

THE RELATIONSHIPS BETWEEN PERCEPTION, PRODUCTION,
LEXICAL ENCODING AND ORTHOGRAPHY IN THE ACQUISITION OF
PALATALIZATION IN L2 RUSSIAN

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Dedicated to my parents

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(to be written after the defense)

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Phonological acquisition implies multidirectional interactions between the four major domains of perception, production, lexical encoding and orthography. The goal of this dissertation is to determine what relationships these domains establish during the acquisition of the secondary feature of palatalization in L2 Russian by American English learners. Experiment 1 examined the relationship between perception and production using an oral picture-naming task and two ABX tasks, one with nonwords and the other with words familiar to learners. The results suggested that learners' perception of the plain / palatalized contrast developed prior to production skills and was strongly affected by the syllable position of the target consonants. Experiment 2 probed a triangular relationship between perception, production and lexical encoding. An auditory word-picture matching task was used to assess learners' ability to encode words with plain and palatalized consonants separately. The results showed that learners accepted most nonwords as accurate productions of target words, either due to their inability to reliably perceive the contrast or their belief that palatalized consonants were free variants of plain consonants. Nonetheless, there was a group of learners who observed the distinction between plain and palatalized consonants in their own production. These findings, when taken together, provide evidence for the claim that accurate production is possible even when separate lexical representations have not been formed yet. Experiment 3 investigated the effects of orthography. Learners performed a written picture-naming task

and a metalinguistic task. Accurate metalinguistic and orthographic knowledge did not have a strong effect on learners' ability to perceive palatalization and encode words with the plain / palatalized consonants separately. Yet, there was a strong relationship between metalinguistic knowledge and production, which suggests that knowledge of grapheme-phoneme correspondences can guide learners to accurate production, even in the absence of perceptual support and accurate lexical encoding, so long as they have already acquired the necessary gestures. This dissertation offers a multifaceted analysis of learners' acquisition and adds to the existing body of literature on the interfaces between the four major domains of phonological development and the acquisition of secondary features.

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Chapter 1. Introduction

1.1. Relationships between perception, production, lexical encoding, and orthography

In first language (L1) acquisition, the domains of perception, production, lexical encoding and orthography represent a unified system that evolves harmoniously with one domain feeding into another. During the first year of life the perceptual system becomes attuned to the phonological system of the surrounding language (e.g., Werker & Tees, 1984), which enables subsequent accurate lexical encoding of words with the native categories. Over the next several years, the production system develops, guided by the established perceptual targets and phonololexical representations stored in the mental lexicon. After mastering oral speech, children embark on acquiring their native orthography by building connections between phonemes and graphemes. The end state of L1 acquisition is largely homogeneous since all speakers without speech or hearing disorders master their native language. Even though individual differences exist for the first language, these are usually on a much smaller scale than individual differences observed in the acquisition of a second language (L2), for example.

Acquisition of L2 phonology exposes learners to numerous novel phenomena that arise from different dimensions of the segmental and suprasegmental levels. While a learner's mind can be compared to a blank slate in L1 acquisition, in L2 acquisition it already has another system of the native language imprinted on it. As a result, L1 phonological categories influence how learners perceive, encode and produce L2 categories. L1 orthographic representations interfere with the formation of grapheme-phoneme correspondences in the L2. The domains of perception, lexical encoding,

production and orthography interact in the target language while engaging the native language. In order to acquire a phonological category successfully in the L2, learners must be able to perceive it accurately in speech and discriminate it from other similar categories in the L2 and L1. They should encode lexical contrasts with this category separately and avoid spurious homophony (see Section 2.2.3). In the written domain, this category should match the grapheme assigned to it by the orthography of the target language, no matter how congruent or incongruent the phoneme-grapheme correspondences are in both languages. When learners produce this category in oral speech, native speakers of that language should be able to unmistakably identify it. The development of the necessary skills and abilities to operate the phonological system of a target language might take diverse routes and occur at various paces for different learners. Exploring the relationships between the major domains of phonological development, such as perception, production, lexical encoding and orthography, from different angles contributes to a deeper understanding of the mechanisms that lead to heterogeneous end states in L2 acquisition.

1.2. Current study

The goal of this dissertation is to explore the relationships between perception, lexical encoding, orthography and the production of palatalized consonants in Russian by American learners in order to determine how they proceed with the acquisition of secondary articulation and identify which areas are most challenging for them. The Russian language manifests a phonemic opposition that is based on the secondary articulation of palatalization, for example, /vies/ ‘weight’ – /viesʲ/ ‘whole’. Almost all

Russian consonants have a palatalized counterpart, which can occur word-initially, word-medially and word-finally and precede both vowels and consonants. Palatalization permeates the entire consonantal system in Russian and cannot be avoided. When speakers of a language without phonemic palatalization, such as English, begin learning Russian, they invariably run into difficulties. It remains unclear why American learners of Russian even at advanced levels of proficiency experience hardships mastering palatalization. This challenge likely stems from a conglomeration of factors, including: (i) an inability to discriminate palatalized and plain consonants in perception; (ii) incorrect phonological encoding due to orthographic interference or a lack of perceptual salience; (iii) inaccurate production caused by the implementation of incorrect articulatory gestures or by the wrong timing of the correct gestures; (iv) lack of metalinguistic knowledge about how palatalization is represented in orthography. Investigating the relationships between the four major domains of phonological development will allow us to uncover the most challenging areas in the acquisition of palatalization and determine the sources of learners' difficulty.

This dissertation is distinct from other existing studies in the field in several important ways. First, it aims to investigate a quadratic relationship between perception, lexical encoding, orthography and production. Most other studies utilize the more common approach of targeting a dichotomous relationship, such as a perception-production link or a perception-encoding link. Second, this dissertation examines the current state of acquisition by employing real words that are familiar to learners instead of nonwords that are acquired as a result of short-term laboratory training. Using familiar words ensures that participants have already encountered the words in spoken and/or

written input, established lexical representations for them and produced them in speech. An experimental paradigm, in which learners are exposed to novel words, usually nonwords, over a period of several hours or days at best is more likely to reveal immediate effects of a specific domain, which are not necessarily sustainable over longer periods of time. Finally, the discussion of results includes not only general trends demonstrated by learners of the same level of proficiency but also individual case studies. Analyzing the performance of specific learners allows us to take their individual differences into account, examine their patterns of acquisition in greater detail and, as a result, provide comprehensive interpretations of the relationships between the major domains of phonological development.

1.3. Overview of the chapters

This dissertation is organized as follows. Chapter 2 reviews the background literature on the relationships between the domains of perception, lexical encoding, orthography and production. At first, it examines the most researched relationship in the literature, the perception-production link. Then it discusses previous studies that investigate how lexical encoding interacts with perception and production. The last section of this chapter probes the effects of orthography on phonological acquisition. Chapter 3 is devoted to the phenomenon of palatalization in Russian. It explores how palatalized consonants reveal themselves in perception, production and orthography and what difficulties learners encounter when acquiring them in Russian. Chapters 4-6 are empirical. Each chapter introduces research questions and hypotheses, describes the method employed to investigate a specific relationship, reports the results and provides a

subsequent discussion. Chapter 4 examines the relationship between the perception of palatalized consonants by American learners of Russian and their ability to produce these consonants in order to establish whether perception skills develop prior to production skills or vice versa. Chapter 5 explores whether American learners of Russian encode words with the plain/palatalized contrast separately and how this lexical encoding interacts with their perception and production of palatalized consonants. Chapter 6 investigates whether learners' orthographic and metalinguistic knowledge of palatalization facilitates or hinders their perception, production and lexical encoding of palatalized consonants. Chapter 7 presents a general summary and conclusions, pedagogical implications on pronunciation training and directions for future research. Chapter 8 provides a list of references used in the dissertation.

Chapter 2. Relationships between perception, production, lexical encoding, and orthography

As stated in the introduction, the links that connect perception, production, lexical encoding and orthography in L2 acquisition are not as clear and straightforward as in L1 acquisition. When learners acquire their L2 phonology, the L1 system is always present (e.g., Abrahamsson & Hyltenstam, 2009). This presence can reveal itself either in an obvious way, for instance, when learners have a noticeable foreign accent, or in a subtle way, when deviations in learners' production are not perceptually salient. This chapter will describe various interactions that exist between the four domains of perception, production, lexical encoding and orthography and demonstrate how they are interconnected. Section 2.1 explores the link between perception and production. Section 2.2 investigates how lexical encoding interacts with perception and production. Section 2.3 examines the effects of orthography on phonological acquisition.

2.1. Perception – production link

This section investigates the development of perception and production skills in L1 acquisition and compares it to L2 acquisition. Two main views on the interaction between perception and production in L2 acquisition are presented with supporting empirical evidence. The first view assumes that perception of nonnative contrasts precedes their production. The other view suggests that production skills can develop independently of perception.

2.1.1. The development of perception and production skills in L1 and L2

Perception and production skills are essential for effective language learning and communication. In L1 acquisition, the development of the perceptual system precedes the acquisition of articulatory gestures necessary to produce sounds of the native language. Babies are not born talking, but they are born as excellent perceivers of language. Until the age of six months, infant perception is language-general, i.e., they can accurately discriminate contrasts, even those that do not exist in their native or surrounding languages (Jusczyk & Luce, 1994; Werker & Tees, 1984). By the end of the first year, as a result of reorganization induced by input, infant perception becomes language-specific and reflects the properties of their native language. According to the Native Language Magnet (NLM) theory, linguistic experience affects the perceived distance between speech sounds and warps the perceptual space underlying them (Kuhl, 1994). Magnet effects result in reconfiguration of the perceptual system, so that acoustic differences that are meaningful in the language receive more weight, whereas others are diminished. The ambient language that infants perceive leads to the formation of perceptual categories, which guide the emergence of the necessary production skills. De Boysson-Bardies, Sagart, and Durand (1984) demonstrated that adult French listeners without any linguistic training were able to discriminate the babble of eight-month old French infants from the babble of Arabic and Chinese infants. Phoneticians were able to do it with younger infants, who were only six months old. The perceptual system is fully developed by the end of the first year, whereas the development of the production system is not complete before the age of six (or even later). Thus, in L1 acquisition, perception skills develop

before production skills, which implies that accurate production of a phonological contrast can be equated with the successful and complete acquisition of that contrast.

The relationship between perception and production is much more complex in L2 acquisition than in L1 acquisition. As early as the 1930s, Polivanov (1931) and Trubetsky (1939) noted that due to the close associations that exist between the native phonemic representations and their perception, an L2 tends to be perceived and classified through the system of the native language, which acts as a 'phonological filter'. Half a century later, Best (1995) proposed the Perceptual Assimilation Model (PAM) that made a set of predictions concerning how listeners categorize and discriminate nonnative sounds with respect to the categories of their native language. Best and Tyler (2007) modified the initial model to account for the perceptual difficulties among L2 learners. According to the PAM, discrimination was expected to be good or excellent if two nonnative phones were perceived as acceptable exemplars of two native categories (two-category assimilation). Best (1990) tested this prediction by presenting English adults with the Ethiopian ejective contrast /pʰ/ - /tʰ/. The discrimination levels were at near ceiling, which suggested that English speakers assimilated the ejectives to their existing English native categories of /p/ and /t/. On the other hand, discrimination was predicted to be poor if two nonnative phones were perceived as equally good or poor tokens of the same native phoneme (single-category assimilation). English adult speakers could perceive neither the difference between the Hindi retroflex /ɖ/ and dental /t̪/, nor the Thompson glottalized /k̚/ and /q̚/ (Werker, Gilbert, Humphrey, & Tees, 1981; Werker & Tees, 1984). The English speakers might have assimilated the Hindi stops to the English /t/ and the Thompson stops to the English /k/. Another prediction made by the PAM was

that if two nonnative phones were perceived as tokens of the same native phoneme, but they differed in goodness of fit to that phoneme (category goodness assimilation), discrimination was likely to be moderate to good. English speakers' ability to differentiate the Farsi contrast between the uvular and velar stops /G/ - /g/ fluctuated from very few errors to near chance performance (Polka, 1987). Such variance can be explained by the pattern of assimilation that the listeners employed i.e., the velar stop /g/ was perceived as a good variant of the native phoneme, whereas the uvular stop /G/ was perceived as a bad or 'foreign' variant of the native velar stop. Some other predictions made by the PAM concerned uncategorized and unassimilated cases. For instance, if a nonnative phone was perceived as a nonlinguistic nonspeech sound, e.g., Zulu clicks, discrimination could be good to excellent (Best, McRoberts, & Sithole, 1998).

The PAM provides quite detailed predictions about how nonnative phones can be perceived, but it does not explore how these assimilation patterns affect production. However, since the PAM is based on the direct realist theory of speech perception (Fowler, 1996), the relationship between perception and production is believed to develop in synchrony and be mutually dependent on each other. The direct realist theory, similarly to the motor theory of speech perception (Liberman, Cooper, Shankweiler & Studdert-Kennedy, 1967; Liberman & Mattingly, 1985), claims that when learners perceive speech, they perceive gestures, or the actual movements of the vocal tract that they extract from the acoustic signal. The knowledge of articulations that they gain as a result of perceiving sounds facilitates their subsequent production. Consequently, when acquiring an L2, the learner's task is to identify the subtle articulatory differences that exist between the sounds in their native and target languages. Indeed, at certain stages of

acquisition, perceptual abilities seem to align with production abilities, however this is not always the case, as will be discussed later in Section 2.1.3. (Baker & Trofimovich, 2006; Flege, MacKay, & Meador, 1999).

2.1.2. Perception skills develop before production skills

The most traditional perspective on the interaction between perception and production in L2 acquisition is that accurate perception is a prerequisite for accurate production. This view states that if learners do not hear the difference between contrasting phonemes in the target language due to the possible interference from their native language, they will not be able to produce the difference either. This view was further developed by Flege (1995) in his Speech Learning Model (SLM). According to the SLM, mechanisms and processes that are necessary to acquire new categories in L2 acquisition are similar to those of L1 acquisition and remain accessible throughout the lifetime. Accurate perceptual targets are necessary to guide learners to accurate production. However, in order to establish these accurate perceptual targets, learners have to be able to discriminate between native and target categories.

“A new phonetic category can be established for an L2 sound that differs phonetically from the closest L1 sound if bilinguals discern at least some of the phonetic differences between the L1 and the L2 sounds. The greater the perceived phonetic dissimilarity between an L2 sound and the closest L1 sound, the more likely it is that phonetic differences between the sounds will be discerned” (Flege, 1995, p. 239).

If two sounds in L2 are perceived as the same and assimilated to one native category due to equivalence classification, discrimination of the contrast will be poor. The ability to discriminate new contrasts decreases with age and the likelihood of a nonnative sound being perceived without reference to the native language diminishes.

Flege, Bohn, and Jang (1997) tested the claims of the SLM by evaluating the production and perception of four English vowels (/i/ - /ɪ/ and /æ/ - /ɛ/) by L2 learners from different L1 backgrounds, who also differed with respect to how much experience they had with English (experienced vs. inexperienced). The participants were asked to read a list of words embedded in a carrier phrase. Then their productions were extracted and presented to English native speakers in an identification task, as well as acoustically analyzed for temporal and spectral differences. The participants also performed a perception task, where they identified the target English vowels in synthetic continua. The results showed that experienced and inexperienced German native speakers produced and perceived a spectral distinction between English /i/ and /ɪ/ more accurately than Korean, Chinese and Spanish native speakers did. This result is not surprising because the German language has an equivalent phonemic contrast to the English /i/-/ɪ/. Spanish, on the other hand, does not have this tense-lax distinction. Inexperienced Spanish participants could neither perceive nor produce the spectral differences between English /i/ and /ɪ/. This is an example of a case when category formation was blocked by equivalence classification, i.e. inexperienced Spanish participants used one category to process both English phones. However, experienced Spanish participants with a length of residence in the US of more than seven years were able to perceive the difference between English /i/ and /ɪ/. Yet, they were not able to produce this difference robustly in terms of spectral characteristics, although they succeeded in contrasting the vowels using duration differences. Multiple regression analyses suggested that the participants' accuracy in producing English vowels was related to their accuracy in perceiving these vowels.

Another study by Flege, MacKay, and Meador (1999) examined the perception and production of English vowels by Italian learners of English living in Canada. Highly experienced learners with an average length of exposure of 35 years were auditorily and visually prompted to produce English words with the target vowels. These productions were further presented for identification to native speakers of English and participants' vowel intelligibility scores were calculated. Learners' perceptual abilities were tested using a categorical discrimination task (oddball). The results showed that the later the age of arrival of the participants in Canada, the worse their performance in production and perception was evaluated. Moreover, there was a significant correlation between the participants' vowel intelligibility scores and performance on the perception task, even when the effects of other variables, such as age of arrival and amount of L1 use, were partialled out. Taken together, these results support the view that in L2 acquisition perception precedes production and prolonged exposure to a target language can help in the development of new categories.

Perceptual skills in L2 can improve not only with experience but also as a result of training, especially if the training includes a high variability approach, whereby learners are exposed to different speakers and various productions of each speaker (Kingston, 2003; Logan, Lively, & Pisoni, 1991; Wang, Jongman, & Sereno, 2003). Bradlow, Pisoni, Akahane-Yamada, and Tohkura (1997) found that perceptual training not only benefited perceptual skills but it also improved production. Adult Japanese learners of English received /ɪ/ - /I/ identification training that involved 45 sessions over a period of three or four weeks. Stimuli included a large number of /ɪ/ - /I/ minimal word pairs produced by American native speakers. Results showed that the trained group

performed significantly better on the perceptual identification posttest than they did on the pretest and they maintained this increase in improvement for the two tests of generalization. After the pretest and posttest, the participants were recorded producing English words alternating in /ɪ/ and /l/, which were judged by American native speakers. Results showed that American native speakers had a significant preference for posttest productions over pretest productions and identified posttest productions significantly better than pretest productions. These findings support the claim that accurate perceptual targets assist in accurate production. It might be the case that high-variability perceptual training with feedback allows learners to develop phonetic categories that are more precise and closer to nativelike, which subsequently results in the improved production of the difficult contrasts.

Studies conducted by De Jong, Silbert, and Park (2009) and De Jong, Hao, and Park (2009) provide additional insight into how perception and production systems interact and why development of perception skills tends to precede development of production skills. The former study investigated abilities of Korean learners of English to identify English obstruents /p b t d f v θ ð / in various prosodic positions and make generalizations based on features. The participants of the study were inexperienced learners of English as a foreign language who were tested in Korea. They listened to nonwords containing target consonants in initial, final and intervocalic positions and were asked to circle the consonants they heard on their answer sheets. Results showed that perception of manner generalized over place of articulation, voicing and prosodic positions. For instance, (i) learners who were accurate at distinguishing coronal stops from fricatives were also accurate at distinguishing labial stops from fricatives; (ii)

learners who distinguished voiceless stops from fricatives also distinguished voiced stops from fricatives; (iii) learners who made fewer errors in distinguishing stops from fricatives in the initial position were also more accurate in the final and intervocalic positions. Voicing perception was generalized over place and manner of articulation but not over prosodic positions. According to De Jong, Silbert, and Park (2009), the existence of such generalizations suggests that perceptual identification skills are not acquired individually for each segment, but rather are generalized across segments that share a specific feature. Being exposed to multiple phones, learners are likely to move from the perception of individual sounds to generalizations that involve entire natural classes, thereby creating a more efficient perceptual system. Consequently, training studies with a high-variability procedure, similar to the one employed by Bradlow et al. (1997), present favorable conditions for the learners to make the necessary generalizations based on a specific feature.

In the other study, De Jong, Hao, and Park (2009) investigated whether analogous generalization effects can be observed in production. For example, if learners were able to produce a voicing contrast for coronals, were they able to produce a voicing contrast for labials as well? The participants of the study were Korean learners of English recruited from basic level English classes in South Korea. They performed two tasks: reading and mimicry. Results suggested that patterns of generalizations discovered in perception were not transferred into production. With respect to the production of manner, learners did not generalize from labials to coronals but they did generalize from voiced to voiceless. This lack of generalization might stem from the fact that place of articulation requires the use of different articulators, whereas voicing distinction involves

the same articulator, viz. glottis. Manner generalization was not observed in the coda position. Voicing production was not generalized either over place or manner of articulation. Taken together, the findings of these two studies imply that perception and production systems, although connected by a larger system of phonology, function and develop differently. The skills that learners have to acquire in perception are different from those in production. Perceptual acquisition relies on the acquisition of features, whereas production relies on the acquisition of gestures and their coordination. Production might require more time and experience to develop because the motor system is not as flexible as the perceptual system. As a result, learners might be able to discriminate a contrast in perception without observing the distinction in production.

In a study by Rose (2010a), 60 American English learners of Spanish at different levels of language proficiency discriminated between the Spanish tap and trill with a minimum average accuracy rate of 86.7%. However, in another study by Rose (2010b) only four learners out of 21 were able to produce the difference between the Spanish tap and trill in a nativelike manner. Rose proposed five developmental stages that American English learners go through when acquiring production of the tap-trill contrast. These results provide additional support for De Jong et al.'s (2009) claim that the perception and production systems differ in the nature of skills that they employ. Perception accuracy can precede production accuracy when the articulation of a contrast requires complex gestures that the motor system needs time to acquire and coordinate.

2.1.3. Production skills develop independently of perception skills

Despite the importance of perceptual support, it is neither necessary, nor sufficient to develop perception skills prior to acquiring the correct articulation of target phonemes (Baker & Trofimovich, 2006; Darcy & Kruger, 2012; Flege & Eefting, 1987; Goto, 1971; Llisterri, 1995; Sheldon & Strange, 1982). In L2 acquisition, unlike in L1 acquisition, accurate production can precede accurate perception. However, learners' ability to produce a category correctly does not entail its nativelike competence. Darcy and Kruger (2012) found that even young learners could produce contrasts that they could not perceive. In their study, bilingual children who were native speakers of Turkish and learners of German, tested at the age of 9-12, were able to produce difficult German vowel contrasts in a nativelike manner preserving the appropriate differences between long and short vowels. However, when learners' perceptual abilities were tested, results showed that learners categorized these vowels differently from age-matched native speakers. In a classic study by Sheldon and Strange (1982), adult Japanese learners of English were able to produce /ɪ/ and /I/ correctly, as judged by American native listeners. However, when these productions were presented to the same Japanese learners in a perception test a month later, they made more mistakes than the American native listeners. The learners were not able to accurately distinguish their own productions in perception, while they were able to accurately produce this distinction, at least in the way that could be identified by American English listeners. Accuracy rates on the perception of their own productions were higher than on the words produced by other speakers. Nonetheless, accuracy rates on the production task were still higher than even on self-perception.

Baker and Trofimovich (2006) proposed that self-perception could be a necessary link between perception and production, especially in situations when production preceded perception. In their study, forty Korean learners of English were tested on the production, perception and self-perception of English vowels. They performed a picture-naming task and an open-choice identification task on their own productions of target words, as well as on the target words produced by native English speakers. Results showed that those learners, who could produce English vowels accurately, could also perceive them accurately in their own productions and in the productions of others. Those learners, who had low accuracy rates in production, also had low accuracy rates in perception and self-perception. However, for four learners with an intermediate level of production (75% of target vowels were correctly identified by American native listeners), the role of self-perception was more salient. Two learners, who perceived vowels accurately (93% correct), also perceived their own productions accurately (81% correct in self-perception) and this difference between perception and self-perception was not significant. However, the remaining two learners whose perception was less accurate (68% correct) than production had self-perception accuracy (86% correct) that exceeded their production accuracy, as well as their accuracy in perceiving the productions of other participants. Baker and Trofimovich suggested that for these learners, accuracy in production was achieved due to the facilitation that they had received from their ability to perceive their own speech. Thus, even when production skills precede perception skills, production is still guided by perception, or self-perception to be more exact.

These findings demonstrate that learners can produce an L2 category in a nativelike manner without reliably perceiving it. The possibility for developing

production accuracy before perception accuracy can be explained by various reasons. First of all, learners can possess articulatory skills that have been positively transferred from another language. For example, Russian native speakers should not have difficulties producing an Arabic voiceless fricative /x/ because the Russian language also has such a consonant in its phonemic inventory. However, they might have difficulties distinguishing this velar fricative in perception from other similar voiceless fricatives that exist in different dialects of Arabic but not in Russian, such as uvular /χ/, pharyngeal /ħ/ and glottal fricatives /h/. Secondly, learners' production skills can surpass their perceptual abilities due to rigorous pronunciation instruction, the focus of which relies heavily on the use of production drills and explicit reference to the vocal tract gestures instead of the perceptual development of sensitivity to auditory cues. Moreover, learners themselves might believe that production skills are more important than perception for communicative purposes and be more willing to invest their time and effort in perfecting their production rather than perception. Accented speech is often negatively evaluated by native speakers of the target language (Anisfeld, Bogo, & Lambert, 1962; Lambert, Hodgson, Gardner, & Fillenbaum, 1960; Rubin, 1992), whereas nonnative perceptual abilities are not as detectable by native listeners as nonnative accented pronunciation.

The relationship between perception and production is not static and can change over time. Baker and Trofimovich (2006) correlated their participants' production and perception scores with age of arrival, use of their L1 and length of residence. They found that all three variables correlated strongly with production and perception accuracy except for length of residence, which did not correlate with perception at all. The results also suggested that perception and production were aligned at the initial and advanced

stages of acquisition but not at the intermediate stage. Bohn and Flege (1997) also found that L2 experience had a stronger effect on the production of new vowel categories than on their perception. In the initial stages of language learning, perception tended to lead production. However, with continued exposure to the L2, learners' production abilities became more nativelike, whereas perceptual skills started to lag behind. Bohn and Flege speculated that one of the reasons for such a mismatch could be social pressure that learners experienced to conform to the production norms in order to avoid stigma about having an accent.

Understanding the relationship between perception and production is further complicated by the different methodologies and population sampling used in previous investigations. For example, learners in an international academic setting might feel less social pressure to conform to the production norms than L2 learners in immigration settings. Characteristics of the participants also vary due to participant age of learning, length of residence in the target country, level of L2 proficiency, amount of native language use, etc. For example, numerous studies have shown that learners with an early age of acquisition develop perception and production skills similar to those of native speakers (Baker & Trofimovich, 2006; Flege, MacKay, & Meador, 1999; Levy & Law, 2010; Llisterri, 1995; Piske, MacKay, & Flege, 2001). Other interfering factors are the consequences of methodological decisions, such as the use of different methods to assess perception and production: (i) acoustic analyses vs. intelligibility tasks in Flege, Bohn, and Jang (1997); (ii) lexical status of stimuli, e.g., words vs. pseudowords in Darcy and Kruger (2012); (iii) choice of acoustic and perceptual correlates in the target words, e.g., spectral vs. temporal in Bohn and Flege (1997); (iv) contextual dependency of target

phonemes, e.g., bilabial context vs. alveolar in Levy and Strange (2008); (v) type of analyses, e.g., group vs. individual data in Levy and Law (2010). In other words, caution should be used when interpreting and comparing results from different studies of production and perception.

2.1.4. Summary

The perception-production interface in L2 acquisition is more complex than in L1 acquisition, primarily due to the interference of the L1 in the formation of new categories. Moreover, there is a host of other confounding factors that make it even harder to reveal the nature of the relationship that exists between these two areas. Perception and production skills can be aligned and interdependent at some stages of L2 acquisition and misaligned at others. The perceptual system is believed to emerge earlier and generalize across segments that share the same feature more than the production system does. The reason for such a difference is that the production system, which controls gestures and their coordination, is less flexible and requires more time to develop than the perceptual system, which utilizes features. As a result, learners might be able to discriminate contrasts in perception but not in production. The presence of accurate perceptual targets facilitates the acquisition of gestures necessary to produce target phonemes. However, if learners feel the social pressure for accent-free pronunciation and have access to rigorous pronunciation instruction, or if the target language requires articulatory gestures that are already familiar to learners, production accuracy can precede perception accuracy. The development of self-perception also seems to have a beneficial effect, especially when perception of other speakers remains a challenge due to inherent variability of phonetic

realizations. In the end, mastery in perception does not guarantee accurate production, just like mastery in production does not imply accurate perception. Successful acquisition of a phonological category implies a multifaceted development of skills and abilities.

2.2. Interactions of lexical encoding with perception and production

This section investigates how L2 learners encode phonological contrasts lexically. It provides a brief overview of spoken word recognition models and pinpoints peculiarities that exist in L2 spoken word recognition, pertaining to noise effects, activation of competitors and clarity of representations. The relationships of lexical encoding with perception and production are thoroughly examined and possible configurations of these interactions are described, e.g., lexical encoding of phonological contrasts with and without perceptual support or the effects of inaccurate lexical encoding on production.

2.2.1. Overview of spoken word recognition models

Accurate perception and production of phonemes are necessary inasmuch as they allow speakers to correctly perceive and produce words. In order to recognize a word, the processing of acoustic-phonetic input must be matched to stored representations of word forms, resulting in lexical access. This is the main commonality that unites all models of spoken word recognition, although there are different approaches to explaining the nature of representations that are involved in lexical access and the mental mechanisms that operate during spoken word recognition. Complete overview of spoken word recognition

models is beyond the scope of this chapter, but some examples of models are provided below to illustrate how spoken word recognition works.

The first model of spoken word recognition, the *Logogen Model* (Morton, 1969), posits that each word in the mental lexicon is represented by a logogen, which stores information about each word's appearance, sound and meaning. Auditory, visual and semantic input activates a specific word's logogen. When activation exceeds a certain threshold, the word is recognized and the response is sent to the output system. Another example of a lexical access model is the *Frequency-Ordered Bin Search Model* (Forster, 1989; Taft & Forster, 1975). It proposes that lexical representations are organized into bins based on roots and their frequency. Within a bin, words are organized according to their frequency, so that high-frequency words, such as 'bookcase', are searched before low-frequency words, such as 'bookworm'.

Unlike the previous two models, the *Trace Model* is highly interactive and uses cascaded activation instead of threshold activation (McClelland & Elman, 1986). Cascaded activation implies that a unit receiving input starts to generate output as soon as other units of the system become active. Similar to the *Trace Model*, the *Shortlist Model* (Norris, 1994) is a connectionist model of spoken word recognition. However, unlike the *Trace Model*, the *Shortlist* does not entail any top-down feedback from the lexical level to phonemic representations. Instead, the *Shortlist* opts for bottom-up processing. Auditory input activates a short list of candidates that enter the competition. The short list is constantly changing depending on the incoming acoustic information. If a word does not longer match the incoming input, its activation decreases even if the word is contextually appropriate.

One of the most influential models developed to account for spoken word processing is the *Cohort Model* (Marslen-Wilson, 1987, 1989; Marslen-Wilson & Welsh, 1978). According to the cohort model, the process of lexical access starts with the initial contact phase, when the onset of the word activates all words in the lexicon (a cohort) that match the perceived input. During the selection phase, the system continues to scan the activated candidates to find the best match for the auditory input it has received. Words that do not match the input are not excluded from the cohort, instead their activation starts to decrease. The higher the number of active candidates is, the stronger the competition between the words is, which, consequently, leads to slower word recognition. During the final stage of integration, the system checks the remaining candidates for their semantic and syntactic properties with respect to the specific context. The point when only one candidate remains is called the recognition point. The *Distributed Cohort Model* (Gaskell & Marslen-Wilson, 1997) is different from its predecessor because it “places less emphasis on word beginnings as a critical element in lexical access” (Traxler, 2012, p. 117). Thus, even words that do not match the onset of the input get activated if they are similar to the spoken word, e.g., the word ‘book’ activates the word ‘boot’, as well as ‘cook’. *The Neighborhood Activation Model* (Luce, 1986; Luce & Pisoni, 1998) goes even further and posits that input activates all similar words that differ from the input by a one phoneme deletion, substitution or addition. For example, the neighbors of ‘cat’ can be ‘pat’, ‘kit’, ‘pan’, as well as ‘scat’ and ‘at’ (Luce & Pisoni, 1998).

In summary, models of spoken word recognition differ from each other in many respects. For instance, how words are represented and stored in the mental lexicon; what

criteria are used to activate and subsequently select the best candidates; how phonological and lexical systems interact and communicate with each other etc. Depending on the spoken word recognition model that a researcher adopts, assumptions can differ on the mechanisms of word recognition at different stages. For instance, with respect to which words get activated, the *Cohort Model* assumes that the words that share the same onset with the input are activated, whereas according to the *NAM*, words in the same neighborhood enter the competition. If a researcher supports the *Trace Model*, then the assumption is that the phonological and lexical systems are constantly interacting providing feedback to each other on the accuracy of the match between the input and competitors. However, the proponents of the *Shortlist Model* believe that words are added to or excluded from the competition only based on the acoustic information of the input. Nonetheless, all these models have the same process to account for, that is, how acoustic-phonetic input is matched to the stored lexical-phonological representations.

2.2.2. Word recognition in a L2

The mechanisms that operate in spoken word recognition in L1 are similar to those active in L2 spoken word recognition. Learners receive acoustic-phonetic input, which activates a certain group of words in the lexicon. The activated words compete to be selected as the best match to the input. Despite the existing similarities, models of spoken word recognition in L1 should be applied with caution to L2 spoken word recognition due to crucial differences that exist between L1 and L2 processing. For example, input, the starting point of spoken word recognition, can be misperceived by L2 learners, which, consequently, would lead to the unnecessary activation of numerous

words in their L2, as well as L1. Since it is not the goal of this study to test which model of spoken word recognition applies best to the spoken word recognition in the L2, no specific model will be assumed here. However, it is necessary to mention what makes L1 processing of spoken input different from L2 spoken word recognition, irrespective of the assumptions of any model. Some of these crucial differences between L1 and L2 processing pertain to the ability to recover from noise, activate and suppress competitors efficiently and establish accurate lexical representations avoiding spurious homophony.

Native listeners recover from noise effects more effectively and make more use of the surrounding context than L2 learners do (Cutler, Weber, Smits, & Cooper, 2004). Gor (2014) investigated the perception of Russian speech in multi-talker babble noise by Russian native speakers, heritage learners of Russian and late learners of Russian with different levels of proficiency. The participants listened to sentences with high-predictability contexts, e.g., ‘I do not have a sister but I have a brother’, and low predictability contexts, e.g., ‘The child did not know that was the answer’, embedded in high noise with a speech-to-noise ratio of 1.5 dB and low noise with a speech-to-noise ratio of 4 dB. The participants were asked to repeat the final word in each sentence. Word identification was significantly more accurate in the low-noise condition and in sentences with high-predictability than in the high-noise condition and in sentences with low predictability. In the high-noise / low-predictability context condition, Russian native speakers significantly outperformed the learner groups. In the high-noise / high-predictability context condition, only advanced heritage learners behaved similarly to Russian native speakers. These results confirm that learners’ ability to recover from noise is less effective than that of native speakers. It means that if communication occurs in a

noisy environment, learners' word recognition is likely to be slower and less accurate, which can result in an increased probability of communication breakdown.

Besides being predominantly accurate, word recognition in L1 is more efficient in terms of the number of competitors activated. This makes lexical selection a more efficient process, because fewer competitors have to be eliminated first. Unlike monolingual native speakers, L2 learners activate more competitors than native speakers due to the influence of their native lexicon and phonological sensitivity to cross-language similarities. For instance, Dutch listeners activated the Dutch word 'kist', which means 'chest', when they heard an English word 'kitten' (Weber & Cutler, 2004). Moreover, perceptual inaccuracies at the phonetic level result in an increase of competitors at the lexical level and the appearance of so-called phantom words. Broersma and Cutler (2008) created nonwords by alternating the voicing feature word-finally in real words, such as 'flight' and 'groove'. When Dutch and English participants were presented with the corresponding nonwords 'flide' and 'groof' in a lexical decision task, Dutch learners considered them to be real words more often than English listeners. When both groups of participants performed a cross-modal priming task with the same nonwords extracted from recordings of two words spanning a word boundary, e.g., 'groof' from 'big roof', results showed that the nonword 'groof' (excised from the phrase 'big roof') was capable of priming the word 'groove' for Dutch learners of English but not for English native listeners. Dutch learners allowed the phantom words to enter into the lexical competition, whereas English native listeners rapidly rejected these phantom words.

Another important difference between spoken word recognition in L1 and L2 is the asymmetry of lexical access (Cutler, Weber, & Otake, 2006; Darcy, Daidone, &

Kojima, 2013; Escudero, Hayes-Harb, & Mitterer, 2008; Weber & Cutler, 2004). In the classic study by Weber and Cutler (2004), Dutch listeners participated in eye-tracking experiments that examined lexical competition in L2 spoken word recognition. The participants saw a grid on a computer screen with four pictures of objects and four geometrical shapes in the corners. The pictures represented a target word with a confusable vowel /æ/ that does not exist in Dutch, e.g., ‘panda’, a competitor with a Dutch-like sound /ɛ/, e.g., ‘pencil’, and two unrelated distractors, e.g., ‘strawberry’ and ‘dress’. The target word and the competitor had the same first syllable. During each trial, the participants were asked to click on one of the words and move it on top of the four geometric shapes. The results showed that the participants did not activate the word ‘panda’ when they heard the word ‘pencil’, which contains the dominant Dutch-like category /ɛ/. On the other hand, when they heard the word ‘panda’ with a confusable sound /æ/, the participants activated both words.

Native speakers also suppress competition much faster than L2 learners. In Weber & Cutler (2004), Dutch learners of English fixated longer on a competitor picture of a ‘pencil’ with a Dutch-like sound /ɛ/, when they heard a word ‘panda’, which has a vowel /æ/ that does not exist in the Dutch vocalic inventory, but which is confusable with the similar Dutch sound /ɛ/. The mapping of the acoustic signal onto the lexical representation (when fixation proportion to the target ‘panda’ increases and fixation proportion to the competitor ‘pencil’ decreases) started from about 300 ms since the target onset for the English native speakers and 500 ms for the Dutch learners of English. Thus, Dutch learners of English retained an activation of competitors for at least an additional 200 ms when compared to English native speakers, although the acoustic

information excluded them as possible candidates. From these findings, it remains unclear whether the effect is perceptual (due to listeners not being able to discriminate the contrast well) or lexical.

2.2.3. Lexical encoding and perception

Lexical encoding of the contrast and its perception are closely interconnected because word recognition presupposes the processing of the auditory input. In L1 spoken word recognition the link between lexical encoding and perception is transparent because they are based on the same phonological categories. In L2, the interaction between perception and lexical encoding is not straightforward due to the interference of the native categories.

The proponents of the ‘categories first’ approach believe that accurate perception of the contrast is necessary for the acquisition of targetlike lexical representations. Inaccurate perception results in a single-category assimilation, when two nonnative phonemes are assimilated to the same native phoneme. As a result, minimal pairs containing that contrast are stored as homophones in the lexicon. Pallier, Colome, and Sebastian-Galles (2001) used a repetition-priming paradigm to test fluent Spanish-dominant bilingual speakers of Catalan. The study also included a control group of Catalan-dominant bilingual speakers of Spanish. The participants performed a lexical decision task on a list of stimuli containing three Catalan-specific phonemic contrasts: /e - ε/, /o - ɔ/, /s - z/ which do not exist in Spanish. Unlike Catalan bilinguals, Spanish bilinguals exhibited a repetition effect on the minimal pair condition, whereas their performance on the lexical decision task was similar to that of the Catalan bilinguals.

These results suggest that although the Spanish bilinguals mastered the Catalan lexicon, they processed Catalan words with difficult contrasts (i.e., difficult given that the contrast does not exist in the native language but only differs by one feature in the target language) as homophones. In a previous study, Pallier, Bosch, and Sebastian-Gallés (1997) found that many early Spanish-dominant bilinguals exhibit a much flatter identification function for a continuum between /e-ɛ/ as compared to the Catalan-dominant bilinguals, suggesting that they have not established two separate categories despite early and sustained exposure to the contrasts.

The other approach called ‘lexicon first’, supported by the Direct Mapping from Acoustics to Phonology model (Darcy et al., 2012), proposes that the lexical encoding of contrasts is independent of phonetic category formation and it can precede it. Learners can use other resources, such as orthography or metalinguistic representations, to establish a lexical contrast. Darcy et al. (2012) examined the acquisition of French vowels /u - y/ and /œ - ɔ/ by American English learners through an ABX and a lexical decision task with repetition priming. Learners’ performance on the ABX was significantly different from that of French native speakers, regardless of their level of proficiency, which means that learners did not establish fully robust phonetic categories for the vowel contrasts. Overall, the learners were more accurate on the /y - u/ contrast than on the /œ - ɔ/. On the lexical decision task, intermediate learners exhibited priming effects on the /u-y/ contrast, whereas advanced learners behaved similarly to the French native speakers. These findings suggest that in a lexical task, learners can detect and use more acoustic cues than what they need or use for a segmental categorization task. It is possible that at the lexical level a distinction can be made, which may not be

implemented in a categorization task like ABX. Language experience can help learners overcome spurious homophony and establish separate representations of word forms.

It is necessary to mention that lexical representations that are created without perceptual support run the risk of being imprecise, which in the end results in asymmetric lexical access and increased word competition (Cutler, 2015). When learners hear a category that is accurately represented in the lexicon, or a dominant category, they suppress competitors faster than when they hear a nondominant category matching to an imprecise or “fuzzy” representation (Broersma & Cutler, 2011; Cutler, Weber, & Otake, 2006; Darcy, Daidone, & Kojima, 2013; Escudero, Hayes-Harb, & Mitterer, 2008; Weber & Cutler, 2004).

Darcy, Daidone, and Kojima (2013) proposed two hypotheses regarding the source of asymmetry in lexical access. According to the phonetic coding deficiency hypothesis, lexical representations are accurate but those containing a nondominant category do not receive sufficient activation due to the lack of perceptual discriminability between dominant and nondominant categories. On the other hand, the lexical coding deficiency hypothesis claims that asymmetry arises from a difficulty located at the lexical coding level, i.e. the nondominant category is represented as a poor match of the dominant category but it does not mean that the dominant category is used in place of the nondominant one. To test their hypotheses, Darcy, Daidone and Kojima compared the performance of American English learners of Japanese and German on an ABX and a lexical decision task. The learners of Japanese were tested on geminate / singleton consonants, and the learners of German were tested on front / back rounded vowels. Both groups of learners performed well on the ABX. However, on the lexical decision task,

learners of Japanese and intermediate learners of German exhibited a significant interaction between consonant type (for Japanese learners) or vowel type (for German learners) and lexical status. It means that words containing dominant categories, viz. singletons for Japanese learners and /u/ and /o/ for German learners, were more accurately recognized than words with nondominant categories, viz. geminate consonants for Japanese learners and /y/ and /ø/ for German learners. On the other hand, nonwords containing nondominant categories were more accurately rejected than those with a dominant category. These results suggest that the contrast was encoded but not in a nativelike manner due to the observed asymmetric pattern in accessing words with target segments. However, advanced learners of German did not show such an interaction and behaved similarly to native speakers, which implies that these learners had developed accurate lexical representations without reference to their native phonology. Darcy, Daidone and Kojima concluded that the source of asymmetry lies at the lexical coding level and the acquisition of phonetic categories is neither a prerequisite nor a guarantee that lexical representations will be targetlike. With experience, learners can achieve accuracy in their lexical representations and access them without reference to their native language.

In a spoken word recognition task, it is difficult to separate the effects of phonetic perception and lexical encoding. For example, it might be the case that the Spanish bilinguals in Pallier et al.'s (2001) study failed to discriminate Catalan-specific contrasts in perception and, therefore, treated minimal pairs as the same words. In order to exclude the effects of perception on lexical encoding, Ota, Hartsuiker and Haywood (2009) designed an experiment that was based on visual word recognition. The participants of

the study were Arabic and Japanese learners of English. The Arabic speakers were tested on the /p-b/ contrast, whereas Japanese learners were tested on the /ɪ-l/ contrast. Both of these contrasts do not exist in Arabic and Japanese respectively. The materials of the study were triplets of words that differed in the target contrast along with a spelling control, e.g., ‘lock – rock – sock’. Four word pairs were constructed using each triplet and their semantic associates. For instance, ‘key’ was the semantic associate of ‘lock’, whereas ‘hard’ was the semantic associate of ‘rock’. Thus, the four constructed stimuli were ‘lock - hard’, ‘rock - key’, ‘sock - hard’ and ‘sock - key’. The participants performed a semantic relatedness decision task, i.e. they were asked to judge whether two words that they saw on the screen were semantically related. Results showed that Japanese learners produced higher error rates and slower reaction times for word pairs involving real homophones, such as ‘key-rock’ than their spelling controls, e.g., ‘key-sock’. Arabic learners performed similarly but only on the /p-b/ condition. Japanese learners of English did not show homophone-like effects on the /p-b/ contrast, just like Arabic learners of English did not have homophone-like effects on the /ɪ-l/ condition. This difference in learners’ performance on two contrasts suggests that homophone-like effects are language-specific and native phonology indeed have an effect on the encoding of lexical entries in the L2, even when auditory perception is not involved, offering support to an interpretation of spurious homophony findings as a *lexical* phenomenon.

2.2.4. Lexical encoding and production

Studies that investigated the link between perception and lexical encoding have established that they are quite independent of each other. Does it hold true for the link between lexical encoding and production? Hayes-Harb and Masuda (2008) provide an insight into this interaction by examining the abilities of American learners of Japanese to encode and produce a contrast between singletons and geminates. Participants performed two tasks: auditory word-picture matching and picture-naming. Learners were able to encode the difference between singleton and geminate consonants lexically, but they could not maintain it in production. Experienced learners performed much better on the production task than inexperienced learners; however, they were still significantly worse than Japanese native speakers. Consequently, lexical encoding alone is not enough to achieve accurate production. Even if learners can create a lexical representation where a geminate consonant is lexically encoded as a poor match to the native category or as /singleton+?/, they also have to know what exactly this /+?/ is and how it is realized in speech, i.e. what gestures are necessary to produce the required distinction.

Deviations in lexical encoding and their effects on subsequent production vary among speakers with different language backgrounds. For example, Japanese learners face challenges with the /r-l/ distinction, as this distinction is not present phonemically in their native language, whereas Arabic speakers tend to confuse /p-b/ (Ota et al., 2009), due to the fact that they lack this specific voicing contrast. Weber, Broersma and Aoyagi (2011) investigated spoken word recognition in foreign accented speech and found that deficiencies of L2 word recognition, such as the activation of multiple candidates, or phantom words, and blurring the distinction between minimal pairs, can actually be

beneficial for L2 listeners. When Dutch and Japanese listeners, who do not have the sound /æ/ in their native phonemic inventories, were presented with the pseudoword /ekt/ recorded by a Dutch speaker, they showed cross-modal priming for the real word /ækt/. However, when the same listeners were presented with the Japanese-accented pseudoword /hapi/, only Japanese listeners showed priming effects for the word /hæpi/. Thus, it seems that foreign-accented words can facilitate word recognition if the listener and the speaker share the same language background or if the difference between the standard and the accented variants is not perceptually salient.

2.2.5. Summary

Native and L2 word recognition includes many of the same processing mechanisms but they differ in the way the word processing unfolds. L1 word recognition is accurate, speedy and effortless. L2 word processing, on the other hand, is slower and less accurate due to the activation and subsequent competition of redundant candidates or phantom words. The lexical encoding of L2 phonological contrasts develops independently of the ability to perceive them in speech. Accurate perception does not ensure accurate lexical encoding, just as the inability to perceive a phonetic contrast does not prevent learners from creating lexical representations. No matter whether learners can or cannot perceive the contrast, it is possible that lexical representations of nondominant categories remain imprecise and accessed asymmetrically due to deficiencies in encoding. However, with language experience and exposure, learners can refine their lexical representations to resemble those of native speakers. The interaction between lexical encoding and production shows that accurate lexical encoding does not

necessarily lead to accurate production. Nonetheless, inaccurate production can still activate the required words due to the peculiarities of L2 word recognition. It still remains unclear whether accurate production entails accurate lexical encoding. Do learners who can produce a specific phonological contrast also develop stable lexical representations of minimal pairs with this contrast?

2.3. Effects of orthography

This section investigates the effects of orthography on L1 and L2 processing with a special focus on the interaction between orthographic knowledge and L2 phonological development. Specifically, it examines how orthography influences the perception, production and lexical encoding of nonnative consonants and vowels, and whether this effect is facilitative or inhibitory.

2.3.1. Orthography in the native language

Orthographies differ with respect to how much information a written or printed symbol represents in a given language. For example, in Chinese, one symbol, or character, can represent an entire word, e.g., 山 [shan] ‘mountain’. In German, on the other hand, one symbol or a sequence of symbols represents only one phoneme, e.g., in the word <Buch> [bux] ‘book’, the letters and <u> represent the corresponding phonemes /b/ and /u/ and a sequence of letters <ch> represent a phoneme /x/. Languages can also differ with respect to what script they employ to convey information and which classes of sounds they represent in their orthographies (Mihalicek & Wilson, 2011). For instance, abjads represent only consonants, although modern abjads have symbols or

diacritics for some of the vowels, and use Arabic or Hebrew scripts, which are written from right to left, e.g., the Arabic word <قلم> [qalam] ‘pen’ consists only of three consonant letters <ق>, <ل>, <م>. Alphabets, unlike abjads, represent both consonants and vowels using the Roman or Cyrillic script, e.g., the Belarusian word <мапа> [malpa] ‘monkey’ written in the Cyrillic script has three consonant letters <М>, <Л>, <П> and two vowels <а>. Orthographies can encode only segmental information or both segmental and suprasegmental information. For instance, in Pinyin, which is the official phonetic system used to transcribe the pronunciation of Chinese characters, the four lexical tones are explicitly marked on nucleus vowels with respective diacritics, e.g., bā ‘eight’, bá ‘pull’, bà ‘father’, bǎ ‘grasp’, ba ‘suggestive particle’.

According to the Orthographic Depth Hypothesis (Frost & Katz, 1992), orthographies can be classified as shallow or transparent and deep or opaque. In transparent orthographies, the grapheme-phoneme correspondences are relatively straightforward and the pronunciation of words can largely be predicted from the spelling, e.g., Italian or Spanish. In opaque orthographies, the relationship between letters and the sounds that they are associated with is much more complicated and lacks transparency. These orthographies do not have a one-to-one correspondence between graphemes and phonemes and can contain unusual pronunciations of certain words, e.g., English or French. The Orthographic Depth Hypothesis states that it is easier for native speakers of languages with transparent orthographies to learn to read due to consistent and relatively simple grapheme-phoneme correspondences. Transparent orthographies allow readers to decode words prelexically, i.e. by mapping letters to sounds one by one. Native speakers of languages with opaque orthographies have to rely more on lexical

decoding of words, which means that readers decode the meaning of a word before they decode its phonemes.

In order to acquire the orthography of another language, learners have to master new grapheme-phoneme representations and, perhaps, a new script. They also have to develop awareness of how congruent or incongruent grapheme-phoneme correspondences are in their native and second languages. For example, the grapheme <w> in Polish denotes the sound /v/ in <woda> /voda/ ‘water’, whereas in English it corresponds to a glide /w/ <water> /wɔrə/. Moreover, learners should know that even congruent phoneme-grapheme correspondences can be context-dependent. In English and French, the letter <t> represents the same phoneme /t/, however, word-finally in French it is not always produced; compare English <cat> /kæt/ and French <chat> /ʃa/ ‘cat’. Also, L2 learners have to pay attention to the potential lack of congruency between auditory and visual-orthographic input in the target language, especially when learners come from a language with a transparent orthography. For instance, in English the same digraph <ea> can be pronounced as /i/ and /e/, e.g., <meat> [mit] and <steak> [stek].

Research on the role of orthography in L1 processing suggests that orthography has an effect on different areas of phonological development, such as perception, lexical encoding and production (e.g., Bürki, Spinelli, & Gaskell, 2012; Bürki, Alario, & Frauenfelder, 2011; Chereau, Gaskell, & Dumay, 2007; Dijkstra, Roelofs, & Fieufs, 1995). A study by Chereau et al. (2007) examined the involvement of orthographic information in speech perception. The participants of the study were British-English native speakers who performed a series of unimodal auditory priming tasks with offset overlap. In the test condition, targets (e.g., spoke) and primes (e.g., broke and cloak)

overlapped phonologically. However, the degree of orthographic overlap varied between the targets and the primes, i.e. the orthographic overlap in the rime between ‘spoke’ and ‘broke’ was much stronger than between ‘spoke’ and ‘cloak’. Participants’ responses were significantly faster when the targets and primes overlapped orthographically than when they did not. This effect was replicated in a speeded and reversed lexical decision tasks. The authors concluded that the observed orthographic boost is the result of the mandatory activation of orthographic representations during spoken word recognition.

Another study by Bürki et al. (2012) found that even a single exposure to orthographic representations could change the content of the mental lexicon. The participants of the study, French native speakers, attended a four-day training to learn the auditory forms of pseudowords used to denote nonobjects. The pseudowords were reduced, i.e. there was no schwa sound in target clusters, e.g. [plur]. On day 4 the participants were exposed once to the orthographic representations of the words that they had learned. Half of the words contained <e>, viz. the orthographic representation of the schwa, e.g., <pelour>, whereas the other half did not, e.g., <plour>. When the participants performed a subsequent naming task, they used a schwa to produce pseudowords that were written with <e>. This effect remained stable even on the following day. Moreover, in a recognition task, the participants tended to erroneously accept pseudowords with a schwa as items learned during their four-day training, even though the participants had been exposed only to non-schwa variants. These findings suggest that even a brief exposure to orthography can have an impact on the stored representations of words and their production. Consequently, when L2 learners start to acquire another language, they are likely to transfer these strong relationships between orthography and other domains of

phonological development into their L2. At the very least, literate learners are likely to expect that such relationships exist in L2. The following three sections will investigate how orthography affects L2 perception, lexical encoding and production.

2.3.2. Orthography and perception

Acquiring L2 phonology implies breaking the perceptual barrier that the native language system creates. As stated earlier in this chapter, learners tend to assimilate or merge similar L2 categories to a single category in their native language. For example, Spanish learners of English tend to assimilate English /i/ and /ɪ/ to their Spanish category /i/ (e.g., Flege, Bohn, & Jang, 1997), whereas English learners often assimilate French /u/ and /y/ to their English category /u/ (e.g., Levy & Strange, 2008). An important question is whether orthography can play a role in phonological processing or acquisition. Simon, Chambless and Kickhöfel Alves (2010) investigated whether learners' exposure to orthographic representations had a positive effect on the acquisition of a new phonological contrast. The participants of their study were native speakers of American English without any formal instruction in French or German beyond high school. During the word-learning stage, they were assigned to one of the two groups. The 'Sound Only' group saw pictures of objects, e.g., a banana or a boat, that were associated with nonwords alternating in vowels /u/ and /y/ and heard pronunciation of those words, e.g., /dyʒ/ or /duʒ/. The 'Sound – Spelling' group was additionally provided with the spelling of the words <dûge> or <douge>. Then the participants were tested on an AXB categorization task using new stimuli with the same contrast. Although the 'Sound-Spelling' group were more accurate than the 'Sound Only' group, the difference was not

significant. The participants' accuracy rates from the two groups ranged from 68.8% correct to 100% in both groups. Thus, the availability of orthographic information does not seem to significantly contribute to better perceptual discrimination of a new phonological contrast. One of the explanations that the authors provided to account for the absence of a positive orthographic effect concerns the interference of the native orthography. Since English belongs to languages with opaque orthographies, which lack one-to-one mappings of graphemes to phonemes, it is possible that American English learners were not used to utilizing orthographic representations to the full extent than speakers with a transparent orthography might be able to.

Escudero and Wanrooij (2010) found evidence of how reliance on transparent orthography of the native language can facilitate perception of phonetic contrasts in the L2. The participants of their study were beginning and advanced Spanish-speaking learners of Dutch, who were tested on their acquisition of the five Dutch contrasts /a - ɑ/, /i - ɪ/, /y - ʏ/, /i - y/ and /ɪ - ʏ/. The participants performed an XAB categorization task and an orthographic task. In the orthographic task, the participants heard vowel tokens and were asked to choose their answers from the orthographic representations of the 12 Dutch vowels. The results of the study showed no significant difference between beginners and advanced learners on the XAB task. The contrast /a-ɑ/ was found to be the most difficult in the XAB task for both groups of learners. However, the results of the orthographic task showed that /a/ and /ɑ/ were identified significantly better than the other vowels. The authors explained this asymmetry in learners' performance by the fact that the corresponding orthographic representations of <aa> and <a>, available in the orthographic task but not in the XAB, alerted learners to the durational cue that

differentiates the contrast /a/ and /ɑ/. Since Spanish orthography is transparent, Spanish-speaking learners must have decoded vowel quantity in Dutch using orthographic representations: <aa> was used for a longer sound, whereas <a> for a shorter sound. The same effect was not found for /y - ʏ/, which are represented in the Dutch orthography by <uu - u>. Unlike /a - ɑ/, these two vowels have spectral rather than durational differences. Therefore, it seems that orthography has a facilitative effect when both auditory and orthographic information reinforce the same distinction.

In another study, Escudero (2015) provided additional evidence that the effect of orthography was present only in contrasts that have already been acquired. The participants of the study were Australian English-speaking and Spanish-speaking participants with and without knowledge of Dutch who were tested on novel Dutch pseudowords with perceptually easy vowel contrasts (e.g., /a - i/) and perceptually difficult contrasts (e.g., /y - ʏ/). One group of participants was exposed only to auditory forms during a word-learning stage, whereas the other could also see spelled forms. During the testing phase learners performed a word-recognition task. Results showed that regardless of learners' language background, no effect of orthography was found for nonminimal pairs and perceptually easy minimal pairs. The effect of orthography was only present for two out of the seven perceptually difficult minimal pairs. These two contrasts /ɪ - y/ and /ɪ - ʏ/ also had high to intermediate accuracy rates in the audio only condition, suggesting that orthography acted as a redundant or extra cue to enhance differences that could already be perceived. Contrary to Escudero and Wanrooij (2010), no effect of orthography was found for /a - ɑ/, which might point to the possible methodological limitations discussed below in this section.

The previous studies examined the effect of orthography on the perception of vowels. Pytlyk (2011) conducted a study to examine the effect of orthography that is shared between L1 and L2 on the perception of L2 consonants. Seven pairs of English and Mandarin phonemes were selected that shared the same letters in English and Pinyin, e.g., the letter <z> represents the sound [z] in English and the sound [ts] in Pinyin. Canadian English native speakers, who had no previous instruction in any Chinese language, were assigned to one of the three groups. Each group received 3 lessons of 1.5 hour each. Participants in the Pinyin group were taught all Mandarin phonemes through the alphabetic system of Pinyin, which uses the Roman alphabet like English. Zhuyin group was taught the same Mandarin phonemes using Zhuyin, a syllabary system that uses character-like symbols. The control group received the same instruction but without the use of orthography. All three groups completed a pretest and a posttest, which was administered through an oddball discrimination task using English and Mandarin phonemes that are represented by the same graphemes in English and Pinyin, viz. <c, z, s, ch, sh, r, h>. The prediction was that the Pinyin group would perform worse than the Zhuyin group because the former group shares orthography with English, which could cause confusion, whereas the Zhuyin group uses a completely different orthography based on character-like symbols. The results found no differences in the perceptual performance of the three groups, which suggests that orthography had little effect on sensitivity to the L1-L2 sound pairs.

It seems logical to expect that orthography should facilitate perception by emphasizing auditory differences that are also represented through written form. However, in practice it turns out that orthography has a marginal, if any, effect on the

perception of phonological contrasts. Even the positive effect that was found in Escudero and Wanrooij (2010) concerning the Dutch vowels /a - ɑ/ was not replicated with a similar group of participants in a later study by Escudero (2015). The lack of consistent evidence in this line of research can indeed mean that there is an absence of interaction between perception and orthography. However, there are other factors that can explain the difficulty of observing reliable benefits. For example, studies often include a training session to familiarize learners with the new contrasts that lasts an hour on average. This period of time might not be enough for participants to receive enough exposure to establish stable grapheme-phoneme correspondences (Pytlyk, 2011; Simon et al., 2010). Secondly, the auditory stimuli of the same phoneme can be variable, especially if they are produced by several speakers. As a result, learners might fail to assimilate different acoustic realizations to the same phoneme. Simon et al. (2010) note that if learners cannot overcome acoustic variability in the input, the fact that in orthography these various realizations are represented by the same letter can be of little help, especially for learners whose native orthography is opaque. On the other hand, learners' perception of the contrast can be so good that it is hard to pinpoint orthographic effects in their performance. Pytlyk (2011) also raises the question of cognitive load in different conditions that can be overruled when performance in those different conditions is compared to each other. Participants in the Pinyin group, who shared orthography with English, could have exerted most of their effort trying to establish differences between grapheme-phoneme correspondences that exist in both languages. The Zhyuin group had higher demands placed on them to master a completely unfamiliar script and map the new graphemes to the new phonemes. The control group had the most challenge coming from

the lack of any orthographic support when learning new Chinese phonemes. Thus, all three groups had different sources of cognitive load, which might have evened out in the comparison. More research is needed to uncover the true nature of interaction between perception and orthography.

2.3.3. Orthography and lexical encoding

The relationship between orthography and lexical representations has been extensively explored in both L1 and L2 (Cutler, Weber, & Otake, 2006; Escudero, Hayes-Harb, & Mitterer, 2008; Hayes-Harb & Matsuda, 2008; Showalter & Hayes-Harb, 2013, 2015; Weber & Cutler, 2004). Escudero, Hayes-Harb, and Mitterer (2008) examined whether orthography has a facilitative effect on establishing novel lexical contrasts. The participants of their study were highly proficient Dutch-English bilinguals who were asked to memorize nonwords alternating in / ϵ - æ /. One group of participants was exposed only to auditory forms during a word-learning stage, whereas the other group was exposed to both auditory and written forms. During the testing phase learners performed a four-way forced choice task using an eye-tracking paradigm. Learners who were exposed to auditory forms only exhibited symmetric confusion when listening to the beginning of two novel words that alternated in the target vowels, e.g., <tenzer> / $\text{t}\epsilon\text{nz}\text{ə}$ / vs. <tandek> / $\text{t}\text{æ}\text{nd}\text{ək}$ /. This suggests that lexical representations for the two items of a pair did not encode the / ϵ - æ / contrast with different vowels. Rather, the symmetric activation pattern suggests that the first syllable of both novel words was encoded as the same homophonous syllable / $\text{t}\epsilon\text{n}$ / in the L2 lexicon. Learners who were exposed to both auditory and visual forms showed asymmetric lexical activation: / ϵ / targets received more

eye-fixations than /æ/. This asymmetric activation pattern suggests that the /ε - æ/ contrast was encoded as separate representations at the lexical level as a result of orthographic exposure. Orthography seemed to have had a positive effect on differentiating between two categories and establishing a lexical contrast for novel words with a difficult alternation.

Orthography was also found to have a facilitative effect not only at the segmental but also at the suprasegmental level. Showalter and Hayes-Harb (2013) investigated whether native speakers of American English without any knowledge of Mandarin utilized orthographic tone marks to encode new words with lexical tones. The participants were assigned to one of two groups. In the ‘Tone Marks’ group, the participants were exposed to pictures of nonobjects and associated nonwords written in pinyin with tone marks, whereas in the ‘No Tone Marks’ group, the participants saw orthographic forms without tone marks. After a word learning phase and a criterion test, the participants performed an auditory word-picture matching task. The ‘Tone Marks’ group performed significantly better on the auditory word-picture matching task than the other group. In the second experiment, the participants were asked to match spelled forms to auditory forms in order to determine whether the participants learned the correspondences between auditory forms and tone marks. The ‘Tone Marks’ group performed significantly above chance (65% correct), whereas the performance of the participants in the ‘No Tone Marks’ groups was not significantly different from chance (51% correct). Taken together, these results suggest that, overall, orthography had a positive effect on the lexical encoding of the tonal contrasts.

Hayes-Harb, Nikol, and Barker (2010) set out to examine whether incongruent

letter-sound mappings introduced by the native orthography could have an effect on the phonological form of new words. The participants of the study were American English speakers who were assigned to one of three groups for a familiarization stage in which they learned nonwords. Participants in the ‘Congruent Orthography’ group were only presented with the spelling of the nonwords that conformed to English. Participants in the ‘Incongruent / Congruent Orthography’ group were presented with both congruent nonwords and incongruent nonwords, which contained either a silent letter or an altered grapheme-phoneme correspondence. For example, the spelled forms were <kamand> and <faza>, whereas the respective spoken forms were /kaməd/ and /fɑʒə/. The auditory group was exposed only to the pronunciation of target nonwords. Then all the groups performed an auditory word-picture matching task. The results showed that learners who were exposed to incongruent grapheme-phoneme correspondences experienced interference from their native orthography and performed less accurately than the participants in the ‘Congruent Orthography’ group and ‘Auditory Only’ group. Moreover, changing a letter-sound mapping, e.g. <z> for /ʃ/, had a more detrimental effect on learners’ performance than adding a silent letter, e.g., <n> in the example <kamand>, perhaps due to wide use of silent letters in English. Thus, grapheme-phoneme correspondences that differ in the native and second languages can lead to the development of inaccurate lexical representations.

Generally speaking, the effect of orthography on lexical encoding is well documented and mostly positive, especially in the formation of separate lexical representations for minimal pairs that are hard to perceive. However, Cutler (2015) cautions that creating lexical contrasts without perceptual support can result in more

disadvantages than benefits. She argues that misperceiving and encoding minimal pairs as homophones, does not create an insurmountable problem for the language. For example, replacing /æ/ with /ɛ/ adds 137 homophones to the English lexicon according to Cutler (2005). A much more serious problem arises by temporary overlap among words, which results in increased competition and processing delays for learners. In this case, not only minimal pairs compete but also words embedded in context. Cutler (2005) claims that 7090 spurious embeddings arise if /æ/ is confused with /ɛ/. Broersma and Cutler (2011) examined learners' sensitivity to embedded-word competitors, using a cross-modal priming paradigm. Their participants performed a lexical decision task for visual stimuli, when listening to words. Dutch learners of English showed priming effects on the visual stimuli 'deaf' when they heard 'deaf' [dɛf], 'def' [dɛf] (extracted from the word 'definite') and 'daff' [dæf] (extracted from the word 'daffodil'). When Dutch participants were presented with the untruncated word 'definite', priming effects for 'deaf' disappeared because longer words suppress the activation of the shorter words embedded within them, even though the lexical representations of these shorter words can be briefly activated. However, when the learners were presented with the word 'daffodil', the activation of the word 'deaf' remained. Cutler (2015) argues that if learners had stored 'daffodil' as 'd[e]ffodil' using the dominant category /e/, then the situation would have been similar to 'definite' and word competition would have been less because the learners would not have activated the word 'deaf'.

To sum up, orthographic knowledge seems to be useful in establishing lexical contrasts that are hard to discriminate in perception, because orthography can explicitly signal where the difference in the minimal pair is located. However, it can also mislead

learners if there are incongruences in grapheme-phoneme correspondences in the native and second languages or perceptual differences between the sounds in a contrast lack salience. Moreover, using orthography as a shortcut to establish lexical contrasts in the absence of perceptual support can aggravate word competition and hinder word recognition. Hearing a word with a nondominant category that has a fuzzy representation can result in the asymmetric lexical access, when learners simultaneously activate words with dominant and nondominant categories. Consequently, even though orthography has the potential to facilitate lexical encoding of perceptually challenging contrasts, it can also negatively affect their L2 processing.

2.3.4. Orthography and production

Knowing grapheme-phoneme correspondences that exist in a specific language allows learners to encode words and sound into a written format and decode written words into sounds. However, due to the incongruence in letter-sound correspondences between the native and target languages, orthography has a serious potential to also mislead learners in their production. Bassetti and Atkinson (2015) examined the pronunciation of experienced Italian learners of English and found that orthography had an impact on their articulation of certain sounds. ‘Silent letters’, e.g., /l/ in ‘walk’ were overtly realized 85% of the time in a read-aloud task and 56% of the time in a word-repetition task. Digraph vowels were produced with 14% longer duration than single-letter vowels, e.g., ‘seen’ vs. ‘scene’. Only 30% of words that require a voiceless consonant in the participle ending <-ed> were actually produced with a voiceless consonant, 50% ended with [d] and another 20% with an epenthetic vowel [Vd].

Homophonic pairs were realized as nonhomophonic 40% of the time, e.g., ‘sun’ vs. ‘son’.

According to the authors, the reason why Italian learners who studied English for an average of ten years made these pronunciation mistakes can be accounted by the differences in the depth of English and Italian orthographies. Italian has a transparent orthography with a one-to-one relationship between phonemes and graphemes, whereas English has an opaque orthography. Therefore, Italian learners are used to mapping graphemes onto phonemes on a one-to-one basis and might apply this strategy to English. The same effect was found in an earlier study by Bassetti (2007), when learners recruited at an Italian university, who had studied Chinese for at least 2.5 years, mispronounced Chinese words written in pinyin. The orthographic convention requires three Chinese rhymes /uei/, /iou/ and /uən/ to be spelled as <wei>, <you> and <wen> when there is no consonantal onset, and as <ui>, <iu> and <un> when the rhyme is preceded by a consonant. When reading the words, learners tended not to pronounce the vowels /e/, /o/ and /ə/ when they saw the orthographic representations <ui>, <iu> and <un> and produced a vowel when exposed to <wei>, <you> and <wen>. Bassetti conjectures that the participants were following the approach of their native transparent phonology. They produced the sounds when they saw the corresponding letters and omitted the sounds when the corresponding letters were omitted in spelling.

The effect of native orthography and specifically the influence of its depth on nonnative speech were examined by Erdener and Burnham (2005). In their study, Turkish speakers, whose orthography is transparent, and Australian English speakers with an opaque orthography were tested on the production of Spanish (transparent) and Irish (opaque) nonwords. During the familiarization stage, the participants were exposed to

each of the four conditions: auditory-only (participants heard the words), auditory-visual (participants heard the words and saw the lower part of the speakers' face producing them), auditory-orthographic (participants heard the words and saw their spelling) and auditory-visual-orthographic (participants heard the words, saw the lower part of the speakers' face producing them and saw the spelling of the words). During the testing phase, the participants performed a word-repetition task and a writing task in the orthographic condition. The results showed that Turkish and Australian participants made fewest errors when spelling was provided and most errors in the auditory-only condition. Overall, Turkish participants made fewer phonetic errors than Australian English speakers in nonorthographic conditions. However, in orthographic conditions, performance was modulated by target language: Turkish participants outperformed Australians on the Spanish nonwords but made more errors than Australian English speakers on the Irish nonwords. The authors argued that Turkish participants had an advantage in Spanish because they were used to straightforward relationships between graphemes and phonemes in their native (transparent) orthography and they had successfully transferred this approach to Spanish. However, this approach led to many additional mistakes when producing nonwords in Irish that has an opaque orthography. Speakers of Australian English did not differ in their performance on Spanish and Irish nonwords. Since English has an opaque orthography, Australian participants were not used to taking advantage of the supplied spelling, which is why their performance on Spanish nonwords did not differ from their performance on Irish nonwords.

Concluding, orthography has the potential to affect production in a negative and positive way. Orthographic depth of the native language affects the way learners operate

the orthography of their L2 . On the one hand, if learners' native orthography is transparent, they are likely to believe that the relationship between sounds and graphemes in the L2 is also one-to-one. This transfer can be helpful if L2 orthography is indeed transparent, but it can be harmful if the L2 orthography is opaque. Incongruences in letter-sound correspondences will result in pronunciation mistakes. On the other hand, learners with an opaque native orthography can be too cautious to rely on the orthography of the L2 because they are aware of the complexities that orthography can embody. This awareness can certainly help avoid mistakes, but it can also prevent learners from utilizing the benefits that orthography can offer.

2.3.5. Summary

Orthography reveals a different face in its interactions with perception, production and lexical encoding. The availability of orthographic representations does not have a strong effect on improving perceptual sensitivity. Difficult contrasts that have already been acquired perceptually to a certain degree can be further reinforced by orthographic representations. However, for contrasts that cannot yet be discriminated in perception, orthography offers little help in improving their perception. Orthography seems to be beneficial for the lexical encoding of phonological contrasts, especially if learners cannot differentiate them in perception. If learners perceive two words in a minimal pair as homophones, orthography explicitly signals them where the difference is located. This knowledge can help learners encode two words in a minimal pair separately. Unfortunately, the side effect of such interaction might be imprecise lexical representations, asymmetric lexical access, increased word completion and slower word

recognition. Finally, the effect of orthography on production is closely related to the nature of the native orthography. Similarities in the depths of orthographies employed by native and second languages can have a facilitative effect, whereas differences in the depths of orthographies can lead to pronunciation mistakes due to incongruent grapheme-phoneme correspondences in native and second languages.

Chapter 3. Palatalization in Russian

Palatalization is a secondary feature of articulation. When two simultaneous articulations have different degrees of constriction, the one with more prominence is called primary articulation. Secondary articulation is an articulation of a lesser degree of stricture, approximant or vowel-like in nature, accompanying a primary articulation of a higher degree, without concealing or changing it (Ladefoged & Maddieson, 1996). For example, compare /l/ in the English words ‘lime’ and ‘ball’. In the word ‘ball’, /l/ is produced with a secondary feature of velarization, which requires “the superimposition of an unrounded high back vowel [ɤ]-like articulation, raising the back of the tongue toward the velum” (Reetz & Jongman, 2009, p. 61). In English, secondary articulation of velarization is not phonemic, which means that even if speakers do not velarize /l/ in the word ‘ball’, the meaning of the word does not change. However, in Marshallese, velarization is phonemic and is utilized to differentiate words, e.g., [m^xatʃ] ‘eel’ vs. [matʃ] ‘eye’ (Reetz & Jongman, 2009). There are different types of secondary articulations, such as labialization, palatalization, velarization and pharyngealization, among the most common. The goal of this chapter is to examine secondary articulation of palatalization in Russian and its acquisition by learners of other languages. Section 3.1 explores palatalization in the Russian language from different perspectives, including historical, phonological, acoustic and articulatory. Section 3.2 describes how Russian palatalized consonants are represented in orthography. Section 3.3 investigates the acquisition of palatalized consonants by learners of Russian.

3.1. Secondary articulation of palatalization in Russian

This section introduces the notion of palatalization in Russian. It provides a phonemic inventory of palatalized consonants in Russian and their distribution.

Palatalized consonants are compared to plain consonants in their articulatory and acoustic properties. The main controversies surrounding Russian palatalization are discussed.

3.1.1. Phonological description of palatalization

Palatalization, which prevails in the Russian language, is “the superimposition of a raising of the front of the tongue toward a position similar to that for /i/ on a primary gesture” (Ladefoged & Maddieson, 1996, p. 363). In Russian linguistics, palatalized consonants are called ‘soft’ and nonpalatalized or plain consonants are called ‘hard’. Historically, palatalized consonants used to be allophones that occurred before front vowels, e.g., <дѣва> /dʲeva/ ‘girl’ (Elkina, 1960). Old Russian had an open syllable structure. Palatalized consonants word-finally appeared as a result of the fall of the ‘jers’, when high front lax vowels called ‘front jers’ disappeared, the consonants that they followed remained palatalized, e.g., /solʲi/ → /soli/ ‘salt’. The contrast between palatalized and plain consonants in Russian developed roughly one thousand years ago (Padgett, 2003b). The secondary articulation of palatalization is phonemic and affects almost all consonants. For instance, in the Russian word /lʲuk/ ‘manhole’, the initial consonant is palatalized. If a speaker fails to produce palatalization in the initial consonant, the meaning of the word will change and become /luk/ ‘onion’.

In contemporary Russian, there are 15 palatalized (soft) consonants that are paired with plain (hard) consonants (Table 3.1):

Table 3.1

Consonant inventory in contemporary Russian (Padgett, 2003a)

	Labial		Dental		Post-alveolar		Palatal	Velar	
Stop	p	p ^j	t	t ^j				k	k ^j
	b	b ^j	d	d ^j				g	g ^j
Fricative	f	f ^j	s	s ^j	ʃ	ʃ:		x	x ^j
	v	v ^j	z	z ^j	ʒ				
Affricate			ts			tʃ			
Nasal	m	m ^j	n	n ^j					
Lateral			l	l ^j					
Rhotic			r	r ^j					
Glide							j		

The palatalized status of velar consonants is a controversial issue in Slavic linguistics. Since palatalized velars have a very limited distribution in the Russian language, they can be argued to be allophones rather than separate phonemes. Palatalized velars occur before the front vowels /i/ and /e/, whereas plain counterparts occur before back vowels /u/, /o/ and the low central vowel /a/. There is only one originally Russian near-minimal pair, in which /k/ alternates with /k^j/ in front of the back vowel /o/: /kot/ ‘cat’ – /tkiot/ ‘(he) weaves’. In loanword phonology, no specific rules are observed. Velar stops can be palatalized before back vowels, for instance, /g^jote/ ‘Goethe’ or /k^jurij/ ‘Curie’, or remain plain before the front vowels /i/ and /e/, e.g., /xempʃir/ ‘Hampshire’ or /kirgiz/ ‘Kirghiz’.

There are six other phonemes that do not have palatalized or plain counterparts. The consonants /ʃ/, /ʒ/ and /ts/ remain always hard, whereas /tʃ/, /ʃ:/ and /j/ are always soft. Although /ʃ/ and /ʃ:/ look similar, they do not form a privative opposition. The phoneme /ʃ:/ can also be pronounced as a sequence of sibilants /ʃtʃ/ (Jones & Ward, 1969). The former variant is characteristic of the Moscow dialect, whereas the latter is typical of the Petersburg dialect (Avanesov, 1972).

Palatalized consonants can occur in the word-initial, word-medial and word-final positions, both before vowels and consonants, e.g., palatalized /lʲ/ in the words /lʲod/ – ‘ice’, /bolʲnoʲ/ – ‘sick’ and /nolʲ/ – ‘zero’ (Table 3.2).

Table 3.2

Minimal pairs with alternating plain and palatalized consonants in the word-initial and word-final positions

Place of articulation	Contrast	Word position	
		Initial	Final
Labial	p – pʲ	/pil/ ‘zeal’ – /pʲil/ ‘(he) drank’	/top/ ‘cami’ – /topʲ/ ‘bog’
	b – bʲ	/bil/ ‘(he) was’ – /bʲil/ ‘(he) beat’	/pogʲib/ ‘(he) perished’ – /pogʲibʲ/ ‘camber’
	f – fʲ	/grafa/ ‘column’ – /grafʲa/ ‘lined, participle’	/ʃtof/ ‘1.23 liter, old Russian liquid measure’ – /ʃtofʲ/ ‘heavy silk’
	v – vʲ	/vil/ ‘(he) howled’ – /vʲil/ (he) twined	/krov/ ‘shelter’ – /krovʲ/ ‘blood’
	m – mʲ	/mil/ ‘(he) washed’ – /mʲil/ ‘dear, short adjective’	/tʲem/ ‘that, Dative, plural’ – /tʲemʲ/ ‘darkness’
Coronal	t – tʲ	/tok/ ‘current’ – /tʲok/ ‘(he) flowed’	/mat/ ‘mat; checkmate; swear word’ – /matʲ/ ‘mother’
	d – dʲ	/dima/ ‘smoke, Genetive, singular’ – /dʲima/ ‘Dima, proper name’	/klad/ ‘buried treasure’ – /kladʲ/ ‘load’
	s – sʲ	/sok/ ‘juice’ – /sʲok/ (he) whipped	/vʲes/ ‘weight’ – /vʲesʲ/ ‘all’
	z – zʲ	/zov/ ‘call’ – /zʲov/ ‘pharynx’	/vʲaz/ ‘elm’ – /vʲazʲ/ ‘Cyrillic calligraphy’
	n – nʲ	/nos/ ‘nose’ – /nʲos/ ‘(he) carried’	/kon/ ‘game, round’ – /konʲ/ ‘horse’
	l – lʲ	/luk/ ‘onion’ – /lʲuk/ ‘manhole’	/ugol/ ‘corner’ – /ugolʲ/ ‘coal’
	r – rʲ	/rad/ ‘glad, short adjective’ – /rʲad/ ‘row’	/sir/ ‘cheese’ – /sirʲ/ ‘dampness’
Dorsal	k – kʲ	/kot/ ‘cat’ – /tkʲot/ ‘(he) weaved’	Palatalized velars are not used word-finally.
	g – gʲ	/god/ ‘year’ – /gʲote/ ‘Goethe’	
	x – xʲ	/xempʃʲir/ ‘Hampshire’ – /xʲek/ ‘hake’	

Minimal pairs with plain and palatalized consonants in word-medial position are less common than in the word-initial or word-final positions. Consider examples from (Padgett, 2003a): /polka/ ‘shelf’ - /polʲka/ ‘polka dance’, /gorʲka/ ‘hill’ - /gorʲko/ ‘bitterly’.

Also, due to the regressive softness assimilation rule that is active in Russian, consonants at morpheme boundaries that are followed by palatalized consonants can also become palatalized. However, this rule does not affect all the consonants; it is more likely to affect consonants with similar places of articulation (Hamilton, 1980), e.g., /zont/ ‘umbrella’ vs. /zonʲtik/ ‘umbrella with a diminutive suffix /-tik/’.

Thus, palatalization is indeed an inseparable part of Russian phonology. Almost half of the Russian consonants are palatalized. They can occur in any prosodic position. If L2 learners fail to acquire palatalization in Russian, it will be reflected in their perceptual abilities, lexical encoding and, obviously, production.

3.1.2. Articulatory features of palatalization

Secondary articulation is closely intertwined with the primary articulation of the consonant and strongly affects the gestural score of that consonant. Bondarko (2005) notes that the impact of the secondary articulation of palatalization can be so strong that a new type of articulation emerges. For example, the production of palatalized coronals /tʲ/ and /dʲ/ requires that the blade of the tongue is behind the teeth for their primary articulation, whereas the front of the tongue touches the hard palate for the secondary articulation. Although the constrictions are expected to happen simultaneously, Jones and Ward (1969) note that the palatalization of coronal stops can result in affrication.

In the plosion of tʲ, the closure made by the blade against the teeth-ridge is released just before the front of the tongue moves away from the hard palate. As a result of this the blade and the front of the tongue are, for a fraction of a second, in a position similar to that for Russian sʲ, and a *very* short fricative element, like Russian sʲ, is heard. (Jones & Ward, 1969, p. 104)

Another example of a significant change in articulation due to palatalization is the coronal trill /rʲ/. According to Bondarko (2005), the articulation of the palatalized /rʲ/

becomes similar to that of a fricative due to the increased noise components and the absence of taps characteristic of a trill. Keating (1993) notes that in the case of palatalized velars, secondary articulation actually becomes primary articulation. The place of primary articulation is significantly more advanced toward the front of the mouth in the production of palatalized velars than in the production of plain ones. Labials are the only consonants in Russian, the primary articulation of which remains independent from secondary articulation. Palatalized labials differ from their plain counterparts in the additional gesture of the tongue, which is in the position for /j/ throughout the articulation of a palatalized labial. During the production of a plain labial, the tongue is not engaged (Jones & Ward, 1969).

Even though it seems that palatalization does not have a single and independent realization in articulatory phonetics, Keating (1993) points out that such an articulatory constant does exist: production of palatalized consonants requires that the tongue should be bunched up and moved towards the hard palate. However, combining secondary articulation with distinct primary articulations results in phonemes with different degree of perceptual salience as well as different complexity of gestural scores. Thus, it is likely to expect variability in L2 learners' ability to perceive and produce various palatalized consonants.

3.1.3. Acoustic features of palatalization

In acoustic phonetics, palatalization commonly reveals itself in transitions between consonants and vowels (Bondarko, 2005; Derkach, 1975; Halle & Jones, 1959; Ladefoged & Maddieson, 1996). A vowel that follows a palatalized consonant displays

differences in formants as opposed to a vowel that follows a plain consonant. The first formant (F1) of a vowel following a palatalized consonant is increasing, whereas the second formant (F2) is raised at the beginning of a vowel and then is decreasing throughout the vowel. A vowel that precedes a palatalized consonant has a decreasing F1 and an increasing F2 throughout but these differences are less salient (Figure 1). Vowels that precede or follow plain consonants do not feature such increases or decreases in F1 and especially in F2. Also, the release in palatalized consonants is louder and longer than in plain counterparts (Kochetov, 2002; Richey, 2000).

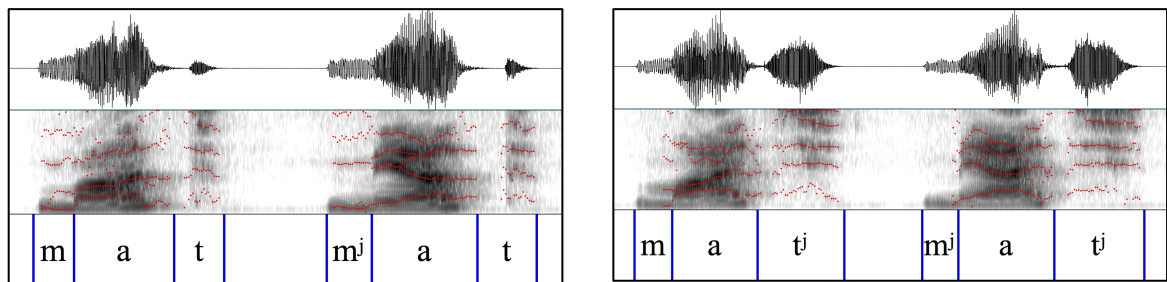


Figure 3.1. Spectrograms of /mat/ ‘mat’, /mʲat/ ‘wrinkled’, /matʲ/ ‘mother’, /mʲatʲ/ ‘to knead’ produced by a female Russian native speaker.

Despite palatalization being considered a feature of consonants (Hamilton, 1980; Jones & Ward, 1969; Kochetov, 2002), the articulatory and acoustic effects of palatalization on the surrounding vowels are substantial. Derkach (1975) examined the degree to which Russian native speakers’ perception of palatalization was dependent on the properties of the vowels following palatalized consonants /sʲ/, /fʲ/ and /xʲ/ in monosyllabic words of VCV structure. In the first experiment, the second vowel was removed and the listeners were presented with VC syllables. As a result, palatalized consonants were perceived as such only 20% of the time. In the second experiment, the VCV sequences were filtered above 1.5 kHz by means of three low-pass filters connected

in succession to attenuate the higher regions of the spectrum by 50 dB, which basically removed F2s. The results showed that the Russian native speakers were able to identify palatalized consonants 80% of the time, which supports the view that F1-transitions alone can provide a robust perceptual cue for palatalization. In the third experiment, the second vowel following the plain consonant in VCV sequences, such as [asa] was replaced with the second vowel extracted from the VCV sequences with a palatalized consonant, such as [asʲa]. Russian native speakers perceived such modified syllables with plain consonants as palatalized. It suggests that perception of palatalization is indeed dependent on the formant values of the subsequent vowels.

Palatalization also has an effect on vowel duration. Ordin (2011) established that if both consonants in CVC syllables are palatalized, the duration of a vowel that is [-back] decreases, whereas the duration of a vowel that is [+back] increases. If the vowel is [+back] and follows a palatalized consonant, the vowel duration also increases. However, the duration of vowels preceding soft consonants is not affected by palatalization in CVC syllables if the first consonant is not palatalized.

To conclude, the most important acoustic cues for palatalization are the first and second formant transitions from consonants into the following vowels. Formant values in vowels that precede palatalized consonants also differ from those that precede plain consonants, but this difference is less salient. In case of palatalized consonants word-finally, the additional acoustic cues, besides the preceding vowel, are the duration and intensity of the release.

3.1.4. Controversies about Russian palatalization

A strong effect of palatalization on the production of vowels and their subsequent fronting, or F2 increase, raises the question among certain scholars of whether even in contemporary Russian the palatalization of consonants is conditioned by vowels and remains allophonic rather than phonemic. Bratkowsky (1980) provides a compilation of evidence supporting her view that Russian has “independently fronted vowels and predictably palatalized consonants” (p. 330). For example, she refers to Jakobson’s work (1929) in historical linguistics to state that those Slavic languages, e.g., Czech, in which the reflexes of front and back Common Slavic vowels (*front jer* <ь> similar to [i] and *back jer* <ъ> similar to [u]) merged, palatalized consonants do not exist either. Indeed, as was already mentioned above, the palatalization of consonants in Old Russian used to be allophonic. The front and back jers followed consonants due to the tendency for open syllables in Old Russian. Over centuries, jers lost their vocalic properties or turned into vowels. However, after the fall of jers allophonic palatalization was ‘phonologized’ (Jakobson, 1929), i.e. consonants that were followed by front jers <ь> remained palatalized. That is why, in contemporary Russian, palatalized consonants occur not only before vowels but also word-finally. Bratkowsky cites the work of several scholars (De Armond, 1975; Lightner, 1972; Pike, 1970) who tried to explain word-final palatalization using different analyses. For example, Lightner (1972) posits a rule that at first adds a vowel after a word-final consonant to palatalize it and then offers another rule that deletes this vowel in the underlying structure. A similar approach is suggested by Pike (1970) who calls word-final palatalized consonants ‘portmanteau phonemes’, which represent consonants with deleted final vowels. Although such alternative accounts can be of

interest to some researchers, Occam's razor, or the principle of parsimony, supports the traditional view that does not require positing any additional rules in the deep structure to account for word-final palatalization.

The reason why such alternative accounts have emerged can be explained by certain related phenomena. First of all, orthography has an effect on how palatalization is perceived by speakers. Plain and palatalized consonants share the same graphemes, whereas subsequent vowels are represented with different letters, e.g., <мат> /mat/ 'mat' vs. <мят> /m'iat/ 'wrinkled'. This orthographic effect will be discussed in more detail in Section 3.2. Bondarko (1966) claims that Russian native speakers treat palatalized and plain consonants differently. When asked to list all the Russian consonants, 90% of the Russian native speakers mentioned only plain consonants and listed palatalized consonants only after they were prompted to do so. Moreover, plain consonants were found to be twice as frequent in Russian as their palatalized counterparts (Bondarko, Zinder & Shtern, 1977). Ten experienced phoneticians transcribed texts of different genres (scientific journals, fiction and newspapers) that contained around 10,000 phonemes each. Then they calculated the frequency of occurrence for each phoneme. The least frequent phonemes in Russian were all palatalized (starting with the least frequent: /xʲ/, /fʲ/, /gʲ/, /zʲ/, /bʲ/, /pʲ/, /kʲ/). The most frequent palatalized consonant was /nʲ/ followed by /lʲ/, /tʲ/, /rʲ/, /sʲ/, /dʲ/, /vʲ/, /mʲ/.

Another controversy that is often mentioned with respect to palatalization is its opposition with velarization. Padgett (2003a, b) argues that plain consonants, especially before front vowels, are velarized and the opposition between plain and palatalized consonants should be reconsidered as the opposition between velarized and palatalized

consonants. Hamilton (1980) also contrasts palatalization with velarization. Jones and Ward (1969) note that plain consonants preceding [u] and [o] are labialized and those preceding [i] velarized. However, Bondarko (2005) and Ladefoged and Maddieson (1996) explicitly state that velarization in Russian affects only plain laterals and velarization cannot be called a contrastive feature in the Russian language.

This dissertation supports the traditional view that palatalization in the Russian language is phonemically encoded in consonants, although it has a salient effect on the phonetic realization of the subsequent vowels. Velarization does not contrast with palatalization. Rather, velarization is a marginal process that affects certain consonants allophonically.

3.2. Orthographic representations of palatalization

Palatalized and plain consonants share the same graphemes in Russian, but palatalization is not opaque. Palatalized consonants are either followed by a letter called the ‘soft sign’ <ь> or by a special set of soft series letters for vowels <и, е, я, ё, ю>. Russian also has a corresponding set of hard series letters for vowels <ы, э, а, о, у> that occur after plain consonants. Thus, although the Russian vocalic system consists of only five vowel sounds /i, e, a, o, u/, it uses ten vowel letters specifically to mark plain and palatalized consonants. In this way, Russian orthography sets a spelling trap for uninformed learners and makes them believe that in minimal pairs like <лук – люк> /luk – liuk/ ‘onion (bow) – manhole’, the initial consonants are the same, whereas the subsequent vowels are different. In reality, however, it is vice versa: the initial consonants are different and the vowels are the same.

The situation with orthographical representations is further complicated by inconsistencies observed in loanwords and a certain class of original Russian words. Consider the words <кафе> /kafɛ/ ‘cafe’ and <кофе> /kofɛ/ ‘coffee’. In the former word, /f/ is plain, whereas in the latter, it is palatalized. However, in the spelling of both words, the fricative is followed by a soft series letter <е>. If the word /kafɛ/ had conformed to the Russian spelling system, it would have been written with a hard series vowel <э> after the plain /f/. Another peculiarity of loanwords is that they can retain plain consonants before /e/ in roots but not at morpheme boundaries, for example, <тест> /test/ ‘test’ vs. <тесте> /testʲɛ/ ‘test, *prepositional, singular*’. In the latter word, the initial /t/ remains plain, even though it is followed by the front vowel /e/; however, the second /t/ is palatalized before /e/ because it is root-final. Antonyuk-Yudina (2010) offers a phonetic account of why stops preceding the front /e/ in Russian borrowings from English are sometimes palatalized and other times not. She claims that the VOTs in stops of the source language, viz. English, affect how native speakers of Russian map these consonants onto Russian palatalized or plain stops. Four native speakers of Russian were recorded producing CV syllables with the stops embedded in a carrier phrase. Four native speakers of English were recorded producing the words ‘kettle, petty, teddy’. The results suggested that the higher VOT in English leads to the stop in Russian being mapped to the palatalized consonant. For example, the VOT of the English /p/ corresponds to or is higher than the VOT of the palatalized stop in Russian; therefore, English borrowings with /pe/ are mapped to palatalized /pʲɛ/, e.g., /pʲermanʲɛnt/ ‘permanent’. The coronals behave differently. English VOTs for /t/ are in between the VOTs for Russian palatalized

and plain stop, which accounts for variability in borrowings that contain coronals, e.g., /tʲɛflon/ or /tɛflon/ ‘Teflon’.

Irregularities in orthography can also be found in original Russian words with sibilants, for example, <шәпот> /ʃopot/ ‘whisper’ and <шорox> /ʃorox/ ‘rustle’. The initial sibilant is followed by a soft series letter <ә>, as well as <o> even though Russian /ʃ/ is not a palatalized consonant. Russian has numerous spelling rules that dictate whether a soft series or hard series vowel letter should be written after sibilants. These rules stem from the historical development of the Russian language (see Hamilton (1980) for an overview of spelling rules).

Despite the fact that there is a lot of indirect evidence in orthography to demonstrate that pronunciation of a consonant changes depending on the vowel that follows, there is also evidence that shows the opposite. Consonant articulation can stay the same even when followed by different vowels in spelling, or it can change when followed by the same vowel grapheme. As a result, such inconsistencies can interfere with the correct lexical encoding of words. Learners, who can neither perceive the difference between palatalized and plain consonants nor identify them in orthography, might erroneously encode minimal pairs, such as /luk –lʲuk/ ‘onion (bow) – manhole’, as homophones in Russian. By contrast, those learners who are familiar with metalinguistic rules and can identify palatalized consonants in orthography might equip themselves with an additional tool that can help them in mastering the difficult Russian contrasts and establishing accurate lexical representations, especially in the absence of perceptual support.

3.3. Acquisition of palatalization in Russian

This section explores the acquisition of palatalized consonants in Russian from the perspective of perception, production and lexical encoding. It also investigates what effect different linguistic features, such as syllable position, place and manner of articulation, have on the acquisition of Russian palatalization by native speakers of different languages.

3.3.1. Perception of palatalized consonants

The perception of palatalized consonants in Russian is the most researched area in L2 acquisition of Russian palatalization (Babel & Johnson, 2007; Bolanos, 2013; Chrabaszcz & Gor, 2014; Diehm, 1998; Kavitskaya, 2006; Kochetov, 2002, 2004; Kulikov, 2011; Larson-Hall, 2004; Lukyanchenko & Gor, 2011; Rice, 2015). As was already stated in Section 3.1, the difference between palatalized and plain consonants is manifested via F2 lowering throughout vowels following palatalized consonants and F2 rising throughout vowels preceding palatalized consonants (e.g., Ladefoged & Maddieson, 1996). Palatalization can also affect the durations of vowels (Ordin, 2011) and consonantal bursts (Kochetov, 2002; Richey, 2000)

Kochetov (2004) investigated whether perceptual salience of palatalized consonants varies between syllable-initial and syllable-final position. Participants of the study, native speakers of Russian and Japanese, performed an identification task on words and nonwords with labial /p-pʲ/ and coronal /t-tʲ/ followed and/or preceded by /a/. Results showed that both Russian and Japanese listeners identified palatalized consonants syllable-initially faster and with a significantly higher accuracy rate than palatalized

consonants in syllable-final position. This suggests that syllable position has a language-independent influence on the perception of consonant contrasts: the syllable-initial position is intrinsically more perceptually salient than the syllable-final position. With respect to individual consonants, both Russian and Japanese listeners identified /p/ and /t/ better than /pʲ/ and /tʲ/. Kochetov explained this asymmetry in the identification of palatalized consonants by differences in the gestures that are employed to produce palatalized coronals and labials. For instance, when producing palatalized labial consonants, lip closure has a lowering effect on F2, which means that the acoustic cue for palatalization, viz. F2 raising, is diminished. As a result, /apʲ/ becomes less salient in comparison to /atʲ/. The lack of audible labial burst in /pʲ/ also contributes to perceptual asymmetry. Consequently, these findings indicate that the perceptual salience of palatalization is dependent upon consonantal features, such as place and manner of articulation, as well as prosodic characteristics of palatalized consonants.

Kavitskaya (2006) also examined the perceptual salience of palatalized consonants in order to determine whether secondary features, in this case palatalization, are as salient as primary features, such as place of articulation and voicing. A Russian native speaker was recorded reading a list of 36 monosyllabic and disyllabic words with the target consonants /p, b, t, d, m, n/ and their palatalized counterparts word-initially followed by the stressed vowels /a, e, u/. Stimuli for the perception experiment were created by using a gating program (*Waves*) to truncate the produced words from the release of the consonants at the first gate of 30 ms and then 60, 90 and 120 ms. The remaining part of each word was replaced by Gaussian noise, which was uniform in amplitude and duration. The stimuli were presented to Russian native speakers in an

identification task. Results showed that cues for palatalization were as perceptually salient as cues for voicing and place of articulation. Palatalized nasals were identified better (i.e. faster in the gating experiment) than palatalized oral consonants. Kavitskaya explained this difference by referring to the acoustic information employed to disambiguate palatalization in stops and nasals. In stops, the cue for palatalization was in the transition of the following vowel, whereas in nasals, the cue was already present in the closure. Similar to Kochetov (2004), Kavitskaya (2006) found that palatalization cues were missed in palatalized labials more often than in palatalized coronals.

Lukyanchenko and Gor (2011) also examined the perception of palatalized and plain labials /p – pʲ/ and coronals /t – tʲ/ in word-initial and word-final position. The participants of their study were Russian native speakers, Russian heritage learners, L2 learners of Russian with an average of three years of formal instruction in Russian and naïve English speakers without any proficiency in Russian. Their perceptual abilities were tested with an AX task. The stimuli were recorded by two female Russian native speakers. Heritage learners performed similarly to Russian native speakers; however, unlike Russian native speakers, they experienced difficulties in hearing contrasts that were less acoustically salient, such as /p – pʲ/ word-finally. L2 learners behaved differently from Russian native speakers and heritage learners. Learners' performance was relatively good in word-initial position. But in word-final position, despite years of instruction and practice with the language, learners were not significantly different from the naïve English speakers who had no experience with Russian. Lukyanchenko and Gor postulated that the learners categorized the i-transition that accompanied palatalized consonants as a vowel cue. The use of this strategy helped learners in the word-initial

position when palatalized consonants were followed by vowels but failed to provide any support in word-final position.

The influence of syllable position indeed seems to be language-independent. Speakers of Russian, English and Japanese from the studies mentioned above found word-final position more challenging than word-initial position. However, the degree of difficulty varied with respect to the native language of the speakers. Unlike syllable position, the influence of consonantal features seems to be language-specific. In a study by Larson-Hall (2004), Japanese learners of Russian and Russian native speakers were tested on their perception of /pⁱ, bⁱ, fⁱ, mⁱ, lⁱ, rⁱ/, among other consonants. Palatalization exists in Japanese and its articulation is similar to Russian (Akamatsu, 1997). Yet its phonemic status is a controversial issue. The participants of the study performed a 4IAX task (double pair task). They heard two pairs of tokens with target consonants embedded in the word-initial position. One pair of words was a minimal pair (AB), while the other pair of words was phonemically the same, but not phonetically identical (AA). The participants were asked to identify the minimal pair. Russian native speakers were able to identify minimal pairs with 100% accuracy. Beginning Japanese learners of Russian, on the other hand, experienced difficulty with the contrasts /r – rⁱ/, /f – fⁱ/, /l – lⁱ/, but not with /m – mⁱ/ and /p – pⁱ/. Therefore, even though Japanese learners were familiar with palatalization in their native language, discriminating palatalized consonants from plain ones could have been complicated by other factors specific to the language, for instance, the fact that the phonemes /r/, /l/ and /f/ do not exist in Japanese.

The contrast /l – lⁱ/ was one of the most difficult for Japanese learners but the easiest for American English learners in a study by Chrabaszcz and Gor (2014). When

American learners of Russian were tested on their perception of /l – li/, /t – ti/ and /f – fi/ in word-final position using a high-variability AX task, the effect of consonant contrasts was statistically significant for learners but not for Russian native speakers. The /l – li/ contrast was the easiest for learners, /t – ti/ occupied the intermediate position and /f – fi/ was the most challenging. It can be argued that velarization of laterals in English helped American English learners be more sensitive to palatalized and velarized /li/ in word-final position in Russian.

Another study aimed at investigating the effects of the native language on the perception of Russian palatalized consonants was conducted by Rice (2015). She asked participants, naïve American listeners without any formal training in Russian and experienced American learners of Russian, to perform a cross-language segmental identification task. The participants heard a labial or coronal consonant, either palatalized or plain, embedded in one of the three syllable positions (CV, VC or CVC) and had to map it onto an English category represented by a letter symbol. The participants were asked to circle an English letter from a list of preset choices, rate goodness of fit between the sound perceived and the letter circled and, finally, indicate whether any additional sounds were perceived with the consonant, e.g. [w], [j], [i] or [l]. The second task was a high-variability ABX. The A and B were always produced by different talkers of the same gender, either males or females, whereas X was produced by the talker of the opposite gender. The results showed that both palatalized and plain consonants were mostly mapped to similar English categories, e.g., Russian /p/ and /pʲ/ were mapped to the English /p/. However, naïve American listeners mapped some palatalized coronals to several categories: Russian /tʲ/ was mapped to English /t/ and /tʃ/, /dʲ/ to /d/ and /dʒ/, /sʲ/ to

/s/ and /ʃ/, and /z/ to /z/ and /ʒ/. The naïve participants rated the plain consonant as a good fit of the corresponding English category and the palatalized consonant as a poorer fit. For example, Russian /s/ was rated as a good fit of English /s/, whereas Russian /sʲ/ was rated as a poorer fit of both English /s/ and /ʃ/. The experienced group showed far fewer instances of multiple category mapping for palatalized coronals. Rice proposed that the naïve listeners compared Russian phones to the closest L1 phonemic category, whereas experienced learners compared Russian consonants to their phonological representations of Russian categories. Both groups of participants indicated that they had perceived a glide with palatalized consonants, especially in prevocalic position and with labial and nasal consonants. Moreover, a significant correlation was detected for the perception of a glide and the average discrimination rates on the ABX task for both groups of participants, and in onset and intervocalic positions for the naïve listener group. These findings indicate that learners, especially experienced learners, tend to map both consonants of a Russian plain-palatalized contrast to one phoneme in their native language, although with different degrees of fit. The perception of a glide that accompanies palatalized consonants is crucial for the ability to discriminate contrasts with palatalization accurately.

A number of studies specifically investigated the perception of a glide following palatalized consonants (Babel & Johnson, 2007; Bolanos, 2013; Diehm, 1998). Listeners were tested on whether they can perceive not only the difference between palatalized and plain consonants, but also whether they can differentiate those consonants from palatalized consonants followed by the fully articulated glide /j/. In Russian, the difference between CV, CʲV and CʲjV is phonemic, e.g., /suda/ ‘ships’ - /sudʲa/ ‘judging’ -

/sudʒa/ 'judge'. Bolanos (2013) used an AXB task to examine the perception of CV, CjV and CijV by native speakers of American English with no previous knowledge of Russian. Results showed that the participants' performance on the word-initial contrast CV – CijV and CV – CjV was above 97% correct. It seems that the presence of a glide helped learners differentiate palatalized consonants from plain ones. The contrast CjV – CijV was more challenging with averages around 92% correct. Russian native speakers had accuracy rates above 97% and did not show significant differences in their perception of the three contrasts. Babel and Johnson (2007) also researched the perception of various sequences with palatalized consonants (CV, CjV, CijV, CijjV) in word-initial position. The participants of the study were native speakers of Russian and American English. They performed an AX task and then rated the perceptual similarity of the sounds. Both groups performed alike on the AX task but they rated the perceptual similarity of the sequences differently. Russian native speakers perceived greater contrast among degrees of palatalization and rated the sounds to be more different than American English listeners.

Concluding, this overview of studies investigating the perception of palatalized consonants suggests that palatalization is salient enough for American English learners to notice it in perception. However, this perceptual salience can vary depending on a number of linguistic features, especially place of articulation, sonorant status and syllable position. The effect of syllable position seems to be language-general. Palatalized consonants are perceived better in syllable-initial position than in word-final position due to the i-transition or a glide that accompanies palatalization as a vowel cue. The influence of consonantal features seems to be language-specific. Nonnative contrasts that pose

difficulty for speakers of one language can be quite easy for speakers of another. The contrasts between plain and palatalized consonants tend to be mapped to a single category with different levels of goodness of fit. Plain consonants represent a good fit, whereas palatalized consonants are categorized as a poorer fit of the native category. Some palatalized consonants can be mapped to several native categories. Experience with the language also plays an important role. Heritage learners typically perform similarly to native speakers. The performance of L2 learners is more volatile and susceptible to various factors. Under certain conditions, e.g., perception of obstruents word-finally, L2 learners do not differ significantly from naïve listeners without any experience with Russian. Under more favorable conditions, e.g., the perception of palatalized consonants in syllable onsets, learners' sensitivity to the palatalization glide is similar to that of Russian native speakers and substantially helps them differentiate palatalized consonants from plain counterparts.

3.3.2. Lexical encoding of palatalized consonants

The research on the lexical encoding of Russian palatalization by L2 learners is scarce. To the best of my knowledge there are only two studies that looked at the phonological representations of words with palatalized consonants in L2 Russian (Chrabaszcz & Gor, 2014; Gor, 2014). Gor (2014) investigated phonological processing by heritage speakers and L2 learners of Russian as part of a bigger project on the perception of speech in noise. The participants were divided into high- and low-proficiency groups using the Interagency Language Roundtable (ILR) testing format, utilized by the US Federal Government to define language ability. The low-proficiency

group had ILR oral proficiency levels from 1 to 2 (intermediate to advanced). The high-proficiency group had ratings 2+ (advanced high) and above. The participants were asked to perform a picture-word discrimination task. The stimulus materials for the task were Russian minimal pairs that differed in the palatalized status of the consonant, e.g. /mat/ ‘checkmate’ and /matʲ/ ‘mother’. Participants heard one word from the minimal pair and saw two pictures associated with the minimal pair on the screen. They had to decide which picture matched the word that they heard. Results showed that Russian native speakers and high-proficiency heritage speakers of Russian behaved very similarly, 99% and 98% correct matches respectively. Low-proficiency heritage speakers performed similarly to high-proficiency L2 learners, 79% and 76% correct respectively. Low-proficiency L2 learners obtained an accuracy rate of 60%, which suggests that these learners did not have stable representations for words with palatalized consonants and their performance was somewhat better than at chance. However, Gor (2014) did not provide a list of minimal pairs that were used in the study, nor was there any mention of whether the words were familiar to learners. The words that form minimal pairs with plain and palatalized consonants in Russian hardly ever constitute the active vocabulary of Russian learners, especially at lower levels of proficiency. If learners were not familiar with the words in the picture-word discrimination task, then they relied on their phonetic rather than lexicophonological knowledge to perform the task.

In another study, Chrabaszcz and Gor (2014) examined the effects of semantic, morphological and syntactic context on the processing of phonolexical ambiguity at the sentence level. The participants of the study were native speakers of Russian and American learners of Russian. They were asked to perform a listening comprehension

task with word identification and a high-variability AX task. The results of the AX task were reported in Section 3.3.1. In the listening comprehension task, the participants were presented with two types of sentences. In congruent sentences, the target word fit the context, e.g., *My younger brother and elder **sister** are coming to see me tomorrow*. In incongruent sentences, there was a mismatch of a specific type, such as semantic ('sister/system'), morphological ('seen/sees'), or syntactic ('seam/seize'), e.g., *My younger brother and elder ***system** are coming to see me tomorrow*. After the participants heard a sentence, they had to decide which of the two words presented on the computer screen, e.g., 'sister' or 'system', occurred in the sentences that they had just heard. In the critical or testing condition, the target words were minimal pairs that differed in the palatalization status of a word-final consonant, e.g., (congruent condition) *A little boy drew a straight **angle /ugoll/** in his geometry notebook*; (incongruent condition) *A little boy drew a straight ***coal */ugoll/** in his geometry notebook*. Results showed that unlike native speakers, L2 learners reached an error rate of 40% in congruent sentences and approximately 60% in incongruent sentences. Chrabaszc and Gor interpreted such results as evidence of fuzziness of lexical representations. L2 learners did not solely refer to the context to resolve ambiguities, but seemed to rely on their phonolexical representations when identifying words. If learners had relied on the context alone, they would have had high accuracy in congruent sentences and high error rates in incongruent sentences, which was not reflected in the results.

The findings of these two studies suggest that American English learners of Russian do not establish accurate lexical representations of words with palatalized consonants. The contrast between plain and palatalized consonants seems to pose so

much difficulty that even low-proficiency heritage speakers, who have continually been exposed to Russian since birth, did not perform equally to Russian native speakers. The reasons for such difficulties can stem from a lack of sufficient perceptual abilities to reliably differentiate palatalized from plain consonants, especially for the coda contrasts, as well as the possible effects of orthography that might mislead learners by employing the same graphemes for plain and palatalized consonants. No study to date has investigated the effects of orthography on the lexical encoding of palatalized consonants in L2 Russian.

3.3.3. Production of palatalized consonants

Even if a learner is able to perceive the difference between palatalized and plain consonants, and can encode this distinction correctly, the articulation of palatalization is a challenge in its own right. Consider palatalized /rʲ/. According to Bondarko (2005), /rʲ/ is the fourth most frequent palatalized consonant in Russian after /nʲ/, /lʲ/ and /tʲ/. The production of a plain trill alone is a challenging task for many learners, who lack this phoneme in their L1, as they struggle to control their speech organs enough to produce the desired acoustic effect of a rolling /r/. Adding the secondary feature of palatalization makes the gestural score for /rʲ/ even more challenging, especially taking into account the fact that the difference in articulation of plain and palatalized rhotics is not very big (Kochetov, 2005). Given that palatalization is pervasive in Russian phonology, learners have to achieve not only accuracy but also automaticity in the articulation of palatalization.

Hacking (2011) examined the productions of palatalized consonants by advanced American learners of Russian, as judged by Russian native speakers in a two-way forced-choice identification task. The learners of Russian were asked to read minimal pairs containing plain and palatalized /p/, /t/, /s/, /n/, /l/, /r/ word-initially before /o/ and word-finally after /o/ and /a/. The words were embedded in a carrier phrase. The productions of words were extracted and presented to Russian native listeners in a two-way forced-choice identification task. Results showed that words with prevocalic contrasts were correctly identified at a rate of 78% and higher with the exception of /rⁱ/, which was correctly identified only 47% of the time. Words with the final contrast were correctly identified 28% of the time for /lⁱ/ and lower for the other consonants. Palatalized /sⁱ, rⁱ, tⁱ/ were never identified as such word-finally. Three palatalized consonants /sⁱ, pⁱ, tⁱ/ were correctly identified 100% of the time in the prevocalic condition, and then the same exact consonants received less than 1% of identification rate in the word-final position. This latter finding suggests that a two-way forced-choice identification task is not fine-grained enough to evaluate whether palatalization was, in fact, produced and what the quality of those productions was. For example, learners who have not mastered palatalization tend to produce palatalized consonants as two sequential gestures /C/ +/j/ with a much longer tongue body gesture, especially in the environment before a vowel (Diehm, 1998). It is not clear whether Russian native speakers would categorize such productions as plain or palatalized in a two-way identification task. Providing raters with a Likert scale and/or more choices in an identification task would allow a better insight into the quality of learners' productions of palatalized consonants.

In a recent study, Hacking, Smith, Nissen and Allen (2016) provided

electropalatographic and acoustic analyses of the palatalized and plain consonants in coda position as produced by advanced American English learners and Russian native speakers. Each participant had a dental mold taken of their palate that was used to construct individual pseudopalates containing 124 electrodes. The measurements taken from the electrodes showed that Russian native speakers contacted many more posterior electrodes (corresponding to the palatal place of articulation) when producing palatalized consonants than did American learners, 45% vs. 22% respectively. During the production of plain consonants, both groups of participants contacted 20% of the posterior electrodes. This suggests that American learners did not realize the most important gestures necessary for the production of palatalization: the tongue should be bunched up and moved towards the hard palate (Keating, 1993). American learners produced palatalized consonants very similar to plain counterparts.

For the acoustic analysis, Hacking et al. measured F2s of the vowels, one of the most salient cues, preceding palatalized and plain consonants at three time points: midpoint, two-thirds of duration and endpoint. The F2s for vowels preceding palatalized consonants produced by Russian native speakers were significantly different from each other and different from F2s for vowels preceding plain consonants. The American learners did not produce significant differences between the three time points, nor did they produce differences between vowels preceding palatalized and plain consonants. Moreover, the F2s of the vowels produced by American learners before palatalized consonants were similar to the F2s for vowels preceding plain consonants produced by the Russian native speakers. This lack of distinction in American learners' F2s for vowels preceding palatalized and plain consonants was also reported in Bolanos (2013) and

Diehm (1998).

In conclusion, palatalization is indeed a challenging articulatory gesture for learners to master. It requires that the tongue body be in the upward position and move towards the hard palate. Primary articulation should occur simultaneously with secondary articulation, which also has co-articulation effects on the neighboring vowels. Learners fail to produce palatalized consonants accurately because their tongue body does not make enough contact with the hard palate. As a result, co-articulation effects on vowels that accompany palatalization are not present in learners' productions either.

3.4. Summary

Palatalization is an important phonemic feature in Russian. Almost all Russian consonants have palatalized counterparts that occur in all word positions. Although plain and palatalized consonants are separate phonemes, in orthography they are represented with the same graphemes. The orthographic code for palatalization is located on the subsequent letter, which is either a soft series vowel letter or a soft sign. In acoustic phonetics, palatalization manifests itself through differences in F1 and F2 formant transitions from consonants into subsequent vowels, as well as in the intensity and duration of the consonant release. In articulatory phonetics, palatalization is generally realized by means of two gestures of the tongue, whereby the tongue is bunched up and moves towards the hard palate. Acquiring palatalization in Russian poses a lot of challenges for learners of Russian. Perceptual salience of palatalization depends on the linguistic features of the palatalized consonant and its syllable position. The effects of linguistic features are language-specific, whereas the effects of syllable position are

language-general. Prevocalic position is more salient for learners of Russian than syllable-final position due to the i-transition or glide that accompanies palatalization and serves as a vowel cue. As a result, learners' performance on prevocalic palatalized consonants surpasses their performance on syllable-final consonants. The difficulties that learners experience in perceiving the difference between plain and palatalized consonants also affect their lexical encoding of the plain / palatalized contrasts. In production, learners tend to replace palatalized consonants with their plain counterparts because they do not utilize gestures necessary to produce palatalization. The empirical research on the acquisition of palatalization in Russian, especially on the lexical encoding of palatalized consonants and the effects of orthography, is limited. This dissertation intends to add to the existing literature about the acquisition of palatalization in Russian.

Chapter 4. Experiment 1: The perception – production link

This chapter examines the ability of American learners of Russian to perceive and produce palatalized consonants as well as the relationship that learners develop between the areas of perception and production. The goal of Experiment 1 is to establish whether perception skills develop prior to production skills or vice versa. Section 4.1 introduces the research questions and hypotheses that arise from the literature review provided in Chapters 2 and 3. Section 4.2 describes the method of Experiment 1 that was employed to investigate the perception – production link in the acquisition of palatalization in Russian. The results of the investigation are presented in Section 4.3 and the subsequent discussion is provided in Section 4.4.

4.1. Research questions and hypotheses

The relationship between perception and production can take different forms as has already been thoroughly explored in Chapter 2. Perception and production skills can develop in synchrony, when learners who perceive target sounds accurately produce them accurately, similarly the sounds that learners cannot discriminate in perception cannot be distinguished in production either (e.g., Fowler, 1996). Another possibility is for perception skills to develop prior to production skills, i.e. learners can perceive the target sounds but cannot yet produce them accurately (e.g., Flege et al., 1997; 1999). Also, production skills can develop independently of perception skills, when learners are able to articulate contrasting target sounds without actually perceiving them as different (e.g., Darcy & Krüger, 2012; Sheldon & Strange, 1982).

This dissertation seeks to examine the acquisition of palatalized and plain consonants in order to uncover the relationship that exists between the perception and production of these consonants by American English learners of Russian. Most research investigating the perception-production link focuses on vowels and consonants that differ in primary features of articulation. This dissertation investigates the acquisition of consonants that differ in the secondary feature of palatalization. From research available on the perception of palatalization in Russian, it is known that the perceptual salience of palatalized consonants varies depending on different linguistic features, such as place of articulation, sonorant status and syllable position (see Section 3.3.1). Research findings on the production of palatalization are less clear-cut but the main findings show that learners fail to produce palatalized consonants because they do not articulate the crucial gestures, such as raising the tongue and moving it towards the hard palate. As described in Sections 3.3.1 and 3.3.3 above, little research has addressed the relationship between perception and production of palatalized consonants in L2 Russian.

The two main research questions that Experiment 1 poses are the following:

1. How do American learners of Russian perceive and produce the plain / palatalized consonant contrast in L2 Russian? Are previously reported syllable position effects on the perception and production of palatalization reliable?
2. What is the relationship between the perception and production of plain vs. palatalized consonants in the acquisition of L2 Russian?

With respect to the first question, it is hypothesized that learners will be able to perceive and produce palatalized consonants in L2 Russian, with learners of higher levels of proficiency performing more accurately on the perception and production tasks than

learners of lower levels of proficiency. In order to produce palatalization in different types of consonants and in various prosodic contexts accurately, learners have to master an array of articulatory gestures that differ depending on the primary features of articulation (see Section 3.1.2 for more details on the articulatory features of palatalization). This might require a substantial amount of time and practice to acquire. For instance, palatalized labials, coronals and velars require different sets of gestures. Palatalization of labials occurs independently from the articulation of their primary features. The main articulators in the production of plain labials are the lips and teeth; the tongue is not involved. In the production of palatalized labials, the lips and teeth perform the same gestures as they do for plain labials. However, the tongue is also engaged: it is bunched up and moves upwards, approximating the hard palate. Palatalization of coronals occurs differently. It intricately engages with primary articulation, because the articulation of both plain and palatalized coronals requires the tongue to be the active articulator. Palatalization of velars fully merges with the articulation of primary features, because the production of palatalized velars requires exactly the same gestures as the production of plain velars. The only difference is that the constriction for palatalized velars occurs at the soft palate rather than at the velum (Jones & Ward, 1969). Thus, learners who have more experience and instruction, are more likely to produce palatalization more accurately.

In perception, advanced learners are also likely to have an advantage over intermediate learners. Due to longer exposure and experience with the contrast between plain and palatalized consonants, advanced learners might have already established two

separate categories for plain and palatalized consonants, whereas intermediate learners might still map palatalized consonants to their plain counterparts in perception.

With respect to syllable position, it is expected that palatalized consonants in the prevocalic position will be more successfully acquired than in the coda position.

Perceptually, the former are more salient than the latter, because in the prevocalic position palatalization is also acoustically encoded in the vowel (e.g., Derkach, 1975). In the production of prevocalic palatalized consonants, subsequent vowels tend to facilitate the articulation of palatalization. The high front vowel /i/ in particular, whose production requires that the tongue should be in contact with the palate, will foster the necessary acoustic effect of palatalization due to co-articulation.

Regarding the second research question, it is expected that, overall, perception skills form prior to production skills in the acquisition of palatalization. The perceptual system is more flexible than the production system since it is more conducive to generalizations based on distinctive or phonological features (Brown, 1998; De Jong, Silbert, & Park, 2009; Thomson, 2011). It means that learners do not acquire perceptual identification skills for each segment individually but rather generalize over a class of consonants that share a specific distinctive feature. For example, learners might transfer their ability to discriminate plain and palatalized laterals to plain and palatalized rhotics. American English learners consider palatalized consonants to be poorer fits of the corresponding plain consonants (Rice, 2015). If learners conceive of palatalization being plain consonants plus “something else”, they are likely to start discerning this additional feature of secondary articulation in perception. Moreover, learners’ ability to discriminate the contrast in one specific pair of consonants can generalize to other classes of

consonants. The motor system is less flexible than the perception system and requires more time to develop the necessary skills to manifest specific linguistic features in spoken speech (De Jong, Hao, & Park, 2009). Since palatalization requires a number of articulatory gestures that vary depending on the natural class of the consonant, learners will need time and practice to acquire all of them individually. For example, ability to produce palatalized laterals might not transfer to the production of palatalized rhotics, since the gestural scores for palatalized consonants with different primary articulations vary a lot (see Section 3.1.2). Thus, thinking of palatalized consonants as plain consonants plus “something else” might facilitate learners’ perception, whereas the ability to produce this “something else”, or palatalization, will require more knowledge and practice. Therefore, it is hypothesized that, at least initially, learners’ performance on the perception tasks will be more accurate than on the production tasks.

4.2. Method

The method employed in Experiment 1 included three tasks (familiarization, oral picture-naming and a subsequent rating task) to evaluate production skills and two tasks (ABX with words and nonwords) to examine perception skills. The oral picture-naming task preceded by the familiarization task was preferred over reading a word list in order to avoid the potential effects of orthography on pronunciation. It was already stated in Section 3.2 that palatalization is not opaque in Russian. Exposing participants to the written forms of target words could have alerted learners to the purpose of the task and led to the hyperarticulation of sounds. Our goal was, on the contrary, to elicit as natural productions of target words as possible. For this reason, only words familiar to learners

and already established in their interlanguage were used in the experiment. The productions that were elicited from learners were later rated by Russian native listeners using a six-point scale. The rating paradigm was used instead of an acoustic analysis due to variability in the phonetic environment of the target consonants. All target words had to be familiar to learners even at lower levels of proficiency. As a result of this inclusion criterion, target words varied in their syllable structure, stress patterns and immediate phonetic environment.

Perception was examined by means of two high-variability ABX tasks. The rationale behind using the ABXs was to examine whether learners can discriminate plain and palatalized consonants at the phonetic level in the case of the ABX with nonwords and at the phonolexical level in the case of the ABX with real words. Performance on the ABX with nonwords was designed to tap into learners' categorical perception of palatalized and plain consonants, whereas the ABX with real words was aimed at determining whether learners were sensitive to the perceptual difference between target words and alternating nonwords. High accuracy rates on the ABXs would suggest that learners had established separate categories for the plain and palatalized consonants and could discriminate them in perception. If the hypothesis for the first research question is correct, advanced learners will perform at higher accuracy levels on the ABXs and rating task than intermediate learners. If syllable position matters, then learners are expected to display higher accuracy rates for words in the prevocalic position than in the coda position. In order to answer the second research question about the relationship between perception and production, learners' performance on the ABXs and rating task will be correlated. If indeed perception develops prior to production, then learners who receive

high ratings from Russian native listeners for their productions of the contrast should also demonstrate high accuracy rates on the perception tasks. If learners have low accuracy rates on perception, their production is likely to have more errors and also be rated low.

4.2.1. Participants

Participants of the study were 59 L2 learners of Russian, all native speakers of American English, from intact classes enrolled in an intensive Russian summer program that offered instruction at nine levels. Enrollment in levels was based on the results of an in-house placement test and previous experience with the language. Participants were tested during their regular Russian Phonetics class. Nineteen participants were excluded from the analysis for the following reasons: three participants were heritage learners of Russian; five participants were native speakers of languages other than English (2 Mandarin, 2 Spanish, 1 Lithuanian); five participants did not complete all tasks; four participants were outliers (error rate above two standard deviations) on the control words and/or distractors; and two participants were previously tested for the pilot study. The data obtained from the remaining 40 participants were used for further analysis. The participants of the study were divided into two proficiency groups with 20 participants in each group. Learners enrolled in levels 3-5 were characterized as intermediate, whereas learners enrolled in levels 7-9 were considered advanced.

Intermediate participants (11 females, 9 males) included three learners enrolled in level 3, five learners from level 4 and 12 learners from level 5. The mean age of the intermediate participants was 25.1 years ($SD = 6.4$, range 19-40). On average, intermediate participants began to study Russian at the age of 19.5 ($SD = 4.1$, range 12-

31). The length of Russian instruction did not exceed 3 years. Three participants spent 1-2 months in a Russian-speaking country and another two participants stayed in Russia, Kazakhstan and Kyrgyzstan for more than a year. Five participants had previous instruction in Russian pronunciation.

The advanced group (8 females, 12 males) included six participants from level 7, eight participants from level 8 and six participants from level 9. The mean age of the advanced participants was 25.9 years ($SD = 5.3$, range 22-41). The mean age of initial Russian instruction was 20.1 years ($SD = 3.8$, range 13-33). The length of Russian instruction was above 4 years. Seventeen out of 20 participants had been to a Russian-speaking country (range 10 days – 2.5 years). Fourteen participants spent more than 2 months in Russia, Ukraine, Moldova, Armenia, Tajikistan, Kazakhstan and Kyrgyzstan ($M = 11.8$, $SD = 9.9$). Six participants of the 14 spent more than a year in a Russian-speaking country. Seven participants reported having had previous instruction in Russian pronunciation.

Ten Russian native speakers (8 females, 2 males) aged 26-42 years ($M = 33.3$, $SD = 5.8$) served as a control group and performed the same tasks as the American learners of Russian.

4.2.2. General procedure

Participants of the study performed eight tasks that evaluated their perceptual abilities, orthographic and metalinguistic knowledge, lexical encoding and production skills (Table 4.1). The tasks were administered during regular class time (50 minutes) to intact classes in a language laboratory at a major midwestern university. The participants

were seated at individual workstations shielded from each other by noise-absorbing partitions. They used Dell PCs and Logitech headsets H390 with a microphone. The participants were told that they would take a diagnostic test to evaluate their pronunciation. The entire testing session took 45 minutes. At the end of the class, and after all tasks were completed, all participants filled in a language background questionnaire (see Appendix C) with the remaining 5 minutes. After data was collected and processed, a rating task was designed for a group of Russian native listeners, professional linguists, who evaluated learners' productions extracted from the oral picture-naming task in a rating task.

Table 4.1

Tasks used in data collection

Task # (in the order they were performed)	Duration	Area targeted
1. Familiarization task	5 minutes	General
2. Oral picture-naming task	5 minutes	Production
3. Written picture-naming task	7 minutes	Orthography
4. Auditory word-picture matching task	5 minutes	Lexical encoding
5. ABX with nonwords	5 minutes	Perception
6. ABX with real words	8 minutes	Perception
7. Metalinguistic task	5 minutes	Orthography
8. Lexical familiarity task	5 minutes	General
Ratings	3-4 hours	Production

In this chapter only the tasks that evaluated production (familiarization, oral picture-naming task and rating task) and perception (ABX with real words and nonwords) are presented. A familiarity task was used to determine whether learners were indeed familiar with all the target words. The following sections describe the materials and procedures specific to each of these tasks.

4.2.3. Task #1: Familiarization

Materials

The materials of the study were based on five pairs of plain coronal consonants and their palatalized counterparts that differed only in the secondary feature of articulation: /t/-/tʲ/, /s/-/sʲ/, /n/-/nʲ/, /l/-/lʲ/, /r/-/rʲ/. The coronal consonants represented five natural classes by manner of articulation (stops, fricatives, nasals, laterals and rhotics) and two natural classes by voicing (voiced and voiceless). Voiced coronal obstruents /d/-/dʲ/, /z/-/zʲ/ were excluded because word-finally they are devoiced in Russian, which could be a confounding variable. Labials were not included because potential target words that ended in /pʲ/, /bʲ/ and /fʲ/ were unlikely to be familiar to intermediate students. Dorsals were avoided because their phonemic status is a controversial issue in Slavic linguistics (see Section 3.1.1 for details). Moreover, palatalized dorsals do not occur word-finally in Russian. Neither labials nor dorsals represent natural classes that are not already represented by Russian coronals. Target consonants were embedded in word-final and intervocalic positions. Word-initial position was not used because the first two consonants were provided to learners in a picture-naming task to facilitate retrieval. Also, words starting with initial coronals and matching the inclusion criteria would be unfamiliar to learners at lower levels of proficiency.

The selection process of real target words was guided by several criteria. First of all, only words that were familiar to students at all levels of proficiency were included (Table 4.2). The words were chosen from the Russian-English vocabulary provided in the textbook “Live from Russia. Volume 2” (Lekic, Davidson & Gor, 1997) that is widely used in first-year Russian courses. Secondly, an effort was made to control for the

phonetic environment surrounding target consonants. In word-final position, all target consonants were preceded by the same vowel. The palatalized status of the consonant preceding the vowel was also controlled for. For example, in /adri^s/ and /zdiesⁱ/, /rⁱ/ and /dⁱ/ were both palatalized, whereas in /salat/ and /spati/, /l/ and /p/ were plain. The reason for controlling the palatalized realization of the preceding consonant was that palatalization could affect the subsequent vowel (Ordin, 2011). If the palatalized status of the preceding consonant had not been controlled for, the participants might have erroneously interpreted a change in the quality of the subsequent vowel as the possible palatalization of the final target consonant. In intervocalic position, all target consonants occurred between two vowels. The vowels that followed the target consonants were the same in words that formed pairs. For instance, in /gazi^eta/ and /ti^otia/, the voiceless stops /t/ and /tⁱ/ in the ultimate syllables were followed by /a/. However, it was not possible to control for the number of syllables, stress and part of speech due to the limits imposed by the vocabulary size of low-intermediate participants.

Table 4.2

Real words with underlined target consonants

Positions	Pairs	Words with plain consonants	Words with palatalized consonants
Word-final: VC / VC ⁱ	t-t ⁱ	/salá <u>t</u> / ‘salad’	/spat ⁱ / ‘to sleep’
	s-s ⁱ	/ádr ⁱ es/ ‘address’	/zdies ⁱ / ‘here’
	n-n ⁱ	/ekzám ^e n/ ‘exam’	/ós ^e n ⁱ / ‘fall’
	l-l ⁱ	/stol/ ‘table’	/sol ⁱ / ‘salt’
	r-r ⁱ	/sáxar/ ‘sugar’	/slovár ⁱ / ‘dictionary’
Intervocalic: VCV / VC ⁱ V	t-t ⁱ	/gazi ^e ta/ ‘newspaper’	/ti ^o tia/ ‘aunt’
	s-s ⁱ	/p ⁱ sáti/ ‘to write’	/tí ^s at ^s a/ ‘thousand’
	n-n ⁱ	/z ^e ná/ ‘wife’	/tán ⁱ a/ ‘Tanya’ (female name)
	l-l ⁱ	/xolódnij/ ‘cold’	/z ^e l ⁱ ónij/ ‘green’
	r-r ⁱ	/sí ^e rij/ ‘grey’	/kú ^r itsa/ ‘chicken’

Note. The superscript // in the transcription denotes the stressed vowel.

Ten fillers that were semantically connected to the target words were added to divert learners' attention from the phenomenon under investigation: /dom/ 'house', /tam/ 'there', /ziimá/ 'winter', /tʃítát/ 'read', /diésiat/ 'ten', /míʃa/ 'Misha (male name)', /sok/ 'juice', /tort/ 'cake', /súmka/ 'purse', /krásnij/ 'red'.

All stimuli were recorded by a female Russian native speaker in a sound-proof recording booth. The stimuli were presented on a sheet of paper, with each word occurring twice. The recording had a sampling frequency of 44.1kHz and a bit rate of 24. The second production of each word was extracted from the recording using PRAAT and saved as an individual audio file for embedding into a PowerPoint presentation. The second production was chosen because the first one was supposedly for practice.

Procedure

The goal of the familiarization task was to ensure that the participants would produce the selected target words in the oral picture-naming task. Each word was matched to a picture to denote the meaning of that word (see Table A1 and Table A2 in Appendix A for a complete list of target words, fillers and matching pictures). The participants saw a picture (Figure 4.1) presented via a timed PowerPoint presentation, heard the pronunciation of that word and were asked to remember what word was used to describe the picture (see Figure B1 in Appendix B for a screenshot of complete instructions). They did not see the written forms of the target words except for the first two letters. Each picture was presented two times for three seconds in a random order, which was the same for all the participants.

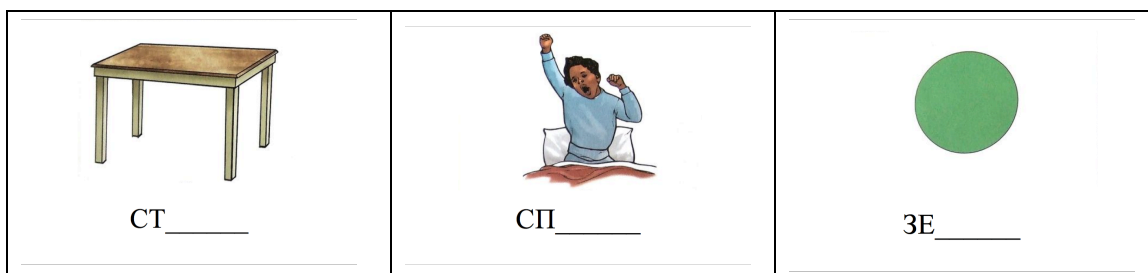


Figure 4.1. Sample pictures of target words: <стол> /stol/ ‘table’, <спать> /spati/ ‘to sleep’, /zjel’onij/ ‘green’

4.2.4. Task #2: Oral picture-naming

Materials

Materials in Task 2 were the same as in Task 1 (see Section 4.2.3). The only difference was the order of pictures in the PowerPoint presentation and the interval of four seconds (instead of three seconds) between the pictures. Also, the audio files with the pronunciation of the words were removed from the PowerPoint presentation.

Procedure

After the participants completed the familiarization task, they performed an oral picture-naming task. They saw the same pictures from Task 1 but they did not hear the pronunciation of the target words. Instead, the participants were asked to say out loud the words that matched the pictures (see Figure B2 in Appendix B for a screenshot of complete instructions). The first two letters were provided in the picture to facilitate retrieval (see Figure 4.1). Participants’ answers were recorded using PRAAT (Broersma & Weenik, 2011) at a sampling frequency of 44.1 kHz with a 16-bit resolution on a mono channel. Recordings were normalized for amplitude.

As a result of the oral picture-naming task, 1982 tokens of target words were produced accurately (total: 2000 tokens = 20 target words x 2 repetitions x 50 participants). Eighteen tokens (9 target words x 2 repetitions) were missing. Advanced learners did not produce three words: two learners of level 8 failed to produce the word /s'eri:j/ 'grey' and a learner of level 7 did not produce the word /slovar:/ 'dictionary'. Intermediate learners did not produce six words: a learner of level 3 failed to produce the words /s'eri:j/ 'grey', /soli/ 'salt', /p'isati/ 'to write', /zi:el'ionij/ 'green'; a learner of level 4 did not produce the word /tan'ia/ 'Tanya' (female name); and a learner of level 5 did not produce the word /slovari/ 'dictionary'.

The second production of each word in the oral picture-naming task was extracted using PRAAT and saved as an individual file, resulting in 991 individual audio files. These files were sorted according to the target word, resulting in a total of twenty separate groups, which is the same as the number of target words. Within each group all 50 tokens or so of the same word e.g., /salat/, /adries/, /ekzamien/, etc. were coded, randomized and then concatenated in PRAAT. Five-second pauses were inserted between words. Each audio file containing 50 tokens (49 or 48 in the case of missing tokens) with the inserted pauses was approximately five minutes long. A total of twenty audio files were created and uploaded to a secure server, where they could be easily accessed by the raters for the rating task (see Section 4.2.8).

4.2.5. Task #5: ABX with nonwords

Materials

A set of nonwords was created of CVCVC structure for the ABX task with nonwords. In test nonwords, palatalized consonants alternated with plain counterparts in word-final and intervocalic positions (Table 4.3). The vowel /a/ preceded and/or followed the target consonants. Syllables with target consonants were always stressed. Control nonwords were created by alternating target consonants with consonants that differed from target consonants in primary articulation.

Table 4.3

Test nonwords and control nonwords with underlined target consonants

Positions	Pairs	Test nonwords with plain consonants	Test nonwords with palatalized consonants	Control nonwords
Word-final: VC / VC ^j	t-t ^j	/vurát/	/vurát ^j /	/vurám/
	s-s ^j	/kulás/	/kulás ^j /	/kulán/
	n-n ^j	/rufán/	/rufán ^j /	/rufás/
	l-l ^j	/kuzál/	/kuzál ^j /	/kuzák/
	r-r ^j	/sugár/	/sugár ^j /	/sugáf/
Intervocalic: VCV / VC ^j V	t-t ^j	/vaták/	/vaták ^j /	/vaśák/
	s-s ^j	/dasáf/	/dasáf ^j /	/daráf/
	n-n ^j	/sanák/	/sanák ^j /	/salák/
	l-l ^j	/palán/	/palán ^j /	/parán/
	r-r ^j	/farát/	/farát ^j /	/fakát/

All stimuli were recorded twice by one male and one female Russian native speaker in a sound-proof recording booth at a sampling rate of 44.1 kHz with a 24-bit resolution on a mono channel and saved as individual audio files for embedding into the stimuli presentation script. Recordings were normalized for amplitude and each item was spliced into a separate sound file. Stimuli A and B were produced by two female Russian native speakers. Stimulus X was always produced by a male Russian native speaker. The

speakers in the ABX changed within a trial, which allowed us to test participants' abilities to categorize phonetic sequences while compensating for phonetic differences.

Procedure

The ABX with nonwords was administered with the DMDX software (Forster & Forster, 2003). Four counterbalanced orderings of 3 stimuli (triplets) were created for test nonwords, resulting in 40 test trials. For example, (i) ABA: /vurat/ - /vurati/ - /vurat/; (ii) ABB: /vurat/ - /vurati/ - /vurati/; (iii) BAA: /vurati/ - /vurat/ - /vurat/; (iv) BAB: /vurati/ - /vurat/ - /vurati/. Stimulus A was always a nonword with a plain consonant and stimulus B was always a nonword with a palatalized consonant. For the control trials, only two counterbalanced orderings were used in order to save time, since the participants had to perform eight tasks in 45 minutes. Thus, each participant received 60 trials total (40 with test nonwords and 20 with control nonwords), which took about 5 minutes to complete. Each trial started with a fixation cross displayed in the center of the screen for 250 ms, before the first audio stimulus was played. Participants were seated in front of a PC wearing headphones. In each trial, they heard three stimuli in a row. They were instructed to decide whether the third nonword (X) matched the first (A) or the second (B) nonword, and indicate their response as fast as possible on the computer keyboard (see Figure B5 in Appendix B for a screenshot of complete instructions). Interstimulus interval was set to 500 ms. Participants had 2000 ms to make their response, before the next trial was initiated. Trials were assigned to six blocks such that the same item did not appear in more than one ordering in one block. Block order was randomized, and within each block, trials were randomized. Participants were given four practice trials before the experimental trials. Feedback was not provided. The task elicited 3000 data points (60

trials x 50 participants). The dependent variables were error rates and reaction times (RTs). RTs were measured from the beginning of the X stimulus.

4.2.6. Task #6: ABX with real words

Materials

The materials for the ABX with real words used the same words as in Task 1 and 2 (see Section 4.2.3). In test nonwords, palatalized consonants alternated with plain counterparts in word-final and intervocalic positions, e.g., ‘sleep’ /spati/ - ¹/spat/ - /spati/ and vice versa, e.g., ‘wife’ /zɛna/ - */zɛnʲa/ - */zɛnʲa/. Control nonwords were created by alternating target consonants in the words with consonants that differed from target consonants in primary articulation. The palatalization status of the alternating consonants in the control nonwords was preserved. For example, palatalized /tʲ/ alternated with palatalized /fʲ/ in the words ‘sleep’ /spati/ and */spafʲ/, whereas plain /n/ alternated with plain /r/ in the words ‘wife’ /zɛna/ and */zɛra/ (Table 4.4).

The stimuli for the ABX with real words were test words (e.g., /solʲ/ ‘salt’) produced with an alternation between a palatalized and plain consonant, for example, */sol/ - /solʲ/ - /solʲ/ or with an alternation between a target consonant and another consonant that differed in primary articulation, for example, /solʲ/ - */somʲ/ - /solʲ/. Similar to the ABX with nonwords, all stimuli were recorded twice by one male and one female Russian native speaker in a sound-proof recording booth at a sampling rate of 44.1 kHz with a 24-bit resolution on a mono channel and saved as individual audio files for embedding into the stimuli presentation script. Recordings were normalized for

¹ Asterisk (*) represents a nonword.

amplitude and each item was spliced into a separate sound file. Stimuli A and B were produced by two female Russian native speakers. Stimulus X was always produced by a male Russian native speaker.

Table 4.4

Real words with underlined target consonants, test nonwords and control nonwords

Positions	Pairs	Test words	Test nonwords	Control nonwords	Gloss
Word-final: VC / VC ^j	t-t ^j	/salát/	/salát ^j /	/salár/	salad
		/spat ^j /	/spat/	/spaf ^j /	to sleep
	s-s ^j	/ádr ^j es/	/ádr ^j es ^j /	/ádr ^j ien/	address
		/zd ^j es ^j /	/zd ^j es/	/zd ^j ep ^j /	here
	n-n ^j	/ekzám ^j ien/	/ekzám ^j ien ^j /	/ekzám ^j iet/	exam
		/ós ^j ien ^j /	/ós ^j en/	/ós ^j el ^j /	fall
	l-l ^j	/stol ^j /	/stol ^j /	/stor/	table
		/sol ^j /	/sol/	/som ^j /	salt
	r-r ^j	/sáxar/	/sáxar ^j /	/sáxat/	sugar
		/slovár ^j /	/slovár/	/slován ^j /	dictionary
Intervocalic: VCV / VC ^j V	t-t ^j	/gaziéta/	/gaziét ^j a/	/gaziéba/	newspaper
		/tiót ^j a/	/tiót ^j a/	/tiót ^j ra/	aunt
	s-s ^j	/p ^j isát ^j /	/p ^j isát ^j /	/p ^j irát ^j /	to write
		/t ^j isát ^j fa/	/t ^j isát ^j fa/	/t ^j imát ^j fa/	thousand
	n-n ^j	/zená/	/zen ^j a/	/zerá/	wife
		/tán ^j a/	/tán ^j a/	/tám ^j a/	Tanya (name)
	l-l ^j	/xolódnij/	/xolód ^j nij/	/xosódnij/	cold
		/zielónij/	/zielón ^j nij/	/zierónij/	green
	r-r ^j	/s ^j ér ^j ij/	/s ^j ér ^j ij/	/s ^j ébij/	grey
		/kúr ^j itsa/	/kúr ^j itsa/	/kúđ ^j itsa/	chicken

Procedure

The ABX with real words was administered with the DMDX software (Forster & Forster, 2003). The interstimulus interval was 500 ms and the response timeout was 2000 ms. Four counterbalanced orderings of 3 stimuli (triplets) were created for 80 test trials. For example, (i) ABA: /sol/ - */sol/ - /sol^j/; (ii) ABB: /sol^j/ - */sol/ - */sol/; (iii) BAA: */sol/ - /sol^j/ - /sol^j/; (iv) BAB: */sol/ - /sol^j/ - */sol/. Stimulus A was always a real word in Russian and stimulus B was always a nonword. For the control trials, only two

counterbalanced orderings were used in order to save time, since the participants had to perform eight tasks in 45 minutes. Thus, each participant received 120 trials total (80 with target words and 40 with controls), which took about 8 minutes to complete. Each trial started with a fixation cross displayed in the center of the screen for 250 ms, before the first audio stimulus was played. Participants were seated in front of a PC wearing headphones. In each trial, they heard three stimuli in a row. They were instructed to decide whether the third stimulus (X) matched the first (A) or the second (B) stimulus, and indicate their response as fast as possible on the computer keyboard (see Figure B6 in Appendix B for a screenshot of complete instructions). Interstimulus interval was set to 500 m. Participants had 2000 ms to make their response, before the next trial was initiated. Trials were assigned to twelve blocks such that the same item did not appear in more than one ordering in one block. Block order was randomized, and within each block, trials were randomized. Participants were given four practice trials before the experimental trials. Feedback was not provided. The task elicited 6000 data points (120 trials x 50 participants). The dependent variables were error rates and RTs. RTs were measured from the beginning of the X stimulus.

4.2.7. Task #8: Lexical familiarity

Materials

Materials in Task 8 were the same as in Task 1 (see Section 4.2.3).

Procedure

Participants' familiarity with the target words was evaluated at the very end of the testing session. American English learners of Russian received a list of the target words

and fillers in Russian that were used in the experiment. They were asked to translate the words into English and choose one of the three following categories that best described their knowledge of each word: 1) I have seen it, I know it, I can use it; 2) I saw it, I don't know it; 3) I never saw it, I don't know it (see Figure B7 in Appendix B for a copy of the answer sheet with instructions). Russian native speakers also received this list of words in Russian and were asked to mark how familiar the words were to them using a seven-point scale: 7 – very familiar, 1 – unfamiliar (see Figure B8 in Appendix B for a copy of the answer sheet).

Only three tokens out of 1000 responses were marked as unfamiliar by the learners, i.e. the participants checked the category 'I saw it, I don't know it'. One unfamiliar word /s'ierij/ 'grey' was marked by an advanced learner of level 7 and two words /slovári/ 'dictionary' and /t'ot'a/ 'aunt' were marked by an intermediate learner of level 3. With respect to translation, eight words out of 1000 were translated inaccurately. The same word /s'ierij/ 'grey' was marked as familiar by the level 8 student but was neither correctly translated nor produced in the oral picture-naming task. Four intermediate learners of levels 3-5 failed to translate the word /s'ierij/ 'grey' and one learner of level 5 did not translate the word /slovári/ 'dictionary' accurately (neither did he produce it in the oral picture-naming task). The learner of level 3 who had marked the words /slovári/ 'dictionary' and /t'ot'a/ 'aunt' as unfamiliar, did not translate them either, however, he produced them in the oral picture-naming task. Combining these results, it can be concluded that nine words (1.1 %) out of 800 target words were not quite familiar to the learners. The five hundred fillers used in the study were all marked as familiar and

translated accurately. Russian native speakers were able to translate all the target words and fillers and marked them as very familiar, i.e. selected 7 on the seven-point scale.

4.2.8. Rating task

Materials

In order to mark their answers, the judges received answer sheets (Figure 4.2) with all the target words listed in a column and detailed instructions printed in advance. The exact time of every fifth production of a word on the audio file was provided in case the raters decided to play back the recording. The judges were asked to evaluate only the productions of the consonants that were boldfaced and in red color using a six-point scale with the following descriptions: 6 – excellent soft; 5 – average soft; 4 – poor soft; 3 – poor hard; 2 – average hard; 1 – excellent hard (see Figure B9 in Appendix B for a copy of instructions in Russian). Assumedly, the more palatalization the learners produced, the higher the rating they received. Since palatalization is a marked category, intuitively it made more sense to assign a higher number to palatalized consonants than plain consonants. Palatalized consonants have some ‘additional’ quality, whereas plain consonants are unmarked and do not have this ‘additional’ quality. Therefore, the scale assigned higher numbers of 4, 5 and 6 to palatalized consonants and lower numbers of 1, 2 and 3 to plain consonants.

ТЫСЯЧА		Твёрдый			Мягкий		
		Отличный	Средний	Плохой	Плохой	Средний	Отличный
Время	1. тысяча	1	2	3	4	5	6
	2. тысяча	1	2	3	4	5	6
	3. тысяча	1	2	3	4	5	6
	4. тысяча	1	2	3	4	5	6
	5. тысяча	1	2	3	4	5	6
0:33	6. тысяча	1	2	3	4	5	6
	7. тысяча	1	2	3	4	5	6

Figure 4.2. Sample answer sheet for the word /tʲisʲatʲa/ ‘thousand’. The left-hand column displays the seven out of 50 productions to be evaluated for a given word. The target consonant is in red. The two main columns for identification “Твёрдый” vs. “Мягкий” (“hard” vs. “soft” respectively) are subdivided into three quality ranges “excellent, average, poor” for hard consonants and “poor, average, excellent” for soft consonants. See text for more details.

Procedure

The audio files were presented to three raters, Russian native listeners, for categorization and goodness ratings. The listeners, or judges, were all female and linguists. Each of the three judges rated all 991 productions (20 target words produced by 50 participants with 9 tokens missing). At first, the judges rated five audio files that contained words with the target plain consonants word-finally. Then, they rated another five audio files with palatalized consonants word-finally, followed by five audio files with plain consonants intervocalically and, finally, the last five audio files with palatalized consonants intervocalically. The files were arranged in such an order as to avoid confusion, especially regarding the target consonants in intervocalic position. Since the judges did not evaluate the production of the entire word but only of the target

consonant, which could have been produced in the ultimate, penultimate or antepenultimate syllable, arranging audio files according to the target word and syllable position allowed raters to concentrate more intently on the target consonant.

The judges were allowed to take breaks between audio files. However, when they started playing a recording with all 50 productions of a specific target word, e.g., /tisiatʃa/ ‘thousand’, they had only five seconds to make a decision about each word. The recording could be paused and the same production of a word could be played multiple times. However, the raters were explicitly instructed to avoid spending too much time on individual words and rely more on their initial judgment.

The raters were instructed, first, to categorize a target consonant as plain or palatalized and, second, assess how good that production was using a six-point scale. Providing raters with a six-point scale gave them flexibility in evaluating participants’ productions. They did not only categorize consonants produced by learners as plain (hard) or palatalized (soft), but they also evaluated the quality of those productions. High ratings on learners’ productions of palatalized consonants and low ratings on the productions of plain consonants were interpreted as accurate productions of the target consonants. Predominantly low ratings or predominantly high ratings for both palatalized and plain consonants meant that learners did not realize the contrasts in their speech accurately.

4.2.9. Analysis

Table 7 presents the research questions, dependent and independent variables as well as the statistical procedures employed to answer the research questions. The

statistical analyses were done using IBM Statistical Package for the Social Sciences (SPSS), Version 24.

Table 4.5

Research questions, variables and analysis methods

Research Questions	Variables	Analysis method
1. How do American learners of Russian perceive and produce the plain / palatalized consonant contrast in L2 Russian? Are previously reported syllable position effects on the perception and production of palatalization reliable?	Ratings IV1: Group (intermediate, advanced, Russian) IV2: Palatalization (plain, palatalized) IV3: Position (intervocalic, final) DV1: Categorization error rates DV2: Rating scores	A generalized linear mixed model on error rates with group, palatalization and position as fixed effects and participant and rater as random effects. A linear mixed-effects mode on rating scores with group, palatalization and position as fixed effects and participant as random effect.
	ABXs (with words and nonwords) IV1: Group (intermediate, advanced, Russian) IV2: Condition (test, control) IV3: Position (intervocalic, final) DV1: D-prime (d') scores based on error rates DV2: Error rates DV3: RTs	A two-tailed t-test on d' with a between factor of group (advanced vs. intermediate). A generalized linear mixed model on error rates with group, condition and position as fixed effects and participant and item as random effects. A linear mixed-effects model on RTs with group, palatalization and position as fixed effects and participant and item as random effects.
2. What is the relationship between the perception and production of plain vs. palatalized consonants in the acquisition of L2 Russian?	Relationship between perception and production DV1: Error rates (ABX with words) DV2: Error rates (ABX with nonwords) DV3: Categorization error rates (Rating task)	Pearson's correlations

DV4: Rating scores for
palatalized consonants
(Rating task)

Note: DV = dependent variable; IV = independent variable.

4.3. Results

4.3.1. Rating task for productions

4.3.1.1. Interrater reliability

The words with target plain and palatalized consonants produced by the participants in the oral picture-naming task were evaluated by three Russian native listeners, who were professional linguists. They rated each token (3 raters x 991 tokens = 2973 tokens total) using a six-point scale. In order to assess the consistency and reliability of the raters, intraclass correlations coefficient (ICC) was computed using SPSS 24. The average measure ICC was .961 with a 95% confidence interval from .956 to .965, $F(990, 1980) = 25.54, p < .001$. It indicates that there was a high degree of consistency and reliability among the raters, i.e. the raters strongly agreed with one another in their ratings.

4.3.1.2. Distribution of rating scores

Figure 4.3 shows the distribution of rating scores for Russian native speakers for their production of target plain and palatalized consonants. In both histograms the scores are highly skewed, which suggests that the contrast between plain and palatalized

consonants was very well maintained in the productions of Russian native speakers. None of the plain consonants were rated as palatalized (because there were no scores higher than 3) and none of the palatalized consonants were rated as plain (because there were no scores lower than 4).

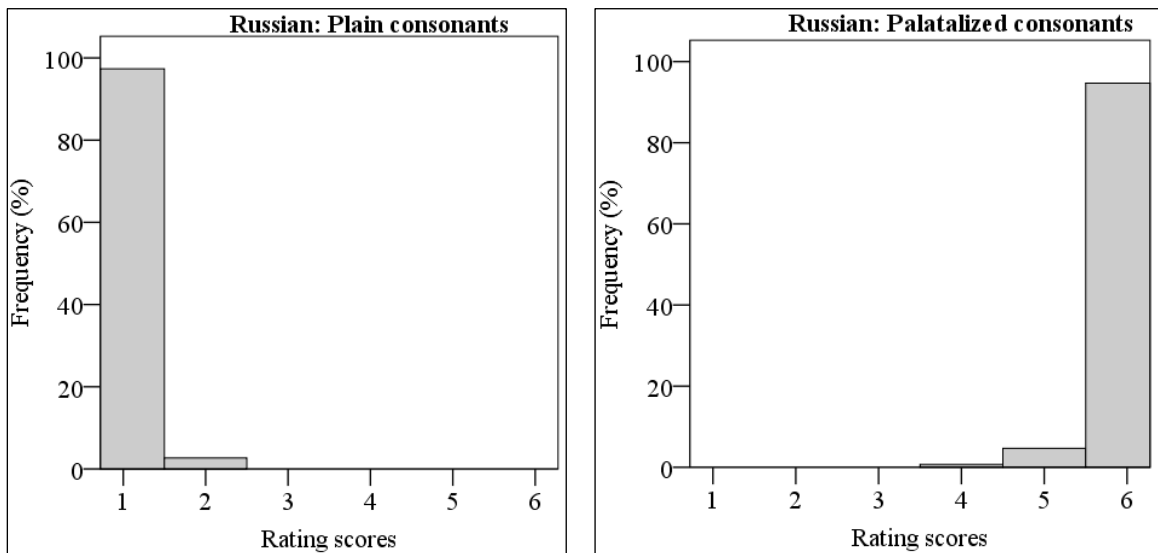


Figure 4.3. Distribution of rating scores for Russian native speakers.

Figure 4.4 shows the distribution of rating scores that the intermediate and advanced learners received for their production of target plain and palatalized consonants. The distribution of scores in the histograms for plain consonants is highly skewed indicating that the learners were able to produce plain consonants well (1 – excellent hard, 2 – average hard, 3 – poor hard on the rating scale) and rarely replaced them with palatalized counterparts. The distribution of scores for palatalized consonants looks different. The scores are more evenly distributed, especially for the intermediate learners. A substantial number of palatalized consonants received scores of 1-3, which means that the raters categorized these productions as those of plain consonants.

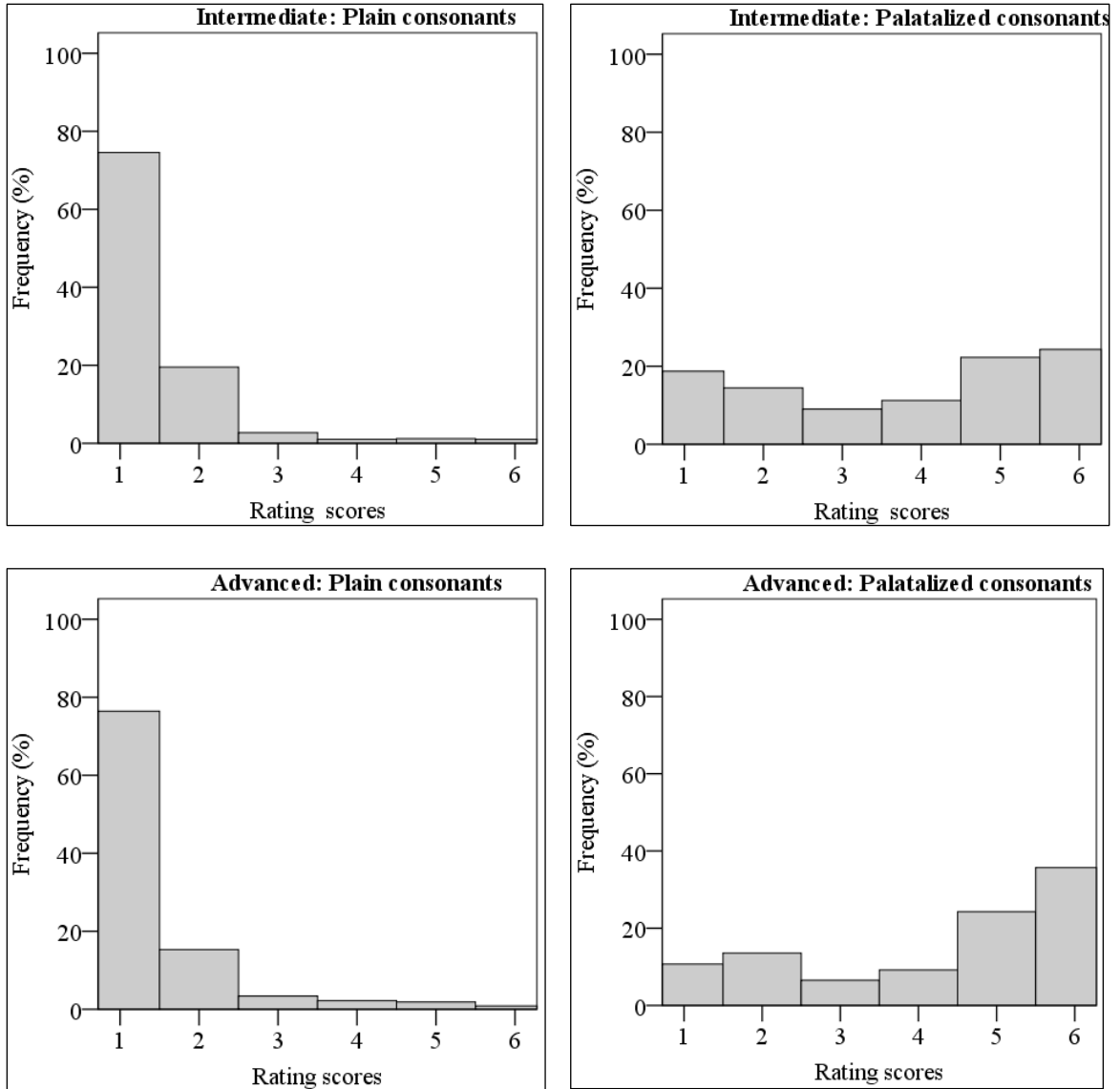


Figure 4.4. Distribution of rating scores for intermediate (top figures) and advanced learners (bottom figures).

4.3.1.3. Categorization error rates

Before assigning a specific rating score, the raters were explicitly instructed to categorize each consonant as plain or palatalized. If a consonant was categorized as plain, it received a rating score of 1 “excellent hard”, 2 “average hard” or 3 “poor hard”. If a

consonant was categorized as palatalized, it received a rating score of 6 “excellent soft”, 5 “average soft” or 4 “poor soft”. For example, if a learner produced a plain consonant word-finally instead of the expected palatalized consonant in the word /solʲ/, that production would be rated as 1, 2 or 3. In other words, a categorization error is a production error made by learners as categorized by Russian native listeners. These categorization errors occurred when learners replaced target consonants with their plain or palatalized counterparts and Russian native speakers categorized these target consonants as such. Table 4.6 presents mean error rates for plain and palatalized consonants for the three groups of participants.

Table 4.6

Mean error rates of miscategorized productions (%) of plain and palatalized consonants and standard deviations (SD) for each group of participants

Palatalization status Group	Plain consonants		Palatalized consonants	
	Mean	SD	Mean	SD
Russian	0	0	0	0
Advanced	5	22	31	46
Intermediate	3	18	42	49

A generalized linear mixed model was run in SPSS 24 on the error rates of consonants that were mispronounced by the participants and as a result categorized by raters as the opposite counterparts. The factors group (Russian native speakers, advanced learners, intermediate learners) and palatalization status (plain, palatalized) were declared as fixed effects. The factors participant and rater were chosen as random effects. The significance cut off point was set at $p < .05$. Type III tests of fixed effects revealed a main effect of group, $F(2, 2967) = 25.22, p < .001$, palatalization, $F(1, 2967) = 67.2, p < .001$, and an interaction between the two factors, $F(2, 2967) = 13.36, p < .001$. The Bonferroni

post hoc tests indicated that both groups of learners made significantly ($p < .001$) more pronunciation errors in palatalized consonants than in plain counterparts. There were no significant differences between the three groups of participants in their productions of plain consonants. However, the raters categorized palatalized consonants produced by intermediate learners as plain counterparts significantly ($p < .001$) more often than palatalized consonants produced by advanced learners. The Russian native speakers made no pronunciation mistakes in differentiating between plain and palatalized consonants as judged by the raters. Their performance was significantly different from the performance of advanced ($p < .001$) and intermediate learners ($p < .001$).

In order to examine the effect of syllable position on the production of plain and palatalized consonants, an additional fixed effect of position (intervocalic, final) was added to the generalized linear mixed model run on the error rates. Type III tests of fixed effects revealed a significant interaction between group, palatalization and position $F(7, 2961) = 10, p < .001$. The Bonferroni post hoc tests showed that syllable position had no effect on the production of plain consonants by the learners (Figure 4.5) but it had a significant effect on the production of palatalized consonants. Both intermediate and advanced learners made significantly ($p < .001$) fewer mistakes in their production of palatalized consonants in intervocalic position (intermediate: $M = 20\%$; advanced: $M = 13\%$) than in word-final position (intermediate: $M = 65\%$; advanced: $M = 49\%$). Also, there was a statistically significant difference between advanced and intermediate learners in their production of palatalized consonants in intervocalic position ($p = .027$) and word-final position ($p < .001$), as well as learners and Russian native speakers in both syllable positions ($p < .001$ for all comparisons).

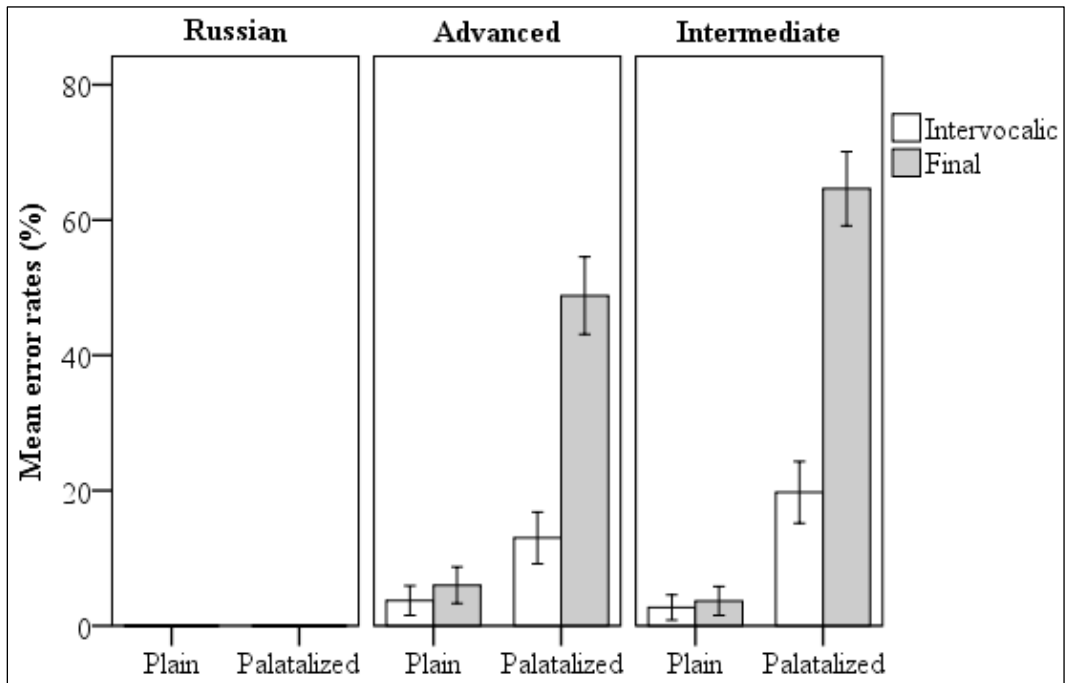


Figure 4.5. Mean error rates for the production of plain and palatalized consonants by learners in intervocalic and word-final positions as judged by Russian native listeners. Error bars show the 95% CI.

4.3.1.4. Rating scores

Table 4.7 presents the mean, median, mode and standard deviations of the rating scores that the three groups of participants received for their production of plain and palatalized consonants.

Table 4.7

Mean, median, mode and standard deviations (SD) of rating scores for the production of plain and palatalized consonants for each group

Palatalization status Group	Plain consonants				Palatalized consonants			
	Mean	Median	Mode	SD	Mean	Median	Mode	SD
Russian	1.03	1	1	0.10	5.94	6	6	0.18
Advanced	1.40	1	1	0.84	4.30	4.67	6	1.59
Intermediate	1.38	1	1	0.71	3.77	4.33	5.67	1.69

A linear mixed effects model was run in SPSS 24 on the mean rating scores averaged across raters. The factors group (Russian native speakers, advanced, intermediate) and palatalization status (plain, palatalized) were declared as fixed effects. The factor participant was chosen as random effect. The significance cut off point was set at $p < .05$. Type III tests of fixed effects revealed a main effect of group, $F(2, 46.44) = 22.28, p < .001$, palatalization, $F(1, 937.73) = 2045.89, p < .001$, and an interaction between the two factors, $F(2, 937.76) = 86.22, p < .001$). The Bonferroni post hoc tests indicated that all three groups of participants received significantly ($p < .001$ for all groups) different mean rating scores for their production of plain consonants and their production of palatalized consonants, which suggests that learners aimed at differentiating plain and palatalized consonants in their production. Also, there was no significant difference in mean rating scores that the three groups of participants received for plain consonants but there were significant differences between Russian native speakers and learners in the production of palatalized consonants. Russian native speakers received significantly higher rating scores for the production of palatalized consonants than advanced ($p < .001$) and intermediate learners ($p < .001$) and advanced learners received higher scores than intermediate learners ($p < .001$).

In order to examine the effect of syllable position on the production of plain and palatalized consonants, an additional fixed effect of position (intervocalic, final) was added to the linear mixed effects model run on the rating scores. Type III tests of fixed effects revealed a significant interaction between palatalization, position and group, $F(2, 931.93) = 14.49, p < .001$. The Bonferroni post hoc tests showed that syllable position had no effect on the production of plain consonants by the three groups of participants (Figure 4.6) but it had a significant effect on the production of palatalized consonants by learners. Both intermediate and advanced learners received significantly ($p < .001$) higher rating scores for their production of palatalized consonants in intervocalic position (intermediate: $M = 4.69$; advanced: $M = 5.01$) than in word-final position (intermediate: $M = 2.85$; advanced: $M = 3.58$). Also, there was a significant ($p < .001$ for both groups) difference in learners' productions of plain and palatalized consonants in intervocalic position and plain and palatalized consonants in word-final position, which suggests that learners tried to differentiate these consonants in their pronunciation. Finally, there was a statistically significant difference ($p < .001$) between advanced and intermediate learners in the production of palatalized consonants in word-final position but not in intervocalic position ($p = .147$). However, in both syllable positions learners' scores on palatalized consonants were significantly lower ($p < .001$ for both groups of learners) than those of the Russian native speakers (intervocalic: $M = 5.95$; final: $M = 5.93$).

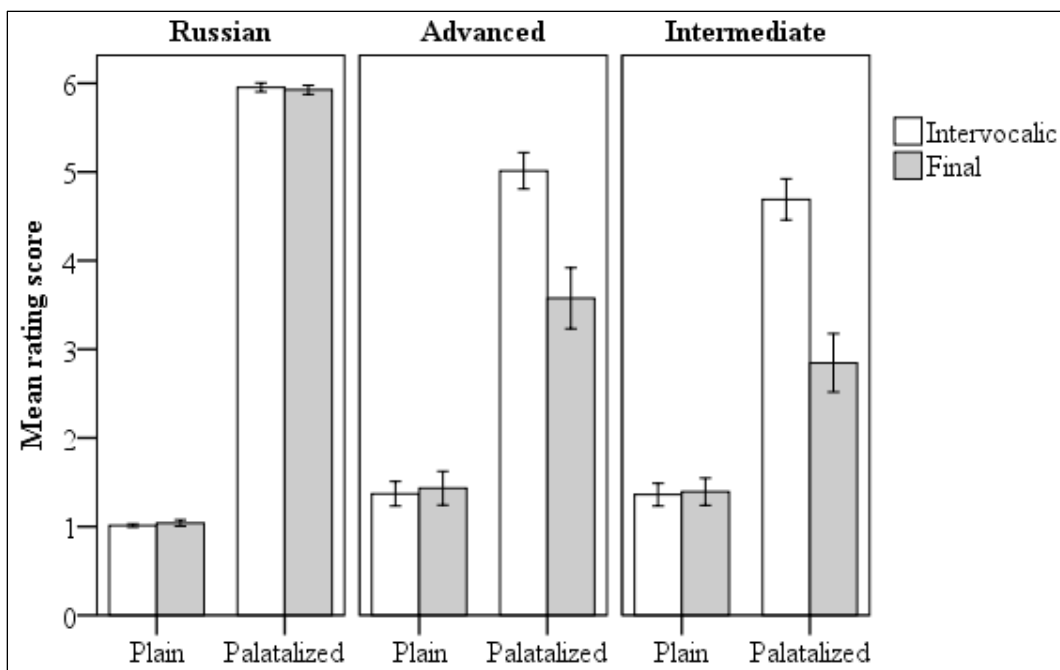


Figure 4.6. Mean rating scores for each group, palatalization status and syllable position.

Error bars show the 95% CI.

4.3.1.5. Summary of results for the rating task

The results of the rating task suggest that American English learners of Russian strived to maintain the distinction between plain and palatalized consonants in their production. Syllable position had a strong effect on learners' ability to produce palatalized consonants. In intervocalic position, both groups of learners made significantly fewer production mistakes in palatalized consonants and received significantly higher ratings than in word-final position. It provides further evidence that a vowel following a palatalized consonant facilitates articulation of that consonant. Learners at an advanced level of proficiency were more accurate in their production of palatalized consonants than intermediate learners. Their mean rating scores for the production of palatalized consonants were significantly higher than those of the

intermediate learners, which indicates that the development of accurate palatalization gestures, especially in the absence of vocalic co-articulation support, requires more time and experience with the target language. Nonetheless, approximately one-third of all the palatalized consonants produced by advanced learners were categorized as plain by Russian native listeners. In word-final position, advanced learners of Russian produced half of palatalized consonants as plain. Intermediate learners' error rates were even higher. These results showed that palatalization remained to be a challenging feature of articulation, especially in word-final position. Both groups of learners differed significantly from Russian native speakers in their error rates and rating scores irrespective of syllable position.

4.3.2. ABX with real words

4.3.2.1. *D-primes*

The sensitivity index or d' was calculated for each participant to identify how sensitive they were to the presence of palatalization in real words. Table 4.8 shows the decision matrix that was employed to determine the number of hits and false alarms in the test condition.

Table 4.8

Decision matrix

	Output: palatalized	Output: plain
Input: palatalized	hit	miss
Input: plain	false alarm	correct rejection

Hit rates (H) and false alarm rates (F) were calculated by dividing the number of hits or false alarms by the number of trials in the test condition. The total number of trials for

each participant was 80. D primes were calculated using the following formula: $d' = z(H) - z(F)$, where z represented the z -score. Standard corrections were applied to hit rates of 1 and false alarm rates of 0. If the hit rate equaled 1, the following formula $1 - 1/2N$, where N is the number of targets, was applied to replace the value of 1. If the false alarm rate equaled 0, then the formula $1/2N$, where N is the maximum number of false alarms, was used to calculate the value that would replace 0 (Wixted & Lee, 2013). The criterion, a specific measure of bias, was calculated as $c = -.5(z(H) + z(F))$ (Boley & Lester, 2009). A high d' indicates a high accuracy at correctly categorizing plain vs. palatalized consonants. A d' that is close to 0 shows a lack of sensitivity. If the value of c is negative, it signifies a bias towards responding *palatalized consonant*. If the value of c is positive, it indicates a bias toward the *plain consonant* response.

The results of the calculations were the following: Russian native speakers $d' = 3.845$, $c = -0.03$, advanced learners $d' = 1.097$, $c = 0.012$ and for intermediate learners $d' = 0.958$, $c = 0.02$. Russian native speakers' d' scores were close to the maximum possible. As expected, they show a very high sensitivity to this contrast. Advanced learners were much less sensitive to it, but still demonstrated slightly higher sensitivity for palatalization than intermediate learners. However, a two-tailed t -test conducted on the d' scores for advanced and beginners showed that the difference was not significant, $t(38) = .88$, $p = .385$. Both groups of learners were very slightly biased to choose *plain* when presented with a palatalized consonant.

4.3.2.2. Error rates

Table 4.9 presents the mean error rates in test and control conditions for each group of participants.

Table 4.9

Mean error rates (%) and standard deviations (SD) for each group of participants and condition

Condition	Test		Control	
Group	Mean	SD	Mean	SD
Russian	3	16	3	17
Advanced	31	46	7	25
Intermediate	32	47	7	26

A generalized linear mixed model was run in SPSS 24 on the error rates. The factors group (Russian native speakers, advanced learners, intermediate learners) and condition (test, control) were declared as fixed effects. The factors participant and item were chosen as random effects. The significance cut off point was set at $p < .05$. Type III tests of fixed effects revealed a main effect of group, $F(2, 5994) = 21.65, p < .001$, condition, $F(1, 5994) = 92.53, p < .001$, and an interaction between the two factors, $F(2, 5994) = 16.36, p < .001$). The Bonferroni post hoc tests indicated that learners made significantly ($p < .001$ for both groups of learners) more errors in the test condition when the difference between the target consonants was based on the secondary feature of articulation than in the control condition when the difference was based on primary features. Russian native speakers' performance in the test condition was not significantly different from that in the control condition. There were no significant differences between the three groups of participants in their performance on control trials but in the test condition both groups of learners were significantly ($p < .001$) less accurate than

Russian native speakers. There was no significant difference between advanced and intermediate learners in the test condition.

An additional fixed effect of position (intervocalic, final) was added to the model in order to examine the effect of syllable position on participants' performance in test and control trials. A significant interaction was revealed between group, position and condition, $F(7, 5988) = 6.34, p < .001$. The Bonferroni post hoc tests showed that learners but not Russian native speakers made significantly ($p < .001$ for all the comparisons) more mistakes on the test trials in both syllable positions than in control trials. Syllable position had no effect on learners' performance in the control condition (Figure 4.7) but it had a significant effect on their performance in the test condition. Both intermediate and advanced learners made significantly ($p < .001$ for both groups) fewer mistakes in intervocalic position (intermediate: $M = 27\%$; advanced: $M = 25\%$) than in word-final position (intermediate: $M = 37\%$; advanced: $M = 36\%$). Finally, there was no statistically significant difference between advanced and intermediate learners in their performance on test trials either in intervocalic ($p = .428$) or word-final positions ($p = .816$), but both groups of learners made significantly ($p < .001$) more mistakes on test trials than Russian native speakers in both syllable positions.

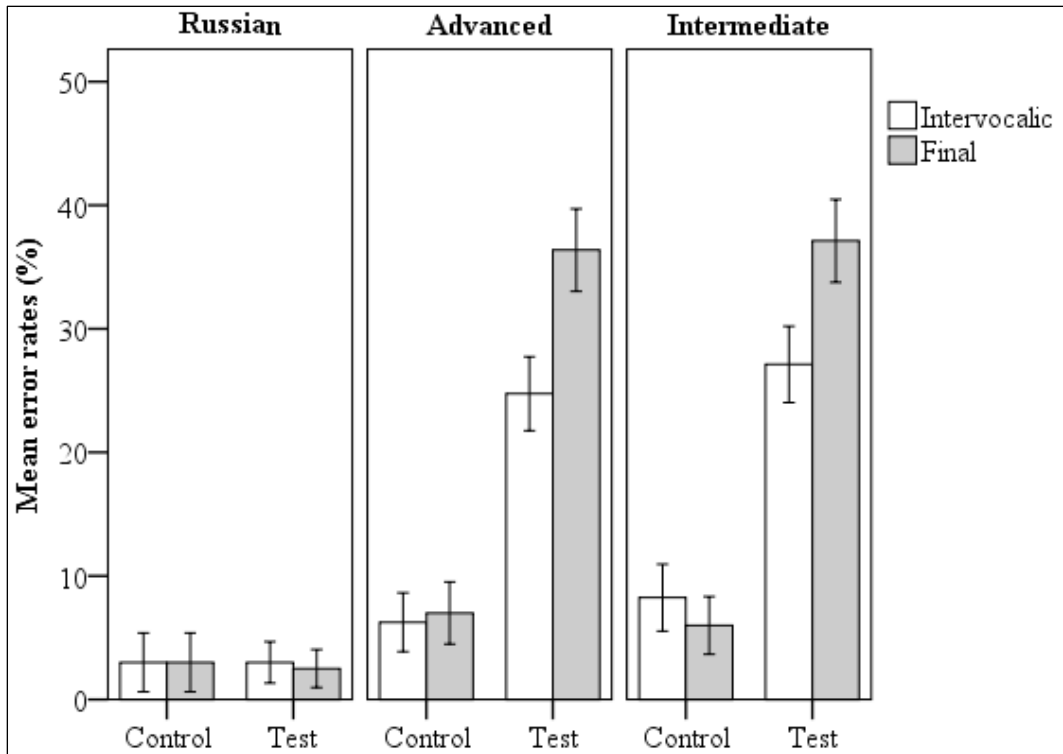


Figure 4.7. Mean error rates for each group of participants and condition in intervocalic and word-final positions. Error bars show the 95% CI.

4.3.2.3. Reaction times

Table 4.10 presents the mean reaction times (RTs) in test and control conditions for each group of participants. RTs were measured from the beginning of the third (X) stimulus. Since target consonants could occur in different syllables within a word, and since the words differed in overall length across the conditions (more monosyllabic items in the word-final position items, vs. only disyllabic words for the intervocalic position items, see Table 4.4), it was decided to adjust the RTs for analysis by subtracting from them the duration of the X stimuli. Mean RTs were calculated for correct responses only.

Table 4.10

Mean adjusted RTs (ms) and standard deviations (SD) for each group of participants and condition

Condition Group	Test		Control	
	Mean	SD	Mean	SD
Russian	416	244	404	244
Advanced	740	270	652	262
Intermediate	647	284	550	252

A linear mixed effects model was run in SPSS 24 on the RTs. The factors group (Russian native speakers, advanced learners, intermediate learners) and condition (test, control) were declared as fixed effects. The factors participant and item were chosen as random effects. The significance cut off point was set at $p < .05$. Type III tests of fixed effects revealed a main effect of group, $F(2, 46.89) = 22.88, p < .001$, condition, $F(1, 115.27) = 16.7, p < .001$, and an interaction between the two factors, $F(2, 4693.34) = 17.16, p < .001$. The Bonferroni post hoc tests indicated that Russian native speakers spent the same amount of time ($p = .623$) on test and control trials and were much faster than the learners to provide their answers in both conditions ($p < .01$ for all comparisons). Learners, on the other hand, spent significantly ($p < .001$) more time on test trials than on control trials. Surprisingly, advanced learners were slower than intermediate learners in test condition ($p = .042$) and in control condition ($p = .017$).

In order to examine the effect of syllable position on learners' performance in test and control trials, an additional fixed effect of position (intervocalic, final) was added to the linear mixed effects model run on the reaction times. Type III tests of fixed effects revealed a main effect of position, $F(1, 114.57) = 31.16, p < .001$ but no significant interactions. All groups spent significantly more time on test and control trials with target

consonants in word-final position than in intervocalic position (Figure 4.8). Of note, this effect might also be due to the later occurrence of the target consonant in word-final items, since the RTs have been adjusted for the overall length of the stimulus, but not for the specific positional occurrence of the target consonant within the word.

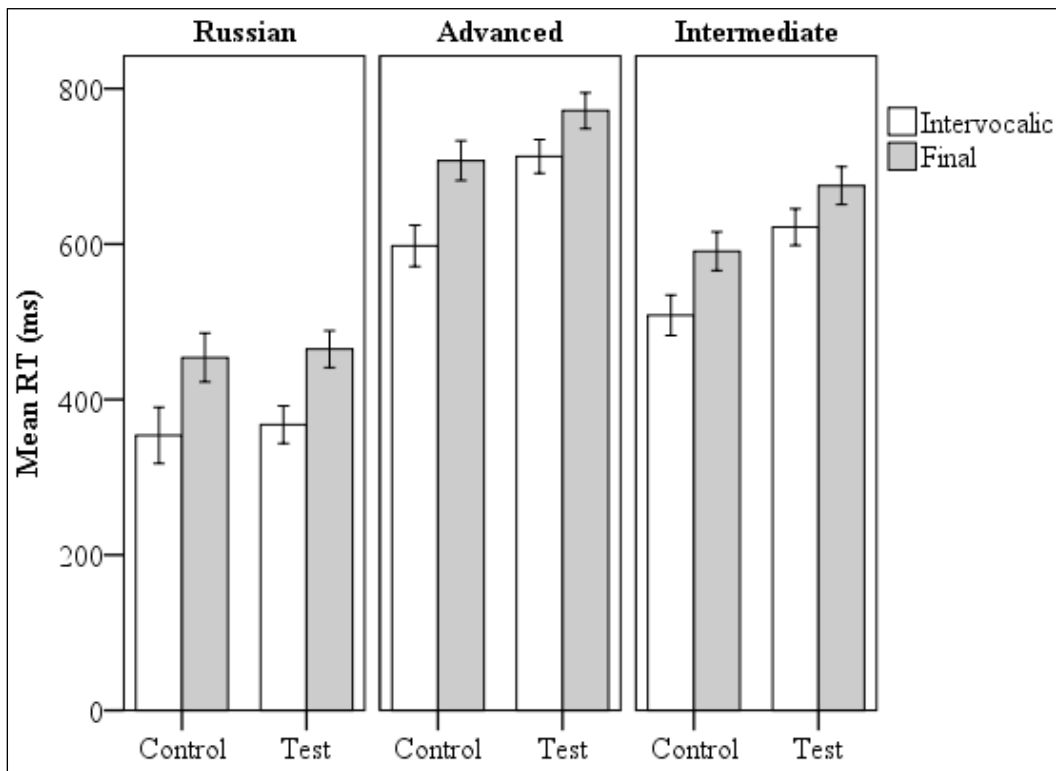


Figure 4.8. Mean RTs for each group of participants and condition in intervocalic and word-final position. Error bars show the 95% CI.

4.3.2.4. Summary of results for the ABX with real words

The results of the ABX with real words suggest that Russian native speakers processed contrasts based on primary features (control condition) and secondary features (test condition) differently from American English learners of Russian. Russian native speakers had a 3%-error rate in both conditions and spent almost the same amount of time in test and control trials (416 ms vs. 404 ms), which suggests that they processed

contrasts based on primary and secondary features similarly. Learners, on the other hand, spent significantly more time on test trials than on control trials, and made significantly more mistakes in the test condition (approximately 30% error rate) than in the control condition (7% error rate). Unlike in the production task, there was no significant difference between the two groups of learners in the test condition, which indicates that intermediate and advanced learners had similar perceptual abilities for contrasts based on secondary features of articulation. The third, bias-free measure of performance, d' scores, also showed no significant difference between the two groups of learners in their sensitivity to palatalization. With respect to syllable position, the results of the ABX in the test condition demonstrated that word-final position might have been more challenging perceptually than intervocalic position: learners made more mistakes in the former position than in the latter. However, in the control condition there was no significant difference in error rates between learners and Russian native speakers in both positions. This suggests that it is not the word-final position per se that creates difficulties for learners but the palatalization contrast in this position, which lacks perceptual salience, that results in greater errors.

4.3.3. ABX with nonwords

4.3.3.1. D-primes

The sensitivity index or d' was calculated for each participant in the test condition only to identify how sensitive they were to the presence of palatalization in nonwords. The same decision matrix and formulas were used for the ABX with nonwords as for the ABX with real words (see Section 4.3.2.1). The total number of trials for each participant

was 40. The results were the following: Russian native speakers $d' = 3.658$, $c = -0.032$, for advanced learners $d' = 1.111$, $c = -0.02$ and for intermediate learners $d' = 1.314$, $c = 0.149$. Intermediate learners demonstrated a higher sensitivity for palatalization than advanced learners but a two-tailed t -test conducted on the d' scores for advanced and beginners showed that the difference was not significant, $t(38) = 1.01$, $p = .318$. Unlike advanced learners, intermediate learners were biased to choose *plain* when presented with a palatalized consonant.

4.3.3.2. Error rates

Table 4.11 presents the mean error rates in test and control conditions for each group of participants.

Table 4.11

Mean error rates and standard deviations (SD) for each group of participants and condition

Condition Group	Test		Control	
	Mean	SD	Mean	SD
Russian	2	14	2	12
Advanced	30	46	7	26
Intermediate	27	45	4	19

A generalized linear mixed model was run in SPSS 24 on the error rates. The factors group (Russian native speakers, advanced learners, intermediate learners) and condition (test, control) were declared as fixed effects. The factors participant and item were chosen as random effects. The significance cut off point was set at $p < .05$. Type III tests of fixed effects revealed a main effect of group, $F(2, 2994) = 11.01$, $p < .001$, condition, $F(1, 2994) = 34.29$, $p < .001$, and an interaction between the two factors, $F(2,$

2994) = 4.77, $p = .009$). The Bonferroni post hoc tests indicated that learners made significantly ($p < .001$) more errors in the test condition than in the control condition but Russian native speakers' performance in the test condition was not significantly different from that in the control condition. There were no significant differences between the three groups of participants in the control condition. However, in the test condition, Russian native speakers had significantly ($p < .001$) lower error rates than the learners. There was no significant difference between advanced and intermediate learners in their performance in the test condition.

In order to examine the effect of syllable position on learners' performance on test and control trials, an additional fixed effect of position (intervocalic, final) was added to the model run on the error rates. Type III tests of fixed effects revealed a significant interaction between condition, position and group, $F(2, 2988) = 7.28, p < .001$. The Bonferroni post hoc tests showed that learners but not Russian native speakers made significantly ($p < .003$ for both groups of learners) more mistakes on test trials than on control trials in both syllable positions. Syllable position had no effect on learners' performance in the control condition (Figure 4.9) but it had a significant effect on their performance in the test condition. Both intermediate and advanced learners made significantly ($p < .001$) fewer mistakes in intervocalic position (intermediate: $M = 18\%$; advanced: $M = 17\%$) than in word-final position (intermediate: $M = 37\%$; advanced: $M = 43\%$). Finally, there was no statistically significant difference between advanced and intermediate learners in their performance on test trials either in intervocalic position ($p = .83$) or word-final position ($p = .24$), but both groups of learners made significantly ($p < .001$) more mistakes on test trials than Russian native speakers in both syllable positions.

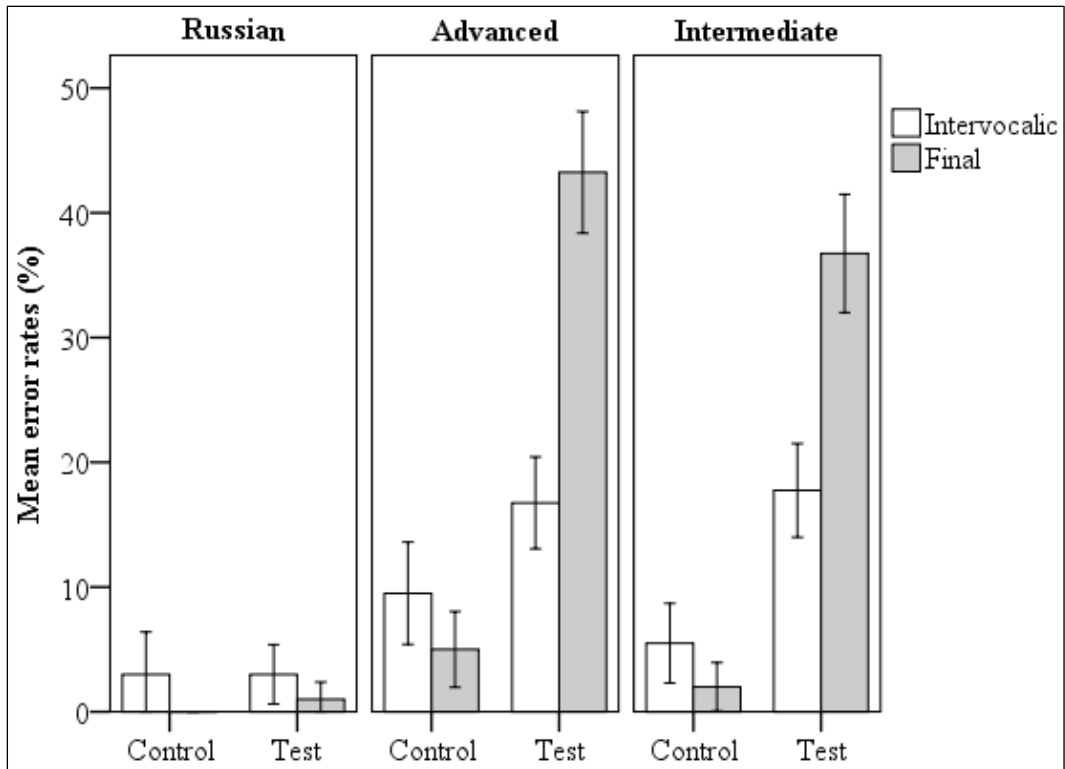


Figure 4.9. Mean error rates for each group of participants and condition in intervocalic and word-final positions. Error bars show the 95 % CI.

4.3.3.3. Reaction times

Table 4.12 presents the mean RTs in test and control conditions for each group of participants. RTs were measured from the beginning of the X stimulus. Since target consonants could occur in different syllables within a word, it was decided to adjust the RTs for analysis by subtracting the duration of the X stimuli. Mean RTs were calculated over correct responses only.

Table 4.12

Mean RTs (ms) and standard deviations (SD) for each group of participants and condition

Condition Group	Test		Control	
	Mean	SD	Mean	SD
Russian	388	256	353	241
Advanced	638	294	587	271
Intermediate	564	296	462	265

A linear mixed effects model was run in SPSS 24 on the RTs. The factors group (Russian native speakers, advanced, intermediate) and condition (test, control) were declared as fixed effects. The factors participant and item were chosen as random effects. The significance cut off point was set at $p < .05$. Type III tests of fixed effects revealed a main effect of group, $F(2, 47.06) = 10.71, p < .001$, condition, $F(1, 56.94) = 6.24, p = .015$, and an interaction between the two factors, $F(2, 2379.96) = 6.42, p = .002$. The Bonferroni post hoc tests indicated that learners but not Russian native speakers spent significantly ($p = .032$ for advanced learners, $p < .001$ for intermediate) more time on test trials than on control trials. In the test condition, there was no significant difference in RTs between intermediate and advanced learners ($p = .33$) but both groups of learners were significantly different from Russian native speakers ($p < .003$).

In order to examine the effect of the syllable position on learners' performance in the test and control conditions, an additional fixed effect of position (intervocalic, final) was added to the linear mixed effects model run on the RTs. Type III tests of fixed effects revealed a main effect of position, $F(1, 54.07) = 10.97, p < .001$ but no significant interactions. Participants spent significantly more time on target consonants in word-final position than in intervocalic position in both conditions (Figure 4.10). However, this

effect might be the result of the later occurrence of the target consonant in word-final position, since the RTs have been adjusted for the overall length of the stimulus, but not for the specific positional occurrence of the target consonant within the word.

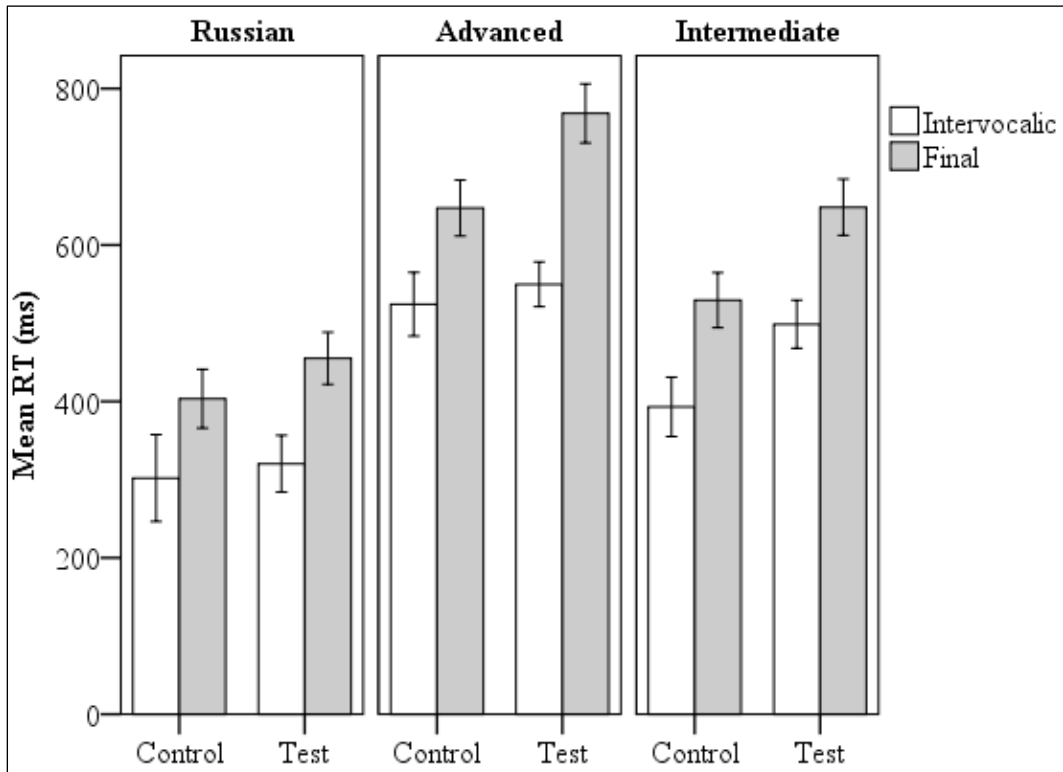


Figure 4.10. Mean RTs for each group of participants and condition in intervocalic and word-final positions. Error bars show the 95% CI.

4.3.3.4. Summary of results for the ABX with nonwords

The results of the ABX with nonwords were very similar to those of the ABX with real words. The same effects and interactions were revealed in both ABX tasks. Russian native speakers did not demonstrate any differences in processing contrasts based on primary features and secondary features. However, learners of both levels of proficiency had significantly longer RTs and made significantly more mistakes in the test

condition than in the control condition. D' scores also showed no significant difference between the two groups of learners in their sensitivity to palatalization, although unlike in the ABX with real words, intermediate learners demonstrated a higher d' than advanced learners. With respect to syllable position, the results of the ABX in the test condition demonstrated that perceptually word-final position was more challenging than intervocalic position: learners made more mistakes in the former position than in the latter and also the RTs in word-final position were longer than in intervocalic position. However, in the control condition there was no significant difference in error rates between learners and Russian native speakers in both syllable positions. Again, just like in the ABX with real words, it supports the claim that it is not the word-final position per se that creates difficulties for learners but the perceptual lack of salience that plain / palatalization contrast has in that specific prosodic position.

4.3.4. Correlations between the rating task and ABX tasks

4.3.4.1. Correlations

Learners' performance on the rating task and ABX tasks was correlated with each other to examine the relationship between perception and production (see Appendix D for individual results). Russian native speakers were excluded from the correlational analysis. For each participant, four measures were aggregated:

- 1) error rates (in %) on test trials on the ABX task with real words;
- 2) error rates (in %) on test trials on the ABX task with nonwords;

- 3) error rates (in %) on the rating task, i.e. errors made by learners in the production of palatalized consonants only, which were categorized by Russian native listeners as plain;
- 4) cumulative rating scores (in %) for palatalized consonants only.

In order to calculate the cumulative rating scores the following formula was used:

$S_{cum} = (S_{act} \times 100\%) / S_{max}$, where S_{cum} is the cumulative rating score, S_{act} is the actual score and S_{max} is the maximum score that the learners could have received. In order to calculate learners' actual scores, the sum of all rating scores was computed for each participant based on the scores they had received for their production of palatalized consonants: $S_{act} = 1N_1 + 2N_2 + 3N_3 + 4N_4 + 5N_5 + 6N_6$, where N_x is the number of words that received such a rating score. For example, for the production of 10 palatalized consonants rated by 3 raters (30 words total) a participant received the following scores: 5 words were rated as 1, 0 words were rated as 2, 6 words were rated as 3, 4 words were rated as 4, 7 words were rated as 5 and 8 words were rated as 6. Thus, this participant's actual score was $S_{act} = 1 \times 5 + 2 \times 0 + 3 \times 6 + 4 \times 4 + 5 \times 7 + 6 \times 8 = 5 + 0 + 18 + 16 + 35 + 48 = 122$. The maximum score (S_{max}) is the score that the participant could receive if he or she produced all words with palatalized consonants and received the highest ratings, i.e. 6, for all tokens: $S_{max} = N_{words} \times N_{raters} \times S_{c_{max}}$, where N_{words} is the number of words that contained target palatalized consonants (in this study it is 10); N_{raters} is the number of raters who evaluated these words (in this study it is 3); $S_{c_{max}}$ is the maximum score on the scale that the participants could receive for their perfect production of the target consonant (in this study it is 6). Thus, the maximum rating score in this study is $10 \times 3 \times 6 = 180$. Now we can calculate the cumulative rating score: $S_{cum} = (S_{act} \times 100\%) / S_{max} =$

$(122 \times 100\%) / 180 = 67.78\%$. This number shows what percentage of the possible maximum score the participant received. Cumulative rating scores were computed for each participant.

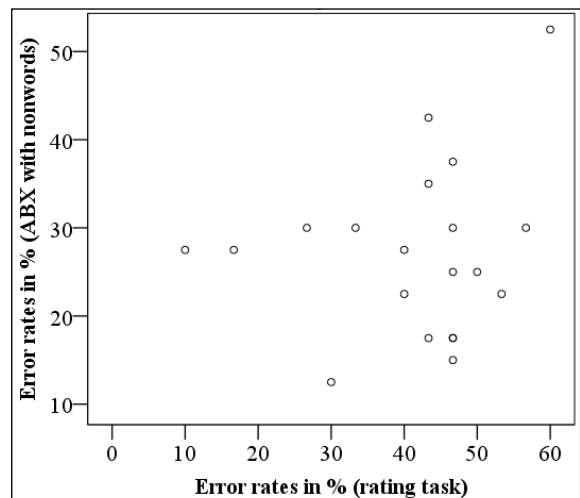
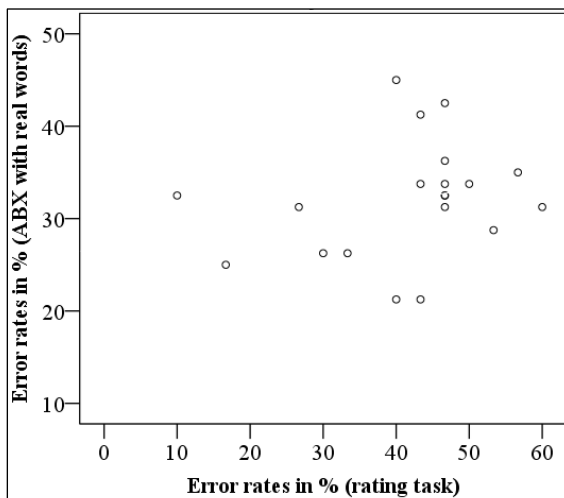
The correlational analysis was performed on the data from intermediate and advanced learners separately. Tables 4.13 and 4.14 present Pearson's correlations for intermediate and advanced learners on the perception and production tasks.

Table 4.13

Pearson's correlations between perception and production for intermediate learners

Measure	1	2	3	4
1. Error (ABX with nonwords)	—			
2. Error (ABX with words)	.399*	—		
3. Error (Rating)	.195	.248	—	
4. Score (Rating)	-.046	-.111	-.742**	—

Note. $n = 20$. * $p < .05$, ** $p < .01$, one-tailed.



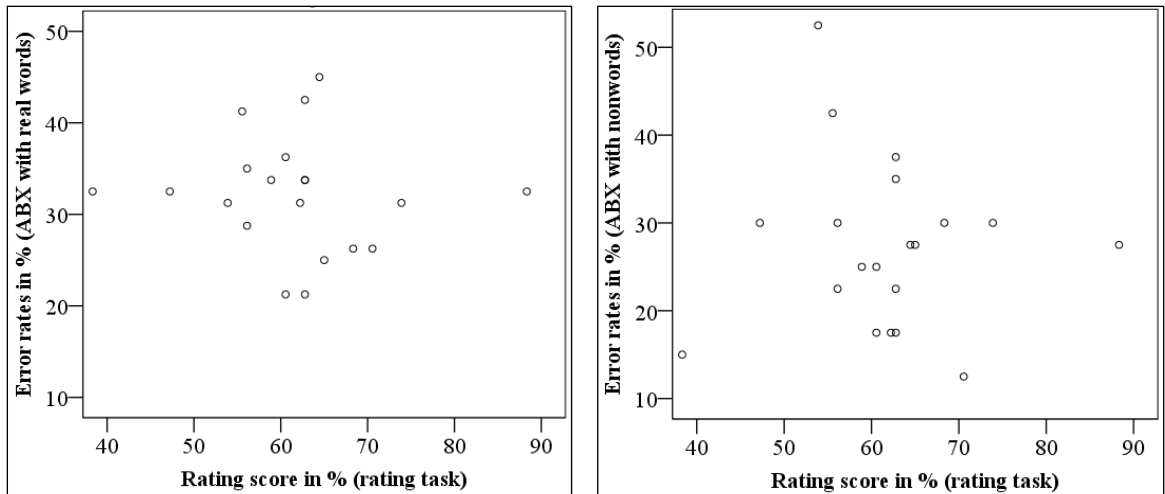


Figure 4.11. Scatterplots of intermediate learners' error rates on the ABX tasks with real words and nonwords, error rates (above panels) and rating scores (lower panels) on the rating task.

There was no relationship between intermediate learners' performance on perception and production tasks (Figure 4.11). However, there were strong, positive, statistically significant relationships between advanced learners' error rates and scores on the rating task and error rates on the ABX tasks (Table 4.14).

Table 4.14

Pearson's correlations between perception and production for advanced learners

Measure	1	2	3	4
1. Error (ABX with nonwords)	—			
2. Error (ABX with words)	.681**	—		
3. Error (Rating)	.582**	.688**	—	
4. Score (Rating)	-.623**	-.721**	-.947**	—

Note. $n = 20$. * $p < .05$, ** $p < .01$, one-tailed.

For the advanced, more errors in perception (ABXs) were related to more errors in production (rating task) (Figure 4.12). None of the learners who had a low error rate on either of the ABXs received a high error rate on the rating task. However, there were

learners who performed very similarly on the ABX with real words, e.g., error rate of 29%, but made a different number of mistakes on the rating task, e.g., 13%, 27% and 47%.

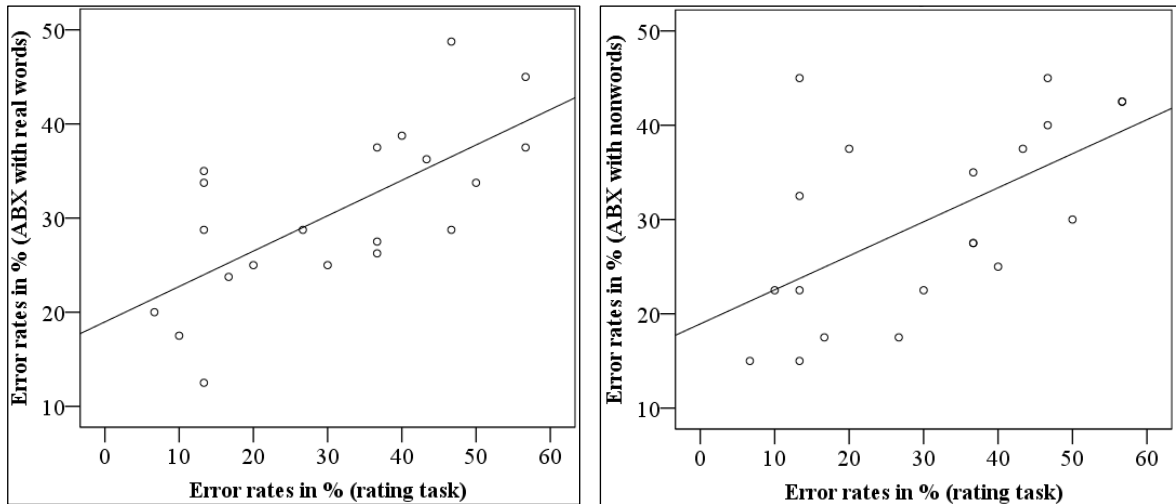


Figure 4.12. Scatterplots of advanced learners' error rates on the ABX tasks with real words and nonwords and error rates on the rating task.

There were also strong, negative, statistically significant relationships between advanced learners' cumulative rating scores on palatalized consonants and the ABX tasks. More errors in perception (ABXs) were related to lower rating scores in production (rating task) (Figure 4.13). Again, none of the advanced learners who had a low error rate on the perception tasks received a very low rating score, which means that learners with relatively good perception skills had relatively good production skills. On the other hand, there were learners with a cumulative rating score of 80% and above but their error rates on the ABX with words were as low as 13% and as high as 35%.

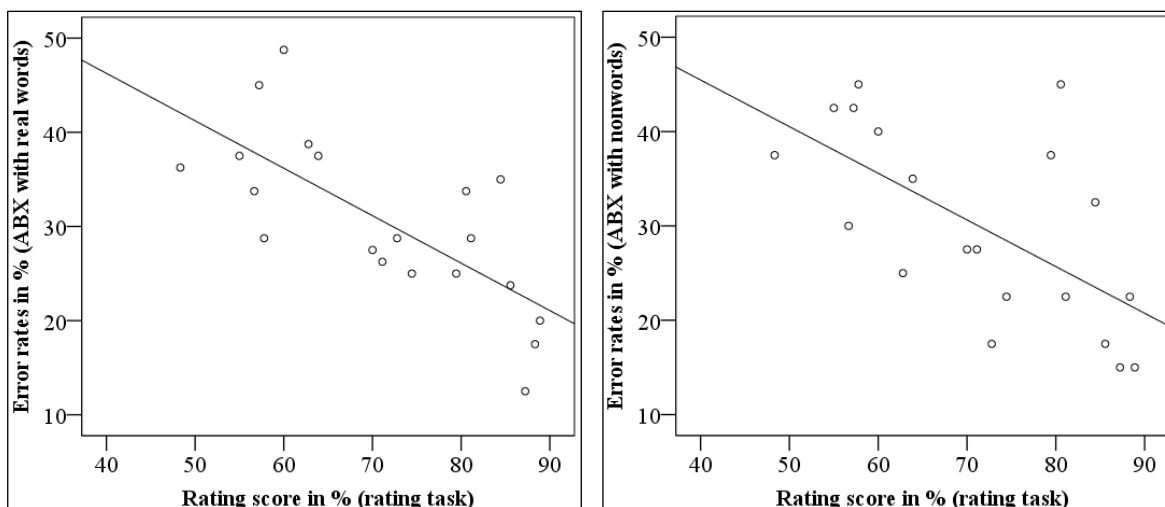


Figure 4.13. Scatterplots of advanced learners' error rates on the ABX tasks with real words and nonwords and cumulative rating scores on the rating task.

4.3.4.2. Summary of results for the correlations

The results of the correlational analysis showed no significant relationships between perception (measured by the ABX tasks) and production (measured by the rating task) in the data of intermediate learners. However, the relationships between perception and production were very strong and statistically significant in the data of advanced learners. The general trend established through the correlational analyses suggests that learners with more accurate perception were likely to have more accurate production, i.e. they clearly discriminated plain and palatalized consonants in their pronunciation and their exemplars of palatalized consonants were judged as excellent by the Russian native listeners. However, individual data suggest different scenarios for the interaction between perception and production. There were learners with very good articulation but relatively poor perception and vice versa, as well as learners with identical levels of perception skills but a wide range of production skills.

4.4. Discussion

4.4.1. Research question #1

The first research question asked whether American English learners of Russian perceive and produce palatalized consonants. The participants were tested on highly frequent words that were familiar to the learners. The target consonants were embedded intervocalically and word-finally to examine the effects of syllable position on the perception and production of palatalization.

4.4.1.1. Production

The results of the rating task, in which Russian native listeners evaluated the production of plain and palatalized consonants, revealed that learners' production skills vary as a result of their proficiency level. Learners of advanced level of proficiency were more accurate in their articulation of palatalized consonants than intermediate learners. Their mean rating scores for the production of palatalized consonants were significantly higher than those of the intermediate learners. They also made fewer categorization mistakes than intermediate learners in their articulation of palatalized consonants as judged by the Russian native listeners. However, despite learners' attempts to maintain the contrast between plain and palatalized consonants in their production, one-third of all the palatalized consonants produced by advanced learners were categorized as plain by Russian native listeners. For intermediate learners, the categorization error rate was above 40%. Unlike for palatalized consonants, the error rates for plain consonants were very low and not significantly different from those of the Russian native speakers, although there were several instances when learners replaced plain consonants with

palatalized counterparts. This asymmetry in learners' performance, when palatalized consonants were replaced with their plain counterparts more frequently than plain consonants were replaced with palatalized ones, suggests that learners were not always aware of the gestures necessary to produce palatalization or could not utilize them accurately. Simply put, learners did not bunch up their tongues to make enough contact with the hard palate during the production of palatalized consonants. As a result, their realizations of palatalized consonants were perceived as plain consonants by Russian native listeners.

The effect of syllable position was particularly strong for both groups of learners but not for the Russian native speakers. Advanced learners produced half of their palatalized consonants as plain in word-final position; intermediate learners mispronounced even more, 65% of all word-final palatalized consonants. Their mean rating scores in word-final position were very low as well, 3.58 out of 6 for advanced learners and 2.85 out of 6 for intermediate learners. In intervocalic position, both groups of learners made significantly fewer production mistakes for palatalized consonants (advanced learners 13%, intermediate 20%) and received significantly higher ratings than in word-final position (advanced learners 5.01, intermediate learners 4.69). These results corroborate the general trend reported in Hacking (2011). In that study advanced learners had an error rate of 22% in intervocalic position and 72% in word-final position as judged by Russian native listeners. Indeed, as stated in the first hypothesis, subsequent vowels tend to facilitate the articulation of palatalized consonants in prevocalic position. Since palatalized consonants require the tongue to be in contact with the palate, all subsequent vowels are somewhat raised and fronted. Even if learners focus only on

adjusting their articulation of the vowel, the consonant also acquires some of the palatalization properties due to co-articulation effects. However, in word-final position, learners cannot use subsequent vowels as a “crutch” to produce palatalized consonants.

Neither group of learners was similar in its performance to Russian native speakers, who received a categorization error rate of 0% and a mean rating score of around 5.94 (out of 6) for the production of palatalized consonants in both syllable positions as judged by other Russian native listeners. Again, this points to the fact that even though palatalized consonants are different from plain consonants only in their secondary feature of articulation, this distinction is of crucial importance in the Russian language and one which native speakers obligatorily observe.

4.4.1.2. Perception

The results of the ABX tasks with real words and nonwords were very similar. The same effects and interactions were revealed in both ABX tasks. Unlike in the rating task that measured their production, intermediate and advanced learners patterned together in perception. No significant differences were found between the two groups of learners in their performance on either ABX task, which suggests that intermediate and advanced learners demonstrated similar perceptual abilities. Learners at both levels of proficiency had significantly longer RTs and made significantly more mistakes in the test condition (31% error rate) than in the control condition (7% error rate). *D'* scores also showed no significant differences between the two groups of learners in their sensitivity to the plain / palatalization contrast.

With respect to the effect of syllable position, the results of the ABXs in the test

condition demonstrated that word-final position was more challenging perceptually than intervocalic position. Learners made more mistakes in the former position than in the latter. In the control condition there were no significant differences in error rates between the two groups of learners in either syllable position. This demonstrates that it is not just the lack of salience of the word-final position that creates difficulties for learners but the plain / palatalization contrast in this specific prosodic position that becomes especially challenging. The findings of this dissertation support those reported in Kochetov (2004), Lukyanchenko and Gor (2011), and Rice (2015). Palatalized consonants are more clearly distinguished from plain ones in prevocalic position than in coda position due to the i-transition or a glide that accompanies palatalization as a vowel cue. Relying on the perception of this glide can help learners discriminate palatalized consonants from their plain counterparts. Also, as mentioned above, the quality of vowels following palatalized consonants changes due to co-articulation effects with palatalization. However, in word-final position, none of these additional cues are present.

Russian native speakers did not demonstrate any differences in processing contrasts in control and test conditions: they had a 3%-error rate in both conditions and spent almost the same amount of time in test and control trials. In the control condition there were no significant differences in error rates between learners and Russian native speakers in both syllable positions. But in the test condition, learners' perceptual performance always remained significantly different from the performance of Russian native speakers. Despite their accumulated experience and substantial exposure to these sounds, advanced learners' perceptual behavior remains strikingly similar to that of intermediate learners in our tasks. This result contrasts with many other perception

studies that have repeatedly shown an advantage in tasks similar to ours for advanced or more experienced learners compared to beginning or less experienced learners (e.g., Flege, Bohn & Jang, 1997; Levy & Strange, 2008). This interesting difference might suggest that secondary features of segments pose a much more challenging problem perceptually for L2 learners than primary features.

4.4.2. Research question #2

4.4.2.1. Perception – production link

The second research question considered the relationship between the perception and production of palatalized consonants in the acquisition of L2 Russian. It was hypothesized that learners' ability to produce palatalization would develop later than their ability to perceive it. The data obtained and analyzed for this dissertation largely support this hypothesis. First, the results described above show that intermediate and advanced learners behaved similarly on both ABX tasks. They did not record any significant differences in error rates or RTs in the test condition, which means that both groups of learners were at the same level of perceptual development. However, on the rating task, learners' results were different. Advanced learners made significantly fewer errors in their production as judged by Russian native listeners and received higher rating scores for palatalized consonants than the intermediate learners.

Perception and production skills seem to be misaligned at the intermediate level of proficiency and then become aligned and interdependent at the advanced level. It takes time for learners to acquire the necessary articulatory gestures to produce the contrast that they recognized 70% of the time. On average, intermediate learners had been studying

Russian for 1.5 - 3 years maximum, whereas advanced learners had been receiving Russian instruction for at least four years. Even though learners' perceptual skills did not change from the intermediate to advanced level, it seems that advanced learners made better use of their perceptual ability to discriminate plain and palatalized consonants in order to improve their production. From the higher rating scores, we can infer that advanced learners produced more accurate gestures and had fewer instances of substituting palatalized consonants with their plain counterparts. Although neither of the groups of learner demonstrated nativelike perception of the contrast between plain and palatalized consonants, advanced learners developed better production skills than intermediate learners. This supports the claim put forward by De Jong et al. (2009) that the L2-attunement of the perceptual system emerges earlier than that of the production system because perception relies on phonological features, whereas the production system relies on gestures and their coordination, making it less flexible and requiring more time to develop. As a result, learners might be able to discriminate contrasts in perception but not in production.

The results of the correlational analysis further support the hypothesis that perception develops prior to production. There were strong and statistically significant relationships between advanced learners' performance on the ABX tasks and their results on the rating task. More accurate perception was associated with more accurate production. For example, learners with the lowest error rates of 15-18% on the ABX with nonwords were also the ones who had the highest rating scores above 85% on the rating task as compared to other participants. Improved perceptual abilities seemed to guide these advanced learners in their production of the plain / palatalized contrast. In order to

disclose this trend more vividly, we compared advanced learners' error rates on the ABX with nonwords, which measured learners' ability to discriminate plain and palatalized consonants at the phonetic level, and rating scores on the rating task, which showed how good learners' productions of palatalized consonants were as judged by Russian native listeners. Using an error rate of 29% on the ABX with nonwords as the splitting threshold, which was a group mean error rate (of advanced and intermediate learners collapsed together) in the test condition, we divided advanced learners into two groups based on their error rates for this task (ABX with nonwords). Advanced learners with an error rate below 29% on the ABX with nonwords, received a group mean error rate of 21% (95% Confidence interval [CI] = 18–25) on this task and a group mean rating score of 78% (CI = 72–85) on the rating task. Advanced learners with an error rate above 29% on the ABX with nonwords received a group mean error rate of 39% (CI = 35–43) on this task, and a group mean rating score of 64% (CI = 55–73). We can observe here that the CI for the rating scores in the two subgroups do not overlap. Thus, advanced learners who were more accurate perceivers were also more accurate producers, whereas advanced learners who struggled with perception also received lower rating scores in production.

The correlational analysis revealed no significant relationships between intermediate learners' performance on the ABX tasks and the rating task. Consequently, learners' perceptual abilities were not related to their production skills. Intermediate learners with an error rate below 29% on the ABX with nonwords, received a group mean error rate of 22% (CI = 18–25) on this task and a group mean rating score of 63% (CI = 55–70) on the rating task. Intermediate learners with an error rate of 29% and above on

the ABX with nonwords received a group mean error rate of 36% (CI = 29–43) on this task and a group mean rating score of 60% (CI = 53–67). We can clearly see that in this case, the 95% confidence intervals for the rating scores are overlapping, even though those for the ABX are not. Thus, both groups of intermediate learners, regardless of their perceptual skills, demonstrated similar and relatively low rating scores on the production of palatalized consonants, which again supports our claim that production develops later than perception.

If production preceded perception, there would be more learners with high rating scores and low accuracy rates on the ABX tasks. However, this trend was not observed either in the data of advanced or intermediate learners. On the ABX with nonwords, 12 intermediate learners and 10 advanced learners achieved an accuracy rate of 71% and above, which is a group mean for both groups of learners on the perception task. But on the rating task, only three intermediate learners out of 20 received a rating score of 71% and above versus 11 advanced learners with the same result. Even though the criterion of 71% accuracy is somewhat arbitrary (although it is related to the group mean accuracy rate on the ABX with nonwords) and can denote different levels of achievement on tasks of various nature, it still provides additional confirmation that accurate realization of the plain / palatalized contrast takes more time to develop than ability to discriminate this contrast in perception. It is also necessary to state that individual data suggest other possibilities for interactions between perception and production. There were two learners, participants #19 and 32 (see Table 6.7 for their results on all the tasks) whose production skills surpassed their perception skills. Their error rates on the rating task were 13% (some of the very lowest in the sample) and their cumulative rating scores were 84% and

81%. These were very good results, especially compared to other learners in the sample. However, their error rates on the ABX with words and nonwords were 35% and 33% respectively for Participant #19 and 34% and 45% for participant 32. Both learners were graduate students enrolled in a Master's program to become Russian teachers. Being aware of the contrast between plain and palatalized consonants in Russian, they might have developed the necessary gestures to articulate this crucial contrast without actually reliably perceiving it. Similar findings have also been previously reported (e.g., Goto, 1971; Sheldon & Strange, 1982). As prospective teachers they might have realized how important it was to observe the difference between plain and palatalized consonants and, as a result, learned to produce it without actually perceiving it.

Concluding, the results of this experiment suggest that as a general trend the perception of palatalized consonants precedes the ability to produce the contrast in speech. However, in certain individual cases, accurate production is still a possibility in the absence of perceptual support.

Chapter 5. Experiment 2: Interactions of lexical encoding with perception and production

This chapter explores lexical encoding of the contrast between plain and palatalized consonants and how it relates to perception and production. The goal of Experiment 2 is to determine whether American learners of Russian encode plain and palatalized consonants separately and what relationships are formed between the lexical encoding and perception of palatalized consonants, as well as the lexical encoding and production of palatalized consonants. Section 5.1 introduces the research questions and hypotheses. Section 5.2 describes the method of Experiment 2. Section 5.3 presents the results, which is followed by the discussion in Section 5.4.

5.1. Research questions and hypotheses

The lexical encoding of phonological contrasts does not depend on learners' abilities to perceive or produce them. Even if learners can perceive the contrast accurately, it does not guarantee that words with this contrast are encoded separately in the mental lexicon (e.g., Darcy et al., 2013). Similarly, a reduced ability to perceive the contrast does not eliminate the possibility of creating separate lexical representations (e.g., Escudero et al., 2008). The interaction between production and lexical encoding is less researched than the interaction between lexical encoding and perception. It is known that accurate lexical encoding does not necessarily lead to accurate production (Hayes-Harb & Masuda, 2008). However, it is not clear whether accurate production can be considered a reliable sign of accurate lexical encoding. This dissertation seeks to

investigate the lexical encoding of plain and palatalized consonants and determine how lexical encoding interacts with the perception and production of these consonants.

Gor (2014) investigated the lexical encoding of minimal pairs with plain and palatalized consonants and found that American learners of Russian did not have stable separate representations for plain and palatalized consonants, especially at lower levels of proficiency. However, the article by Gor (2014) did not provide the list of minimal pairs that were used in the study, neither did it mention whether the words were familiar to learners or not. The words that form minimal pairs with plain and palatalized consonants in Russian hardly ever constitute the active vocabulary of Russian learners, especially at lower levels of proficiency. Even judging by the only example that Gor (2014) provided, viz. /mat/ 'checkmate' and /matʲ/ 'mother', we cannot assume that learners were familiar with the Russian word /mat/ 'checkmate'. This dissertation only used words that were familiar to learners to ensure that learners had already established lexical representations for these words. Using real words was also preferred over the use of novel word forms which are usually acquired for the purpose of the experiment through a word-learning paradigm (e.g., Escudero et al., 2008, Hayes-Harb & Masuda, 2008). This approach was employed to help avoid certain issues that surround the lexical encoding of new contrasts, such as how much time should pass for the learning of new words to consolidate and trigger strong lexical competition effects (Dumay & Gaskell, 2007). For a novel word to trigger lexical competition effects, it has to behave as any other known word, i.e. a novel word has to develop a similar degree of depth or representation and have many exemplars from which to generate a strong lexical phonological representation. There is no study to the best of our knowledge that has investigated the interaction between the production of

palatalized consonants and their lexical encoding. Thus, this dissertation adds to the existing knowledge about the lexical encoding of contrasts that differ in secondary features of articulation and poses the following research questions:

1. Do American learners of Russian encode plain and palatalized consonants separately in L2 Russian? What effect does syllable position have on the lexical encoding of the contrast?
2. What are the relationships between the perception, production and lexical encoding of palatalized consonants as acquired by American English learners of Russian?

Hypothetically, American learners of Russian should encode plain and palatalized consonants separately, especially at higher levels of proficiency. It is not only the perceptual difference between plain and palatalized consonants that can alert learners to the existing contrast, but also orthographic and metalinguistic knowledge that explicitly directs to the existing differences. This latter possibility will be further researched in Experiment 3, Chapter 6. Syllable position should also have an effect on the lexical encoding of palatalization. Numerous perceptual studies have shown that palatalized consonants in the prevocalic position are much more easily perceived than in word-final position. Thus, the perceptual difference between plain and palatalized consonants in this syllable position might be more salient for learners to notice, which can promote accurate representations of words with this contrast.

Regarding the second research question, it is hypothesized that learners' ability to encode palatalized consonants is related to their ability to perceive the distinction. If learners are able to differentiate between plain and palatalized consonants in perception,

it signals to them that this difference has to be encoded. If learners cannot perceive the difference, accurate encoding is still possible if by accurate encoding we mean separate representations for a lexical contrast. It might be the case that learners encode words with palatalized and plain categories separately but their representations of nondominant categories (see Darcy et al., 2013), or palatalized consonants, are not precise and accessed asymmetrically during processing.

With respect to the interaction between lexical encoding and production, our hypothesis is that the development of accurate production skills is unlikely if learners fail to encode the difference between plain and palatalized consonants. If learners store the words in a lexical contrast as homophones, there is no motivation for them to produce a difference in speech, because they are not even aware that there is a difference in the first place. However, if learners create separate representations for the lexical contrast (even if one of the representations is “fuzzy” or imprecise), there is a chance that production will be accurate, or at least some contrast will be maintained in speech. The fuzziness of representations can be compensated with pronunciation instruction. The only potential situation, in which learners might be able to produce a lexical contrast with palatalized consonants without lexically encoding it, would be if they were prompted to do so explicitly e.g., in an imitation task. In order to accomplish that, learners should possess latent articulatory skills that they have transferred from another language or acquired as a result of rigorous articulatory training. If production is inaccurate, accurate lexical encoding is still possible. Learners often times cannot produce palatalized consonants correctly because they are unaware of the gestures that should be used to achieve the desired acoustic effect. However, they might have already established targetlike lexical

representations, especially if they can perceive the difference. In Hayes-Harb & Masuda (2008), learners were able to encode the contrast between singleton and geminate consonants in Japanese but they were not able to produce it because they might not have known how to realize the quantity effect in speech.

5.2. Method

The method chosen to examine the lexical encoding of plain and palatalized consonants was an adapted version of the auditory word-picture matching task (AWPM) (Hayes-Harb & Masuda, 2008). The participants were asked to decide whether the pronunciation of the word that they heard matched the picture that they saw on the screen. This task was chosen over a lexical decision task in order to avoid task effects and ambiguities in interpreting participants' answers. Consider this example. Since no minimal pairs of existing words were used in this study, the test nonword */sol/ differed from the real word /soli/ 'salt' only in the palatalized status of the final consonant. The control nonword for the word 'salt' was */somi/. If learners had been asked to determine whether the words they heard were real words or nonwords, they might have incorrectly assumed that the test nonword */sol/ was a real word because the difference was very small, whereas the control nonword /somi/ was the nonword that they were expected to determine. In order to avoid this confusion, learners were guided to pay close attention to the minute differences in the pronunciation of the words that they heard and determine whether that pronunciation was correct for the pictures that they saw. These instructions were expected to make learners attend to the signal more carefully. In addition, learners received four training items before experimental trials started. The prediction was that

learners, who had encoded the difference between plain and palatalized consonants, would reject the test nonwords like */sol/. Even if their representations were not quite precise, the knowledge that there were two different categories for plain and palatalized consonants should have forced the learners to reject */sol/ because it lacked additional features to make the final consonant palatalized. If learners had failed to encode the distinction between plain and palatalized consonants, then the test nonword */sol/ would be accepted and considered a representation of the word ‘salt’ /soli/. In general, performance on the words with target consonants in intervocalic position was expected to be more accurate than on the words with target consonants word-finally.

Participants’ performance on the auditory word-picture matching task was correlated with their performance on the rating task (see Section 4.2.8) and ABX with real words and nonwords (see Sections 4.2.5 and 4.2.6). If our hypothesis is correct that learners’ ability to encode palatalized consonants is related to their ability to perceive and produce the distinction, then learners who have low error rates on the AWPM task should also have low error on the ABXs and low error rates on the rating task. Performance in these three tasks should be positively correlated.

5.2.1. Participants

The participants in Experiment 2 were the same as in Experiment 1 and the reader is referred to Section 4.2.1 for further details.

5.2.2. General procedure

The general procedure of the experiment was laid out in Section 4.2.2. For the description of the tasks that evaluated production of plain and palatalized consonants (familiarization, oral picture-naming task and rating task) the reader is referred to Sections 4.2.3, 4.2.4 and 4.2.8. For the description of the tasks that evaluated perceptual abilities of learners (ABX with real words and nonwords) the reader is referred to Sections 4.2.5 and 4.2.6. In this chapter only the task that evaluated lexical encoding (AWPM task) is presented. The following section describes the materials and procedure specific to this task.

5.2.3. Task #4: Auditory word-picture matching task (AWPM)

Materials

Materials in Task 4 were the same as in Task 1 (see Section 4.2.3). For all test words, two corresponding nonwords were created: test nonwords and control nonwords. For the test nonwords, a plain consonant was replaced by its palatalized counterpart and vice versa (e.g., [solʲ] ‘salt’ was made into a test nonword by changing the final consonant to a plain one, *[sol]). For the control nonwords, the change always involved other primary contrasts (e.g., *[somʲ]) (see Section 4.2.6, Table 4.4). All stimuli were recorded twice by a female Russian native speaker in a sound-proof recording booth at a sampling rate of 44.1 kHz with a 24-bit resolution on a mono channel and saved as individual audio files for embedding into the stimuli presentation script.

Procedure

The AWPM task was administered after the oral picture-naming task and before the ABX with nonwords. During the task the participants saw a picture and had to decide whether the pronunciation of the item that they heard was correct and matched the picture by pressing a designated button “Yes” or “No” as fast as possible (see Figure B4 in Appendix B for a screenshot of complete instructions). Four practice trials were used to familiarize the participants with the task, and to clarify the need to focus on the phonetic details of the items. Instructions also further reinforced that learners should pay close attention to the minute differences in the pronunciation of the words that they heard. The participants were warned that some of the items were nonwords. For example, the participants saw a picture of salt /solⁱ/ and heard either a word with a palatalized consonant word-finally [solⁱ] or without it *[sol]. The participants did not see written forms of the words. The task included 80 experimental trials: 20 test words e.g., [solⁱ] ‘salt’; 20 test nonwords, e.g., [sol]; 20 control nonwords, e.g., [somⁱ], and 20 fillers (10 fillers x 2 presentations), e.g. [sumka] ‘purse’. The test words and fillers were paired with pictures such that they required a ‘yes’ answer, whereas test nonwords and control nonwords required a ‘no’ answer. In this way, half of the trials required a positive answer, whereas the other half required a negative answer. Stimuli were presented with DMDX (Forster & Forster, 2003).

Each trial started with a fixation cross displayed in the middle of the screen for 250 ms. Then the picture located in the center of the screen and the audio file were presented simultaneously. Participants had 2000 ms to make their response, before the next trial was initiated. Trials were assigned to eight blocks such that the test word [solⁱ],

test nonword [sol] and control nonword [somʲ] did not appear in the same block. Block order was randomized, and within each block, trials were also randomized. The task took five minutes to complete.

Errors were tallied and RTs were measured from the onset of the audio file. Error rates allowed us to determine whether learners had established lexical representations for palatalized consonants. Reaction times were used to make tentative conclusions about the lexical access of dominant and nondominant categories. The auditory word-picture naming task produced 4000 data points (80 trials x 50 participants).

5.2.3. Analysis

Table 5.1 presents the research questions, dependent and independent variables as well as the statistical procedures employed to answer the research questions. The statistical analyses were done using IBM Statistical Package for Social Sciences (SPSS), Version 24.

Table 5.1

Research questions, variables and analysis methods

Research Questions	Variables	Analysis method
1. Do American learners of Russian encode plain and palatalized consonants separately in L2 Russian? What effect does syllable position have on the lexical encoding of the contrast?	AWPM task IV1: Group (intermediate, advanced, Russian) IV2: Condition (word, test nonword, control nonword, filler) IV3: Palatalization (plain, palatalized) IV4: Position (intervocalic, final) DV1: D-prime scores based on error rates DV2: Error rates	A two-tailed t-test on d' scores with a between factor of group (advanced vs. intermediate). A generalized linear mixed model on error rates with group and condition as fixed effects and participant and item as random effects. A generalized linear mixed model on error rates in the test nonword condition with group, palatalization and position as fixed effects and participant as

	DV3: RTs	random effect. A linear mixed-effects model on RTs with group and condition as fixed effects and participant and item as random effects. A linear mixed-effects model on RTs with group, palatalization and position as fixed effects and participant as random effect.
2. What are the relationships between the perception, production and lexical encoding of palatalized consonants as acquired by American English learners of Russian?	Relationship between perception, production and lexical encoding DV1: Error rates (ABX with words) DV2: Error rates (ABX with nonwords) DV3: Categorization error rates (Rating task) DV4: Rating scores for palatalized consonants (Rating task) DV5: Error rates in the test nonword condition (AWPM task)	Pearson's correlations

Note: DV = dependent variable; IV = independent variable.

5.3. Results

5.3.1. AWPM task

5.3.1.1. *D-primes*

The sensitivity index or d' was calculated for each participant in the test condition to identify how sensitive they were to pronunciation mistakes based on palatalization.

Table 5.2 shows the decision matrix that was employed to determine the number of hits and false alarms in the test condition.

Table 5.2

<i>Decision matrix</i>		
	Output: correct pronunciation	Output: incorrect pronunciation
Input: real word	hit	miss
Input: test nonword	false alarm	correct rejection

The same formulas were used to calculate hit rates, false alarm rates, d' -primes and criterions as in the ABX with words (see Section 4.3.2.1) The total number of trials for each participant was 40. The results were the following: Russian native speakers $d' = 3.60$, $c = -0.012$, advanced learners $d' = 0.924$, $c = -1.141$ and for intermediate learners $d' = 0.628$, $c = -1.286$. The difference between intermediate and advanced learners was not significant in a two-tailed t -test, $t(38) = 1.88$, $p = .068$. For this experiment, a negative bias indicates a tendency to respond *correct pronunciation*, whereas a positive bias can be interpreted as a tendency to choose the response *incorrect pronunciation*. Both groups of learners demonstrated extremely low d' and were strongly biased to choose *correct pronunciation* when presented with test nonwords.

5.3.1.2. Error rates

Overall, the error rates in all conditions were low for all groups, except in the test nonword condition, where the two learner groups displayed a high error rate (Figure 5.1). A generalized linear mixed model was run in SPSS 24 on the error rates. The factors group (Russian native speakers, advanced learners, intermediate learners) and condition (word, test nonword, control nonword, filler) were declared as fixed effects. The factor participant and item were chosen as random effects. Type III tests of fixed effects for error rates revealed that there was a main effect of group, $F(2, 3988) = 30.53$, $p < .001$, condition, $F(3, 3988) = 93.6$, $p < .001$, and an interaction between the two factors, $F(6,$

3988) = 14.25, $p < .001$. The Bonferroni post hoc tests showed that intermediate learners made significantly ($p = .008$) more errors than advanced learners in the test nonword condition, when presented with test nonwords */sol/ or */stoli/ instead of the real words /sol/ ‘salt’ or /stol/ ‘table’ (intermediate: $M = 82\%$, advanced: $M = 74\%$) and both groups of learners were significantly less accurate on this condition than Russian native speakers ($p < .001$ for both groups of learners). No significant differences were found between learners and Russian native speakers in the other three conditions.

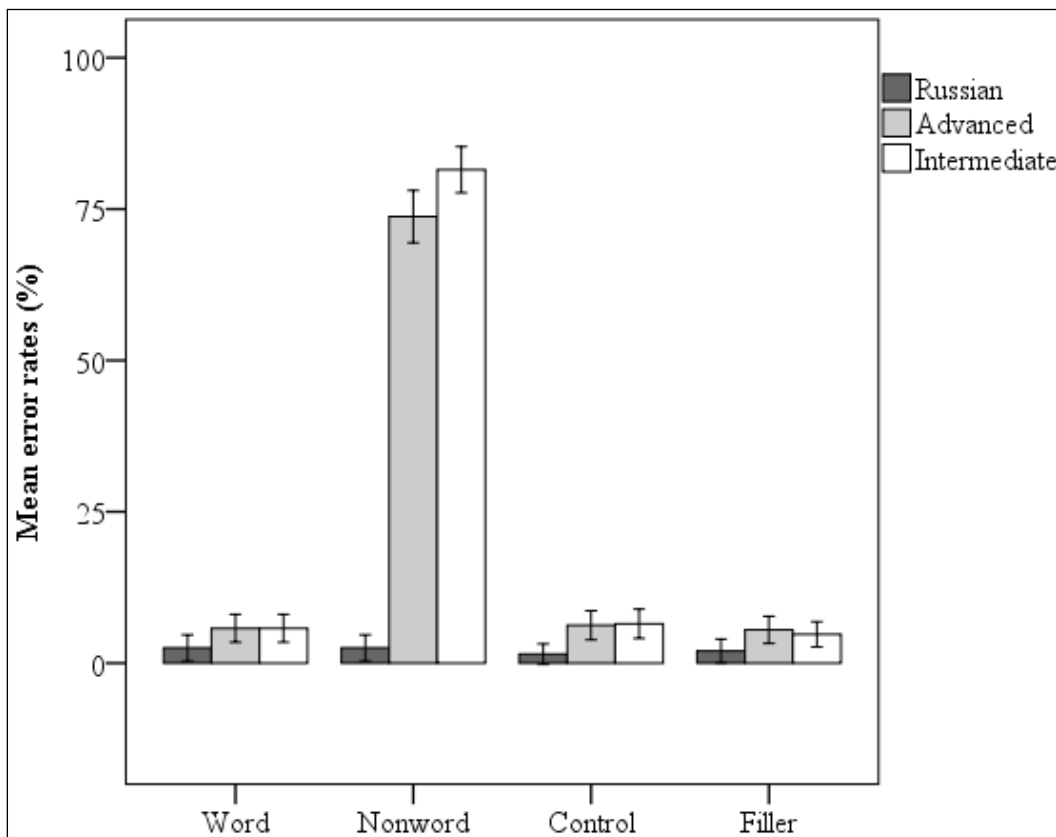


Figure 5.1. Mean error rates for each group and condition. Error bars show the 95 % CI.

A generalized linear mixed model was run on the error rates to examine the effects of syllable position and palatalization status of the target consonants in the test nonword condition only. The factors group (Russian native speakers, advanced learners, intermediate learners), position (intervocalic, final) and palatalization status (plain,

palatalized) were declared as fixed effects. The factor participant was chosen as random effect. Type III tests of fixed effects for error rates revealed that there was a main effect of group, $F(2, 995) = 56.59, p < .001$, palatalization, $F(1, 995) = 4.4, p = .036$, and position, $F(1, 995) = 53.68, p < .001$ but no significant interactions. Additional generalized linear mixed models were run for each group separately on the error rates to examine the effects of syllable position and palatalization. No main effects of syllable position or palatalization were found in the data of Russian native speakers. There was a main effect of position, $F(1, 396) = 20.05, p < .001$ in the data of intermediate learners, who made significantly ($p < .001$) more errors in the word-final position ($M = 91\%$) than in intervocalic position ($M = 73\%$). There was also a main effect of position, $F(1, 396) = 32.12, p < .001$, as well as a marginally significant effect of palatalization, $F(1, 396) = 3.77, p = .053$ and a marginally significant interaction between position and palatalization, $F(1, 396) = 3.77, p = .053$, in the data of advanced learners. Overall, advanced learners made fewer errors in intervocalic than in word-final position. In intervocalic position, the error pattern was modulated by palatalization. Advanced learners made significantly ($p < .001$) more errors by accepting test nonwords with a plain consonant ($M = 72\%$), e.g., */zielonij/ instead of /ziel'ionij/ 'green', than test nonwords with a palatalized consonant ($M = 49\%$), e.g., */xol'iodnij/ instead of /xolodnij/ 'cold' (see Figure 5.2).

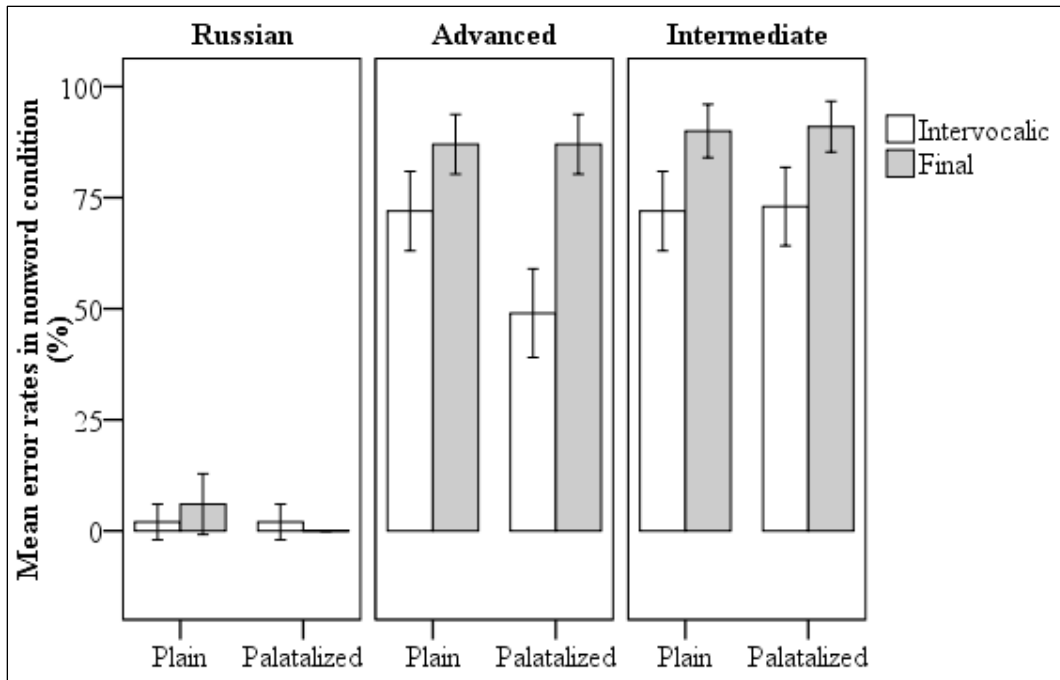


Figure 5.2. Mean error rates on nonwords with plain and palatalized consonants in both positions for each group. Error bars show the 95 % CI.

5.3.1.3. Reaction times

RTs were measured from the beginning of the X stimulus. Since target consonants could occur in different syllables within a word, it was decided to adjust the RTs for analysis by subtracting the duration of the X stimuli. Figure 5.3 shows that learners indeed processed test nonwords differently from any other condition. A linear mixed effects model was run on mean RTs declaring group (Russian native speakers, advanced learners, intermediate learners) and condition (word, test nonword, control nonword, filler) as fixed effects and participant and item as a random effects. Type III tests of fixed effects for RTs revealed a main effect of group, $F(2, 49.12) = 16.05, p < .001$, condition, $F(3, 78.95) = 19.85, p < .001$, and a significant interaction between group and condition, $F(6, 3122.33) = 20.09, p < .001$. The Bonferroni post hoc tests showed that both groups

of learners spent significantly more time ($p < .001$ for both groups and all conditions) on test nonwords (intermediate: $M = 771$ ms, advanced: $M = 790$ ms) than on real words (intermediate: $M = 516$ ms, advanced: $M = 573$ ms), control nonwords (intermediate: $M = 528$ ms, advanced: $M = 588$ ms) or fillers (intermediate: $M = 470$ ms, advanced: $M = 569$ ms). Despite the fact that learners spent significantly more time on test nonwords, their error rates in accepting these nonwords were extremely high. Russian native speakers did not process test nonwords differently than real words, control nonwords or fillers.

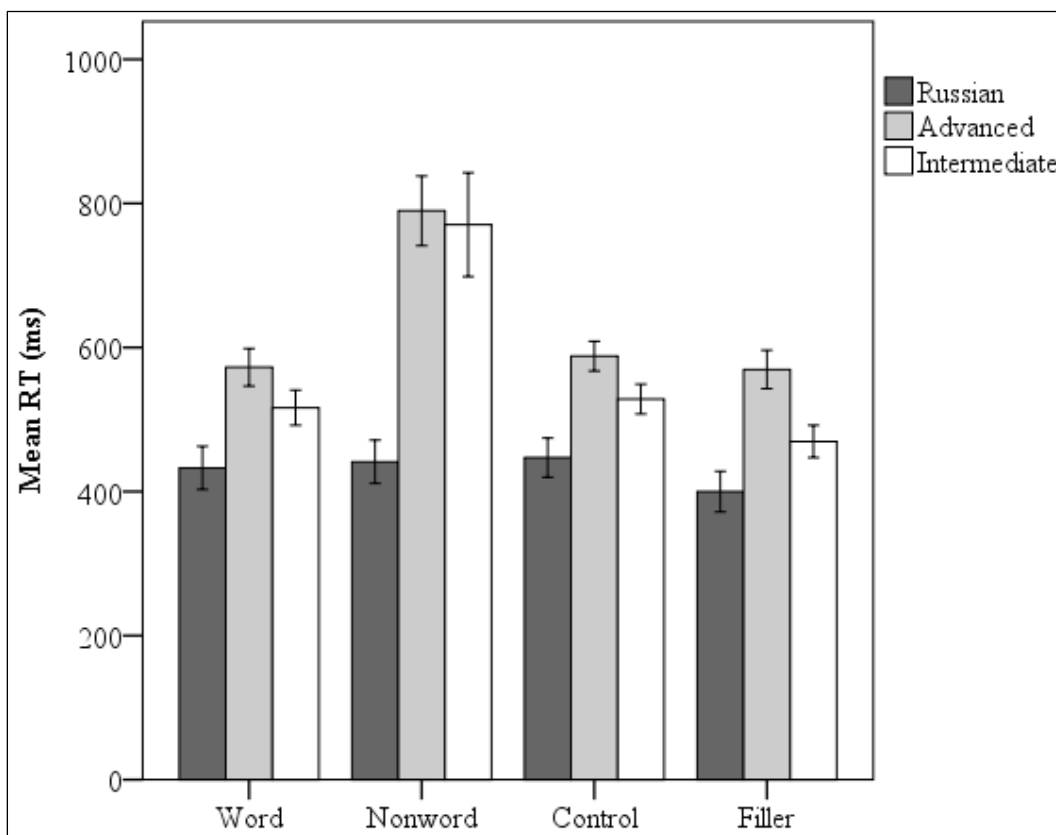


Figure 5.3. Mean RTs for each group and condition. Error bars show the 95 % CI.

In order to examine the effect of syllable position and palatalization on learners' performance in the test nonword condition, an additional linear mixed effects model was run on the mean RTs. The factors group (Russian native speakers, advanced learners, intermediate learners), position (intervocalic, final) and palatalization status (plain,

palatalized) were declared as fixed effects. The factor participant was chosen as random effect. Type III tests of fixed effects revealed a main effect of position, $F(1, 345.59) = 20.72, p < .001$ and a significant interaction between group and palatalization, $F(2, 336.68) = 4.69, p = .01$. Participants spent significantly ($p < .001$) more time on test nonwords with target consonants in word-final position than in intervocalic position (Figure 5.4). However, just as for the RT data for the ABX task, it is possible that these effects are slightly inflated by the fact that word-final consonants occurred one syllable later in the items as opposed to intervocalic consonants. Advanced learners spent less time making decisions about test nonwords with palatalized consonants ($M = 735$ ms) than plain consonants ($M = 825$ ms) in intervocalic position (which mirrors their behavior on error rates), but this difference was not statistically significant. However, Russian native speaker were significantly ($p < .001$) faster to reject nonwords with palatalized consonants, e.g., */stoli/ instead of /stol/ ‘table’ than */sol/ instead of /soli/ ‘salt’.

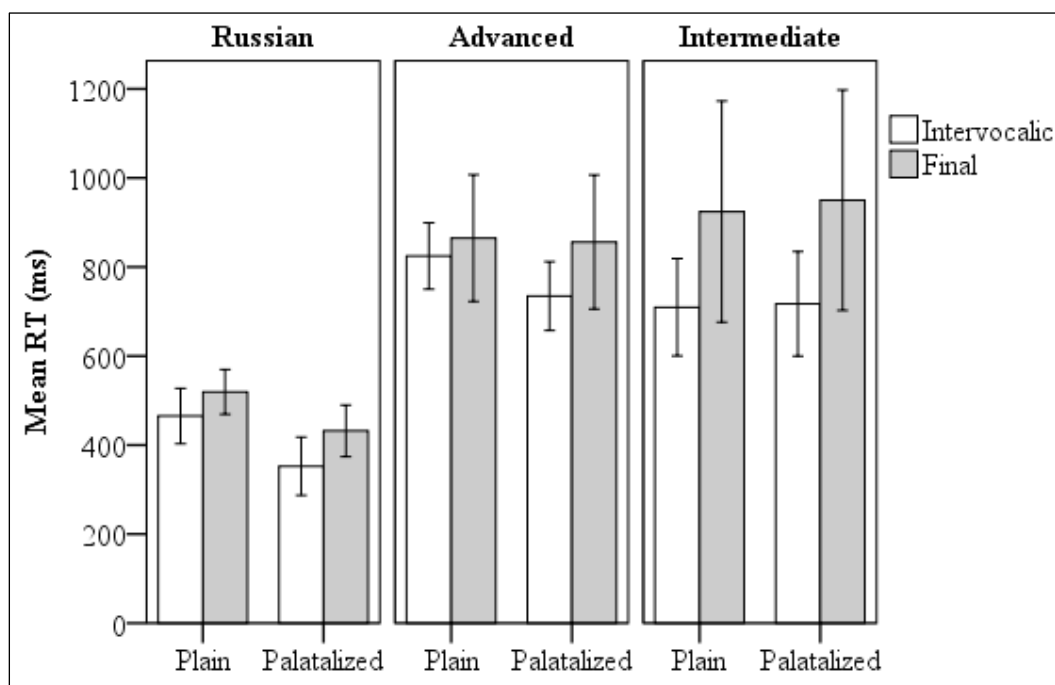


Figure 5.4. Mean RTs for each group in the test nonword condition with plain and palatalized target consonants in intervocalic and word-final positions. Error bars show the 95 % CI.

5.3.1.4. Summary of results for the AWPM task

The results of the AWPM task showed that learners did not encode the contrast between plain and palatalized consonants separately even in familiar words. Unlike Russian native speakers, learners mistakenly accepted most test nonwords that differed in secondary feature of palatalization as correct productions of Russian words, even though they spent significantly more time on test nonwords than any other type of stimuli. Both groups of learners demonstrated extremely low d' scores and were biased to choose 'correct pronunciation' when presented with test nonwords. However, learners' error rates on control nonwords that differed from real words in primary features were very low and did not differ from those of the Russian native speakers. Syllable position had a strong effect on learners' error rates and RTs. Both groups of learners accepted almost all test nonwords (around 90%) with a target consonant in word-final position, despite spending more time on consonants in word-final position than intervocalic position. Advanced learners made significantly more errors by accepting nonwords with a plain consonant than nonwords with a palatalized consonant in intervocalic position. Intermediate learners, on the other hand, did not show any preference for the palatalization status of a target consonant. They equally accepted test nonwords with plain and palatalized consonants in both syllable positions.

5.3.2. Correlations between the AWPM task, rating task and ABX tasks

5.3.2.1. Correlations

Learners' performance on the AWPM task was correlated with their performance on the ABX and rating tasks to examine the relationship between lexical encoding, perception and production (see Appendix D for individual results). Russian native speakers were excluded from the correlational analysis. For each participant, five measures were aggregated:

- 1) error rates (in %) on test trials on the ABX task with real words;
- 2) error rates (in %) on test trials on the ABX task with nonwords;
- 3) error rates (in %) on the rating task, i.e. errors made by learners in the production of palatalized consonants only, which were categorized by Russian native listeners as plain;
- 4) cumulative rating scores (in %) for palatalized consonants only;
- 5) error rates (in %) in the test nonword condition on the AWPM task.

The correlational analysis was performed on the data from intermediate and advanced learners separately. Tables 5.3 and 5.4 present Pearson's correlations for intermediate and advanced learners.

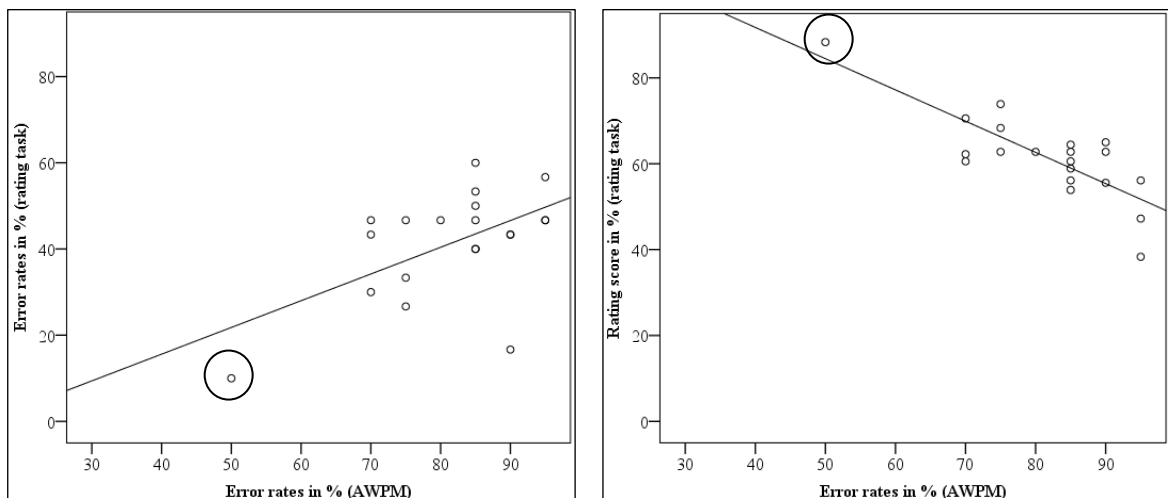
Table 5.3

Pearson's correlations between lexical encoding, perception and production for intermediate learners

Measure	1	2	3	4	5
1. Error (ABX with nonwords)	—				
2. Error (ABX with words)	.399*	—			
3. Error (Rating)	.195	.248	—		
4. Score (Rating)	-.046	-.111	-.742**	—	
5. Error (AWPM)	.267	.225	.551**	-.804**	—

Note. $n = 20$. $*p < .05$, $**p < .01$, one-tailed.

There was no relationship between intermediate learners' performance on perception and lexical encoding tasks. However, there were strong, statistically significant relationships between intermediate learners' error rates in the test nonword condition on the AWPM task and errors rates and rating scores received by the participants on the rating task. More errors on the AWPM task were related to more errors on the rating task, as well as lower rating scores (Figure 5.5). However, there were learners who had error rates of 17% or 27% and scores of 65% and 74% on the rating task, but then extremely high error rates of 90% or 75% respectively on the AWPM task. The learner, Participant #14 (represented by the circled lone dot in Figure 5.5), with the lowest error rate of 50% on the AWPM task had also the lowest error rate of 10% on the rating task as well as the highest cumulative rating score of 88% (see Table 6.7 for his results on all the tasks). It suggests that this learner's production skills developed prior to establishing accurate phonolexical categories for plain and palatalized consonants.



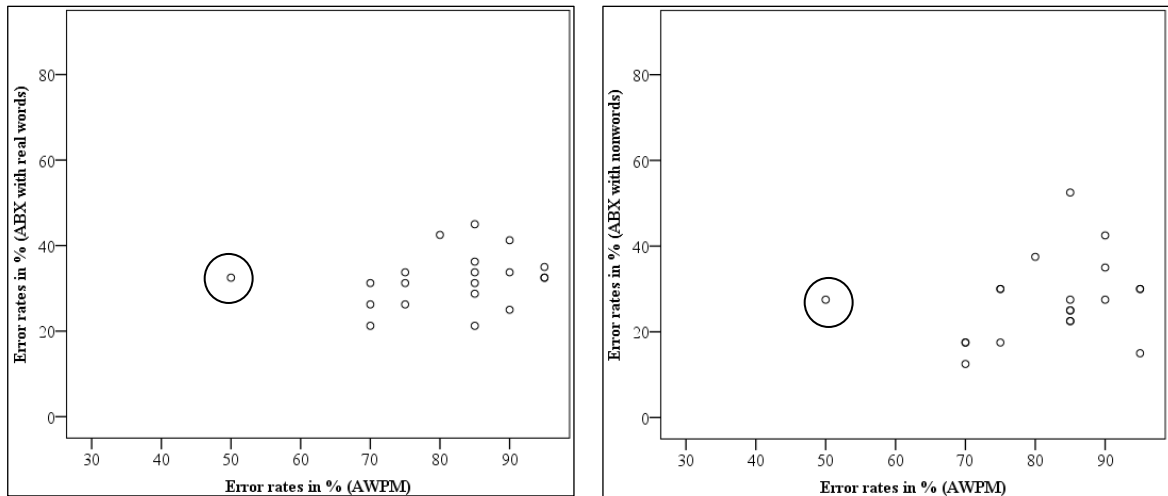


Figure 5.5. Scatterplots of intermediate learners' error rates in the test nonword condition on the AWPM task, cumulative rating scores, error rates on the rating task and ABX with real words and nonwords.

Advanced learners' performance on the AWPM task was correlated not only with their performance on the production tasks but also on the perception tasks (Table 5.4). There were moderate statistically significant relationships between advanced learners' error rates in the test nonword condition on the AWPM task, cumulative rating scores and error rates on the rating task. Similarly to intermediate learners, advanced learners who had higher error rates on the AWPM task, also had higher error rates on the rating task and lower rating scores (Figure 5.6). However, there were also learners, participants # 34 and 32, with very low error rates of 7% and 13% and rating scores of 89% and 81% on the rating task but high error rates of 70% and 90% on the AWPM (see Table 6.7 for their results on all the tasks). The best performance on the AWPM task was demonstrated by Participant #51 (represented by the circled dots in Figure 5.6), whose error rate was 35%. This learner's performance on the perception and production tasks was also one of the most accurate in the data set (see Table 6.7).

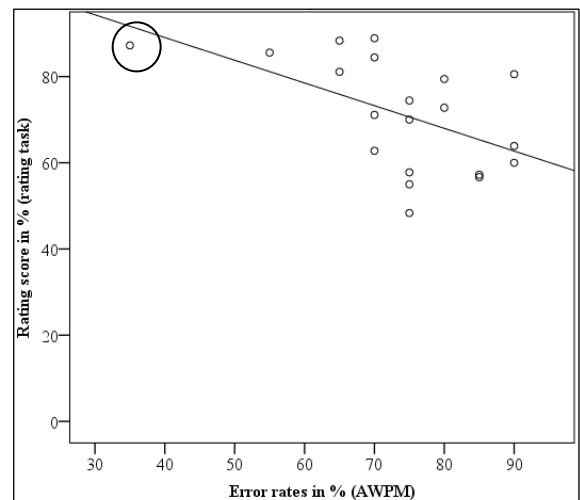
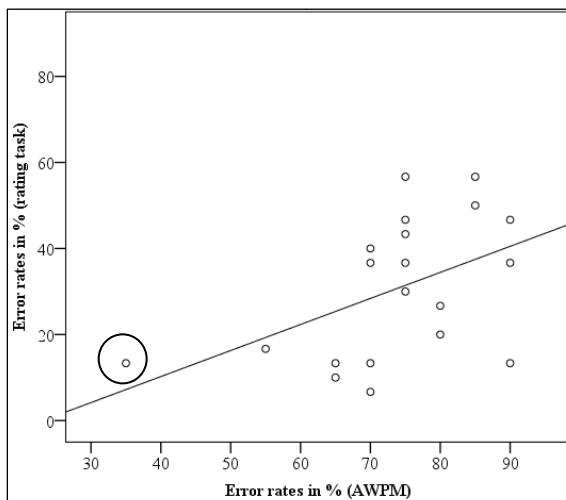
Table 5.4

Pearson's correlations between lexical encoding, perception and production for advanced learners

Measure	1	2	3	4	5
1. Error (ABX with nonwords)	—				
2. Error (ABX with words)	.681**	—			
3. Error (Rating)	.582**	.688**	—		
4. Score (Rating)	-.623**	-.721**	-.947**	—	
5. Error (AWPM)	.657**	.715**	.478*	-.532**	—

Note. $n = 20$. * $p < .05$, ** $p < .01$, one-tailed.

There were also strong, positive, statistically significant relationships between advanced learners' error rates in the test nonword condition on the AWPM task and the ABX with nonwords and words. More errors in perception (ABX tasks) were related to more errors in lexical encoding (AWPM task). However, accurate perception was not a guarantee of accurate lexical encoding. Advanced learners with an error rate of 15% or 18% on the ABX with nonwords had an error rate of 70% and 80% on the AWPM task.



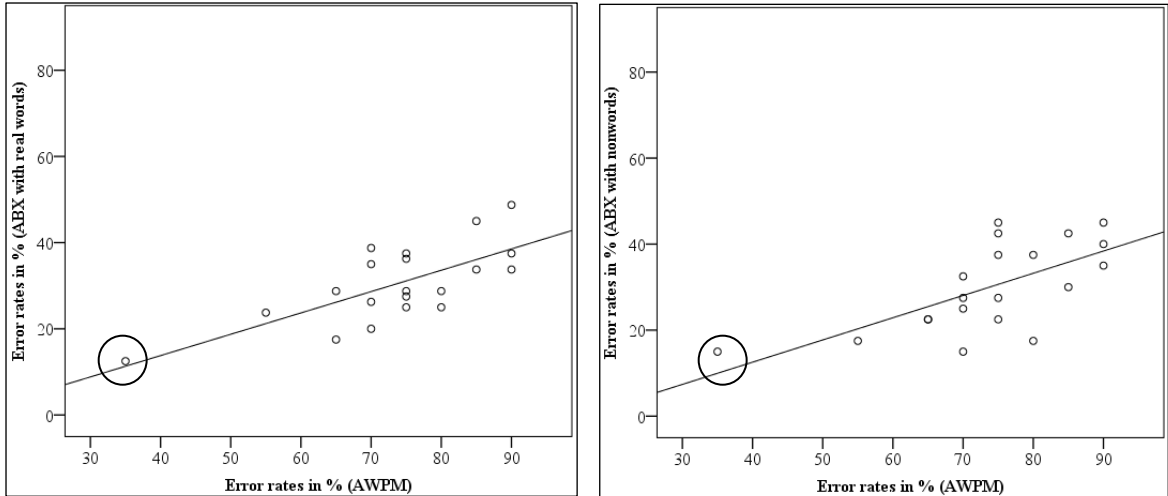


Figure 5.6. Scatterplots of advanced learners' error rates in the test nonword condition on the AWPM task, cumulative rating scores, error rates on the rating task and ABX with real words and nonwords.

5.3.2.2. Summary of results for the correlations

The results of the correlational analysis showed significant relationships between lexical encoding (measured by the AWPM task) and production (measured by the rating task) in the data of both groups of learners. The general trend established through the analyses suggested that learners with a more accurate performance on the AWPM task were also more accurate at differentiating and articulating plain and palatalized consonants in production. However, individual data of intermediate and advanced learners showed that learners with very good production skills, who were able to reliably distinguish plain and palatalized consonants in their articulation, could still fail to encode words with these contrasts accurately. With respect to the relationship between perception (measured by the ABX tasks with real words and nonwords) and lexical encoding (measured by the AWPM task), only advanced learners demonstrated a

significant correlation between their performance on the ABX tasks and the AWPM task. In general, advanced learners with more accurate perception had more accurate lexical encoding. However, perceptual ability to discriminate plain and palatalized consonants did not guarantee that learners would encode the contrast between these consonants accurately. Both groups of learners, advanced and intermediate, with the lowest error rates on the ABX tasks had extremely high error rates on the AWPM task.

5.4. Discussion

5.4.1. Research question #1

5.4.1.1. Lexical encoding

The first research question asked whether American English learners of Russian encoded a difference between plain and palatalized consonants in L2 Russian words and what effect syllable position had on their encoding. It was hypothesized that learners at higher levels of proficiency should encode plain and palatalized consonants separately, especially if palatalized consonants occur in prevocalic position. The results showed that learners did not encode the contrast between plain and palatalized consonants clearly even in familiar words. Unlike Russian native speakers, advanced and intermediate learners mistakenly accepted most test nonwords, which differed from the real words in secondary feature of palatalization, as correct productions of Russian words. Performance on control nonwords, which differed from real words in primary articulation, was excellent and similar to Russian native speakers. This suggests that learners did not accept all nonwords indistinctly. Rather, the difficulty appears centered on the plain /

palatalized contrast, which seems to not be robustly encoded in the long-term lexical representations for these familiar words.

The syllable position of the target consonants affected the performance of both groups of learners on the AWPM task. Learners obtained higher error rates by accepting test nonwords with target consonants in word-final position than in intervocalic position. Intermediate learners accepted test nonwords with either plain or palatalized consonants regardless of syllable position, whereas advanced learners showed an asymmetry in intervocalic position, rejecting test nonwords with a palatalized consonant much more often than nonwords with a plain consonant. Such asymmetry in error rates is reminiscent of findings that rejecting a nondominant (palatalized) category as incorrect in test nonwords is somewhat 'easier' than rejecting a dominant (plain) category (Cutler, Weber, & Otake, 2006; Darcy, Daidone & Kojima, 2013; Weber & Cutler, 2004). The L2 category that is most similar to the native category is considered to be dominant, i.e. plain consonants in Russian are phonetically similar to their English consonant equivalents. Palatalized consonants represent new categories for American English learners of Russian. Due to their potential perceptual confusion with the plain counterparts, they represent nondominant categories. In a classic study by Weber and Cutler (2004), Dutch listeners did not activate the word 'panda' when they heard the word 'pencil', which contains the dominant Dutch-like category /ɛ/. On the other hand, when they heard the word 'panda' with a confusable nondominant category /æ/, the participants activated both words. A similar effect was observed in another study with Japanese learners, who could not discriminate between the English sounds /ɪ/ and /l/ and activated the word 'locker', when they heard the word 'rocket' but not vice versa (Cutler, Weber, & Otake, 2006). In

this study, learners were more willing to reject the nonword */xolʲodnij/ with a nondominant palatalized category /lʲ/ (the real word being /xolodnij/), which was reflected in lower error rates and shorter RTs, than the nonword */zielonij/ with a dominant plain category /l/ (the real word being /zielʲonij/). Further research with a different experimental paradigm, such as the use of an eye-tracking or a lexical decision task, is needed to uncover the processing characteristics of plain and palatalized consonants by learners of Russian.

To conclude, in intervocalic position, learners might have erroneously encoded the difference between words and test nonwords with the plain / palatalized contrast in terms of vowels, rather than consonants. Additional acoustic cues carried by vowels in intervocalic position, as well as orthographic differences in vocalic graphemes (which will be further discussed in Chapter 6), might have made the difference between words and test nonwords more salient. In word-final position, since neither extra acoustic nor orthographic cues were available, both groups of learners had extremely high error rates of around 90% for both palatalized and plain test nonwords.

5.4.2. Research question #2

5.4.2.1. Perception – lexical encoding link

The second research question probed the relationship between perception and lexical encoding. The hypothesis that learners' ability to encode palatalized consonants is related to their ability to perceive the distinction was supported only partially. Just to remind, the ABX results showed that learners' perception of the plain-palatalized contrast was not very stable: the two proficiency groups patterned the same and made errors in

almost one-third of all trials. The correlational analysis revealed a strong relationship between the perception and lexical encoding of the contrast in the performance of advanced, but not intermediate learners. The learners with the highest error rates on the ABX also had the highest error rates on the AWPM task. There was not a single advanced or intermediate learner with a high error rate on the ABX and a low error rate on the AWPM task, which supports the hypothesis that lexical encoding is closely intertwined with learners' perceptual abilities. However, two learners with comparatively low error rates of 15% and 18% on the ABX obtained high error rates of 70% and 80% respectively on the AWPM task. Possibly, despite being able to perceive the difference between plain and palatalized consonants, advanced learners treated Russian palatalized consonants as free variants, and, as a result, failed to reject most test nonwords on the AWPM task. Another explanation is that these learners, despite successfully having learned to discriminate the plain / palatalized contrast in perception, have not yet updated their lexical representations for words with this contrast.

Consequently, good perceptual discrimination of the plain / palatalized contrast does not immediately guarantee that words with this contrast are encoded accurately in the mental lexicon. The ability to perceive palatalization provides a foundation for learners to encode this difference. However, perception alone is not enough to guarantee accurate lexical representations of words with a plain / palatalization contrast. The exact reasons for this difficulty are unclear. Further investigation presented in Chapter 6 will aim at uncovering the possible influence of orthography and metalinguistic knowledge on the lexical encoding of palatalized consonants in L2 Russian.

5.4.2.2. *Production – lexical encoding link*

Regarding the relationship between the production of palatalized consonants and their lexical encoding, it was hypothesized that creating separate representations for the lexical contrast, even if one of the representations was “fuzzy” or imprecise, would help maintain this contrast in speech. The results of the correlational analysis suggested that learners with more accurate lexical encoding of the contrast were also better at producing plain and palatalized consonants. However, the hypothesis that the development of accurate production skills was unlikely if learners failed to encode the difference between plain and palatalized consonants was not supported.

One intermediate and six advanced learners out of 40 learners tested in the study, whose error rates ranged from 50% to 90% ($M = 66\%$) on the AWPM task, received the highest cumulative rating scores ranging from 81% to 89% ($M = 85\%$) and the lowest error rates ranging from 7% to 17% ($M = 12\%$) on the rating task (see Table 6.7 for their results on all the tasks). The results show that these learners were able to produce the difference between plain and palatalized consonants without presenting robust evidence that they have encoded the contrast lexically. The hypothesis stated that learners would be able to produce a lexical contrast with palatalized consonants without lexically encoding it under one of the following conditions: 1) if learners were prompted to do so explicitly e.g., in an imitation task; 2) if they possessed latent articulatory skills that they have transferred from another language; or 3) if they had acquired the necessary gestures for palatalization as a result of rigorous articulatory training. In order to elicit the productions of test words with the target consonants, the learners performed a picture-naming task in this study. They were neither given a model that they could have imitated

nor explicitly asked to produced palatalized consonants in the words. With respect to the second condition, two advanced learners reported knowledge of another language in their background questionnaires. One learner (Participant #54) reported Spanish (ability to speak 4 out of 10). The other learner (Participant #19) reported German and Arabic (ability to speak 2 out 10). Although Arabic and Spanish do have several palatalized sounds in their inventories, e.g., /li/ in Arabic or /ni/ in Spanish, it is unlikely that the learners were able to benefit substantially from their knowledge of palatalized sounds in these languages. First, the learners' proficiency in these languages was intermediate at best. Second, unlike the Russian language, Spanish and Arabic employ palatalization only marginally in their phonemic inventories, i.e. only a few consonants in each of these languages can be considered palatalized, whereas in Russian palatalization affects 15 consonants. As far as the third condition is concerned, the background questionnaires revealed that four out of seven learners were enrolled in a Russian Phonetics class in the past. However, it is not known how rigorous their articulatory training of palatalized consonants was. As a result, none of the conditions proposed by the hypothesis could clearly explain why learners were able to produce the contrast between plain and palatalized consonants without actually encoding it in their mental lexicon.

Information provided in the background questionnaires also revealed that six out of seven learners (except Participant #34) spent 5 to 20 weeks in Russia either on a study abroad program or travelling for leisure. According to Piske, Mackay and Flege (2001), length of residence in a community, where L2 is the dominant language, has most effect on the degree of foreign accent during the first year of stay. Consequently, massive exposure to native input, especially in a Russian-speaking environment, might have had a

positive influence on these learners' pronunciation and allowed them to perfect their productions of the highly frequent and familiar words used in this study. The reason why the learners accepted incorrect productions on the AWPM task despite being able to produce the contrast can be explained in two ways. First of all, since lexical encoding is dependent on learners' perceptual abilities, learners might not have been able to reliably hear the difference between the real words and test nonwords on the AWPM task. Their error rates on the ABX with the same group of words ranged from 18% to 34% ($M = 27\%$). Even though an error rate of 18% is one of the lowest received by the learners, it is still significantly higher than a 3%-error rate obtained by the Russian native speakers. The second reason might stem from the fact that the learners might be treating palatalized and plain consonants as free variants – perhaps due to their likely exposure to English-influenced versions of these words among peers as well. They might be assuming that the difference between a plain and a palatalized consonant is not significant enough to reject a nonword that sounded almost the same as a real word, especially taking into account the fact that no minimal pairs were used in the experiment. As one of the learners remarked in a spontaneous comment after the experiment, even though pronunciation */xolʲodnij/ of the word /xolodnij/ 'cold' was incorrect, he had accepted it because there was no word */xolʲodnij/ in Russian anyway and the difference between the correct and incorrect pronunciation was very small. However, despite being "subtle" in this learner's view, this difference was shown to be very crucial for Russian native speakers: their error rate on test nonwords was only 3%.

To sum up the answer to the second research question, it can be concluded that learners' ability to perceive plain and palatalized consonants facilitates lexical encoding,

although it does not guarantee it. Learners with relatively good perception of the contrast can still fail to encode the difference between plain and palatalized consonants. A scenario in which a learner is able to encode the contrast without being able to perceive it was not supported by these data but again, it is necessary to mention that almost none of the learners were able to reliably encode words with the plain / palatalized contrast in the first place. With respect to the relationship between perception and production, it was found that learners who performed better at encoding the difference between plain and palatalized consonants were also better at producing this contrast. However, accurate lexical encoding does not seem to be a prerequisite for accurate production.

Chapter 6. Experiment 3: Effects of orthography

This chapter examines the effects of orthography on the perception, production and lexical encoding of plain and palatalized consonants by American learners of Russian. The goal of Experiment 3 is to establish whether the orthographic and metalinguistic knowledge that Russian learners acquire facilitates their perception, production and lexical encoding of palatalization. Section 6.1 introduces the research questions and hypotheses. Section 6.2 describes the method that was used to investigate the effects of orthography. Section 6.3 presents the results and Section 6.4 provides a discussion of the main findings.

6.1. Research questions and hypotheses

In previous research, orthography has been found to have positive, negative and no effect on perception, production and lexical encoding. Difficult contrasts that have already been acquired perceptually to a certain degree can be further reinforced by orthographic representations (e.g., Escudero, 2015). However, for contrasts that cannot yet be discriminated in perception, orthography offers little help. The availability of orthographic representations seems to be beneficial for the lexical encoding of phonological contrasts, especially in the absence of perceptual support (e.g., Escudero et al., 2008). Unfortunately, the side effect of this interaction might be imprecise lexical representations, asymmetric lexical access, increased lexical competition and slower word recognition. In production, differences in the depths of orthographies employed by various languages can lead to pronunciation mistakes caused by incongruent grapheme-phoneme correspondences in native and second languages (e.g., Bassetti & Atkinson,

2015).

This dissertation set out to investigate how orthography influences perception, production and lexical encoding of palatalized consonants. It differs from previous studies investigating the effects of orthography in several ways. First of all, the difference in the target contrasts between plain and palatalized consonants is based on the secondary feature of articulation instead of the primary articulation researched in other studies. Secondly, the orthographic code for palatalization is located on the neighboring letter, which creates an orthographic trap for learners. For example, the palatalized status of the initial consonant <Л> in the word <ЛЮК> /lʲuk/ ‘manhole’ can be determined by the following soft series vowel <Ю>. In the word-final position, it is the letter called soft sign <Ь> that is used to mark palatalization, e.g., <СОЛЬ> /solʲ/ ‘salt’. Thirdly, in order to decipher the orthographic code for palatalization, learners have to acquire the necessary metalinguistic knowledge. They have to know which vowels are used after plain consonants and which vowels are used after palatalized consonants. They also have to be familiar with the use of the soft sign, peculiarities of loanword phonology and other exceptions. Finally, this dissertation uses only words that are familiar to learners instead of novel contrasts that are only acquired for the purposes of the experiment through a word-learning paradigm (e.g., Escudero et al., 2008, Hayes-Harb & Masuda, 2008). Studies that employ novel contrasts assume that the specific orthographic knowledge is not present at the outset of the experiment. By exposing learners to novel orthographic representations, researchers determine whether the newly-acquired knowledge of orthography has an immediate effect on perceptual abilities, phonolexical representations, phoneme-grapheme congruency etc. However, this short-term laboratory word learning is

not quite representative of what happens in the real world with “real” learners. For instance, the novel word studies posit that if learners know the written form of words as a result of being exposed to it, and if that form is conducive to encoding the contrast, then learners’ phonolexical encoding will be more accurate. Our study tests the assumption that there is a link between knowing the written form of words and the accuracy of learners’ perception, lexical encoding and production by actually measuring the current knowledge of learners’ orthography and assessing whether it indeed has an impact on learners’ performance on highly familiar words. There is no study to date that has investigated the effects of orthography on the acquisition of palatalized consonants in L2 Russian. Thus, the research questions that this experiment poses are the following:

1. Do American English learners of Russian possess orthographic and metalinguistic knowledge of the difference between plain and palatalized consonants in L2 Russian? What effect does syllable position have on this knowledge?
2. How does orthographic and metalinguistic knowledge acquired by American English learners of Russian interact with the perception, production and lexical encoding of contrasts involving palatalized consonants?

To measure their orthographic and metalinguistic knowledge, learners were asked, first, to provide the spelling of test words on the written picture-naming task, and then to identify which sounds were palatalized in these words on the metalinguistic task. High error rates on these tasks would indicate unstable orthographic and / or metalinguistic representations. Concerning the first research question, it is hypothesized that learners at lower levels of proficiency might have unstable orthographic and metalinguistic

representations of the plain / palatalized contrast, whereas learners at the advanced level of proficiency should have more stable orthographic and metalinguistic knowledge. At lower levels of proficiency, learners can overlook metalinguistic explanations and fall into the orthographic trap, i.e. they might report that the palatalized sounds are the vowels, because Russian has a different script than English, the orthographic code is located on the neighboring letter and the perceptual salience of palatalized consonants is not very high. At higher levels of proficiency, the concept of palatalization and the way it is represented in orthography becomes more salient not only for phonological reasons but also for morphological reasons. The stem system that governs Russian morphology involves almost all notional parts of speech. The endings in the synthetic Russian language, which uses bound morphemes to denote grammatical relationships, can differ depending on whether the stem ends in a palatalized or plain consonant. Thus, if learners want to speak and write grammatically in Russian, it is crucial that they know how to distinguish plain from palatalized consonants.

With respect to the effect of the syllable position, it is expected that learners will make more metalinguistic errors in intervocalic position than in word-final position due to the spelling trap. As previously stated in Section 3.2, palatalized and plain consonants share the same graphemes in Russian. In intervocalic position, palatalized consonants are followed by a special set of soft series vowel letters <и, е, я, ё, ю>, whereas plain consonants are followed by a corresponding set of hard series vowel letters <ы, э, а, о, у>. The Russian language utilizes ten vowel letters specifically to mark palatalization, even though these ten vowel letters represent five vowel sounds /i, e, a, o, u/. Learners, who do not possess the necessary metalinguistic knowledge of plain and palatalized

consonants, might erroneously believe that in minimal pairs like <лук – люк> /luk – lʲuk/ ‘onion (bow) – manhole’, the initial consonants are the same, whereas the subsequent vowels are different. In reality, however, the initial consonant in the word <лук> is plain /l/, whereas the initial consonant in the word <люк> is palatalized /lʲ/. The letters <y> and <ю> represent the same vowel /u/. In word-final position, palatalized consonants are marked with a letter <ь> called “soft sign”. If learners, especially at lower levels of proficiency, are not familiar with this function of the soft sign, they can omit this letter in their spelling on the orthographic task, since <ь> does not represent any independent sound. However, on the metalinguistic task, the name of the letter soft sign can signal to the learners that the consonant preceding it should be soft or palatalized.

Regarding the second research question, it is hypothesized that orthographic and metalinguistic knowledge can affect the perception, lexical encoding and production of words with the plain / palatalized contrast. Learners, who consistently do not hear the difference between plain and palatalized consonants, might be able to rely on orthographic information to develop better perceptual sensitivity for palatalization since palatalization is not opaque in Russian. Orthography could also be helpful in the lexical encoding of words, especially if learners cannot discriminate the contrast in perception. Even if encoding is imprecise, as long as learners create two separate categories for a lexical contrast with palatalized and plain consonants, it gives them an opportunity to refine their representations with experience and exposure. However, orthography can also do learners a disservice by fostering incorrect lexical encoding, especially in the prevocalic position. For example, if learners do not possess the necessary orthographic and metalinguistic knowledge of palatalization, they might believe that the difference

between two words, such as <лук - люк> /luk - liuk/ ‘onion (bow) – manhole’, pertains to the vowel and erroneously encode it as such. Thus, even though the words with plain and palatalized consonants will be encoded separately, the phonolexical representations will be inaccurate. Words that have palatalized consonants word-finally, i.e. marked with a soft sign letter <ь>, should not create this type of a problem. On the contrary, the soft sign might signal that the consonant preceding it should be encoded differently than a plain consonant. Finally, in production, the effect of orthography can also be twofold. On the one hand, metalinguistic knowledge of palatalization can alert learners to the location of palatalized consonants and help them articulate words with the plain / palatalized contrast more accurately. On the other hand, if learners are not familiar with the fact that plain and palatalized consonants share the same graphemes in Russian, they might be led to think that all consonants are plain and replace palatalized consonants with the plain counterparts in articulation.

6.2. Method

The orthographic knowledge of participants was tested using a written picture-naming task. The participants were not aware of the phenomenon under investigation. The learners were asked to write words for the pictures that they had seen in the familiarization task. Since the spelling of the words were not provided to the learners at any time during the experiment and the words were all familiar, the participants were forced to supply the orthographic forms that they had already acquired when learning Russian. However, knowing how to spell a word correctly did not imply that the participants knew what the graphemes that they had written represented. For example,

when learners wrote <соль>, were they aware that the final consonant was palatalized since it was marked by the soft sign or did they simply reproduce the spelling of the word? A metalinguistic task was designed to answer this question. At the very end of the testing session, the participants were asked to underline palatalized consonants in the words that they had supplied. In order to do this, learners would have to refer to their explicit knowledge of palatalization. If our hypotheses are correct, then lower-proficiency learners should have a lower accuracy rate on the orthographic and metalinguistic tasks than higher-proficiency learners. If orthography has a positive effect on the perception, lexical encoding and production of palatalized consonants, then participants' performance on the orthographic and metalinguistic task should positively correlate with the participants' performance on the other tasks: ABXs tasks (perception), rating task (production) and AWPM task (lexical encoding). In case of a negative effect, the correlations should be negative.

6.2.1. Participants

The participants in Experiment 3 were the same as in Experiment 1 and the reader is referred to Section 4.2.1 for further details.

6.2.2. General procedure

The general procedure of the experiment was laid out in Section 4.2.2. For the description of the tasks that assessed production of plain and palatalized consonants (familiarization, oral picture-naming task and rating task) the reader is referred to Sections 4.2.3, 4.2.4 and 4.2.8. For the description of the tasks that evaluated perceptual

abilities of learners (ABX with real words and nonwords) the reader is referred to Sections 4.2.5 and 4.2.6. For the description of the task that examined the lexical encoding of plain and palatalized consonants (AWPM task) the reader is referred to Section 5.2.3. In this chapter only the tasks that probed orthographic and metalinguistic knowledge are presented. The following sections describe the materials and procedure specific to these tasks.

6.2.3. Task #3: Written picture-naming task

Materials

Materials in Task 3 were the same as in Task 1 (see Section 4.2.3). The only difference was the order of pictures in the PowerPoint presentation and no time interval between slides. Also, the audio files with the pronunciation of the words were removed from the PowerPoint presentation.

Procedure

The participants performed a written picture-naming task after the familiarization (Task 1) and oral picture-naming (Task 2) (see Sections 4.2.3 and 4.2.4). They saw the same pictures from Task 1 and 2 and were asked to write words that matched the pictures on the provided answer sheets (see Figure B3 in Appendix B for a screenshot of complete instructions). Each picture in the PowerPoint presentation was presented only once in a random order, which was the same for all the participants. The participants did not hear the pronunciation of the target words but the first two letters were provided on the answer sheets as well as in the PowerPoint presentation below the pictures to facilitate retrieval.

The task was self-paced and took approximately seven minutes. No feedback was provided. No practice items were given.

As a result of the written picture-naming task, 995 tokens of target words were supplied, while five words were missing (total: 1000 tokens = 20 target words x 50 participants). Three advanced learners did not write the word /s'ierij/ 'grey' and one intermediate learners failed to supply two words: /s'ierij/ 'grey' and /z'ielionij/ 'green'.

6.2.4. Task #7: Metalinguistic task

Materials

Materials in Task 7 were the same as in Task 1 (see Section 4.2.3). The only difference was that learners did not use the PowerPoint presentation but instead received the answer sheets from Task 3 (written picture-naming task).

Procedure

The metalinguistic task together with the familiarity task (see Section 4.2.7) was the last task that the participants did. The participants received their answer sheets back from the written picture-naming task and were asked to circle palatalized consonants in the words that they had supplied in the written picture-naming task. The task was self-paced and took approximately five minutes.

The answers on both tasks were coded so that each correct answer on either task received one point (Table 6.1). It is also important to mention that even if participants spelled the word incorrectly e.g., <сол> instead of <соль>, they still could receive a point in the metalinguistic task if they circled the final consonant as palatalized.

Table 6.1

Coding used in the written picture-naming task and metalinguistic task

Target word	Supplied forms	Written picture-naming task	Metalinguistic task
Plain consonant	холод <u>н</u> ый	1	1
intervocalicly	холод <u>н</u> ый	1	0
<холод <u>н</u> ый>	холо <u>д</u> ный	0	1
/xolodnij/ ‘cold’	холо <u>д</u> ный	0	0
Palatalized consonant	зе <u>л</u> ёный	1	1
intervocalicly	зе <u>л</u> ёный	1	0
<зе <u>л</u> ёный>	зело <u>н</u> ый	0	0
/zielʲonij/ ‘green’	зе <u>л</u> оный	0	1
Plain consonant	сто <u>л</u>	1	1
word-finally	сто <u>л</u>	1	0
<сто <u>л</u> >	сто <u>л</u> ь	0	1
/stol/ ‘table’	сто <u>л</u> ь	0	0
Palatalized consonant	со <u>л</u> ь	1	1
word-finally	со <u>л</u> ь	1	0
<со <u>л</u> ь>	сол	0	0
/solʲ/ ‘salt’	со <u>л</u>	0	1

6.2.5. Analysis

Table 6.2 presents the research questions, dependent and independent variables as well as the statistical procedures employed to answer the research questions. The statistical analyses were done using IBM Statistical Package for Social Sciences (SPSS), Version 24.

Table 6.2

Research questions, variables and analysis methods

Research Questions	Variables	Analysis method
1. Do American English learners of Russian possess orthographic and metalinguistic knowledge of the difference between plain and palatalized consonants in L2 Russian? What effect does syllable position have on this knowledge?	Written picture-naming task, metalinguistic task IV1: Group (intermediate, advanced, Russian) IV2: Palatalization (plain, palatalized) IV3: Position (intervocalic, final) DV1: Error rates (Written picture-naming task) DV2: Error rates (Metalinguistic task)	A generalized linear mixed model on error rates with group, palatalization and position as fixed effects and participant as random effect.
2. How does orthographic and metalinguistic knowledge acquired by American English learners of Russian interact with the perception, production and lexical encoding of contrasts involving palatalized consonants?	Relationship between perception, lexical encoding, production and orthography DV1: Error rates (ABX with words) DV2: Error rates (ABX with nonwords) DV3: Categorization error rates (Rating task) DV4: Rating scores for palatalized consonants (Rating task) DV5: Error rates in the test nonword condition (AWPM task) DV6: Error rates (Written picture-naming task) DV7: Error rates (Metalinguistic task)	Pearson's correlations

Note: DV = dependent variable; IV = independent variable.

6.3. Results

6.3.1. Written picture-naming task

In the written picture-naming task, the participants supplied written forms of the words that they saw in the pictures. Only errors in the plain or palatalization status of the target consonants were considered. Russian native speakers wrote all consonants (plain and palatalized) accurately. Both advanced and intermediate learners had an error rate of 4%, which suggests that learners were very familiar with the orthographic representations of the plain and palatalized consonants in the target words. Table 6.3 presents mean error rates for plain and palatalized consonants for the three groups of participants.

Table 6.3

Mean error rates of misspelled plain and palatalized consonants (%) and standard deviations (SD) for each group of participants

Palatalization status Group	Plain consonants		Palatalized consonants	
	Mean	SD	Mean	SD
Russian	0	0	0	0
Advanced	5	22	3	16
Intermediate	2	14	6	24

A generalized linear mixed model was run in SPSS 24 on the error rates from the written picture-naming task to examine the effects of group, syllable position and palatalization status of the target consonants. The factors group (Russian native speakers, advanced learners, intermediate learners), position (intervocalic, final) and palatalization status (plain, palatalized) were declared as fixed effects. The factor participant was chosen as a random effect. Type III tests of fixed effects for error rates revealed no significant main effects or interactions. All participants were able to supply accurate plain and palatalized orthographic representations for the target consonants in the target words.

6.3.2. Metalinguistic task

In the metalinguistic task, participants were asked to circle all palatalized consonants in the words that they had supplied in the previous written picture-naming task. Russian native speakers had a mean error rate of 2% (SD = 14%), advanced learners' error rate was 24% (SD = 43%), and intermediate learners made 25% (SD = 43%) of errors. Table 6.4 presents mean error rates for plain and palatalized consonants for the three groups of participants.

Table 6.4

Mean error rates of misidentified plain and palatalized consonants (%) and standard deviations (SD) for each group of participants

Palatalization status	Plain consonants		Palatalized consonants	
	Mean	SD	Mean	SD
Russian	0	0	4	20
Advanced	11	32	38	49
Intermediate	7	26	42	50

Figure 6.1 presents each group's mean error rates on plain and palatalized consonants in intervocalic and word-final position. In order to determine whether syllable position or the palatalization status of the target consonant had an effect on learners' ability to identify plain and palatalized consonants, a generalized linear mixed model was run in SPSS 24 on the error rates in the metalinguistic task. The factors group (Russian native speakers, advanced learners, intermediate learners), position (intervocalic, final) and palatalization status (plain, palatalized) were declared as fixed effects. The factor participant was chosen as a random effect. Type III tests of fixed effects for error rates revealed that there was a significant interaction between group, position and palatalization status, $F(7, 983) = 3.12, p = .003$. In intervocalic position, both groups of

learners made significantly more errors ($p < .001$ for both groups) identifying palatalized consonants (intermediate: $M = 53\%$, advanced: $M = 47\%$) than plain consonants (intermediate: $M = 8\%$, advanced: $M = 5\%$), which means that learners did not circle half of the palatalized consonants followed by the soft series vowel letters <е, ё, и, ю, я>. In word-final position, learners also made more errors ($p < .001$ for intermediate, $p = .058$ for advanced) identifying palatalized consonants (intermediate: $M = 32\%$, advanced: $M = 28\%$) than plain consonants (intermediate: $M = 6\%$, advanced: $M = 17\%$), which means that learners did not circle one third of the palatalized consonants followed by the soft sign <ь>. Both groups of learners ($p < .002$ for intermediate, $p < .003$ for advanced) were more likely to identify palatalized consonants that were followed by the soft sign <ь> than when followed by the soft series vowel letters <е, ё, и, ю, я>. There was no statistically significant difference between intermediate and advanced learners in their error rates on identification of plain and palatalized consonants in either syllable position. Russian native speakers' performance was affected neither by the palatalization status of the target consonants nor their syllable position.

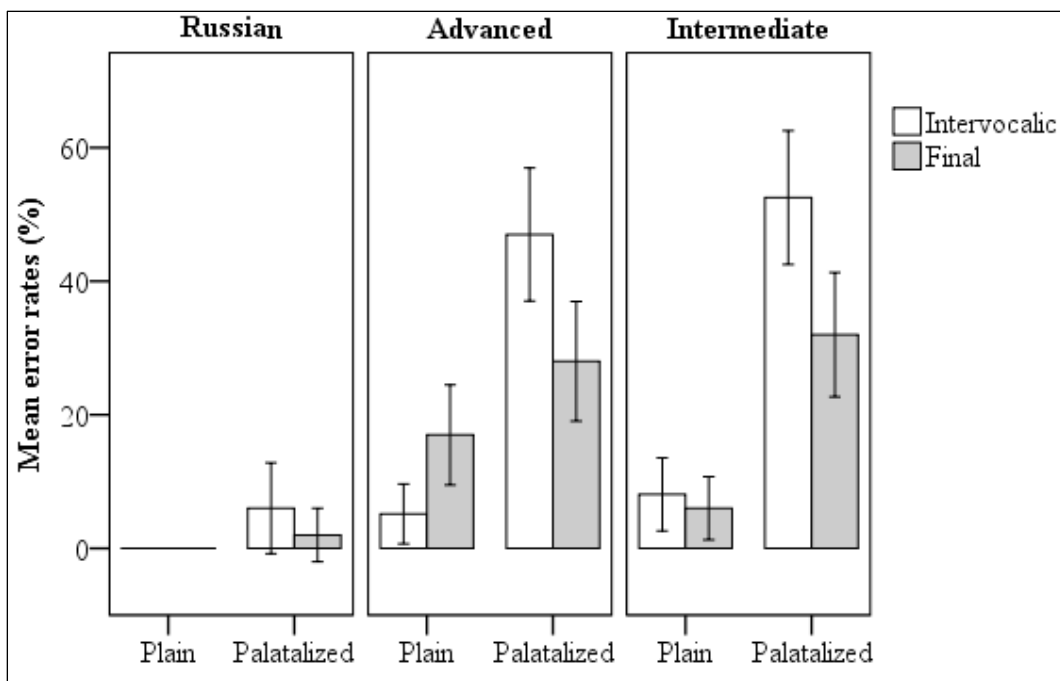


Figure 6.1. Mean error rates on plain and palatalized consonants in intervocalic and word-final position for each group of participants. Error bars show the 95% CI.

Data obtained on the written picture-naming task were combined with the data from the metalinguistic task to determine whether learners were aware of the phonological categories that the graphemes they had supplied represented. Four conditions were created depending on whether learners were able to write target words accurately with respect to the palatalization status of the target consonants (+/-Spelling) and whether they were able to accurately identify plain and palatalized consonants (+/-Metalinguistic knowledge). Figure 6.2 represents the percentage of target words in each condition. Russian native speakers were able to correctly identify plain and palatalized consonants in 98% of correctly spelled target words, whereas learners were able to successfully identify plain and palatalized consonants only in 75% of words. In 21% of the correctly spelled words, learners were unable to identify the plain or palatalization status of the target consonants. This finding suggests that learners' ability to write a word

accurately does not imply that learners were metalinguistically aware of the phonemes represented by the graphemes that they had actually used.

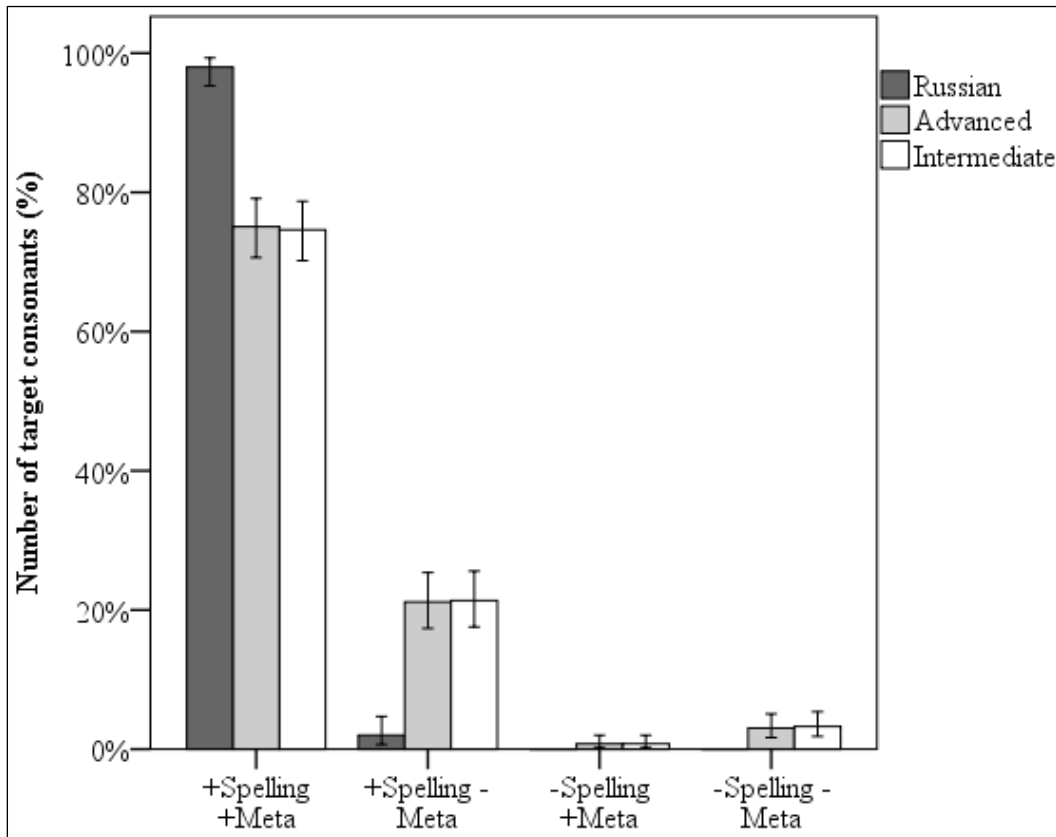


Figure 6.2. Percentage of target consonants for each group of participants and condition. Error bars show the 95% CI.

6.3.3. Summary of results for the written picture-naming task and metalinguistic task

The results of the written picture-naming task showed that both groups of learners were able to write words with the target plain and palatalized consonants accurately. Their error rates were very low and not significantly different from those of the Russian native speakers. However, when learners were asked to identify palatalized consonants in the words that they had written, they were able to do it only in 75% of correctly spelled

words. Their performance was affected not only by the palatalization status of the target consonants but also by the syllable position. Both groups of learners made significantly more mistakes in the identification of palatalized consonants than plain consonants. Intervocalic position was more challenging than word-final. The highest error rates were observed in the identification of palatalized consonants in intervocalic position: learners missed almost half of the palatalized consonants in that specific syllable position. The performance of Russian native speakers was not affected either by the palatalization status of the target consonants or their syllable position.

6.3.4. Correlations between the written picture-naming task, metalinguistic task, ABX tasks, AWPM task and rating task

6.3.4.1. Correlations

Learners' performance on the written picture-naming task and metalinguistic task was correlated with their performance on the ABXs, AWPM task and rating task to examine the relationship between orthography, perception, lexical encoding and production (see Appendix D for individual results). Russian native speakers were excluded from the correlational analysis. For each participant, seven measures were aggregated:

- 1) error rates (in %) on test trials on the ABX task with real words;
- 2) error rates (in %) on test trials on the ABX task with nonwords;
- 3) error rates (in %) on the rating task, i.e. errors made by learners in the production of palatalized consonants only, which were categorized by Russian native listeners as plain;

- 4) cumulative rating scores (in %) for palatalized consonants only;
- 5) error rates (in %) in the test nonword condition on the AWPM task;
- 6) error rates (in %) on the written picture-naming task;
- 7) error rates (in %) on the metalinguistic task.

The correlational analysis was performed on the data from intermediate and advanced learners separately. Tables 6.5 and 6.6 present Pearson's correlations for intermediate and advanced learners.

Table 6.5

Pearson's correlations between orthography, lexical encoding, perception and production for intermediate learners

Measure	1	2	3	4	5	6	7
1. Error (ABX with nonwords)	—						
2. Error (ABX with words)	.399*	—					
3. Error (Production: Rating)	.195	.248	—				
4. Score (Production: Rating)	-.046	-.111	-.742**	—			
5. Error (Lex. encoding: AWPM)	.267	.225	.551**	-.804**	—		
6. Error (Spelling: WPN)	-.184	-.021	.213	-.228	.143	—	
7. Error (Metalinguistic)	.474*	.237	.425*	-.446*	.532**	.270	—

Note. $n = 20$. * $p < .05$, ** $p < .01$, one-tailed.

There was no relationship between intermediate learners' performance on the written picture-naming task and the other tasks, which means that learners' ability to spell plain and palatalized consonants accurately was not related to their performance on perception, production and lexical encoding tasks. However, there were moderate, statistically significant relationships between intermediate learners' error rates on the metalinguistic task on the one hand and error rates on the ABX with nonwords, AWPM task, rating task as well as rating scores on the rating task on the other hand. Learners who made more errors on the metalinguistic task also made more errors on the ABX with

nonwords. However, there was no significant correlation between learners' ability to identify palatalized consonants on the metalinguistic task and their ability to perceptually discriminate palatalized consonants from their plain counterparts in the same words on the ABX with words (Figure 6.3). This lack of correlation suggests that even though learners know the location of palatalized consonants in words, it does not help them hear the consonants better in the same words. Higher error rates on the metalinguistic task were related to higher error rates on the AWPM task, higher error rates on the rating task and lower rating scores on the rating task. Participant #14 (see Table 6.7 for his results on all the tasks) with a perfect accuracy rate of 100% on the metalinguistic task demonstrated the most accurate production (error rate of 10% and rating score of 88% on the rating task) and lexical encoding (error rate of 50%) of the plain/palatalized contrast among other intermediate learners. Despite the general trend, individual data of other participants suggest that learners with a low error rate of 15% on the metalinguistic task could still have very high error rates of 90% or 95% on the AWPM task, which means that metalinguistic knowledge was not enough for learners to create separate lexical representations for words with plain and palatalized consonants.

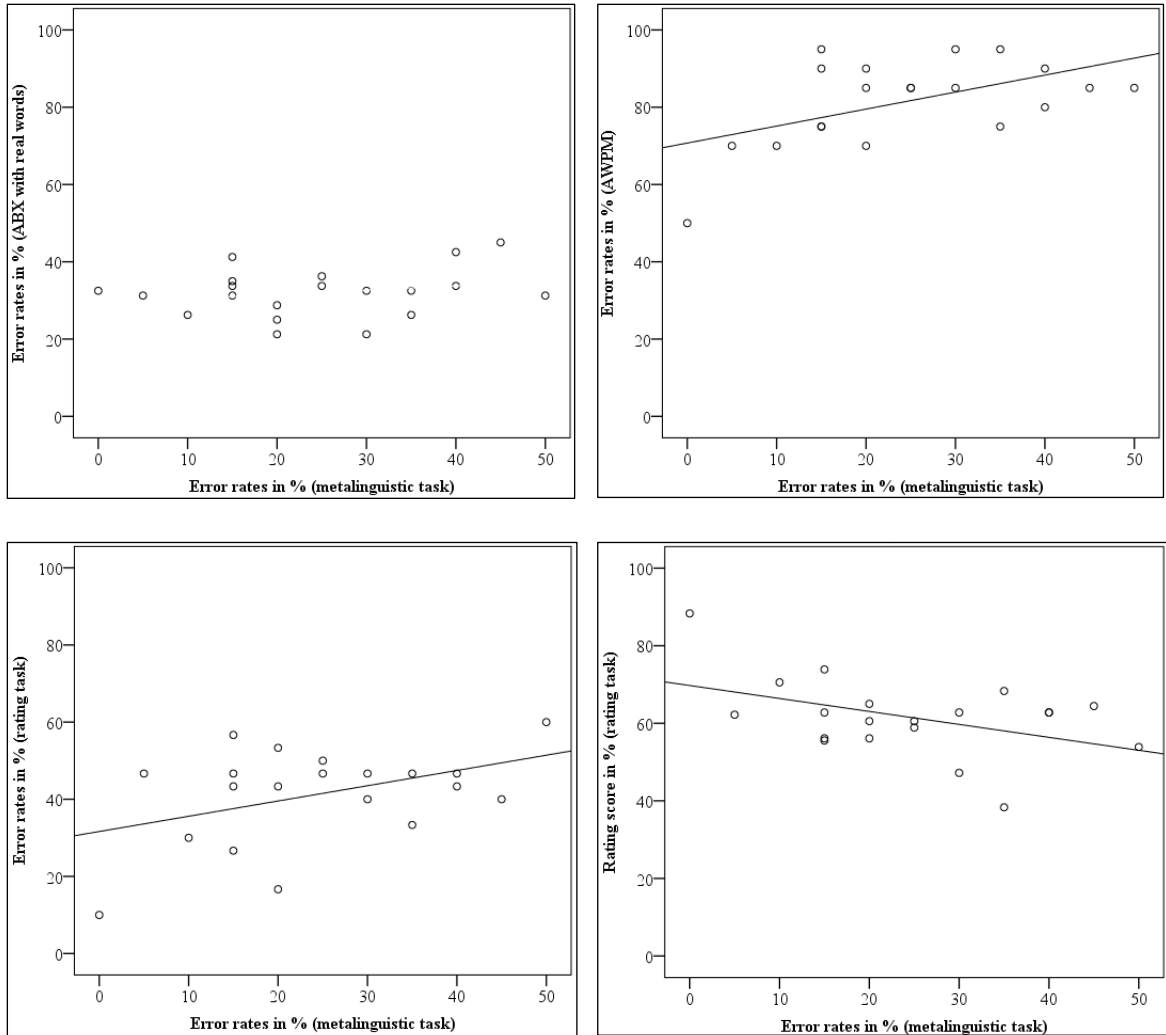


Figure 6.3. Scatterplots of intermediate learners' error rates on the metalinguistic task, ABX with real words, AWPM task, rating task and cumulative rating scores on the rating task.

Advanced learners' performance on the written picture-naming task correlated with their performance on the ABX with real words and rating task (Table 6.6). There was an especially strong statistically significant relationship between advanced learners' error rates on the written picture-naming task and their error rates and rating scores on the rating task. It suggests that learners' knowledge of how to spell plain and palatalized consonants in the target words was related to how accurate these consonants were

produced in these words. However, no significant relationship was found between learners' performance on the written picture-naming task and the AWPM task, which means that learners' ability to accurately write words with the target contrasts was not related to their ability to establish separate categories for words with plain and palatalized consonants in the mental lexicon.

Table 6.6

Pearson's correlations between orthography, lexical encoding, perception and production for advanced learners

Measure	1	2	3	4	5	6	7
1. Error (ABX with nonwords)	—						
2. Error (ABX with words)	.681**	—					
3. Error (Production: Rating)	.582**	.688**	—				
4. Score (Production: Rating)	-.623**	-.721**	-.947**	—			
5. Error (Lex. encoding: AWPM)	.657**	.715**	.478*	-.532**	—		
6. Error (Spelling: WPN)	.378	.399*	.686**	-.628**	.135	—	
7. Error (Metalinguistic)	.629**	.447*	.647**	-.673**	.416*	.651**	—

Note. $n = 20$. * $p < .05$, ** $p < .01$, one-tailed.

Advanced learners' performance on the metalinguistic task correlated with learners' performance on all the other tasks that examined perception, production and lexical encoding. Higher error rates on the metalinguistic task were related to higher error rates on the ABX with words, AWPM task and rating task as well as lower rating scores on the rating task (Figure 6.4).

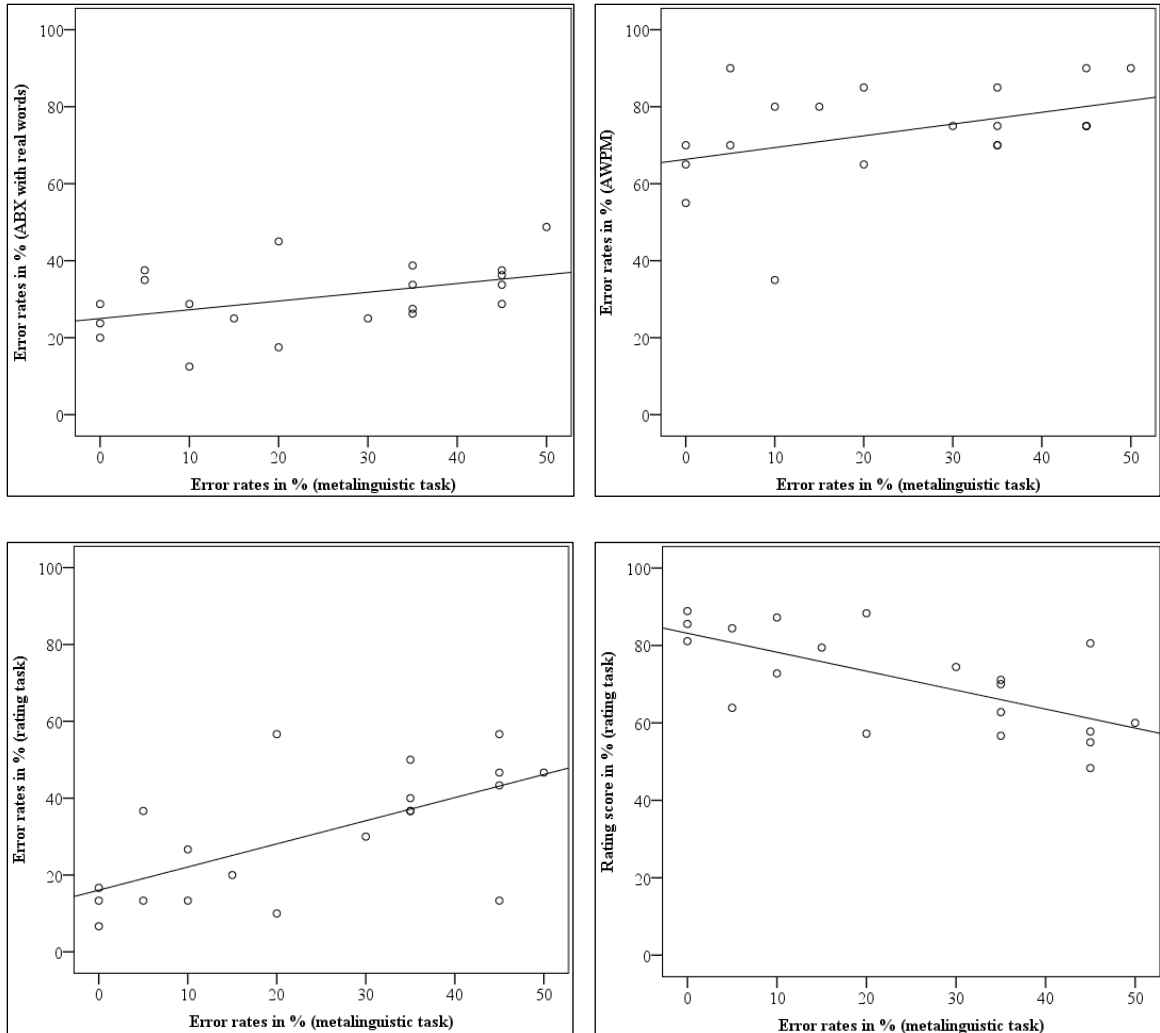


Figure 6.4. Scatterplots of advanced learners' error rates on the metalinguistic task, ABX with real words, AWPM task, rating task and cumulative rating scores on the rating task.

The strongest correlations were observed between advanced learners' performance on the metalinguistic task and rating task, which suggests that learners' awareness of the palatalization status of a consonant can foster its accurate articulation. All the participants listed in Table 6.7 received the highest rating scores (above 80%) and lowest error rates (below 17%) on the rating task observed in the data sample. Four out of seven advanced learners, who had the best results on the rating task, demonstrated excellent metalinguistic knowledge with an error rate of 5% and below. However, one

learner, Participant #32, with a relatively high rating score of 81% and a low error rate of 13% on the rating task had one of the highest error rates of 45% on the metalinguistic task. On the other hand, a learner with an error rate of 5% on the metalinguistic task receive a below average ($M = 71\%$) ratings score of 64% and an above average ($M = 31\%$) error rate of 37% on the rating task. These results suggest that metalinguistic knowledge is not a guarantee or a prerequisite of accurate articulation but it seems to be helpful in guiding learners when they have to switch from plain to palatalized gestures.

Table 6.7

Individual data of participants, who received the highest scores on the rating task

ID	Group	Error rate (ABX with nonwords)	Error rate (ABX with words)	Error rate (Rating task)	Score (Rating task)	Error rate (AWPM task)	Error rate (Written picture-naming task)	Error rate (Metalinguistic task)
14	Intermediate	28	33	10	88	50	0	0
19	Advanced	33	35	13	84	70	5	5
20	Advanced	18	24	17	86	55	0	0
32	Advanced	45	34	13	81	90	0	45
34	Advanced	15	20	7	89	70	0	0
48	Advanced	23	29	13	81	65	0	0
51	Advanced	15	13	13	87	35	5	10
54	Advanced	23	18	10	88	65	0	20

6.3.4.2. Summary of results for the correlations

The results of the correlational analysis showed no significant relationships between intermediate learners' ability to write plain and palatalized consonants accurately (measured by the written picture-naming task) and other domains of phonological development, such as perception, production and lexical encoding.

However, there was a strong relationship between advanced learners' performance on the

written picture-naming task and their ability to produce plain and palatalized consonants on the rating task. A moderate statistically significant relationship was observed between advanced learners' ability to write words with the plain/palatalized contrast and their ability to discriminate this contrast in perception.

The correlational analysis also revealed significant relationships between metalinguistic knowledge (measured by the metalinguistic task), production (measured by the rating task) and lexical encoding (measured by the AWPM task) in the data of both groups of learners. The general trend established through the analyses suggested that learners with a more accurate performance on the metalinguistic task were also more accurate on the rating task and AWPM task. However, individual data of intermediate and advanced learners showed that learners with very accurate metalinguistic knowledge of plain and palatalized consonants could still demonstrate difficulties in their production and lexical encoding of the plain/palatalized contrast. With respect to the relationship between perception (measured by the ABX tasks with real words) and metalinguistic knowledge, only advanced learners demonstrated a significant correlation between these two domains. In general, advanced learners with more accurate metalinguistic knowledge possessed better perceptual abilities, however, the correlation was only moderate. Intermediate learners did not have a significant correlation between their performance on the ABX with real words and metalinguistic task.

6.4. Discussion

6.4.1. Research question #1

6.4.1.1. Orthography

The first research question asked whether American learners of Russian possessed orthographic and metalinguistic knowledge of the plain / palatalized contrast in Russian. The hypothesis suggested that learners at lower levels of proficiency might have unstable orthographic and metalinguistic representations of palatalized consonants, whereas learners at the higher levels of proficiency should have more accurate orthographic and metalinguistic knowledge due to their increased experience with the Russian language. These hypotheses were partially confirmed by the results. Intermediate and advanced learners behaved very similarly on the written picture-naming task and metalinguistic task despite their differences in proficiency and experience with the language (intermediate learners studied Russian for a maximum of 3 years, advanced learners studied Russian for a minimum of 4 years). Both groups of learners demonstrated highly accurate orthographic knowledge of palatalized consonants but less stable metalinguistic knowledge. In the written picture-naming task, intermediate and advanced learners behaved similarly to the Russian native speakers and were able to write 96% of all words accurately with respect to the plain or palatalized status of the target consonants. However, when asked in the metalinguistic task to circle palatalized consonants in the supplied words, learners made errors in more than 20% of the target consonants. Taken together, these results reveal a clear distinction between the knowledge of the written forms of words (*viz.* orthographic knowledge) and the knowledge of phonemes that the graphemes in these words represent (*viz.* metalinguistic knowledge).

Learners' performance on the metalinguistic task was affected by the syllable position and palatalization status of the target consonants. Learners made significantly more errors when identifying palatalized rather than plain consonants, which suggests that learners did not utilize the orthographic code for palatalization: the soft sign <ь> word-finally and palatalized series vowel letters <е, ё, и, ю, я> in intervocalic position. They also made more errors in intervocalic position than in word-final position, that is, identifying palatalized consonants was more difficult when they were followed by vowels than when they were followed by the soft sign. This pattern can possibly be explained by the difference in the orthographic salience between the two positions. With respect to intervocalic position specifically, learners might have fallen into the spelling trap and thought that palatalized and plain consonants followed by vowels were the same and the vowels were different, whereas in reality the consonants differed in their palatalization status but the vowels were the same. In word-final position, the name of the letter 'soft sign' might have alerted learners that the consonants preceding it should be palatalized because in Russian linguistics and also in Russian language teaching palatalized consonants are called 'soft'. As a result, learners' performance was significantly more accurate when identifying palatalization word-finally than in intervocalic position.

6.4.2. Research question #2

The second research question investigated how orthographic and metalinguistic knowledge acquired by American English learners of Russian interact with the perception, production and lexical encoding of contrasts involving palatalized consonants.

6.4.2.1. Perception – orthography link

With respect to the relationship between perception and orthography, it was expected that learners would rely on orthographic and metalinguistic information to develop better perceptual sensitivity for palatalization. The results showed that intermediate learners' ability to spell words with plain and palatalized consonants accurately as well as their metalinguistic knowledge of grapheme-phoneme representations had no association with their perceptual abilities. In other words, even though intermediate learners were aware of the presence of palatalized consonants in familiar Russian words, it did not seem to relate to their discriminatory ability in the ABX task with the same words. Advanced learners, on the other hand, performed differently. There was a statistically significant relationship between advanced learners' ability to write and identify palatalized consonants and their ability to perceptually discriminate palatalized consonants from their plain counterparts on the ABX with the same words. However, this relationship was only moderate. Both groups of learners had a 4% error rate on the written picture-naming task, 24-25% error rate on the metalinguistic task and 31-32% on the ABX with real words. Taken together, these results suggest that orthographic and metalinguistic knowledge of palatalization seems to be independent from the ability to distinguish between plain and palatalized consonants in perception. Although learners demonstrated nativelike knowledge of the spelled forms of highly familiar Russian words, their perceptual abilities require a substantial improvement to match those of Russian native speakers. Moreover, the individual data of advanced learners on the metalinguistic task suggest that knowledge of grapheme-phoneme correspondences had an effect only when it reinforced the distinction that the learners

were already able to perceive. If learners had an error rate above the mean of 32%, neither their highly accurate orthographic knowledge nor metalinguistic knowledge seemed to be helpful. These results corroborate the claim made by Escudero and Wanrooij (2010) that orthography has a facilitative effect only when both auditory and orthographic information reinforce the same distinction and if the contrast is already discriminated in perception.

Section 2.3.2 discussed some of the factors that could have prevented the detection of the perception-orthography link in previous studies. For example, the use of one-hour training sessions to familiarize learners with novel contrasts most likely did not provide enough exposure for learners to establish stable grapheme-phoneme correspondences (Escudero, 2015; Simon et al., 2010). Differences in cognitive load evened out the comparisons between groups presented with novel contrasts in scripts similar and different from their native language (Pytlyk, 2011). Inherent acoustic variability in the auditory stimuli produced by various speakers prevented learners from assimilating these realizations to the same phoneme (Simon et al., 2010). This dissertation made an attempt to neutralize these task effects by employing highly frequent Russian words that were familiar to learners and that they had encountered multiple times both in written and spoken input. It guaranteed that learners were tested on the phonetic, orthographic and metalinguistic knowledge that had been established in their interlanguage over years of instruction and experience rather than hours of training sessions. Yet, the relationship between perceptual abilities and learners' orthographic and metalinguistic knowledge was not robust, which leads to the conclusion that the perception of challenging phonemes is not clearly linked to the knowledge of the

graphemes to which these phonemes correspond.

6.4.2.2. Lexical encoding – orthography link

Regarding the relationship between lexical encoding and orthography, it was hypothesized that orthographic and metalinguistic knowledge could facilitate the lexical encoding of words with plain and palatalized consonants, especially if learners had difficulty discriminating the contrast in perception. For example, in the perceptually nonsalient word-final position, the soft sign <ь>, which is used to mark palatalized consonants, would signal that the consonant preceding it should be encoded differently than a plain consonant. However, in prevocalic position, orthography was hypothesized to have an inhibiting effect on the accurate lexical encoding of palatalized consonants due to the difference in vowel graphemes following plain and palatalized consonants or the so-called spelling trap.

The results of the AWPM task showed that learners did not encode the contrast between plain and palatalized consonants separately even in familiar words. Surprisingly, there were four learners who identified 100% of the plain and palatalized consonants accurately on the metalinguistic task but their error rates on the AWPM task ranged from 50% to 70%. It seems that metalinguistic knowledge of how palatalization is represented in orthography is independent of establishing separate categories for plain and palatalized consonants since the error rates on the AWPM task were so high. However, these four learners with 0% error rates on the metalinguistic task also had the lowest error rates on the AWPM, which were still quite high at 50-70%. Overall, learners' performance on the AWPM task was correlated with their performance on the metalinguistic task: higher

error rates on the metalinguistic task were associated with higher error rates on the AWPM task.

The syllable position of the target consonants affected the performance of both groups of learners on the AWPM task and the metalinguistic task. Learners obtained higher error rates on the AWPM task by accepting more nonwords with target consonants in word-final position than in intervocalic position. However, on the metalinguistic task, learners made significantly more mistakes identifying palatalized consonants in intervocalic position than in word-final position. Previous studies suggest that the plain / palatalized contrast in prevocalic position is perceptually more salient than in word-final position due to the additional acoustic cues carried by vowels (Kochetov, 2002, 2004; Lukyanchenko & Gor, 2011; Rice, 2015). Indeed, the results of the ABX task with words showed that intermediate and advanced learners had significantly lower error rates in intervocalic position (intermediate: $M = 27\%$; advanced: $M = 25\%$) than in word-final position (intermediate: $M = 37\%$; advanced: $M = 36\%$). Thus, learners were able to perceive the difference between words and nonwords in intervocalic position, but they likely assigned the source of this perceptual difference to the vowels that carry the orthographic code rather than the target consonants. As a result, on the metalinguistic task, they made 40% more mistakes in intervocalic position than in word-final position. These findings confirm our hypothesis that learners can fall into the spelling trap and erroneously attribute the difference between plain and palatalized consonants in terms of subsequent vowels rather than the actual consonants in intervocalic position.

In word-final position, learners' performance on the metalinguistic and AWPM tasks was reversed. Learners made fewer errors identifying palatalized consonants on the

metalinguistic task and more errors accepting nonwords on the AWPM task, which did not support our hypothesis that orthography would have a facilitative effect on the lexical encoding of palatalized consonants, particularly in word-final position. Perceptually, the difference between plain and palatalized consonants word-finally is quite subtle. When Lukyanenko and Gor (2011) examined the perception of palatalized and plain consonants using a high-variability AX task, they found that in word-final position, learners of Russian, despite years of instruction and practice with the language, were not significantly different from naïve English speakers without any knowledge of Russian. American learners of Russian tend to map plain and palatalized consonants to similar English categories, for instance, Russian /p/ and /pʲ/ would be mapped to the English /p/ (Rice, 2015).

It may be the case that learners' inability to discriminate plain and palatalized consonants word-finally in perception interfered with their lexical encoding of the contrast, despite the fact that learners were aware of the plain or palatalized status of the consonants in the target words (see Section 5.4.2.1 for more details). Showalter and Hayes-Harb (2015) describe a similar situation whereby a lack of perceptual ability overrode the benefit of metalinguistic and orthographic knowledge in encoding a perceptually challenging contrast. Their study investigated how native speakers of American English encoded novel nonwords written in Arabic script with the /k - q/ contrast. Participants were assigned either to a group in which Arabic script was available for learning nonwords or to a group lacking orthographic support. After the word-learning stage, participants performed an AWPM task. The results revealed no difference between the two groups. Subsequent manipulation of the quality of the orthographic

input, including additional instruction in Arabic script, did not lead to any changes between the two groups. Even when the target words were presented to the participants using the Roman alphabet, their performance decreased. The authors speculated that the velar-uvular contrast was very difficult for the participants to perceive. Moreover, the use of the Roman letters <k> and <q>, which represent the same phoneme /k/ in English, might have fully neutralized the contrast in perception and led to the development of inaccurate lexical representations.

Concluding, the ability to spell words with plain and palatalized consonants correctly does not imply that learners possess accurate and complete orthographic knowledge of palatalization. In order to correctly identify palatalized consonants in orthography, learners have to possess metalinguistic knowledge of the orthographic codes that are used in Russian to mark palatalization. In intervocalic position, the orthographic code for palatalization is realized through the use of special vowels that follow plain and palatalized consonants. These vowels also carry additional vocalic cues, which help learners perceive the difference between plain and palatalized consonants. The findings of this dissertation revealed that learners erroneously rely on the vowels following plain and palatalized consonants rather than the consonants themselves to encode plain / palatalized contrasts in Russian. In word-final position, the difference between plain and palatalized consonants is marked by the absence or presence of the soft sign <ь> grapheme following the consonant. Even though learners seem to be aware of the function of this letter and can accurately identify the plain or palatalized status of final consonants orthographically, they still fail to encode the contrast due to a lack of perceptual ability to discern plain and palatalized consonants in this syllable position.

Thus, the effect of orthography on the lexical encoding of palatalized consonants in L2 Russian reveals itself differently depending on the syllable position of the target consonants and the corresponding difference in graphemes employed to mark palatalization in orthography.

6.4.2.3. Production – orthography link

Orthography was hypothesized to have a beneficial effect on the production of plain and palatalized consonants so long as learners possessed the necessary orthographic and metalinguistic knowledge. This hypothesis was largely supported. The results of the correlational analysis showed that there was a statistically significant relationship between learners' metalinguistic knowledge and their ability to produce palatalized consonants accurately. Learners' awareness of the presence of palatalized consonants in target words was related to more accurate production of the words. This relationship was particularly strong in the data of advanced learners. Unlike intermediate learners, advanced learners' also demonstrated a strong relationship between their ability to write words with plain and palatalized words accurately and their production of these words.

Such a strong correlation between advanced learners' metalinguistic knowledge, orthographic knowledge and production skills helps shed light on some individual cases analyzed in Chapters 4 and 5. In Section 4.4, the performance of Participants #19 and #32 was discussed to illustrate a scenario where production skills surpassed perceptual abilities. It was speculated that these learners were able to produce plain and palatalized consonants relatively accurately without reliably perceiving the distinction because they were enrolled in a Master's program to become Russian teachers, which likely led to an

increased awareness of the importance of the plain / palatalized contrast in the Russian language. Participant #19 demonstrated excellent orthographic and metalinguistic knowledge of palatalized consonants, which suggests that knowing the exact location of palatalized consonants in target words enabled the learner to produce palatalization accurately. The other Participant #32 represents a more “mysterious” case, since his performance not only on the ABXs but also on the metalinguistic task and AWPM task was among the least accurate in the data sample (see Table 6.7 for his results on all the tasks). Even though his error rate on the written picture-naming task was 0%, this result alone cannot account for the learner’s ability to achieve high accuracy in producing palatalized consonants. The language background questionnaire states that this learner spent only five weeks in Russia, had no previous pronunciation instruction and was not proficient in any other foreign languages. Then, how did this participant manage to produce palatalization, such a challenging articulatory feature, accurately? One explanation can be that this learner possessed excellent mimicry or phonetic imitation ability, which was found to be a valid predictor of pronunciation accuracy in studies by Purcell and Suter (1980) and Thompson (1991). Just to remind the reader, learners heard all target words pronounced by a Russian native speaker in the familiarization task before producing them in the subsequent oral picture-naming task. Another explanation may be rooted in the realms of exemplar-based learning (e.g., Pierrehumbert, 2001), when learners acquire and store the productions of individual words as exemplars without relying on a specific rule or prototype. Since all the target words were frequent and very familiar to the learner, he might have treated them as set “chunks” without parsing them

into individual phonemes. As a result, the learner was able to produce the target words accurately being guided by the stored representations of these exemplars.

Section 5.4 discussed the performance of seven learners who despite high error rates on the AWPM task (above 50%) received the highest scores on the rating task (above 80%) (see Table 6.7). Among the reasons discussed in Section 5.4 to account for these results were learners' length of residence in a Russian-speaking country, perceptual difficulties discerning the plain / palatalized contrast and treatment of palatalized consonants as free variants rather than separate phonemes. Performance on the written picture-naming task and metalinguistic task provide an additional piece to the puzzle of learners' acquisition of palatalization. Except for the "mysterious" case of Participant #32, who had an error rate of 45% on the metalinguistic task, the other six learners demonstrated solid metalinguistic knowledge with a mean error rate of only 6%. Just for comparison, the rest of the participants, who received a score below 80% on the rating task, had a mean error rate of 28% on the metalinguistic task. Despite inherent limitations of correlational studies regarding causality, this might still suggest that metalinguistic knowledge can guide learners to more accurate articulation by alerting them when to produce palatalized consonants, regardless of their perceptual abilities.

The hypothesis that metalinguistic knowledge of palatalization helps learners articulate words with the plain / palatalized contrast more accurately was not supported when the data is examined separately for each syllable position. Both groups of learners made significantly fewer production mistakes and received significantly higher rating scores for their production of palatalized consonants in intervocalic position than word-final position, although their performance on the metalinguistic task was quite the

opposite. Error rates on the metalinguistic task were 40% lower in word-final position than in intervocalic position. The reason why learners were able to produce palatalized consonants more accurately in intervocalic position, despite being unaware of the palatalized status of the consonants, is best explained by the co-articulation effects caused by the following vowels. As mentioned in previous chapters, vowels that follow palatalized consonants are more raised and fronted than vowels following plain consonants. Learners, who had fallen into the spelling trap, might have thought that it was a difference in the production of vowels rather than consonants that made the words with the plain / palatalized contrast sound differently. As a result, they focused on the articulation of vowels instead of consonants, but due to the co-articulation effects the preceding consonants were also palatalized and, therefore, scored as such by the raters. In the word-final position, it was not possible to utilize these co-articulation effects. Since learners did not acquire the gestures necessary to produce palatalized consonants that are not followed by a vowel, they showed less accurate productions in word-final position, even though they were aware of the fact that the consonants were palatalized.

Concluding, metalinguistic and orthographic knowledge seems to be helpful in production, if learners avoid falling into the spelling trap and acquire the gestures necessary to produce palatalized consonants in isolation, e.g., in word-final position. In this case, even if learners' perceptual abilities are not yet well developed and lexical representations of words with plain and palatalized consonants are imprecise, learners' production has a chance to be relatively accurate because their metalinguistic knowledge can potentially guide and alert them when they need to produce palatalized consonants. However, if learners fall into the spelling trap, their production of palatalization in

intervocalic position can be realized somewhat accurately due to the co-articulation effects of the subsequent vowel, but their production of the word-final palatalized consonants is likely to remain inaccurate.

Chapter 7. General discussion and conclusion

The goal of this dissertation was to investigate the relationships between the four domains of phonological development, which are perception, lexical encoding, production and orthography, during the acquisition of palatalized consonants by American learners of Russian. Experiment 1 focused on the perception – production link in order to establish whether the ability to discriminate plain and palatalized consonants in perception is a prerequisite for accurate production. Experiment 2 investigated the lexical encoding of the plain / palatalized contrast and how it interacts with learners' ability to perceive and produce palatalized consonants. Experiment 3 probed the effects of orthography to determine whether orthographic and metalinguistic knowledge has a facilitative or inhibitory effect on the perception, lexical encoding and production of palatalized consonants. Learners performed eight tasks that tapped into their knowledge in each domain. The innovation of this dissertation is that it examined learners' current knowledge of very familiar words with the plain / palatalized contrast instead of employing an experimental approach where learners are exposed to novel contrasts and nonwords through a word-learning paradigm. All the tasks in this study, except for the ABX with nonwords, used exactly the same twenty target words and ten fillers, which were all familiar to learners. Section 7.1 summarizes the main findings of the dissertation. Section 7.2 presents the main conclusions regarding the relationships that have been detected between the four domains of phonological development. Section 7.3 offers pedagogical implications. Section 7.4 proposes directions for future research.

7.1. General summary

Palatalization in Russian is definitely one of the most challenging features for American English learners to master. Despite numerous years of instruction and experience with the Russian language, even highly proficient learners of Russian do not fully acquire palatalization. Mistakes in the articulation of palatalized consonants add a significant degree of perceived foreign accent to the speech of nonnative speakers and can often act as a litmus test to separate native speakers from L2 learners of Russian. Such persistence of palatalization errors was the main motivation for this dissertation, which set out to examine not only the production of palatalized consonants but also other domains of phonological development in order to uncover why palatalization is so difficult for American learners of Russian.

Table 7.1 presents a summary of the results, mainly the error rates on the different tasks that learners performed. Even a brief look at the table suggests that learners still need to improve considerably in all four domains of phonological development in order to approach nativelike knowledge of palatalization in Russian. Learners' performance on the perception tasks (ABX with nonwords and real words) shows that they can discriminate the difference between plain and palatalized consonants only about 70% of the time. They can also produce this difference with approximately the same rate of success as judged by the professional linguists, who were all Russian native speakers, on a rating task. The highest error rates were obtained by learners on the AWPM task, which was employed to examine learners' lexical encoding of the plain / palatalized contrast. About two thirds of nonwords that had incorrect plain or palatalized consonants were accepted by learners as correct productions of target words. The most accurate

performance was demonstrated on the written picture-naming task, when learners were asked to provide the written forms of the target words. That was the only task in which learners did not differ significantly from Russian native speakers. However, when learners were asked to identify plain and palatalized consonants in the words that they had written on the metalinguistic task, their error rates increased to almost 40% for palatalized consonants (excluding errors for plain consonants).

Table 7.1

Summary of results with SD (in parentheses) on specific conditions of tasks for each group of participants

Domain & tasks	DV	Russian (N = 10)	Advanced (N = 20)	Intermediate (N = 20)
Perception				
ABX with nonwords: test condition	ER	2 (14)	30 (46)	27 (45)
ABX with words: test condition	ER	3 (16)	31 (46)	32 (47)
Production				
Rating: palatalized consonants	ER	0 (0)	31 (46)	42 (49)
	Score	5.94 (0.18)	4.30 (1.59)	3.77 (1.69)
Lexical encoding				
AWPM: test nonword condition	ER	3 (16)	74 (44)	82 (39)
Orthography:				
WPN: palatalized consonants	ER	0 (0)	3 (16)	6 (24)
Metalinguistic: palatalized consonants	ER	4 (20)	38 (49)	42 (50)

Note: DV = dependent variable, ER = mean error rates (in %)

The effect of syllable position was found to have a significant effect on learners' performance for the different tasks. In intervocalic position, palatalized consonants are followed by vowels, which possess additional acoustic cues in perception, facilitate production due to co-articulation effects and carry the orthographic code for palatalization. In word-final position, palatalized consonants are less perceptually salient, harder to articulate and are followed by a letter called soft sign to mark palatalization in

orthography. Learners' performance was significantly more accurate in intervocalic position than in word-final position on all the tasks, except for the metalinguistic task (Table 7.2). However, it is worth mentioning that syllable position did not have an effect on contrasts that differed in primary articulation. Word-final position posed difficulty for learners only when they had to discern the secondary feature of palatalization.

Table 7.2

Summary of results on specific conditions of tasks for each group of participants in intervocalic position and word-final position

Domains & tasks	DV	Russian	Advanced	Intermediate
		I / WF	I / WF	I / WF
Perception				
ABX with nonwords: test condition	ER	3 / 1	17 / 43	18 / 37
ABX with words: test condition	ER	3 / 3	25 / 36	27 / 37
Production				
Rating: palatalized consonants	ER	0 / 0	13 / 49	20 / 65
	Score	5.95 / 5.93	5.01 / 3.58	4.69 / 2.85
Lexical encoding				
AWPM: test nonword condition	ER	2 / 3	61 / 87	73 / 91
Orthography:				
WPN: palatalized consonants	ER	0 / 0	2 / 3	2 / 10
Metalinguistic: palatalized consonants	ER	6 / 2	47 / 28	53 / 32

Note: DV = dependent variable, ER = mean error rates in (%), I = intervocalic, WF = word-final

Learner proficiency was significant only on the rating and AWPM tasks and even then the difference was not very large. The fact that advanced learners did not show notable progress in their acquisition of palatalization in comparison to intermediate learners suggests that this secondary feature of articulation is indeed extremely challenging and is not likely to be fully acquired implicitly through exposure and language practice alone. Intermediate learners performed similarly to advanced learners

on the ABX tasks, written picture-naming task and metalinguistic task. However, the two groups of learners were qualitatively different from each other in a number of ways. Intermediate learners were recruited from levels 3-5, whereas advanced learners were enrolled in levels 7-9 of an intensive summer Russian program that offers instruction at nine levels. (Level nine is characterized as sixth-year Russian.) Enrollment in levels was based on the results of an in-house placement test and previous experience with the language. Intermediate learners had a maximum length of Russian instruction of three years, whereas advanced learners had studied Russian for at least four years (see Section 4.2.1 for more details). On the other hand, it might be the case that despite all these differences between the two groups of learners, they remained quite comparable. Perhaps, only long-term experience with the language via immersion and prolonged length of residence in a Russian-speaking country can lead to mastery of palatalization (e.g., Flege & MacKay, 2004; Flege, MacKay & Meador, 1999). Even though five intermediate learners and seven advanced learners reported having received instruction in Russian pronunciation, little is known about the quality and length of that instruction. Moreover, learners' performance on the metalinguistic task with an accuracy rate of only about 60% on palatalized consonants shows how unstable their knowledge of palatalization was. Section 7.3 will discuss what kind of pronunciation instruction might be beneficial to foster learners' acquisition of palatalization.

7.2. Conclusions: relationships between perception, production, lexical encoding and orthography

This dissertation examined not only how American learners of Russian perform in different domains of phonological development when acquiring palatalization but also the interfaces that exist between these domains. Analyses of individual data were especially helpful in identifying relationships that did not reveal themselves in general trends.

With respect to the most commonly researched link between perception and production, this dissertation revealed that, at least for the learners in the current study, perception skills developed prior to production in the acquisition of palatalization. From the current dataset, it seems that it took more time for our learners to reach a similar (arbitrary) accuracy level in production than in perception. Despite their differences in language experience and instruction, intermediate and advanced learners demonstrated almost identical results on both ABX tasks. It seems that learners' perception somewhat plateaued at a certain level, since even in the salient intervocalic position their error rates did not approach those of Russian native speakers. Moreover, there was not a single learner out of 40 tested in the study who was able to discriminate plain and palatalized consonants with an error rate below 13%. However, intermediate and advanced learners differed significantly in their performance on the production task. Advanced learners received higher ratings and made fewer categorization mistakes. As a general trend, learners who evidenced more accurate perception were also likely to have more accurate production. But there were also advanced learners with identical levels of perception skills (e.g., error rates around 20%) who had a wide range of production skills (e.g., error rates ranged from 7% to 43%). The scenario whereby production surpasses perception

was not characteristic of this data set, but there were two advanced learners who had very low error rates on the rating task (13%) and above average error rates on the ABX task with words (around 35%). Bohn & Flege (1997) note that at later stages of acquisition production can surpass perception due to social pressure. Indeed, these two learners were prospective Russian teachers and most likely they were quite motivated to improve their pronunciation (see Sections 4.4.2.1 and 6.4.2.3 for a more detailed description of this case study).

Individual data of learners with the highest rating scores for their production of palatalized consonants revealed a strong association between learners' production skills and their metalinguistic knowledge. It is necessary to clarify that in this dissertation metalinguistic knowledge means knowledge of grapheme-phoneme correspondences. Learners' ability to spell words correctly does not necessarily mean that they are familiar with the phonemes that these graphemes represent in the language. So, learners with solid metalinguistic knowledge, regardless of their perceptual abilities, received consistently higher scores on the rating task. This relationship could suggest that metalinguistic knowledge can guide learners to more accurate articulation by alerting them when to produce palatalized consonants – despite the limitations of correlational studies for a causal or a directional effect. On the other hand, learners with higher error rates on the metalinguistic task (above 20%) or those who fell into the spelling trap did not tend to receive high rating scores ($M = 61\%$) for their production of palatalized consonants, especially in word-final position.

So far, it can be concluded that learners with relatively accurate production are more likely to have relatively stable perceptual abilities, as well as solid metalinguistic

knowledge. To the best of our knowledge, the question of whether accurate production implies accurate lexical encoding has not been raised in the previous literature. This dissertation investigated the link between lexical encoding and production and determined that overall, learners who performed better on the AWPM task were also more accurate at producing the plain / palatalized contrast. However, accurate lexical encoding did not seem to be a prerequisite for accurate production. Learners with extremely high error rates on the AWPM task (above 70%) also received some of the highest rating scores (above 80%) for their production of palatalization. Again, it is possible to speculate that what might have guided these learners to accurate production in the absence of accurate lexical encoding and most often insufficient perceptual support was their very solid metalinguistic knowledge.

In general, learners' performance on the AWPM task was extremely inaccurate with very high error rates in the test nonword condition where learners accepted more than two thirds of nonwords as correct productions of target words. Thirty-five learners out of 40 had an error rate above 70%. One of the most obvious explanations is that learners were not able to hear the difference between plain and palatalized consonants. Indeed learners with the highest error rates on the ABX tasks also had the highest error rates on the AWPM task. However, there were a couple of advanced learners who had relatively low error rates on the ABX with words (around 20%) but error rates above 70% on the AWPM task using the same words. Surprisingly, one of these learners had an error rate of 0% on the metalinguistic task, which means that he was aware of the presence of palatalized consonants in the target words and could somewhat reliably perceive the difference between plain and palatalized counterparts. The explanation that

was provided in Section 5.4.2.1 discusses the possibility of learners' treating palatalized consonants as free variants. But there is another explanation that can be considered here. Ganong (1980) investigated the interaction between perception and the mental lexicon and found that the lexical status of a word affects phonetic categorization much more for acoustically ambiguous stimuli than for acoustically unambiguous stimuli. When participants in Ganong's study were presented with the stimuli of the acoustic continua 'dask - task', the lexical effect was stronger at the phoneme boundary than at the endpoints of the continua. When listeners received input (e.g., 'task'- real word or 'dask' - nonword) with an ambiguous initial consonant, the lexical entry 'task' got activated. It fed activation back to the phonemic level, which in turn increased the activation of the phoneme /t/ over /d/, since 'task' was a real word and 'dask' was not. As a result, the ambiguity was resolved in favor of a real word over a nonword. Basically, this reflects the mechanism of the *Trace Model* of word recognition (see Section 2.2.1). Since the perceptual difference between plain and palatalized consonants was not very salient to our participants, especially in word-final position, and no minimal pairs were used in the study, learners accepted most nonwords that differed in the secondary articulation of palatalization as possible productions of target words. In control trials, the Ganong effect was not observed because the difference between words and nonwords, which differed in the primary articulation, was not acoustically ambiguous for learners. Thus, insufficient perceptual sensitivity to the plain / palatalized contrast together with imprecise lexical representations and the Ganong effect might have contributed to extremely high error rates in the test condition on the AWPM task.

A scenario in which a learner was able to encode the plain / palatalized contrast

lexically without being able to perceive it was not sustained by this data. The proponents of the 'lexicon first' approach, supported by the Direct Mapping from Acoustics to Phonology model (Darcy et al., 2012) suggest that the lexical encoding of contrasts can precede phonetic category formation if learners use other resources, such as orthography or metalinguistic representations, to establish a lexical contrast. In this dissertation, no clear link was found between learners' orthographic and metalinguistic knowledge on the one hand and accurate lexical encoding on the other hand. Very large error rates on the AWPM task (78%), extremely low error rates on the written-picture matching task (4%) and relatively low error rates on the metalinguistic task (25%) suggest that if there is such a link, the effects of knowing the orthography are not spontaneous and immediate. Even learners with perfect metalinguistic knowledge had an error rate above 50% on the AWPM task. This might be a consequence of ignoring orthographic information combined with perceptual difficulties discerning the plain / palatalized contrasts in the early stages of acquisition. As a result, even though learners now possess the necessary orthographic and metalinguistic knowledge and can even perceive the contrast to some degree, the updating of lexical representations may take a substantial amount of time, perhaps until their perception becomes more reliable.

Orthography was not found to be closely related to learners' perceptual abilities either. The correlational analysis revealed a moderate relationship only for advanced learners. Individual data suggests that metalinguistic knowledge served to reinforce the distinction that the learners were already able to perceive. Learners with the lowest error rates (below 10%) on the metalinguistic task still had a mean error rate of 28% on the ABX with words, which was almost the same as the mean group error rate of 31% (Table

7.1).

Concluding, learners' ability to perceive plain and palatalized consonants seems to have the greatest influence on how they progress in their acquisition of the contrast. Failure to reliably discriminate the contrast perceptually likely affects whether learners are able to produce palatalized consonants accurately in speech and encode words with this contrast separately. Metalinguistic knowledge, or knowledge of phoneme-grapheme correspondences, is not enough to enhance perceptual sensitivity and guarantee accurate lexical encoding in the absence of perceptual support. However, metalinguistic knowledge seems to be useful in helping learners develop accurate production of palatalized consonants, even when learners are not able to perceive or encode them. Consequently, hearing learners, who can masterfully articulate palatalized consonants in Russian, does not mean that these learners indeed have fully acquired palatalization, i.e. can perceive the plain / palatalized contrast and encode words with it.

7.3. From research to teaching: pedagogical implications

The findings of this dissertation can offer pedagogical implications to teaching palatalization to American English learners of Russian. First of all, perceptual training should be an indispensable component of the Russian Pronunciation curriculum. Previous studies have found that perceptual training in the L2 benefits not only perception but also production (Bradlow et al., 1999; Thomson, 2011; Wang et al., 2003). Performance of American English learners of Russian on various tasks in this dissertation suggests that a lack of perceptual sensitivity to the plain / palatalized contrast affects not only learners' production but also their lexical encoding. Therefore, perceptual training offered to

learners of Russian should employ a high-variability approach with samples from multiple talkers and target consonants embedded in various prosodic environments. Real words that learners encounter on a regular basis rather than nonwords should be used in this training in order to improve their lexical encoding. It would also help learners, who initially encoded words with plain / palatalized consonants inaccurately, to recover from these mis-encodings by updating their lexical representations of these words with time and sufficient diverse input. Another important component that should be included to improve perceptual abilities is the development of self-perception. Baker and Trofimovich (2006) claim that self-perception could be a necessary link between perception and production, especially in situations when production skills surpass perception abilities. Learners, who cannot yet perceive the contrast in the speech of other people but can hear the perceptual difference in their own production of this contrast, are more likely to have better pronunciation and in the long run more accurately perceive problematic categories.

Articulatory training is an obligatory building block of pronunciation instruction. For American English learners acquiring the distinction between plain and palatalized consonants in L2 Russian, it should be context-dependent and concentrate on the description and acquisition of gestures necessary for the production of palatalization. The results of this dissertation showed that palatalized consonants in word-final position were extremely challenging to articulate accurately even for very proficient learners of Russian. In intervocalic position, the presence of the following vowels allowed for a more accurate production of palatalization due to co-articulation effects. However, even then both intermediate and advanced learners were significantly different from the

Russian native speakers. Using electropalatographic and acoustic analyses, Hacking et al. (2016) found that American English learners produce palatalized consonants as plain because they do not realize the most important gestures for the production of palatalization, i.e. bunching up the tongue and moving it towards the hard palate. Learners should be aware of these important gestures and be able to combine them with the primary articulations of palatalized consonants. It can be achieved as a result of intensive articulatory practice and, most importantly, accompanying explicit feedback from the instructor. In a study by Saito & Lyster (2012), Japanese learners of English, who received corrective feedback in the form of recasts, improved significantly in their production of English /l/ and /ɭ/, a contrast that is notoriously difficult for Japanese native speakers. Moreover, their production of the contrast improved not only only at a controlled-speech level, but also generalized to spontaneous speech, regardless of the following vowel contexts. The other group of Japanese learners of English, who were only exposed to form-focused instruction explaining the difference between English /l/ and /ɭ/ without providing corrective feedback on learners' production of the contrast, behaved similarly to learners in the control group.

Finally, American English learners of Russian should have a clear understanding of the differences between plain and palatalized consonants and their representations in orthography. Developing solid metalinguistic and orthographic knowledge of palatalization can help learners in improving their production, especially if they have persistent difficulties discriminating the plain / palatalized contrast perceptually. It can also make them realize that plain and palatalized consonants are not free variants but

rather separate phonemes and despite having very subtle perceptual differences they should be encoded separately in the mental lexicon.

7.4. Future directions for research

This dissertation can serve as a springboard for future research on the acquisition of palatalization in L2 Russian. Since American English learners' performance on the lexical encoding of the plain / palatalized contrast was the least accurate, with extremely high error rates, it would be worthwhile to continue investigating this domain. For example, one of the key findings of this dissertation was that advanced learners with excellent metalinguistic knowledge and relatively good perceptual abilities still accepted test nonwords as possible productions of highly familiar words. Learners might have encoded the words incorrectly at the initial stages of acquisition when they still lacked the necessary perceptual and metalinguistic expertise and never subsequently updated their incorrect lexical representations. Future research might uncover whether learners at later stages of acquisition can correctly encode novel words with palatalized consonants and whether this process is easier than updating the "entrenched" forms of familiar words.

Another avenue of research might investigate word processing and how learners access words with plain and palatalized consonants. In this dissertation, advanced learners rejected test nonwords with palatalized consonants (non-dominant category) more often and faster (although the difference in reaction times was not significant) than test nonwords with plain consonants (dominant category) in intervocalic position but not in word-final position. Adding a different method, such as a repetition-priming paradigm or an eye-tracking experiment, would triangulate the results of this dissertation. It would

also provide a deeper understanding of why learners' behavior differs on plain and palatalized consonants in two syllable positions and whether learners indeed rely on subsequent vowels rather than consonants to encode the difference between words with plain and palatalized consonants in intervocalic position.

Future research into the effectiveness of pronunciation instruction would be especially beneficial for teachers and L2 learners of Russian. It would help determine what kind of intervention is necessary to eliminate incorrectly or incompletely acquired palatalized consonants and whether gains in one domain, e.g., perceptual training on the plain / palatalized contrast, might transfer to the other domains, e.g., production and lexical encoding. It would also be compelling to compare the performance of learners who come from a native language without palatalization, such as English, to learners, whose native language employs palatalization to a certain extent, e.g., Spanish. The current dissertation used correlational evidence to explore the presence of relationships between these domains but it is critical to examine these questions with other methods that are more suited to explore causal and directional relationships.

This dissertation contributes to existing knowledge in the field by taking an innovative approach to investigating the relationships between the four major domains of phonological development in the acquisition of the secondary feature of articulation. Importantly, these domains were explored using the same set of familiar words with two proficiency groups of learners. This dissertation has explored the interfaces of perception, production, lexical encoding and orthography and determined the possible routes of acquisition using not only group data but also referring to individual case studies to account for specific interactions and scenarios. It also laid the groundwork for future

research on the relationships between the four major domains using other linguistic phenomena as well as for further investigation of the acquisition of palatalization in L2 Russian with other research designs, populations and linguistic materials.

Chapter 8. References

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Appendix A

Experimental stimuli and pictures

Table A1

Real words with underlined target consonants and matching pictures

Position	Conso nant	Spelling	IPA	Translation	Picture
Word-final: VC / VC ^j	t	<салат>	/salát/	‘salad’	 СА _____
	tʃ	<спать>	/spatʃ/	‘to sleep’	 СП _____
	s	<адрес>	/ádrʲes/	‘address’	 АД _____
	sʲ	<здесь>	/zdʲesʲ/	‘here’	 ЗД _____
	n	<экзамен>	/ekzámʲen/	‘exam’	 ЭК _____
	nʲ	<осень>	/ósʲenʲ/	‘fall’	 ОС _____

	l	<стол>	/stol/	'table'	
					СТ_____
	lj	<соль>	/solj/	'salt'	
					СО_____
	r	<сахар>	/sáxar/	'sugar'	
					СА_____
	rj	<словарь>	/slovárj/	'dictionary'	
					СЛ_____
Intervocalic: VCV / VCV	t	<газета>	/gaziéta/	'newspaper'	
					ГА_____
	tj	<тётя>	/tjótja/	'aunt'	
					ТЁ_____
	s	<писать>	/p'isátj/	'to write'	
					ПИ_____
	sj	<тысяча>	/tj'sjatja/	'thousand'	1000
					ТЫ_____

n

<жена>

/zɛná/

‘wife’



ЖЕ _____

nʲ

<таня>

/tánʲa/

‘Tanya’
(female
name)



ТА _____

l

<холодный>

/xolódnij/

‘cold’



ХО _____

lʲ

<зелёный>

/zʲelʲónij/

‘green’



ЗЕ _____

r

<серый>

/sʲerʲij/

‘grey’



СЕ _____

rʲ

<курица>

/kúʲitsa/







‘chicken’



КУ _____

Table A2

Fillers and matching pictures

Spelling	IPA	Translation	Picture
<дом>	/dom/	'house'	 ДО _____
<там>	/tam/	'there'	 ТА _____
<зима>	/z'ímá/	'winter'	 ЗИ _____
<читать>	/tʃítátʲ/	'read'	 ЧИ _____
<десять>	/d'ies'jati/	'ten'	10 ДЕ _____
<миша>	/m'íʃa/	'Misha (male name)'	 МИ _____
<сок>	/sok/	'juice'	 СО _____

<торт>

/tort/

'cake'



ТО _____

<сумка>

/súmka/

'purse'



СУ _____

<красный>

/krásnij/

'red'



КР _____

Appendix B


Instructions

Dear participant!

Thank you for agreeing to participate in this experiment!
You will be asked to do a series of exercises to test your knowledge of Russian words.

In **exercise 1A** you will see a picture and hear a word. The first two letters of the word will be provided. Remember what word is used to describe the picture. The presentation is timed. You will see each picture for 3 seconds. Each picture will be presented 2 times in a random order.

Press the **Spacebar** to start



CY _____

Figure B1. Instructions for the familiarization task (screenshot).

Dear participant!

In **exercise 1B**, you will see the same pictures but now you have to say the words that match the pictures. You will have 4 seconds to do that. If you stumble in the middle of the word, please, repeat the word again. You will see each picture 2 times.

Press the **Spacebar** to start

Figure B2. Instructions for the oral picture-naming task (screenshot).

Dear participant!

In **exercise 2A** you will see the same pictures but now you have to write the words that match the pictures. The first two letters are provided on the answer sheet. The presentation is self-paced.

Figure B3. Instructions for the written picture-naming task (screenshot).

Exercise 3

You will see a picture and hear a word.
You have to decide
whether the pronunciation of the word you hear is correct.

If you think that the pronunciation of the word is correct, press
the **LEFT** button **DA**.

If you think that the pronunciation of the word is incorrect,
press the **RIGHT** button **HET**.

Respond as quickly as possible

At first you will have 4 trials for **PRACTICE**

Press the **SPACEBAR** to start.

Figure B4. Instructions for the auditory word-picture matching task (screenshot).

Exercise 4A

You will hear three non-words.
You have to decide whether the last word you hear
is similar to the first or the second word.

If you think that the third word is similar to the first word,
press the **LEFT** button **1**.

If you think that the third word is similar to the second word,
press the **RIGHT** button **2**.

Respond as quickly as possible
At first you will have 4 trials for **PRACTICE**

Press the **SPACEBAR** to start.

Figure B5. Instructions for the ABX with nonwords (screenshot).

Exercise 4B

You will hear three words.
You have to decide whether the last word you hear
is similar to the first or the second word.

If you think that the third word is similar to the first word,
press the **LEFT** button **1**.

If you think that the third word is similar to the second word,
press the **RIGHT** button **2**.

Respond as quickly as possible
At first you will have 4 trials for **PRACTICE**

Press the **SPACEBAR** to start.

Figure B6. Instructions for the ABX with words (screenshot).

How well do you know these words? Provide the English translation for each word and indicate your familiarity with these words. Check one box only for each word.

	English Translation	I have seen it, I know it, I can use it	I saw it, I don't know it	I never saw it, I don't know it
сахар				
торт				
здесь				
стол				
зима				
курица				
десять				
холодный				
спать				
экзамен				
тысяча				
там				
жена				
серый				
осень				
словарь				
красный				
Миша				
соль				
адрес				
сумка				
писать				
читать				
тётя				
зелёный				
салат				
газета				
Таня				
сок				
дом				

Figure B7. Instructions for the lexical familiarity task for American English learners.

Эти слова знакомы вам?								
	очень знакомы			→				незнакомы
	7	6	5	4	3	2	1	
сахар								
торт								
здесь								
стол								
зима								
курица								
десять								
холодный								
спать								
экзамен								
тысяча								
там								
жена								
серый								
осень								
словарь								
красный								
Миша								
соль								
адрес								
сумка								
писать								
читать								
тётя								
зелёный								
салат								
газета								
Таня								
сок								
дом								

Figure B8. Instructions for the lexical familiarity task for Russian native speakers.

ИНСТРУКЦИЯ

Дорогие эксперты!

Внимательно прочитайте инструкцию. Удостоверьтесь, что Вы находитесь в тихой комнате. Желательно выполнять это задание в наушниках. Послушайте слова и оцените, насколько **мягко или твёрдо** участники произносят определённые согласные в словах.

Всего Вы услышите около 1000 слов, которые будут поделены на **4 блока**:

1. Твёрдые согласные в конце слова (салат, адрес, экзамен, стол, сахар)
2. Мягкие согласные в конце слова (спать, здесь, осень, соль, словарь)
3. Твёрдые согласные в середине слова (газета, писать, жена, холодный, серый)
4. Мягкие согласные в середине слова (тётя, тысяча, тая, зелёный, курица)

Сконцентрируйте Ваше внимание только на согласном, выделенном красным цветом. Не обращайте внимание на неточности в словесном ударении и произношении других звуков. Если произнесённое слово отличается от того, которое у Вас в списке, например, “холодно” вместо “холодный”, не обращайте на это внимание. Вы оцениваете только твёрдость или мягкость согласного, выделенного красным цветом.

У Вас будет 5 секунд, чтобы оценить каждый согласный. Вы можете останавливать презентацию, если хотите послушать слово ещё раз. Рекомендую не останавливать, чтобы это задание не заняло слишком много Вашего ценного времени. Останавливайте запись в том случае, если Вы отвлеклись или не расслышали слово.

Всего Вы прослушаете 20 аудиофайлов, каждый из которых содержит около 50 слов. Все слова в одном файле одинаковые, например, “салат”.

Оцените мягкость и твёрдость согласных, **выделенных красным цветом**, используя шкалу от 1 до 6:

- 1 – отличный твёрдый согласный
- 2 – средний твёрдый согласный
- 3 – плохой твёрдый согласный (скорее мягкий согласный)
- 4 – плохой мягкий согласный (скорее твёрдый согласный)
- 5 – средний мягкий согласный
- 6 – отличный мягкий согласный

БОЛЬШОЕ СПАСИБО!

Figure B9. Instructions for raters in the rating task.

Appendix C

Language background questionnaire

(This information will remain confidential)

A. Personal information

1. Sex: ___M ___F
2. Age: _____
3. Country & city of birth: _____
4. Native language(s): _____
5. Student: ___Graduate ___Undergraduate Other _____
6. Major: _____
7. Are you left or right-handed? ___Left ___Right
8. Have you ever had any kind of a speech or hearing disorder? ___Yes ___No
If "Yes", please explain: _____
9. Do you take part in any musical activities? ___Yes ___No
If "Yes", please explain (e.g. play an instrument, sing in a choir): _____

B. First language(s)

1. What is the native language of your:
mother? _____ father? _____
2. Did you learn your native language from birth? ___Yes ___No
If "No," please explain: _____
3. What language(s) did you speak at home as a child? _____
4. Are you most comfortable speaking your native language? ___Yes ___No
If "No," please explain: _____

For non-native speakers of English only:

5. What is your age of arrival in the US? _____
6. How many years and months have you lived in the US? _____

C. Education and language use

1. What language(s) do you use...
At home? _____ At work? _____
At social events? _____

2. Did you receive formal education in countries other than the US? ___ Yes ___ No
 If “Yes”, in what language(s) were you educated and where (what country)?

Elementary/Middle school: *Language* _____ *Country* _____

High School: *Language* _____ *Country* _____

College: *Language* _____ *Country* _____

D. Second languages

If you speak languages other than your native language, indicate the level of competence you have for each of the languages you speak. ***Start with the language that you know best.***

LANGUAGES	English	Russian			
How did you learn these languages? (check all that apply)					
<i>At home</i>					
<i>At school</i>					
<i>At a language school</i>					
<i>At the university</i>					
<i>Living in the country</i>					
<i>Other (please specify)</i>					
Estimate your ability to speak this language spontaneously (none 1 2 3 4 5 6 7 8 9 10 perfectly)					
Estimate your ability to understand this language (none 1 2 3 4 5 6 7 8 9 10 perfectly)					
Estimate your ability to read this language (none 1 2 3 4 5 6 7 8 9 10 perfectly)					
Estimate your ability to write this language (none 1 2 3 4 5 6 7 8 9 10 perfectly)					
First exposure to this language, i.e. when did you hear it for the first time? (age)					
First use of this language, i.e. when did you start to speak it? (age)					

For learners of Russian only:

1. Have you ever been to a Russian-speaking country? ___ Yes ___ No

If “Yes”, when and where did you go and how long did you stay there?

Country _____ Year _____

Duration of your visit (years, months or weeks) _____

2. Have you ever taken a course in Russian Phonetics? ___ Yes ___ No

If “Yes”, when and where did you take it?

Country/University _____ Year _____

Appendix D

Individual results of American English learners

ID	Group	ABX nonwords	ABX words	Ratings	Cumulative rating score	AWPM (nonword condition)	Written picture-naming	Metalinguistic
1	I	25	34	50	59	85	10	25
2	I	38	43	47	63	80	10	40
4	I	30	33	47	47	95	5	30
5	I	30	35	57	56	95	5	15
7	I	25	36	47	61	85	0	25
9	I	13	26	30	71	70	0	10
12	I	30	31	27	74	75	0	15
13	I	18	31	47	62	70	5	5
14	I	28	33	10	88	50	0	0
15	I	23	29	53	56	85	0	20
16	I	53	31	60	54	85	0	50
17	I	30	26	33	68	75	5	35
18	I	28	25	17	65	90	5	20
19	A	33	35	13	84	70	5	5
20	A	18	24	17	86	55	0	0
21	A	40	49	47	60	90	10	50
22	A	45	29	47	58	75	10	45
27	A	38	36	43	48	75	5	45
29	A	23	25	30	74	75	5	30
30	I	15	33	47	38	95	5	35
31	A	28	28	37	70	75	5	35
32	A	45	34	13	81	90	0	45
33	A	35	38	37	64	90	0	5
34	A	15	20	7	89	70	0	0
35	I	18	21	43	61	70	10	20
36	I	35	34	43	63	90	5	40
40	A	25	39	40	63	70	5	35
41	I	18	34	47	63	75	5	15
45	I	28	45	40	64	85	5	45
46	I	23	21	40	63	85	5	30
47	A	18	29	27	73	80	0	10
48	A	23	29	13	81	65	0	0
49	A	38	25	20	79	80	0	15
50	I	43	41	43	56	90	0	15
51	A	15	13	13	87	35	5	10
52	A	43	38	57	55	75	5	45

53	A	30	34	50	57	85	10	35
54	A	23	18	10	88	65	0	20
55	A	28	26	37	71	70	5	35
56	A	43	45	57	57	85	5	20

Note: All numbers in the table are in % and represent error rates, except for *Cumulative rating score*. In the *Group* column, I = intermediate and A = advanced.

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MA, Teaching English as a Second Language August 2008 – May 2010
Department of English
Saint Cloud State University, Saint Cloud, Minnesota, USA

BA, Modern Foreign Languages September 1998 – June 2003
Department of English
Minsk State Linguistics University, Minsk, Belarus

TEACHING EXPERIENCE

Associate Instructor

Indiana University, Bloomington, Indiana
Department of Slavic Languages and Literatures

Taught the following courses:

- Elementary Russian SLAV-R101. Fall 2011, 2012, 2014.
- Elementary Russian SLAV-R102. Spring 2011, 2013, 2015.

Russian Instructor

Indiana University, Bloomington, Indiana
Summer Language Workshop (SWSEEL)

Designed and taught the following courses:

- Russian Phonetics (Levels 1 – 9). Summer 2013, 2014, 2015, 2016.
- Video Lab / Listening (Levels 2 – 8). Summer 2011, 2012.

Teaching Assistant

Saint Cloud State University, Saint Cloud, Minnesota
Intensive English Center

Designed and taught the following English courses (listed by language skills):

- Conversation (Pre-Level 1). Summer 2009.
- Conversation (Level 1). Summer 2009.
- Reading (Level 1). Summer 2009.

- Reading (Level 4). Fall 2008, Spring 2009, Summer 2010.
- Reading (Level 5). Fall 2009.
- Listening & Note-taking (Level 4). Fall 2009.
- Listening & Note-taking (Level 5). Spring 2010.
- Vocabulary (Level 3). Fall 2008, Spring 2010, Summer 2010.
- Vocabulary (Level 4). Fall 2008, Spring 2009.
- Structure (Level 3). Spring 2010, Summer 2009.
- Academic Skills (Level 4). Summer 2010.

Lecturer

Belarusian State University, Minsk, Belarus

School of International Relations

Department of English for the Humanities

Designed and taught the following courses:

- First-year English (Reading, Speaking, Listening). Fall 2005, Spring 2006, Spring 2007.
- Second-year English (Speaking, Listening, Writing). Fall 2007, Spring 2008.
- Third-year English. Fall 2006.
- Fourth-year English. Fall 2006.
- English for Specific Purposes (International Relations). Fall 2005.
- British Country Studies (Geography, History, Culture). Spring 2006, Spring 2007.
- American Country Studies (Geography, History, Culture). Fall 2007, Spring 2008.

English Teacher

Secondary School #166 (with intensive foreign language instruction), Minsk, Belarus

Taught the following courses:

- General English (Grades 8 – 11). Fall 2002 – Spring 2005.
- British & American Country Studies (Grade 11). Spring 2004, 2005.

PEER-REVIEWED CONFERENCE PRESENTATIONS

Simonchyk, A., & Darcy, I. (August, 2016). *Lexical encoding and perception of palatalized consonants in L2 Russian*. Paper presented at the 8th Annual Pronunciation in Second Language Learning and Teaching Conference, Calgary, Canada.

Simonchyk, A., & Darcy, I. (April, 2016). *The effect of orthography on the lexical encoding of palatalized consonants in L2 Russian*. Paper presented at the Sound to Word in Bilingual and Second Language Speech Perception Conference, Iowa City, Iowa.

Simonchyk, A., & Darcy, I. (September, 2014). *Acquisition of word-final devoicing by American learners of Russian*. Poster presented at the 6th Annual Pronunciation in Second Language Learning and Teaching Conference, Santa Barbara, California.

Simonchyk, A. (April, 2014). *Teaching Russian pronunciation through communication*. Paper presented at the 67th Annual KFLC: The Languages, Literatures and Cultures Conference, Lexington, Kentucky.

Simonchyk, A. (March, 2014). *Acquisition of word-final voicing in American English by native speakers of Russian*. Paper presented at the Midwest Slavic Conference, Columbus, Ohio.

Simonchyk, A. (April, 2013). *Phonological analysis of Belarusian-accented English: an overview of contributing factors*. Paper presented at the Midwest Slavic Conference, Columbus, Ohio.

INVITED TALKS

Simonchyk, A. (July, 2015). *A first look at the acquisition of palatalization in Russian*. Paper presented at the Summer Language Workshop, Indiana University, Bloomington, Indiana.

Simonchyk, A. (July, 2013). *Belarus - the land under white wings*. Paper presented at the Summer Language Workshop, Indiana University, Bloomington, Indiana.

PUBLICATIONS

Simonchyk, A., & Darcy, I. (2016). *The effect of orthography on the lexical encoding of palatalized consonants in L2 Russian*. Manuscript submitted for publication on December 1, 2016.

Simonchyk, A., & Darcy, I. (2016). *Lexical encoding and perception of palatalized consonants in L2 Russian*. Manuscript submitted for publication on November 15, 2016.

Simonchyk, A. (2017). Acquisition of the feature [+voice] in word-final position by native speakers of Russian. *IULC Working Papers, 17*, 1-27.

Simonchyk, A., & Darcy, I. (2015). Acquisition of word-final devoicing by American learners of Russian. In J. Levis, R. Mohamed, M. Qian & Z. Zhou (Eds.), *Proceedings of the 6th Pronunciation in Second Language Learning and Teaching Conference* (ISSN 2380-9566), Santa Barbara, CA (pp. 85-94). Ames, IA: Iowa State University.

Simonchyk, A. (2010). *Phonological analysis of Belarusian-accented English: An overview of contributing factors* (Unpublished master's thesis). St. Cloud State University, St. Cloud, MN.

Simonchyk, A. I. (2008). National symbols. Public holidays. In A. I. Simonchyk (Ed.), *British Studies. Part II: Customs, Traditions and Holidays* (pp. 4-29). Minsk: Belarusian State University.

Simonchyk, A. I. (2008). The late Middle Ages. The Tudors. National symbols. Public holidays. In I. V. Krivko (Ed.), *Keys to the textbooks British Studies* (pp. 7-10, 21-25). Minsk: Belarusian State University.

Simonchyk, A. I. (2007). The late Middle Ages. The Tudors. In S. A. Zudova (Ed.), *British Studies. Part I: History* (pp. 19-32). Minsk: Belarusian State University.

PROFESSIONAL EXPERINCE

Reviewer for the PSLLT 2016 Proceedings January – February 2017

ACTFL OPI tester of Russian with full certification valid March 2014 – March 2018

Coordinator of the Slavic Symposium February 2014 – May 2015
Department of Slavic and East European Languages and Cultures
Indiana University, Bloomington, Indiana

Research assistant to Dr. Maria Shardakova Fall 2013 – Spring 2014
Department of Slavic and East European Languages and Cultures
Indiana University, Bloomington, Indiana

Chair of the curriculum committee for program accreditation
Intensive English Center January 2009 – May 2010
Saint Cloud State University, Saint Cloud, Minnesota

Secretary & departmental liaison to the university library
Department of English for the Humanities September 2007 – August 2008
School of International Relations
Belarusian State University, Minsk, Belarus

LEADERSHIP / SERVICE

GPSO Representative September 2014 – May 2015
Diversity Committee
Graduate and Professional Student Organization
Indiana University, Bloomington, Indiana

Graduate Student Representative January 2014 – May 2015
Department of Slavic and East European Languages and Cultures Indiana
University, Bloomington, Indiana

President and founder September 2008 – May 2010
Russian Club PRIVET!
Saint Cloud State University, Saint Cloud, Minnesota

AWARDS, FELLOWSHIPS & SCHOLARSHIPS

- Neatrou-Edgerton Fellowship** Fall 2016
Department of Slavic and East European Languages and Cultures,
Indiana University, Bloomington, Indiana
- REEI Mellon Endowment Student Grant-in-Aid of Travel** May 2016
Russian & East European Institute
Indiana University, Bloomington, Indiana
- Spring College of Arts and Sciences Travel Award** April, 2016
College of Arts and Sciences
Indiana University, Bloomington, Indiana
- REEI Mellon Endowment Student Grant-in-Aid of Research** November 2015
Russian & East European Institute
Indiana University, Bloomington, Indiana
- Conference Travel Award** Spring 2015
Department of Slavic and East European Languages and Cultures
Indiana University, Bloomington, Indiana
- REEI Mellon Endowment Student Grant-in-Aid of Travel** Spring 2014
Russian & East European Institute
Indiana University, Bloomington, Indiana
- IU Graduate Fellowship for New Incoming Students** Fall 2010, Spring 2012
Department of Slavic and East European Languages and Cultures
Indiana University, Bloomington, Indiana
- Elizabeth Cully Scholarship** May 2009
Department of English
Saint Cloud State University, Saint Cloud, Minnesota

PROFESSIONAL AFFILIATIONS

- Second Language Psycholinguistics Lab at Indiana University Fall 2013 – present
- American Council on the Teaching of Foreign Languages Spring 2013 – present
- Golden Key International Honor Society January 2010 – present

LANGUAGES

- Native: Russian
- Near-native: English, Belarusian
- Low-intermediate: German
- Elementary: Arabic, Croatian, French, Polish