LEARNING OUTCOMES FOR LARGE VERSUS SMALL GRAIN ORTHOGRAPHIC INSTRUCTION IN ADULT L2 LEARNERS OF RUSSIAN CYRILLIC

by

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Abstract

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Learning outcomes for large versus small grain orthographic instruction in adult L2 learners of Russian Cyrillic

Thesis directed by Assistant Professor Christine Brennan

The process of learning a second language includes the acquisition of literacy skills. Currently, there is no standardized practice for teaching a new orthography, though research suggests that there are clear differences between languages with different orthographic depth, and the corresponding grain sizes that evolve as cognitive strategies. This study investigated the effects of two different instruction methods on reading outcomes for adult L2 learners of Russian. This study extends research done by Brennan & Booth (2015), which trained adults to read an artificial orthography. Here, we trained 34 literate English-speaking adults on Russian Cyrillic orthography with initial instruction that directed attention either to large or small grain size units (i.e., words or letters). After controlling for overall phonological skills, we found that small grain instruction resulted in higher accuracy for letter-phoneme matching, while large grain instruction led to greater accuracy with reading whole words in rime-rhyme foil trials. Additionally, differences among individual learners affected outcomes, as those in the large grain group who displayed greater phonemic skills also had slower reaction times. This same effect was not found for the small grain group, suggesting that these particular learners continued to apply small grain analysis even when large grains would have resulted in faster

times. Overall, these results show that when adults are learning to read a second orthography, both large and small grain instruction can be beneficial in facilitating the development of accurate and efficient reading ability, thereby allowing the learner to use literacy as a scaffold for oral language development including vocabulary growth and increased grammar knowledge in order to improve L2 proficiency.

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I. Review of Literature

Acquiring a second language (L2) is a valuable skill in a hyper-connected global community, and there are many languages that are desirable to learn based on their significant presence in the international dialogue. One such language is Russian, which is becoming increasingly relevant to the English-speaking world. From a socio-political standpoint, Russia frequently dominates foreign policy efforts, news stories, and cultural mythos in the United States. Consequently, Russian is viewed as a critical language by the US State Department, and therefore more students might be choosing to study the language in the foreign language classroom. But to become a capable user of Russian or any other language, oral proficiency is not enough; a learner must become literate as well. Reading is a complex process that involves the interconnection of many different skills, including lower-level processes (e.g., word recognition) and higher-level processes (e.g., contextual understanding to support comprehension of that word). Unlike with spoken language, to learn reading, explicit instruction at some level is necessary (Adams, 1994). For most native English speakers, literacy is taught after they have learned to speak and have a good base in oral language. However, for L2 learners, this is rarely the case: in the foreign language classroom, reading is often used as a tool to grow basic language skills that are still developing across multiple domains. For example, reading passages might be used to teach new vocabulary to students, or to practice pronunciation. Therefore, learning to read efficiently and quickly is a huge benefit to learning a second language, even though current instruction practices generally do not focus on this type of training. Previous research on acquisition of second language orthographic knowledge shows different outcomes given word versus letter training. Brennan & Booth (2015) trained English-speaking adults to read an artificial orthography and found that large grain instruction resulted in higher accuracy for rime-rhyme matching and faster reaction times for reading tasks. Given the influence of semantic and syntactic knowledge, it is unknown if a comparison of similar methods were conducted with a natural orthography if similar results would be found. The current study aims to compare initial instruction that emphasizes either large or small grain size units (i.e., words or letters) for typical adults learning to read a natural second orthography, Russian Cyrillic in this case. The results of this study extend the findings of Brennan & Booth (2015) by testing if the learning outcomes discovered in the original study are consistent with a natural orthographic system. These findings will be of high interest to those teaching or learning a second orthographic system as part of L2 learning, especially those teaching or studying Russian.

One major challenge of L2 literacy acquisition is the presence of a new orthography that must first be familiarized and adopted, despite inherent inconsistencies (e.g., irregular spellings, letters having more than one pronunciation, and exceptions to established rules). Orthography as a term relates to what kind of alphabet a language uses, how words are spelled, and the degree of correspondence between letters and sounds. Alphabets are perpetually being modified over time in the name of improving reading fluency, despite a lack of a regularized process to determine how and why to choose particular design elements (Hirshorn & Fiez, 2014). Because of petrified irregularities, spelling reforms, sound shifts, splits, and mergers, not all orthographies are created equal, and this can have wide-ranging effects for individuals learning to read an L2, regardless of the quality of literacy instruction. Despite these difficulties, adults learning a new language must learn the corresponding orthography in order to be proficient, yet less is known about the efficacy and the outcomes given different instruction methods when adults are learning an L2 orthographic system.

Instruction methodology should consider the influence of orthographic depth. Written languages can be divided into two rough categories: shallow or deep orthographies. In a shallow orthography, the link between phonemes and graphemes is generally 1:1; that is, one phoneme is consistently coded as a single grapheme, with no overlap between other phonemes and graphemes. An example of an orthographically shallow language is Spanish, where written "a" is always pronounced as /a/ in all contexts and positions. On the opposite end of the spectrum, a language with a deep orthography has overlapping and inconsistent phoneme-to-grapheme correspondence. English is generally viewed as having a deep orthography, where the letter combination "ough" is pronounced differently in "through (/u/)," "thorough (/o/)," and "rough (/əf/)." The orthographic depth hypothesis (Katz & Frost, 1992) notes these discrepancies and posits that shallow vs. deep orthographies result in processing differences: shallow orthographies more easily support word recognition due to the predictable involvement of the phonological system, and deep orthographies reveal the morphology of spoken language more so than the exact pronunciation. This central dichotomy in learning to read thus begs the question of how orthography affects reading overall, which is a nuanced and understudied area of research. For reference, in the discussion that follows, the subsequent definitions will be used: a phoneme is defined as a single unit of speech sound that is combined with other speech sounds to create a word (e.g., the /s/ sound at the beginning of "sing"). A letter is a visual symbol that is combined with other visual symbols to create a written word (e.g., "i" is a letter that makes up the written word "sing"). A grapheme is a letter or combination of letters that represents a single phoneme (e.g., “ng” signifies the phoneme /ŋ/ at the end of the word “sing”). In some cases, “letter” and “grapheme” are used somewhat interchangeably, in reference to the fact that many graphemes are denoted by a single letter. The word rime refers to written rhymes (e.g., “sing” and “bring” have the same rime “-ing” for their respective endings).

Instruction for alphabetic orthographies often includes explicit alphabetic instruction involving a small-grain focus for both children learning their first orthography and for adults learning their second orthography. For children, orthographic instruction has evolved over time, resulting in inconsistencies and wide-ranging changes in reading instruction expectations. Consequently, there is no universally accepted method for teaching reading across writing systems. In English, reading is frequently taught by first learning the names of letters; however, in Spain, a focus on syllables is employed in early reading instruction (Hirshorn & Fiez, 2014). For alphabetic orthographies, such as English, the teacher typically begins to teach reading by introducing each letter of the alphabet individually, and the child is then meant to use these explicit letter-sound correspondences as a way to access knowledge of phonemes (Ziegler & Goswami, 2005; Ziegler & Goswami, 2006). For children, phonological awareness, or the idea that smaller pieces of sound comprise words, is the biggest predictor of future reading development in all languages studied thus far (Ziegler & Goswami, 2005, 2006).

Although the capability of phonological awareness to predict future reading success is consistent across languages, the capacity for phonological awareness in the first language (L1) can vary depending on the depth of the orthography. According to Branum-Martin, Tao, Garnaat, Bunta, and Francis (2012), cross-language correlations between phonological awareness measures are contingent on the similarity of the orthographies and the grain size involved in tasks. Research has shown that phonological awareness can develop more rapidly in a shallow orthography versus a deep one (Spencer & Hanley, 2003), and this level of phonological consistency affects learning rates in addition to the development of phonological awareness (Hirshorn & Fiez, 2014). In a language with a shallow orthography, such as Italian, students will make fewer errors after one year of formal instruction, whereas in English and other equivalent languages, children will still demonstrate inaccuracies well beyond this period (Spencer & Hanley, 2003). Overall, the orthographic depth hypothesis explains that students will subconsciously adjust their reading strategies based on the specific features and amount of transparency of the orthography they are learning, and research supports these processing differences for L1 child learners.

Orthographic instruction can focus on two main grain sizes: large (rimes and syllables) and small (letters). In a shallow orthography, phonological recoding works well as a strategy because the phoneme-grapheme correspondence is systematic, and this means learners can trust and rely on the printed letters, or small grains (Ziegler & Goswami, 2006). The ability to generalize this approach explains the quick success of shallow orthography readers after a single year, and signals that children dealing with a deeper orthography must look elsewhere for consistent or reliable information: for example, in large grains. The psycholinguistic grain size theory proposed by Ziegler & Goswami (2005) encompasses this phenomenon by finding evidence that the consistency of the orthography triggers readers to develop different grain sizes as basic psycholinguistic units. Children learning to read orthographically transparent languages tend to create orthographic representations at the smallest grain size whereas less consistent orthographies force readers to develop both small and large grain sizes simultaneously (Goswami, Ziegler, Dalton, & Schneider, 2003). For English, learners must switch back and forth when decoding text, and this natural “consequence” of the deep orthography results in a switching cost that makes English readers lag behind readers of other languages in accuracy and fluency (Goswami et al., 2003). Cognitive strategies developed to complement shallow or deep orthographies also employ different types of memory. Phoneme recoding falls more into procedural memory, whereas whole word or rime-based learning accesses declarative memory processes (Hirshorn & Fiez, 2014). Larger grain sizes can also be more accessible to beginning readers than isolated sounds, which lack context and easy connections to spoken words. Orthography additionally affects reading in a more direct way: in a study by Castles, Holmes, Neath, & Kinoshita (2003), the authors found that literate adults are affected substantially by automatic and subconscious orthographic influences. For example, phonemic awareness was better for an orthographically transparent word (e.g., /m/ in dim) than an orthographically opaque one (e.g., /m/ in limb). Thus, orthography influences the cognitive strategy underlying the ability to read fluently, and also affects phonemic awareness itself, showing that once orthography is learned, it inherently changes language processing indefinitely.

As far as adults learning an L2 orthography in a foreign language classroom, unsurprisingly, the process depends on the specific features of the two orthographies in question. Unlike children learning to read in an L1, adults in an L2 reading context differ most notably due to prior reading experience, cross-linguistic effects, and limited linguistic knowledge of the L2 (Koda, 1995, cited in Akamatsu, 1999). So, while there may be some overlap and language general features available to learners regardless of the L1 (e.g., alphabetic rules), the language-specific elements mean that literacy in L2 is not simply an additive feature, and that both positive and negative transfer can occur. Spanish-speaking learners of English have been shown to transfer Spanish phonological skills (small grain) and morphological awareness (large grain) to support word reading in English (Goodwin, August, & Calderon, 2015). However, not all skills may transfer: Abu-Rabia (2001) tested adult Russian-English bilinguals, and found that linguistic skills such as phonological skills, spelling, and word identification could be transferred over to the L2 (English), but specific orthographic skills did not. This indicates that orthographic skills are language-specific, and even the type of writing system can influence this. Akamatsu (1999) compared Persian, Japanese, and Chinese adults learning English, and discovered that Persian readers were less influenced by case alternation on test words than the other two groups, due to the "facilitating influence" of the alphabetic Persian orthography, versus the logographic Chinese and syllabic Japanese writing systems. Thus, readers from an alphabetic L1 background are able to draw on phonemic information and display advanced intraword analytical ability, but non-alphabetic L1 readers may be less capable of accessing this same strategy, and instead may utilize holistic visual cues to a greater extent (Yamashita, 2013). Although the type of orthography matters, so too does the depth difference between the two languages. In a meta-analysis of neuroimaging studies by Liu & Cao (2016), the authors found that when L2 is more transparent than L1, the L2 could be processed using the L1's network without much accommodation needed, but if the L2 was more opaque than the L1, this was not the case. Beyond outward performance on reading, the different paths separating large and small grain, and deep and shallow orthography also leave neurological evidence on the brain. To this effect, Liu & Cao (2016) established that shallow orthographies are associated with "greater involvement of the left temporo-parietal regions underlying phonological assembly, whereas deeper orthography is more related to lexical-level processing regulated by the ventral prefrontal gyrus and left inferior temporal gyrus." The brain areas involved in reading demonstrably differ between the type of writing system in these specific areas, which establishes that orthography has an effect on cognitive processing, and that the direction of depth influences this change for L2 readers.

Other studies have addressed the current knowledge base regarding L2 orthographic instruction methods, and previous research reports different outcomes depending on whether large or small grain instruction was emphasized. For example, Bitan & Karni (2004) compared three training conditions for learning an artificial alphabetical script: whole words with explicit letter decoding instruction, alphabetical whole words with no explicit instruction (i.e., implicit learning), and non-alphabetical whole words. While they found that some participants in the second group were able to implicitly learn rules for letter decoding based on whole-word knowledge, the group with explicit training performed better at reading trained items, generalizing to untrained stimuli, and retaining these abilities up to six months after the initial instruction. Consequently, the researchers posited that implicitly derived letter knowledge is "not more fluent, and may even be disadvantageous, compared to the explicitly instructed letter knowledge" for generalization and retention. One paper that investigates both methods is Brennan & Booth (2015), which investigated the effect of grain size on letter and rime recognition accuracy and processing speed. In this study, outcomes on decoding and processing speed given different types of instruction were compared when English-speaking adults were learning to read a novel artificial orthography. The two conditions were small grain (i.e., letter) or large-grain (i.e., word) instruction, accomplished by training one group on isolated letters and another group on whole combinations. The results revealed that the two groups were statistically equivalent in accuracy on word reading, but the word-trained group had higher accuracy for rime recognition as well as faster reaction times. These results support the idea that the type of instruction has an effect on reading outcomes; however, this and previous studies (e.g., Bitan & Karni, 2003, 2004; Bitan et al., 2005) have all employed artificial orthographies in order to control for exposure and experience effects. Although artificial writing systems allow for better control over many variables, it may not be truly representative of how natural second orthographies would be learned; most natural languages are not as clean and transparent as the simplified artificial orthographies are designed to be. There are often overlaps between graphemes, allophonic variations, and varying degrees of orthographic depth. Presently, no studies have been done to confirm that artificial language learning of orthography mirrors the same linguistic process present in an L2, although some studies have shown evidence of this link in other areas, such as semantics (e.g., Ettlinger, Morgan-Short, Faretta-Stutenberg, & Wong, 2015). Therefore, it is unknown if similar outcomes to Brennan & Booth (2015) would be observed when L2 learners are faced with a true natural orthography. To address this, the current study replicates the Brennan & Booth (2015) paper using Russian to investigate if the methods of instruction influence learning outcomes for adults learning a novel orthographic system in a natural language.

Current foreign-language instruction practices regarding orthography are varied, and Russian, as with English, has particular features that might confuse the L2 learner. Despite the fact that different languages seem to promote one particular grain size over the other, instruction methods frequently do not follow the corresponding grain size (Hirshorn & Fiez, 2014). Instruction for second languages often includes some initial orthographic training, with letters taught individually paired with a demonstration of the corresponding phoneme. Generally, after this brief introduction to the letters and their matching sounds, the focus quickly shifts to comprehension and word learning (Nassaji, 2011). Russian in particular can be a challenge for new students, because it uses the Cyrillic alphabet, which can be an unfamiliar script to many, despite its otherwise transferable alphabetic properties. Reading in Russian has been considered an easier skill to acquire than writing itself (Kerek & Niemi, 2009). Consequently, instead of a reading-based and systematic approach, letters are grouped by common shapes or the beginnings required to physically write the letters in Cyrillic cursive, thus focusing on the more difficult skill of writing. As far as the Russian language itself, it is stress-timed like English, but has more complex syllable phonotactics (e.g., up to four consonants in one syllable), which can create problems for learners of the language (Boulware-Gooden et al., 2015). However, the presence of many similarities between the two, such as with stress, uppercase vs. lowercase letters, representation of both consonants and vowels, and text direction, would be expected to facilitate orthographic learning of the other language, even if unfamiliar phonotactics interfere on other levels (Schwartz, Kahn-Horwitz, & Share, 2014).

Although English and Russian are both alphabetic systems, they differ in terms of orthographic depth. English uses the Roman alphabet, with 26 letters that are combined into around 200 graphemes, and then mapped onto the 45 phonemes of American English phonology. Because sounds can be represented with multiple different graphemes, the relationship between these two features is inconsistent, so English can be considered a language with a deep orthography. For example, the sound /i/ can be represented graphemically as “ee” in “keep,” “ea” in “east,” “ie” in “brief,” “e” in “me,” or “y” in “happy.” In contrast, Russian uses the Cyrillic alphabet, which contains 21 consonants and 10 vowels, all of which are generally represented by a single grapheme for 39 phonemes. A study done by Kerek & Niemi (2009) found that Russian was comparable to other languages with shallow orthography in terms of accuracy of letter naming and accuracy of monosyllabic nonwords, but has higher “feedforward” (grapheme-phoneme) than feedback (phoneme-grapheme) consistency, which gives it some passing features of a deeper orthography language. Although context-dependent changes and exceptions to the rule exist (Boulware-Gooden, Joshi, & Grigorenko, 2015), overall Russian is considered more regular than English in its phoneme-grapheme correspondence. According to the tenets of the orthographic depth hypothesis, exceptions and predictable environmental changes increase the complexity of the script, but do not globally affect consistency or completeness of the Russian orthography (Schmalz, Beyersmann, Cavalli, & Marinus, 2016). Therefore, although the Russian writing system demonstrates a few features of lesser uniformity, it presents globally as a shallow orthography.

The two alphabets also share some similar-looking and/or similar-sounding letters. See the appendix for all graphemes in the Russian Cyrillic alphabet as well as the corresponding IPA transcription. As evident in the table, 15 letter shapes are in common with English letters (<E, A, И, Г, В, У, О, Х, Р, Н, К, М, П, С, Т>); however, only 6 have the corresponding phonemes in common as well: /k/, /t/, /m/, /a/, /o/, and /s/. The presence of these ambiguous letters has been shown to cause slower reaction times in bi-alphabetical readers of the Roman and Cyrillic alphabets (Lukatela & Turvey, 1998). In a study done by Marian & Kaushanskaya (2004), the researchers tested Russian-English bilinguals and found that when two orthographies share letters, mutual characters are recognized visually but not necessarily attributed to a particular script right away, and that despite this initial delay, language attribution (i.e., knowing the word is in Russian Cyrillic instead of English) has a role in word recognition and processing (cited in Angermeyer, 2005). Unlike an artificial orthography in a simulated language-learning environment, potential confounds such as overlapping letters better mirror a realistic experience of an L2 learner, and thus provide added insight regarding the effect of small or large grain instruction in regards to these specific graphemes.

Regardless of particular pedagogical strategy, the fact remains that reading in a new orthography can be difficult and stressful to students, and often creates a sense of anxiety around the task. This anxiety and stress can interfere with comprehension and production, as students are automatically overwhelmed when reading to learn new information, where reading is an extremely common way to teach new material, grammar, or vocabulary beyond classroom instruction. Saito, Garza, & Horwitz (1999) note that anxiety towards reading in a foreign language is language-independent, and can be due to unfamiliar scripts and writing systems as well as unfamiliar cultural material inherent in the reading. The authors specifically examined Russian, and found that this was the least anxiety-provoking language out of Spanish and Japanese, and that this was likely due to the fact that the alphabet is phonetically dependable once learned (Saito et al., 1999). Regardless, students can and do experience anxiety when reading Russian, and professors cannot assume that reading proficiency follows oral proficiency. Additionally, with the more complex phonotactics of Russian resulting in longer words with more consonant clusters, visually the printed language can take more time to decipher and resolve into discrete syllables or words. The authors suggest that target language literacy should be taught more explicitly to ensure academic success for students (Saito et al., 1999).

Because previous studies have used artificial orthographies and idealistic contexts for L2 orthography learning, this study trains typical adults on Russian Cyrillic. Using a natural orthography will provide greater ecological validity to findings from previous studies that trained artificial orthographies. Specifically, this study aims to determine if the advantages given large grain instruction are maintained in a natural language: in this case, Russian. If so, this study can potentially inform foreign language instruction practices involving literacy teaching.

II. Research Questions

1. Do different methods of instruction result in differences of letter-sound matching accuracy for English-speaking adults learning Russian Cyrillic?

We predict that participants who received initial instruction in small grain units will demonstrate better accuracy for letter-sound matching. Once learned, the Russian alphabet is phonologically dependable, and learners who are exposed more to individual letters or graphemes will be able to rapidly acquire accuracy in decoding. Focusing attention on these small units will prime their ability to recognize and accurately match letters and sounds.

2. Do different methods of instruction result in differences of rime-rhyme matching accuracy for English-speaking adults learning Russian Cyrillic?

We predict that participants who received initial training in large grain units will demonstrate increased accuracy for rime-rhyme matching. Rimes are a more accessible unit of language for learners who are learning to read an L2 orthography. Such results would be consistent with studies of children learning to read, who demonstrate increased facility to combine a sequence of syllables into a whole word, as compared to blending together a string of phonemes (Hirshorn & Fiez, 2014). The group with rime training will be able to use analogy to accurately locate similar rimes and combine them with implicit letter learning from this same exposure.

3. Does large grain instruction promote a faster processing speed as compared to small grain instruction for English-speaking adults learning Russian Cyrillic?

We predict that participants who received initial training in large grain units versus small grain will show faster reaction times for both letter-sound and rime-rhyme tasks. Instead of recognizing each letter and its associated phoneme, and then combining these individual units into a single word, those with rime training will be able to process multiple sounds for the same larger unit at the same time, and thus accomplish this task more quickly than the participants who must individually recode each presented grapheme.

III. Methods

The methods for this study replicated the methods from Brennan & Booth (2015), with the exception of shortening the training and trial period to two days, and changing the artificial orthography to a natural one; in this case, Russian Cyrillic. Utilizing a natural orthography creates results that are more ecologically valid, and more realistically explore second language acquisition in a typical situation faced by L2 learners. Besides these two changes, we followed the methods of the previous study as closely as possible.

Design

Two separate forms of initial instruction were included to emphasize either large or small grain size as the between-subjects variable. We examined the effect of initial instruction on accuracy and RT (for correct trials) on a cross-modal word matching task following training on two separate days (within-subjects variable), as well as cross-modal matching tasks across two different orthographic grain sizes (i.e., smaller: letters, and larger: rimes) as the within-subjects variable at Day 2. Finally, we examined whether the relationship between phonological awareness skill and accuracy on cross-modal word matching depended on method of instruction and point in learning (i.e., Day 1 and Day 2).

Participants

Participants were 34 literate, typical English-speaking adults, ages 19-38 years. Pre-testing performance ensured that groups were matched in reading and phonological skill. Participants were recruited from the University of Colorado and the nearby community using emails and online fliers in accordance with IRB requirements. Participants were given questionnaires to ensure that they meet the following criteria: (1) no previous exposure to Russian or the Cyrillic alphabet, (2) normal hearing and vision, (3) no neurological disease or psychiatric disorders, and (4) no learning disability. Brennan & Booth (2015) found effects with 37 subjects, so the participant numbers of the current study closely mirror the same group sizes, and could be expected to also show significant results.

Procedure

Participants completed two sessions. The initial session included standardized testing using subtests from the *Test of Word Reading Efficiency, 2nd Edition* (TOWRE-2) and *Comprehensive Test of Phonological Processing, 2nd Edition* (CTOPP-2). Both the first and second sessions involved computer training and testing on the Cyrillic orthography. Both training sessions included a cross-modal word matching test of trained words, both rimes (large grain) and letters (small grain). This test is called "cross modal" because the participants integrated visual and auditory stimuli while reading; they were shown the letters while hearing phonemes pronounced by a native speaker, and then made a judgement regarding correspondence between the two. For all training and tests, participants sat in a quiet room approximately 24 inches from a 24-inch flat screen monitor and wore headphones.

Pre-testing

Standardized assessments were administered in order to match phonological and reading skill across the instruction groups. Standardized measures included the following: Sight Word Efficiency and Pseudoword Efficiency from the *Test of Word Reading Efficiency-2* (TOWRE-2) (Torgesen, Wagner, & Rashotte, 1999) and three subtests from the *Comprehensive Test of Phonological Processing-2* (CTOPP-2): Elision, Blending Words, and Phoneme Isolation (Wagner, Torgesen, and Rashotte, 1999). Elision and Phoneme Isolation were included because each measure involves different methods of grain size manipulation. Elision requires phonological manipulation at smaller and larger grain sizes. For Elision, participants delete single phones from words and then synthesize the remaining sounds into other words. For example, delete /n/ from "snail" (correct response is "sail"). In contrast, Phoneme Isolation requires manipulation only at the smallest phonological grain size (i.e., phones). For this measure, participants must break a given word into separate phonemes. For example, the correct response to "what is the first sound in the word 'man'?" is /m/. Elision therefore requires a two-step process involving deletion of a small grain followed by synthesis of small grain into larger grain, whereas Phoneme Isolation requires a one-step process involving breaking a large grain unit (word) into small grain components (phones). Average standardized testing scores on reading ability (TOWRE-2 Sight Word Efficiency) and phonological skill (CTOPP-2 Elision and Phoneme Isolation) for the two instruction groups (large and small) revealed no significant group differences.

	Instruction groups		Effect of group	
	Large	Small	F	Sig.
CTOPP Elision[a]	96.08 (5.33)	89.84 (23)	0.072	p = 0.791
CTOPP Blending Words[a]	88.59 (8.87)	81.46 (22)	1.008	p = 0.324
CTOPP Phoneme Isolation[a]	91.73 (6.89)	87.13 (23)	0.013	p = 0.909
TOWRE SWE time[b]	49.80 (5.70)	53.84 (9.05)	2.923	p = 0.098
TOWRE PDE[b]	54.31 (9.52)	59.58 (22.68)	2.792	p = 0.106

Table 1. Pretesting of subjects assigned to the large grain or small grain instruction groups. Performance on three CTOPP-2 subtests and the two TOWRE-2 subtests revealed no differences between groups. [a] Because some subjects were over the age limit for standardized scoring of the CTOPP-2, the percent accuracy for each subtest is reported here. [b] Because some subjects were over the age limit for standardized scoring of the TOWRE-2, the total time to read all words in the subtest is reported here.

Stimuli

Auditory stimuli included recorded words spoken in Russian and digitally processed using Praat software. All auditory stimuli were spoken by the same female native speaker (F0 approximately 200 Hz) with a similar loudness level. It is ecologically valid to employ a native-sounding Russian speaker, because most L2 Russian students would be learning from either a native speaker or an instructor with native-like pronunciation.

There were 32 words and these words comprised four rhyme families so that identification and matching of rimes to rhymes could be tested. Rhyme families are sets of words that share the vowel and consonants following the vowel. In English, an example would be: flap, clap, trap, snap, and strap. Russian words were selected based on sets of rhyme families and all words were either nouns or verbs.

Along with the audio clip, each of the words was also presented in Russian Cyrillic (no English words were presented throughout the entire procedure). A standard font was used to type the words and letters in the Cyrillic alphabet. The font was black on a white background. Sixteen training words were visually and auditory presented during instruction and exposure, and the other 16 words were presented during rime-rhyme and onset testing only.

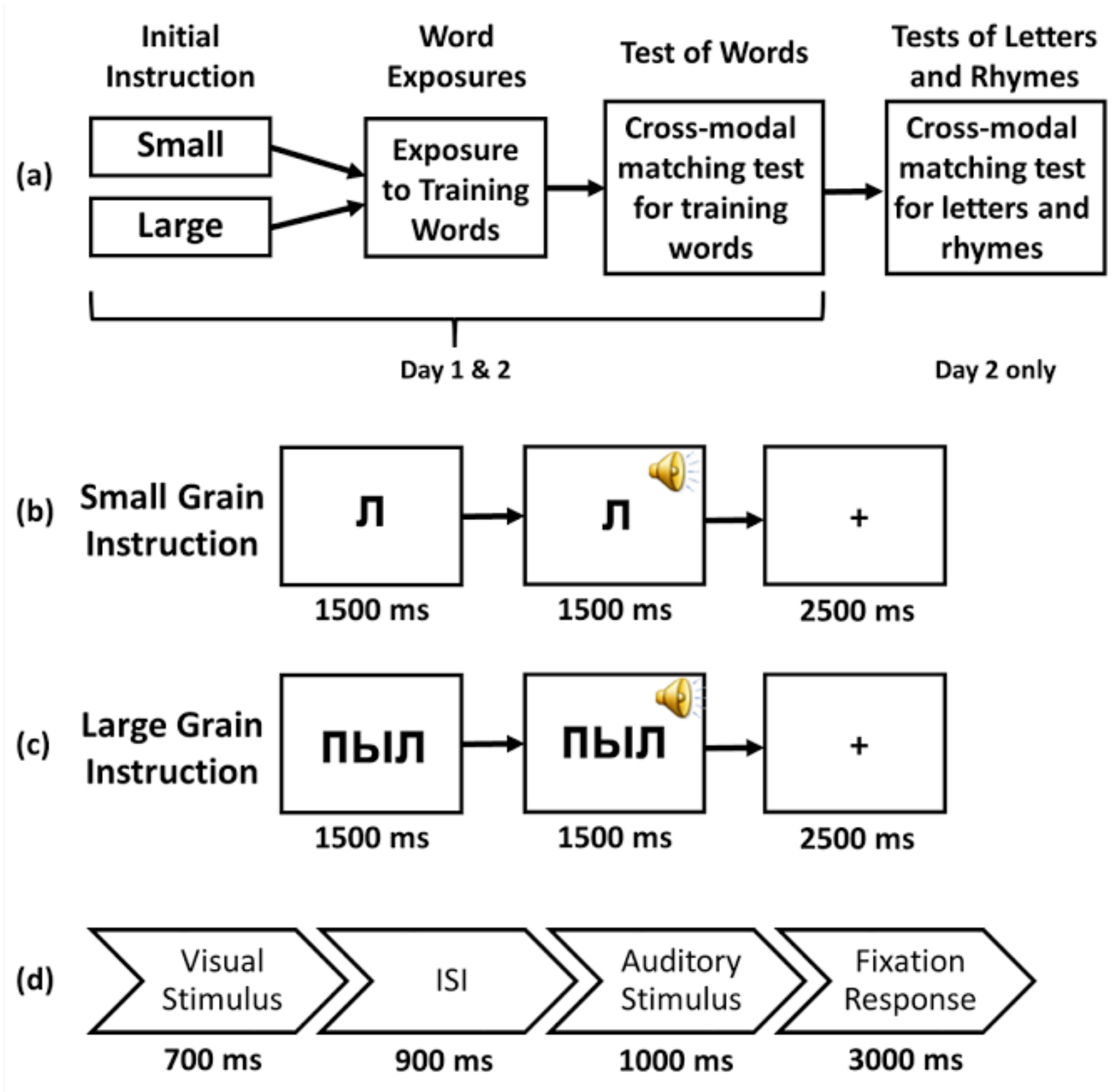

Figure 1. Design of Instruction. (a) Training will be provided for two days and will involve instruction and testing. Participants will be given only one form of initial instruction: large or small grain instruction. Each participant will receive the same form of instruction at the beginning of each training session. (b) Large grain instruction will involve a single presentation of each of the 16 training words, each whole-word visually presented and paired with the pronunciation. (c) Small grain instruction will involve a single presentation of each of the 19 single letters, each letter will be presented visually and then paired with the pronunciation. (d) Test measures for trained words, rimes, and letters will include forced choice cross-modal matching judgments.

Instruction

Training was provided to participants across two training sessions. Generally, this occurred over two consecutive days. Each day of training included initial instruction (which differed for each group) followed by exposure to training words and a test of trained words (see Figure 1a). Exposure to training words and tests were exactly the same for both instruction groups, so the only difference between the groups was the nature of the initial instruction. On the second day, there were two additional tests for letter-sound matching and rime-rhyme matching. Brennan & Booth (2015) tested for three days because it allowed all of their participants to achieve high accuracy on the cross-modal word matching task for trained words; however, because they found a ceiling effect with letters after two days, the trial period for this study was two days in order to produce useful data regarding letter learning for both groups.

After participants were divided into two groups, participants in each group were given only one form of initial instruction that focused on different grain sizes: large or small (see Figure 1b and 1c). The initial instruction was provided at the beginning of each training session.

The initial large grain instruction directed explicit attention to the largest grain size for the stimuli being trained (whole words). As such, initial large grain instruction involved the single presentation of each of the 16 training words (see Figure 1b). Each word was presented only once during the training condition. Words were presented visually in black text and accompanied by an auditory presentation of the corresponding spoken word. Visual word duration was 3000ms with the auditory presentation of the word beginning 1500ms after the visual presentation. Each word presentation was followed by a fixation lasting 2500ms. Pseudorandomized order was used to minimize the occurrence of similar graphemes or rimes being presented in direct sequence. Participants were told to remember as much as they could.

In contrast, the initial small grain instruction directed explicit attention to the smallest grain size, (letters/phones). As such, initial small grain instruction included a single presentation of each of the 19 single letters, one letter at a time (see Figure 1.1c). Each letter was presented once, in a randomized order. Letters were presented visually in black text and accompanied by an auditory presentation of the corresponding phone. Letters were presented visually for 3000ms with the initiation of the auditory phone beginning 1500ms after visual presentation. The duration for the letter exposures was selected because it falls within the range of previous studies that also utilized timed letter instruction training (Bitan and Karni, 2003; Bishop, 1964; Knafle & Legenza, 1978).

Following the initial instruction on the two training days, all participants experienced a program of passive exposure to all 16 training words (Trained Words Exposure). During this word exposure, each training word was presented seven times in pseudorandomized order. Therefore, all participants (regardless of the initial instruction) saw each training word seven times during this portion of training. In order to direct attention to large versus small grain size, the participants given initial large grain instruction also saw the training-words during the initial instruction component of training, whereas the participants given initial small grain instruction saw each of the letters instead of words. The format of the word exposure trials was exactly the same as the initial large grain instruction format (see Figure 1b). Passive exposure was utilized because we postulated that initial form instruction that emphasized either letters or words would be adequate to draw explicit attention to different grain sizes and allow us to measure generalization effects that occurred following word exposures. In this way, the large grain group was expected to focus on larger grains simply as a result of showing entire words instead of singular graphemes and phonemes, and vice versa for the small grain group. Directions prior to word exposures and testing were the same for both instruction groups.

Test Measures

Test measures included forced choice cross-modal matching judgments for trained words, onsets, rimes, and letters. Each trial consisted of a visual presentation (word or letter) followed by an auditory presentation (word or letter). Participants were instructed to determine if the visual and auditory word/letter presentations matched using the keyboard. Participants could respond as soon as they heard the auditory stimulus and had a total of 1100ms before the next trial began (see Figure 1d). Accuracy and RT were logged. For the cross-modal rime matching and onset matching tasks, novel pseudowords were used, and matches and foils all had the same initial letters or rimes, respectively, thus requiring participants to make judgments based on the rime or onset component of the word (generally, rimes consisted of the last 2-3 letters, and onsets comprised the first 2-3 letters). The cross-modal letter matching task involved presentations of letters and phonemes. Foils included phonemes for other graphemes in the study (vowels for vowels and consonants for consonants).

Following the Trained Words Exposure on the first day, the only test given was the cross-modal word matching task for trained words. Following training on the second day, all cross-modal matching tasks were given (trained words, onsets, rimes, and letters).

Statistical Analysis

To determine if different methods of orthographic instruction (i.e., large grain instruction (words emphasized) or small grain instruction (letters emphasized)) result in differences between instruction groups in learning outcomes, we utilized general linear model analysis of variance to compare accuracy and reaction time on tests of (1) trained words, (2) letter-sound matching, (3) conflict letters, (4) rime-rhyme matching, and (5) rime-rhyme foils only (onset correct but rime incorrect).

The post-hoc analysis of conflict letters included a subset of trails from the letter-phoneme matching test. Specifically, letters that resemble English but have a different pronunciation (e.g., "в" looks like English alphabet grapheme "B" which generally corresponds to the bilabial phoneme /b/, but in Russian is actually the labiodental phoneme /v/). Cyrillic letters in this category were <е, г, в, и, у, х, р, н, п>, which resemble English letters <e, r, B, u, y, x, p, H, n>, respectively. To determine if there were differences between instruction groups, accuracy and RT on trials with these conflict letters were analyzed separately using a general linear model analysis of variance.

For the rime-rhyme matching we also analyzed a subset of data in order to determine if there were differences between instruction groups on either accuracy or RT when trials were more challenging. Specifically, we analyzed the foil trials of the rime-rhyme test in which the onset was correct, but the rime portion of the word was incorrect. These trials demanded that subjects recognized the rime/rhyme portion of the word (not just the onset) in order to respond accurately. To determine if there were differences between instruction groups, accuracy and RT on rime-rhyme foil trials, these trials were analyzed separately using a general linear model analysis of variance.

All of the group analyses described above were completed with and without phonological skill (all three CTOPP-2 measures) entered as a covariate and results are reported with and without this covariate.

In order to determine if phonological skill influenced learning outcomes, correlations between test performance and phonological awareness measures (CTOPP-2 Elision and Phoneme Isolation) were calculated separately for each instruction group. In order to determine if reading skill influenced learning outcomes, additional correlations between test performance and reading measures (TOWRE-2 SWE and PDE) were also calculated for each instruction group.

In order to control for family-wise error rate, a type I error rate (alpha) of 0.05 was assigned and a Bonferroni correction was utilized for all analyses.

IV. Results

Trained words test results

A repeated measures analysis was completed to examine the effects of group and day on accuracy for the test of trained words (see Table 2). There was a significant effect of day, with all subjects showing higher accuracy on the test of trained words on the second day compared to the first day ($F(33,1) = 25.778$, $p < .001$), but there was no significant effect of group ($F(33,1) = 0.234$, $p = 0.632$), nor a significant interaction between day and group ($F(33,1) = 0.105$, $p = 0.748$).

A repeated measures analysis was completed to examine the effects of group and day on RT for the test of trained words (see Table 2). There was no significant effect of day (F(33,1) = 0.089, *p = 0.970*), and there was also no significant effect of group (F(33,1) = 0.933, *p = 0.341*), nor was there a significant interaction between day and group (F(33,1) = 0.001, *p = 0.970*).

	Instruction groups		Effect of group	
	Large	Small	F	Sig.
Accuracy				
Day 1 Trained Words	75.96 (19.92)	78.49 (10.76)	0.213	*p = 0.647*
Day 2 Trained Words	89.74 (7.73)	90.63 (8.56)	0.099	*p = 0.755*
Reaction Time				
Day 1 Trained Words	1043 (301)	1088 (87)	0.361	*p = 0.552*
Day 2 Trained Words	1032 (148)	1074 (90)	1.024	*p = 0.319*

Table 2. Accuracy and RT was measured for the matching test for trained words following instruction on both days of training. There was no significant effect of group for accuracy or RT on either day for the test of trained words.

Letter-phoneme matching test results

A general linear model analysis of variance revealed that the difference between instruction groups on accuracy for the letter-phoneme matching test trended very close to significant (F(33,1) = 3.994, *p = .054*) (see Figure 2, Table 3). When controlling for phonological skill (CTOPP-2: Elision, Blending Words, and Phoneme Isolation added as covariates to the ANOVA), the effect of group was significant with the small grain instruction group achieving higher accuracy than the word instruction group (F(33,1) = 7.185, *p = .012*).

Letter-phoneme matching: conflict letters test results

A general linear model analysis of variance revealed no significant differences between instruction groups on accuracy (F(33,1) = 1.387, *p = .248*) or reaction time (F(33,1) = .077, *p = .784*) on trials including conflict letters during the phoneme-letter matching test (see Table 3). There was no significant effect for RT between instruction groups on the letter-phoneme matching test (F(33,1) = 0.485, *p = .491*).

There was no significant effect for RT between instruction groups on the phoneme-letter matching test (F(33,1) = .485, *p = .491*), nor was the effect significant when controlling for phonological skill (F(33,1) = 1.074, *p = .309*).

	Instruction groups		Effect of group		Effect of group (controlling for phonological skill[c])	
	Large	Small	F	Sig.	F	Sig.
Accuracy						
Letter-Phoneme Matching	71.29 (12.55)	79.29 (10.72)	3.994	*p = 0.054~*	7.185	*p = 0.012**
Conflict Letters Only	70.07 (13.64)	74.96 (17.75)	0.779	*p = 0.384*	0.947	*p = 0.339*
Rime-Rhyme Matching	81.62 (12.88)	78.86 (11.77)	0.351	*p = 0.558*	0.319	*p = 0.577*
Rime-Rhyme Foil Trials Only	87.60 (13.85)	76.76 (21.43)	2.936	*P = 0.097*	5.214	*p = 0.03**
Reaction Time						
Letter-Phoneme Matching	902 (132)	931 (111)	0.485	*p = 0.491*	1.074	*p = 0.309*
Conflict Letters Only	989 (180)	992 (160)	0.002	*p = 0.962*	0.014	*p = 0.906*
Rime-Rhyme Matching	1150 (111)	1179 (120)	0.533	*p = 0.471*	2.181	*p = 0.151*
Rime-Rhyme Foil Trials Only	1246 (178)	1356 (239)	2.212	*p = 0.147*	2.187	*p = 0.151*

Table 3. Instruction group comparisons for accuracy and RT on the letter-phoneme matching test, the rime-rhyme matching test (in novel words), conflict letters only, and rime-rhyme foils only. Results are shown for the effect of group and the effect of group when controlling for phonological skill (i.e., the three CTOPP-2 phonological measures were entered as covariates).

<u>Rime-rhyme matching test results</u>

A general linear model analysis of variance revealed that the difference between instruction groups on overall accuracy on the rime-rhyme matching test was not significant (F(33,1) = .351, *p = 0.558*) (see Table 3). When measures of phonological skill (CTOPP-2 Elision, Blending Words, and Phoneme Isolation) were added as covariates to the ANOVA, there was no significant effect of group on accuracy on the rime-rhyme matching test (F(33,1) = 0.319, *p = 0.577*).

There was no significant effect for RT between instruction groups on the rime-rhyme matching test (F(33,1) = .533, *p = .471*), nor was the effect significant when controlling for phonological skill (F(33,1) = 2.181, *p = .151*) (see Table 3).

Rime-rhyme matching: foil only test results

Although there was a bigger group difference between accuracy for the foil trails, the effect did not reach significance (F(33,1) = 2.936, *p = .097*) (see Table 3, Figure 2); however, when measures of phonological skill (CTOPP-2: Elision, Blending Words, and Phoneme Isolation) were added as covariates to the ANOVA, there was a significant effect of group with the large grain instruction group achieving higher accuracy than the letter instruction group (F(33,1) = 5.214, *p = 0.03*).

There was no significant effect for RT between instruction groups on the rime-rhyme foil trials (F(33,1) = 2.212, *p = .147*), nor was there a significant effect for RT on the rime-rhyme foil trials when controlling for phonological skill (F(33,1) = 2.187, *p = 0.151*) (see Table 3).

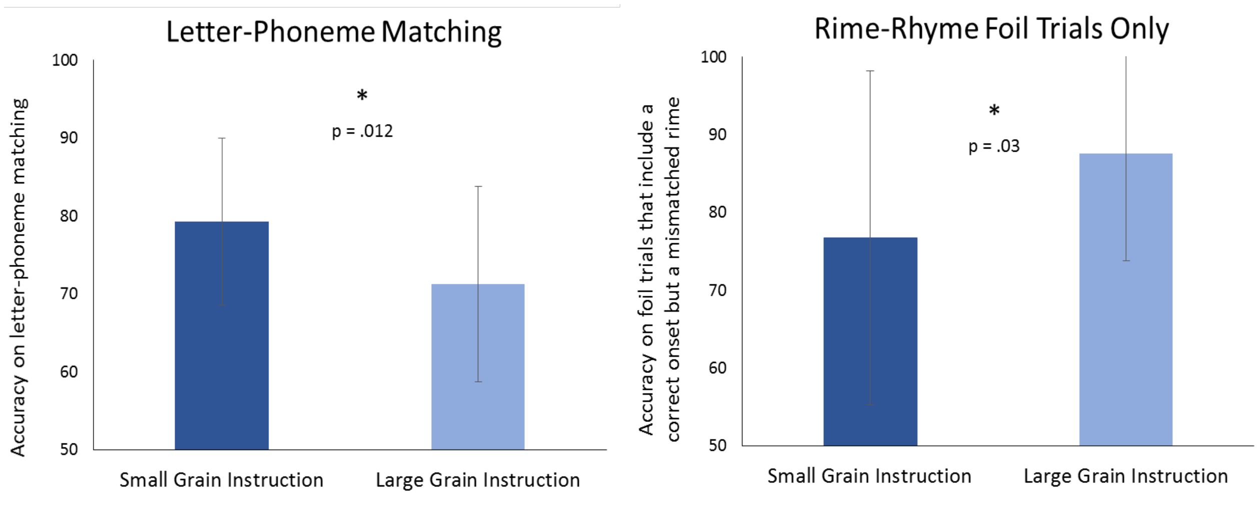

Figure 2: Letter-phoneme matching task accuracy; Rime-rhyme foil trials accuracy. When phonological skill was entered as a covariate, results indicated that there was a significant effect of group, with the small grain instruction group achieving greater accuracy on the letter-phoneme matching, and the large grain instruction group attaining higher accuracy on the rime-rhyme foil trials.

<u>Phonological skill</u>

For the small grain instruction group, there were no significant correlations between phonological skill(s) (Elision, Blending Words, and Phoneme Isolation) and accuracy on any of the outcome measures (see Table 4). For the small grain instruction group, there were no significant correlations between phonological skill(s) (Elision, Blending Words, and Phoneme Isolation) and RT on any of the outcome measures (see Table 4).

For the large grain instruction group, there were several significant correlations between phonological skill(s) (see Table 4), specifically, Elision and letter-phoneme matching RT (r = 0.742, p = 001), Blending Words and letter-phoneme matching accuracy (r = 0.665, p = 0.004) and letter-phoneme matching RT (r = 0.650, p = 0.005), and Phoneme Isolation and conflict letters RT (r = 0.521, p = 0.032).

	Elision	Blending Words	Phoneme Isolation	TOWRE SWE time[b]
Small grain instruction				
Letter-Phoneme Matching Accuracy	-0.039	0.075	-0.037	0.413
Letter-Phoneme Matching RT	0.188	0.195	0.293	-0.235
Conflict Letters Only RT	0.065	0.055	0.135	-0.222
Rime-Rhyme Matching RT	-0.28	-0.178	-0.264	**-0.540***
Large grain instruction				
Letter-Phoneme Matching Accuracy	0.307	**0.665****	0.05	-0.414
Letter-Phoneme Matching RT	**0.742*****	**0.650****	0.239	0.021
Conflict Letters Only RT	0.306	0.215	**0.521***	0.223
Rime-Rhyme Matching RT	0.396	0.397	0.027	-0.403

* $p < 0.05$ corrected, ** $p < 0.01$ corrected, *** $p < 0.001$ corrected

Table 4. Correlations between CTOPP-2 and TOWRE-2 subtests and task performance. When controlling for phonological skill, as represented by the three CTOPP-2 subtests, there were no correlations for the small grain instruction group; however, significant correlations were found for the large grain instruction group in letter-phoneme matching accuracy and RT, and RT with conflict letters. There was a significant negative correlation for the small grain instruction group between performance on the Sight Word Efficiency subtest and the rime-rhyme matching RT.

Reading skill

For the large grain instruction group, there were no significant correlations between reading skill (TOWRE-2 SWE time) and accuracy or RT on any of the outcome measures (see Table 4).

For the small grain instruction group, there was a significant negative correlation between reading skill (TOWRE-2 SWE time) and rime-rhyme matching RT ($r = -0.540$, $p = 0.025$) (see Table 4, Figure 3).

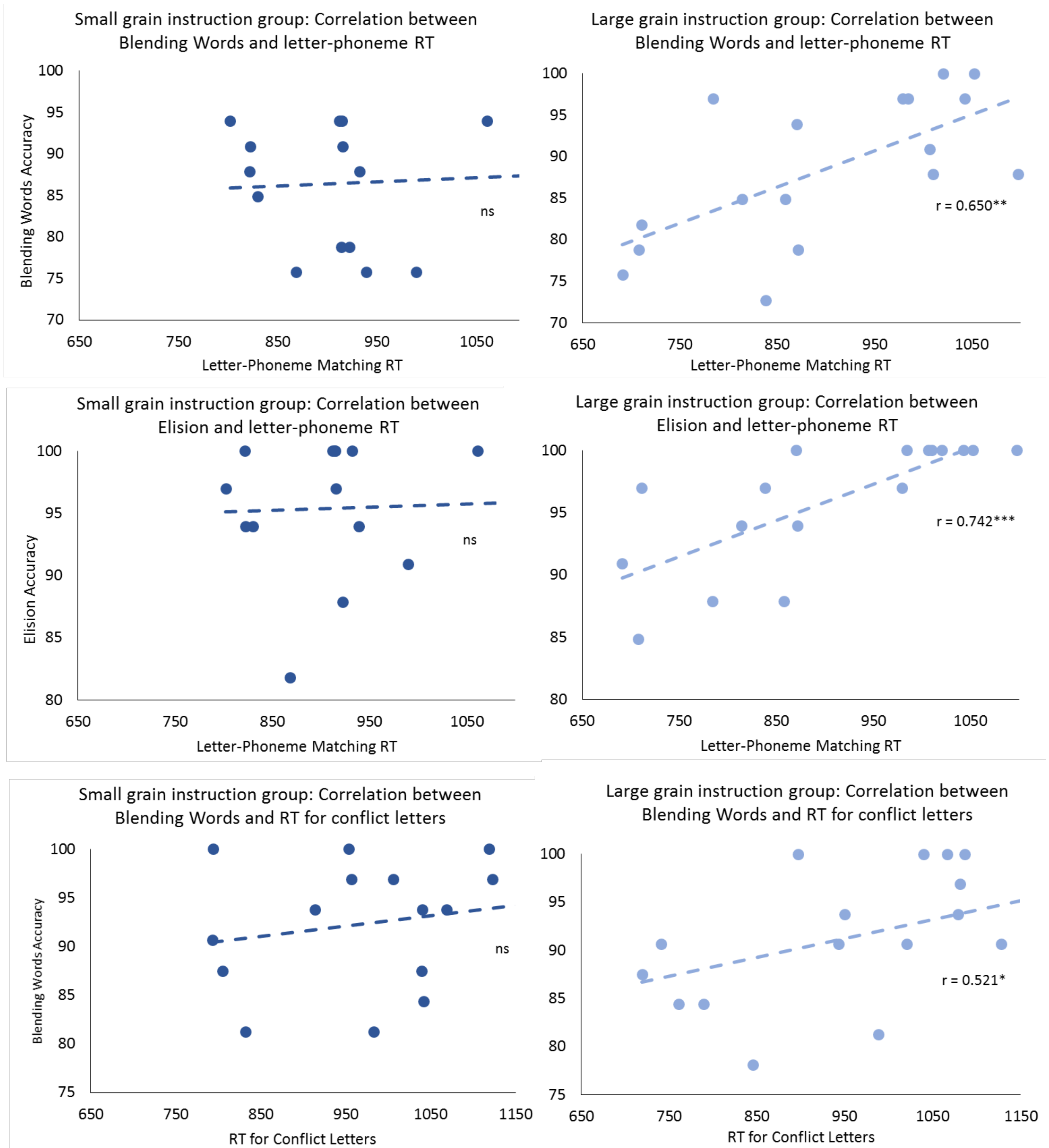

Figure 3. Graphs of correlation analyses for RT. A significant positive correlation was found between the large grain group and phonological skills (as measured by the three subtests of the CTOPP-2), where this group performed more quickly on letter-phoneme matching and conflict letters. No similar correlations were found for the small grains instruction group.

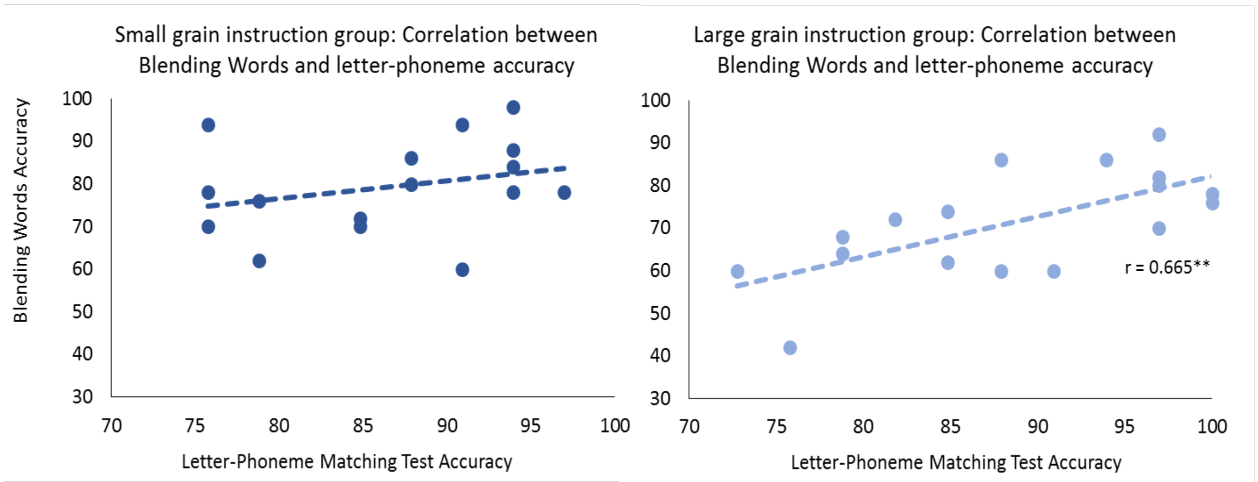

Figure 4. Graphs of correlation analyses for accuracy. A significant positive correlation was found for the large grain instruction group between performance on the Blending Words subtest and letter-phoneme task accuracy. This was not found for the small grain instruction group.

V. Discussion

This study aimed to determine if initial instruction that directed attention to large or small grain units resulted in differences in outcome measures for letter-sound matching accuracy and rime-rhyme matching accuracy. Because the subjects trained on Russian Cyrillic were already literate in English, these adults already had the ability to manage granularity and therefore should have high sensitivity to both large and small grain units. Despite the high sensitivity that English-speakers would have to small grain units, we expected that initial instruction that focused adults' attention to either larger or smaller units would result in differences in accuracy on letter-phoneme matching and rime-rhyme matching. We found that when controlling for phonological skill, initial instruction emphasizing small grain units resulted in significantly higher accuracy on Cyrillic letter-sound matching and initial instruction emphasizing large grain units resulted in significantly higher accuracy on Cyrillic rime-rhyme matching.

The current results are consistent with the findings of Bitan & Karni (2004) and Brennan & Booth (2015). Both of these previous studies trained adults to read artificial orthographies and found that different instruction methods resulted in differences in accuracy for letter learning and rime-rhyme matching. Specifically, Bitan & Karni (2004) found an advantage for explicit small grain instruction on letter-phoneme skill and novel word decoding. Brennan & Booth (2015) found an advantage for large grain instruction on rime-rhyme matching. The current findings support these previous studies and demonstrate that similar effects are found when a natural orthography is trained.

This study also aimed to determine if different forms of initial instruction resulted in differences in RT. While faster RT was reported by Brennan & Booth (2015) for both letter and rime-rhyme tasks for the group given large grain instruction, we found no statistically significant differences on RT for any tasks. While average RT for the large grain instruction group was faster on all tasks and measures, these differences were small and did not reach significance. While we predicted that large grain instruction would promote a faster processing speed (faster RT) as compared to small grain instruction for English-speaking adults learning Russian Cyrillic, this was not the case. One possible reason for the differences in RT results may be due to differences in overall complexity between the artificial orthography trained in the Brennan & Booth (2015) study versus the natural orthography trained here. The orthographic system trained in this study was natural and as a result was more complex than the artificial orthography used previously. In contrast to Brennan & Booth (2015), adults in this study were trained and tested on words that had greater variability in word shape and size and were trained and tested on 31 letters (as opposed to 19 in the previous study). Further, the letters trained by Brennan & Booth (2015) were specifically created so that they were not similar to English, but the Russian Cyrillic letters included those that were either familiar (with similar phoneme correspondences or contrasting phoneme correspondences) or unfamiliar letters (no similar letters occur in English). It is likely that when a new orthography is more complex, as is the case here, any advantages for RT given large grain instruction are minimized.

Potentially, disparities between previous studies and the current results could relate to the extant differences between a writing system from a natural language and the created and controlled orthographies used in other studies. While artificial orthographies allow for more control and thus potentially less ecologically similar situations than an L2 environment, research overall indicates that artificial languages are likely equally valid in providing results in a language-learning paradigm. For example, Ettlinger et al. (2016) employed an artificial language with semantic components to study morphosyntax processes in adults. For more complex artificial languages, results correlated positively with indices of L2 learning, and this was not accounted for by general intelligence alone. Although not all artificial paradigms might approximate L2 learning, their results show sufficient overlap for some components of language, including the fact that both processes are supported by verbal working memory. Taylor, et al. (2011) found that adults were able to derive the sounds of individual characters from whole-word forms presented in an artificial orthography, which was definitely evidenced in the current study, where adults demonstrated the same behavior with the Russian Cyrillic alphabet. Based on their experiments, the researchers concluded that studies with artificial orthographies hold good validity for exploring further theories related to orthographic learning. Recently, brain imaging research has provided more direct evidence towards the link between artificial and natural languages by showing that the same brain regions activate for both while reading aloud (Taylor, Davis, & Rastle, 2017). Finally, Hirshorn & Fiez (2014) note that utilizing artificial orthographies is a promising prototype for further advancement, including theoretical advancement, altering or designing writing systems, diagnosing and treating reading disorders, and exploring second language learning. Consequently, the differences in this study's results are likely not simply the result of using a natural orthography over an artificial one. Artificial orthographies can continue to be used as a valid tool for further research in the area of reading instruction and grain size, although future studies should consider investigating both contexts to uncover more conclusive and universal results.

We found several significant correlations for RT and the large grain instruction group but not the small grain instruction group on the letter-phoneme task. Specifically, phonological skill was positively correlated with RT, meaning high individual skill on phonological awareness was associated with higher (or slower) RT on the letter-phoneme matching task (all letters and conflict letters). Two factors may have played a role in whether an individual had a faster or slower RT for letter-phoneme matching. One factor is individual skill in phonological ability and the other is the method of instruction provided. When the method of instruction provided emphasized large grain analysis but there was an inherent higher level of phonological skill (specifically, phonemic skill), the result is slower RT. This may be due to small grain analyses employed by the individuals with strong phonemic awareness. In contrast, when the method of instruction emphasized small grain analysis, there does not seem to be an impact on RT. However, small grain analyses emphasized in the small grain instruction resulted in slower RT for all individuals in that instruction group regardless of phonemic skill, because attention is explicitly being directed at the smallest units. Greater explicit attention to the smallest units will result in longer RTs. As a result of encouraging explicit analyses of letters, there is less variability on RT regardless of whether individuals have higher or lower phonemic skill. These results extend those reported by Brennan & Booth (2015) which revealed that high phonological skill compensated for the limitations of the method of instruction provided. Although in this case, high skill did not result in compensation for the limitations of the instruction, but rather, high skill in phonemic awareness influenced outcomes given large grain but not small grain instruction.

Given the high accuracy on all outcome measures achieved by the adults given large grain instruction (all above 70%), it is evident that these participants were able to effectively recognize and segment large units to recognize letter patterns and infer phoneme-grapheme correspondences. This mirrors the findings of Bitan & Karni (2004) and Brennan & Booth (2015), who found that letter knowledge was learned implicitly by their large grain experimental groups. Because our stimuli lacked a semantic context, this could have resulted in atypical learning of reading for the participants (Taylor et al., 2011). However, our results do indicate that English speakers learn Russian orthography quickly and easily in this context even without semantic knowledge of the words they are learning to read and they are able to apply small grain decoding strategies to unfamiliar words after only two training sessions. Because of their reading experience in English, the adults in this study were equipped with both small and large grain word reading strategies, which are a necessity for reading in English. In this study, adults were learning to read words in Russian Cyrillic and may not have needed to access larger grain patterns once they determined the reliability of grapheme-to-phoneme correspondence in Russian Cyrillic.

Further, adults in this study were not learning an orthographic system with a drastically different mapping system, like a morpheme-based system such as Chinese; therefore, there was likely a great deal of positive transfer that facilitated the performance of adults in both instruction groups. Due to the similarity of Russian and English, transfer of word reading skills from L1 could account for the overall high accuracy for both groups on trained words. Because both English and Cyrillic orthographic systems are alphabetic, stress-timed, and involve a fairly overlapping phonologic system, transfer from L1 to L2 is likely. Unlike English, however, Cyrillic is a more transparent orthography, so adults skilled in reading English would not necessarily need to access large grain strategies for reading and could instead rely on dependable small units for accuracy regardless of instruction group. Koda (2007) provides more insight on the transfer process by noting that L2 readers can draw on prior literacy experience in one language and know generally what is to be expected in mapping sounds to letters. Because the participants in this study were highly proficient readers already, their prior experience likely equated to a thoughtful and strategic approach to this new orthography, and this helped them quickly determine how it functioned. Further, phonological skill plays a critical role in L2 reading, and phonological awareness in both languages is often highly correlated, providing substantial facilitation between the two orthographic systems (Koda, 2007). Russian Cyrillic and English are fairly structurally similar in the phonotactics of words, thus placing somewhat similar processing demands on novice readers and facilitating transfer of L1 reading competency to emerging L2 reading skills.

The results from the current study can inform approaches to L2 orthographic instruction. Specifically, the current results along with previous findings support the use of both large and small grain instruction. We found that instruction that emphasis large grain units facilitates recognition of larger letter patterns such as those occurring in rimes-rhymes which is also consistent with the findings of Brennan & Booth (2015). Explicit instruction for small grain units appears to be better for letter-phoneme correspondence. This conclusion is consistent with the findings of Bitan & Karni (2004), which state that explicit small grain training is more effective than implicit acquisition of letter-phoneme correspondence and transfer to novel words. Further, Bitan & Karni (2004) also show that the persistence of new knowledge over time is better given explicit instruction of small grain units. Direct letter instruction of an artificial orthography also has been shown to result in greater "offline" improvement between sessions (Bitan & Booth, 2012). Additionally, pairing explicit reading instruction with greater phonological pre-exposure and semantic context has been shown to increase learning and generalization, with semantic information showing a stronger influence at later stages of training (Taylor et al., 2011). Of course, many research findings in the area of reading involve a distinction between shallow and deep orthographies, so it would also be important to consider the similarities between the linguistic systems of writing. In a language with a deeper orthography, less transfer would be expected, and thus teachers should incorporate more strategies such as the ones mentioned above in Taylor et al. (2011). Wise, Yoncheva, & McCandliss (2011) pointed out that individual preferences exist for proficient literate readers, with some preferring a whole-words strategy and others relying more heavily on a grapheme-phoneme correspondence strategy. The type of strategy instinctively applied by learners had a significant effect on their learning patterns in outcomes in a new orthography. Consequently, teachers must also consider personalized factors and how they fit into the type of orthography while determining strategies for early reading instruction.

Limitations of this study included a population of participants that was fairly homogenous, with a large number of young, educated, female graduate students. A more diverse population may yield different results. Future directions for research in this area might investigate different types of alphabetic orthographies, such as Korean Hangul. Because there is an overlap between Russian Cyrillic and English, where Russian Cyrillic resembles acceptable alphabetic shapes potentially previously encountered by English literates, the positive transfer between L1 and L2 could both help but also interfere with new learning. In contrast, the Korean orthography, known as Hangul, would be highly unfamiliar to English readers but is another example of a more consistent alphabetic system. The lack of easy transfer between the two orthographies may elucidate the effects of different instruction methods in a way that this study could not. Other types of orthographic systems, such as logographic systems like Chinese, should also be studied, as participants familiar with an alphabetic orthography may interact with these discrete symbols in an entirely different way, and thus might benefit more from a different type of instruction.

In conclusion, the current study provides evidence that initial instruction emphasizing small grain units results in higher accuracy for letter-phoneme matching whereas initial instruction emphasizing large grain units results in higher accuracy for rime-rhyme matching for adults learning a second, natural alphabetic orthography. Further, the current results reveal that for adults given large grain instruction, high individual phonemic skill was associated with slower RT for letter-phoneme matching. In contrast, high phonemic skill was not associated with RT for adults given small grain instruction, suggesting that explicit analyses of the smallest units might minimize differences in RT that can otherwise arise when phonological skill is high. Future investigations should investigate differences in learning outcomes for L2 orthographic learning given large versus small grain instruction with other natural languages that are less similar to the L1.

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Appendix.

Grapheme	IPA		IPA		IPA
а	/ a /	й	/ j /	у	/ u /
б	/ b /	к	/ k /	ф	/ f /
в	/ v /	л	/ l /	х	/ x /
г	/ g /	м	/ m /	ц	/ ts /
д	/ d /	н	/ n /	ч	/ tɕ /
е	/ jɛ /	о	/ o /	ш	/ ʂ /
ё	/ jo /	п	/ p /	щ	/ ɕ /
ж	/ ʐ /	р	/ r /	ы	/ ɨ /
з	/ z /	с	/ s /	э	/ ɛ /
и	/ i /	т	/ t /	ю	/ ju /
				я	/ ja /

Table 5. Lowercase Russian Cyrillic letters and IPA transcription

/pɨɫ/ пыл	/kraj/ край	/ɐtˈvʲet/ ответ	/ˈvrat͡ɕ/ врач
/krɨɫ/ крыл	/zɐˈdaj/ задай	/vɐˈspʲet/ воспет	/pɐˈlat͡ɕ/ палач
/zɐˈbɨɫ/ забыл	/ʂɐˈgaj/ шагай	/skʲɪˈlʲet/ скелет	/stʊˈkat͡ɕ/ стукач
/ʊˈmɨɫ/ умыл	/pədrɐˈʐaj/ подражай	/sʊˈjet/ сует	/ɐˈdːat͡ɕ/ отдач
/plɨɫ/ плыл	/prʲɪt͡stɐˈvaj/ представай	/fʊrˈʂʲet/ фуршет	/tɐlˈmat͡ɕ/ толмач
/pɐˈsɨɫ/ посыл	/zəkɐˈpaj/ закопай	/ɐˈbʲet/ обет	/kuˈsat͡ɕ/ кусач
/ʊˈnɨɫ/ уныл	/kɐˈt͡ɕæj/ качай	/prʲɪˈvʲet/ привет	/gɐrˈlat͡ɕ/ горлач
/vɨɫ/ выл	/xrɐˈmaj/ хромай	/ʐɨˈlʲet/ жилет	/pʲɪrˈvat͡ɕ/ первач

Table 6. All words used in initial training and generalization testing, including pronunciation in IPA transcription and orthographic representation.