, B. (2001). Comparing the L1 and L2 mental lexicon. *Studies in Second Language Acquisition, 23*(1), 41-69.

Zevin, J. D., & Seidenberg, M. S. (2002). Age-of-acquisition effects in reading and other tasks. *Journal of Memory and Language*, 47, 1-29.

Ziegler, J. C., Muneaux, M., & Grainger, J. (2003). Neighborhood effects in auditory word recognition: Phonological competition and orthographic facilitation. *Journal of memory and language, 48*(4), 779- 793.

Ziegler, J.C., & Muneaux, M. (2007). Orthographic facilitation and phonological inhibition in spoken word recognition: A developmental study. *Psychonomic Bulletin & Review, 14* (1), 75-80.