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Pescado or Fish? Rapid Automatic Naming Performance for Young Spanish-Speaking English Language Learners

Stephanie Michelle McMillen Mrs.

PESCADO OR FISH? RAPID AUTOMATIC NAMING PERFORMANCE FOR YOUNG SPANISH-SPEAKING ENGLISH LANGUAGE LEARNERS

by

Stephanie Michelle McMillen

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Abstract

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Rapid automatic naming (RAN) is a behavioral task that measures how quickly and accurately an individual can name a set of pictured items. This task is an important predictor for reading success in young children, regardless of the number of languages spoken. As a measure of lexical processing efficiency, RAN reflects the speed and accuracy of lexical access and retrieval, which is required for comprehension and production of spoken and written language. The aim of this dissertation was to investigate the longitudinal performance across languages on a RAN Objects task for young Spanish-speaking English language learning (ELL) children, as well as the predictive value of the task measures for later word reading for ELL and monolingual children.

Although the ELL children were reported to have little experience with English prior to entering kindergarten, we found that ELL children were actually faster and more accurate in English than in Spanish by the end of kindergarten. Another surprising finding was that when compared to their monolingual English-speaking peers, ELL children were equally as fast and accurate as the monolinguals on this RAN Objects task in English. Additionally, we found that these early RAN measures were significantly predictive of later word reading for both ELL and monolingual children. Based on our findings, we proposed that ELL children have a rapid shift in lexical processing efficiency from their first to their second language during the kindergarten year. This shift occurs much earlier than previously reported and may be facilitated by a combination of cognitive-linguistic and environmental factors, including lexical density, the strength of lexical connectivity, and priming effects secondary to environmental context.

Overall, this work expands upon prior research by emphasizing the predictive value of the errors produced on the RAN Objects task. This work also supports evidence-based practice by demonstrating that the time of testing, language of testing, and the types of measures used are important considerations when identifying children for potential reading deficits. Taken together, these findings provide theoretical and practical insight into the importance of the RAN Objects task as an indicator of lexical processing for young Spanish-speaking ELL children.

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Chapter 1

Introduction

In the U.S., formal education is predominantly conducted in only English with little support for children who speak other languages. Upon entrance into the public school systems, these children are required to learn English for both oral and written communication. With the number of English Language Learners (ELLs) growing in the United States (U.S. Department of Education, National Center for Educational Statistics, 2016), there is escalating pressure on educators and speech-language pathologists to provide culturally and linguistically appropriate assessments to measure academic progress in the school systems.

An integral component of academic success is reading. Reading is a language-based skill, which requires the integration of linguistic information with visual input to create meaning derived from print. Upon entrance into elementary school, it is common practice for monolingual English-speaking children to learn oral and written language in their native language, English. On the other hand, ELL children in the U.S. begin learning one oral language at birth (e.g., Spanish) and—upon entrance into an academic setting after the age of 3—are then required to simultaneously learn a second oral language with its corresponding orthography for their non-native language, English. Because ELL children do not have the linguistic foundation to support their literacy-learning nor support from literacy knowledge in their native language, it might be expected that ELL children's reading performance falls behind that of their monolingual English-speaking peers. Due to the differences in linguistic knowledge for ELL children and their monolingual English-speaking peers, it is important to consider lexical development for dual language learners. Specifically, it is important to understand what and how linguistic characteristics in the first language can potentially support second language-learning for long term academic success.

For ELL children, some language knowledge is partially distributed across the two language systems in their lexicons, including semantic knowledge (Dijkstra, 2005; Oller & Pearson, 2002); however, not all linguistic elements for both oral language and literacy are bound to a single lexicon. That is, some oral language and literacy abilities share characteristics across lexicons, which causes facilitation[1] for processing linguistic information across languages (Miller et al., 2006). Facilitation in the context of lexical access means that one entity (e.g., representation) supports the identification of another entity via the automatic spread of activation. For example, letter sounds may be shared across languages and knowing that a letter represents a specific sound[2] (e.g., /l/ is represented by the symbol 'L' or 'l' in both English and Spanish) is a skill that can facilitate lexical processing. Not only is this the case for languages that share similar orthographic systems (e.g., Spanish and English are both alphabetic systems), but facilitation also occurs at the phonological level both within and across languages (Colomé & Miozzo, 2010; Costa, Miozzo, & Caramazza, 1999; Wu, Cristino, Leek, & Theirry, 2013). Theoretically, facilitation may provide a window into how lexical processing, or efficiency of lexical access and retrieval, is influenced by the quantity and quality of linguistic knowledge represented among the lexicons of bilingual individuals, as well as how this processing is affected by having multiple lexicons as compared with having a single lexicon. Facilitation

[1] Although facilitation may occur, shared knowledge between lexicons in bilingual individuals may hinder processing. This is called *interference* and has been experimentally demonstrated in picture naming paradigms with bilingual adults (e.g., Costa et al., 1999; see also Colomé & Miozzo, 2010, for facilitation effects during picture naming paradigms in bilingual adults).

[2] Knowledge about letters, or graphemes, and their corresponding sounds, or phonemes, is called alphabetic knowledge (Ehri, 2000).

would cause faster, more accurate processing because activation would automatically spread to features shared across the lexicons (e.g., Logan, 1980).

In addition to facilitation, transfer can also positively or negatively impact lexical processing because knowledge from one language is applied to another language (Cummins, 1984, 1991, 2000). Theoretically, like facilitation, transfer may occur with respect to lexical information, where knowledge that overlaps across two lexicons eases the efficiency of comprehension and production. For example, if a native English speaker is learning Spanish and hears the word "bicicleta" in a sentence, comprehension will be reached more efficiently for that word because the already established phonological and semantic features in the English lexicon will transfer to the developing Spanish lexicon. In addition to this example, transfer is also used in regard to skills, where an advanced skill (i.e., a skill that has been practiced often), such as a typically-developing adult's phonological awareness skills, would transfer to another language, even for an individual with little knowledge of the second language. Transferrable skills and knowledge that can be shared across languages may initially be more advanced in a young ELL child's native or first language (i.e., L1) because of his experience with that language. However, as the child begins learning and using the second language, these transferrable skills are believed to support lexical processing and learning in the second language (i.e., L2; MacWhinney, 1992). As such, measuring transferrable skills and knowledge in young ELL children could be beneficial for language assessment practices.

Practically, Durgunoğlu (2002) and Bialystok and Hakuta (1994) proposed that skills which can transfer cross-linguistically could be used as diagnostic indicators of potential language impairments in ELL children. Key language-based transferrable skills could be measured in young ELL children in their L1, and these scores could be used to predict later performance on related language skills in their L2. As such, poor performance on tests measuring these early-developing transferrable skills are considered to be a marker of potential language impairment. Accurately evaluating early-developing language-based skills is important for the identification of children who are at risk for or who have language impairment. For practitioners, it is difficult to accurately and efficiently assess young ELL children particularly because they are in the early stages of learning their L2, English, which is the primary language of instruction in mainstream American public schools. Because early identification of children with language impairment is critical to intervention, identifying and/or developing new methods for assessing young ELL children is paramount to clinical practice. Identifying and measuring skills that are transferrable across languages provides practitioners with a method of assessment that would rule out a delay in skills acquired due to limited L2 proficiency (Nakamoto, Lindsey, & Manis, 2012).

Two measures have become increasingly important in predicting reading success: rapid automatic naming (RAN) and phonological awareness (PA). RAN is a behavioral task reflective of lexical processing efficiency, whereas PA is a skill developed in response to experience with phonological units in oral and written language. Furthermore, research has demonstrated that both RAN and PA can transfer across languages (Lindsey, Manis, & Bailey, 2003; Manis, Lindsey, & Bailey, 2004). Thus, these measures have the potential to identify ELL children who may be in danger of having impaired reading.

The focus of this dissertation work was to evaluate the performance of young Spanish-speaking ELLs on a RAN objects task. Of particular interest was comparing performance in both Spanish and English in a longitudinal study design, as well as comparing ELL children's performance on the RAN test in English to that of young monolingual English-speaking children. Few investigations to date have explored or directly compared RAN performance by ELL children, including speed and accuracy, in Spanish and English. Exploration of RAN performance across languages and groups of children may provide insight into how lexical processing—specifically, lexical access and retrieval—is influenced by the development of a dual lexical system. An additional focus of this research was to understand the within and across language predictive relationships that RAN and PA have with later real and nonword reading in both Spanish-speaking ELL and English-speaking monolingual children. Insight into how the timing and language of testing, as well as how the measures are related to later word reading, may provide clinicians and educators additional evidence to support early test administration to this culturally and linguistically diverse population of children. Before introducing the studies, the theoretical foundation of rapid automatic naming and its significance for reading in monolingual, bilingual, and ELL children will be explained.

Chapter 2

Literature Review

What is Rapid Automatic Naming?

Rapid automatic naming measures how quickly and accurately an individual can name a set of pictured items. Superficially, these picture naming tasks seem inconsequential; however, researchers have found that the complexity of these tasks is intrinsically related to literacy development. As such, RAN is more than a simple picture naming task; it is a behavioral measure which relies on the coordination of multiple processes into a synchronized access and retrieval unit (Bowers & Wolf, 1993; Torgesen, Wagner, Rashotte, Burgess, & Hecht, 1997; Torgesen, Wagner, & Rashotte, 1994; Wagner, Torgesen, & Rashotte, 1994; Wolf & Bowers, 1999). Importantly, RAN and reading are both tasks that require rapid and accurate access and retrieval of linguistic information for production and comprehension. Individuals who lack this requisite efficiency and accuracy in processing linguistic information would inevitably perform poorly on both tasks. Geschwind and Fusillo (1966) were the first to develop and use a rapid color naming task with adults who had acquired alexia. These researchers found that although patients with alexia could indeed name the various colors, the patients were slow and inaccurate, indicating inefficient access and retrieval of linguistic information from the mental lexicon for production. In 1972, the rapid color naming task was incorporated into the Mental Examiner's Handbook, and was used as a criterion-based measure of performance (Denckla & Cutting, 1999).

In the early 1970s, researchers began to explore the implications of rapid naming as a developmental measure of processing. This rapid color naming task was redesigned by Denckla (1972) and used to collect norms on kindergarten children. After this initial study, Denckla partnered with Rudel to develop three additional rapid naming tasks using familiar objects, digits, and lower case letters. Each of these tasks used 5 pictured items presented serially in a pseudo-randomized repeating order; the RAN Objects task was based on common words four-year-olds knew from the Stanford Binet Test of Intelligence. Denckla and Rudel (1974) were the first to link performance on RAN tasks to developmental, as opposed to acquired, reading ability, thereby establishing RAN as a predictor of reading success (Denckla & Cutting, 1999; Denckla & Rudel, 1976).

Today it is widely accepted that RAN is both a concurrent and longitudinal predictor of reading ability for monolingual English-speaking children (see Norton & Wolf, 2012, for a review); however, some RAN tasks have been shown to be more strongly related to reading than others. Methodological conditions within the RAN tasks that can be manipulated include the presentation style—discrete (also called isolated naming) and serial naming[1]—as well as the stimulus type which consists of alphanumeric (letters and digits) and non-alphanumeric (colors and objects). Of these presentation styles, serial naming tasks are more predictive of reading performance through the fourth grade, whereas discrete naming tasks show a minimal relationship with later reading outcomes after first grade (de Jong, 2011; Walsh, Price, & Gillingham, 1988; Wolf & Bowers, 1999). Additionally, rapid serial naming can be used to distinguish groups of good readers from those who are poor readers, whereas discrete naming cannot differentiate reading ability (Perfetti, Finger, & Hogaboam, 1978).

[1] Discrete naming is a presentation format where stimuli are individually presented on a (computer) screen. A blank screen is presented in between the stimulus screens, and all screens are shown for a pre-determined set amount of time. The time that the blank screen is displayed is called the "inter-stimulus interval". For discrete RAN tasks, researchers typically measure the average time it takes for an individual to name each item from the beginning of each item presentation. The stimuli for the discrete RAN tasks are always similar to those found in the serial RAN tasks—colors, objects, numbers, and letters. Serial RAN tasks present the test stimuli in a (semi-) continuous string of items so that the participants see all of the pseudo-randomized stimuli on one page or screen (Logan, Schatschneider, & Wagner, 2011).

The stimulus type used in the RAN task also significantly influences the strength of the relationship with reading for monolingual English-speaking children. Alphanumeric (digits and letters) RAN was more strongly related to both decoding accuracy and reading fluency[2] than nonalphanumeric (objects and colors) RAN. RAN colors tasks lose predictive ability for word reading outcomes after the first grade; however, the predictive relation between word reading and RAN objects tasks remain strong through the third grade (de Jong, 2011; Georgiou, Parrila, Kirby & Stephenson, 2008). In sum, all RAN tasks are positively correlated with reading; however, the type of stimuli used and the presentation style both have a significant effect on the relationship between RAN and reading.

RAN as a Reflection of Processing Efficiency: Implications for Lexical Structure and Representation

Rapid automatic naming tasks reflect a complex relationship between processing in various domains—including visual, lexical, and motoric domains—which are inherently entwined. The integration of these systems allows for the automatic processing of information encountered in the environment; however, this processing is dependent upon the quality of the representations stored in long term memory as well as the efficiency of spreading activation. Robust representations are those that have numerous strong connections with other information stored in long term memory; this robustness allows for activation to spread rapidly throughout these separate cognitive systems (e.g., visual, lexical, and motoric). With regard to RAN, it is believed that RAN is a component of the broader cognitive picture, representing processing specifically within the lexical system. Theoretically, RAN is an indicator of linguistic processing within the mental lexicon, which includes linguistic constituents required for oral as well as written (i.e.,

[2] Here, reading fluency comprises both the accuracy and rate for reading connected text.

orthographic) language. A breakdown in the efficiency of lexical processing—including processing of orthographic information—would result in slow and inaccurate rapid naming (Wolf & Bowers, 1999).

Some monolingual English-speaking children with dyslexia have been reported to have poor performance on RAN tasks, including poorer accuracy for naming pictured stimuli as well as overall slower naming. This difficulty may be indicative of fewer, weaker connections between lexical information, resulting in underspecified linguistic and/or orthographic representations (Wolf & Bowers, 1999). Slowed lexical processing would result from poorer quality of lexical representations, which would cause a cascading effect on the timing of the activation spreading to other systems for further processing. In relation to reading, this inefficient processing would cause integration of information for comprehension to be adversely impacted, as well as poorer fluency[3] during reading (Bowers, 1995; Wolf, 1997; Wolf & Bowers, 1999).

With regard to processing for spoken language tasks, including verbal fluency and picture naming tasks, typically-developing sequential and simultaneous bilingual individuals have slower performance on these tasks in comparison to their monolingual peers (Bialystok, 2007). This relatively poorer performance for bilinguals may be secondary to the quantity and quality of lexical connections where fewer and/or weaker connections would hinder efficient spreading activation, resulting in slowed lexical processing and verbal production in comparison to their monolingual peers. Alternatively, simultaneous bilinguals would theoretically have the opportunity to develop robust lexical representations in each language, which should lead to efficient lexical processing and naming in each language, as required for the RAN tasks. However, the robustness of lexical representations is dependent upon the quantity and quality of

[3] Reading fluency is defined as a slower reading pace with inaccurate retrieval of linguistic information.

experience with each language, as limited exposure to a language would lead to underdevelopment of the representations in that language. Given that simultaneous bilingual children gain dual language proficiency by communicating in both languages in the home and/or school environments, they could potentially complete RAN tasks equally well in each language. Alternatively, sequential bilingual (or ELL) children who have more limited experience with their second language and presumably less well-developed lexical representations would be predicted to have poorer performance on RAN tasks.

Relative to their monolingual peers, weaker lexical representations for bilinguals may be due to more limited frequency of language use and may limit the efficiency of lexical access and retrieval. Lexical development has been explored through the receptive-expressive vocabulary gap, which is the discrepancy between receptive and expressive vocabulary knowledge in each language. In general, receptive vocabulary tends to be significantly greater than expressive vocabulary, which tends to be more limited. This phenomenon occurs in both adults who have experience with both languages as well as children who have restricted exposure to their second language (Gibson, Peña, & Bedore, 2014; Oller et al., 2007; Windsor & Kohnert, 2004). In a study exploring Spanish-English emergent bilinguals in kindergarten, Gibson and colleagues (2012) found that sequential bilingual children had a small receptive-expressive gap in English (L2) and a large gap in Spanish (L1). Interestingly, this gap persisted across all groups of children regardless of amount of the children's English exposure, mother's education, mother's English proficiency, and the number of adults and children in the home. The authors concluded that these children had difficulty accessing their L1 for production on standardized vocabulary measures while immersed in the L2 environment. They also concluded that the onset of the receptive-expressive gap occurred abruptly as children who had limited L2 exposure prior to entering the English-only kindergarten environment had a robust vocabulary gap (Gibson, Oller, Jarmulowicz, & Ethington, 2012).

Gibson et al. (2014) took a slightly different approach in their examination of language experience on the receptive expressive gap in 778 Spanish-English bilingual preschoolers. Each of the children was placed in one of five language groups ranging from functionally monolingual to balanced bilingual. The authors found that all children, regardless of language group, presented with a receptive-expressive language gap. Although this gap was not significantly large in Spanish, there was a significant discrepancy was found for English. The magnitude of the gap in both languages increased as children's second language exposure decreased. That is, children who had more exposure to English had a smaller receptive-expressive gap in their L2 than children who had very little exposure to English. The authors concluded that language exposure is the most important factor influencing the receptive-expressive gap and that this gap is much more likely to be present in the L2 than the L1.

Two possible accounts for these findings have been proposed: A sociolinguistic account and a suppression mechanism. The authors stated that their findings might support an account of bilingual lexical access where the children's first language (Spanish) is suppressed as a result of being immersed in a second language (English) environment (i.e., school); however, it may also be that the relative levels of activation (also known as "relative activation"; see Costa, Santesteban, & Ivanova, 2006, for more information) are greater for the L2 than the L1 in contexts where the L2 is the primary means for communication (Gibson et al., 2012). A suppression mechanism may also be implicated in the receptive-expressive gap in multilingual individuals. This mechanism could facilitate vocabulary learning in the L2 by suppressing L1 interference (Oller et al., 2007). This may explain why young emergent bilingual children are able to understand vocabulary but have difficulty with production in their L1. Young school-aged children learning a second language would have limited vocabulary knowledge in their L2; thus, the suppression mechanism would allow them to express the vocabulary terms that they know in their L2, resulting in a smaller receptive-expressive gap in the L2. This reasoning falls in line with a model of bilingual lexical access called the *Inhibitory Control* model proposed by Green (1998). The task demands imposed by the environment would suppress the non-target language (Spanish), causing greater relative activation for the target language (English) and leading to the receptive-expressive gap (Gibson, Oller, Jarmulowicz, & Ethington, 2012).

Another interpretation of the receptive-expressive gap proposed by Oller, Pearson, and Cobo-Lewis (2007) falls in line with a sociolinguistic account, which proposes that when the second language is the predominant language in the environment, these children are required to use the first language less. This decrease in use would cause relative activation of the L1 lexicon to be lower than that of the L2 lexicon. More limited activation of the L1 may in turn lead to decreased readiness for expression in the L1 while still maintaining adequate levels of activation for language comprehension. This account is supported by Linck, Kroll, and Sunderman (2009), who proposed that when bilinguals are immersed in an environment where the L2 is predominant, their L1 is suppressed.

Alternatively, when language use has decreased in one language because language experience is now divided between multiple languages, the connections between lexical information may weaken, resulting in less efficient processing within the specified lexicon(s). This scenario would support the “weaker links hypothesis”, where phonological and semantic representations have accumulated fewer and weaker links between them within each lexicon due to lower frequency of use. This would result in poorer lexical accessibility for bilinguals as compared with monolinguals (Gollan, Montoya, Cera, & Sandoval, 2008; Gollan, Montoya, & Werner, 2002; Gollan, Montya, Fennema-Notestine, & Morris, 2005; Gollan & Silverberg, 2001).

The effects of priming[4] secondary to environmental context, suppression, and/or weaker links could contribute to lexical interference, which would slow processing speed and may inhibit accurate and rapid verbal production. This interference may be the result of a bottle-neck effect between languages, where information is in competition between the two languages. Interference effects at the lexical level are well-documented in research pertaining to adult bilinguals; however, for adult bilinguals who learned their L2 at a young age, facilitation effects occur for words that are translation equivalents or one word in each language that share a single meaning (e.g., "perro" in Spanish and "dog" in English). Facilitation effects occur at the phonemic level where words that shared similar phonemic properties are named faster (Colomé & Miozzo, 2010; Costa et al., 1999; Hermans, Bongaerts, de Bot, & Schreuder, 1998; Titone, Libbon, Mercier, Whitford, & Pivena, 2011; Wu et al., 2013). As such, words that share cognate status[5] across languages result in faster naming speed in both bilingual children and adults because these word types share both phonological features and semantic features (Gollan & Acenas, 2004; Gollan et al., 2005; Poulin-Dubois, Bialystok, Blaye, Polonia, & Yott, 2013; Titone et al., 2011).

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[4] Priming can be defined as the involuntary activation of information stored in memory that is associated with a perceived stimulus. This activation increases the efficiency of access and retrieval for the primed information. For example, if Spanish-speaking ELL children are emerged in an English-only environment, it would theoretically cause them to be more efficient at naming items in English relative to Spanish because the English lexicon would have a higher activation level relative to the Spanish lexicon. Thus, lexical access and retrieval would be faster for English lexical items as compared with Spanish lexical items.

[5] Cognates are words that phonologically and semantically similar across two languages and share etymological roots. For example, "bicycle" and "bicicleta" are cognates in English and Spanish, respectively.

In sum, bilingual children experience a complex combination of lexical facilitation and inhibition relative to monolinguals for naming pictured items. These processes inevitably determine accessibility of linguistic information and control processing speed and accuracy during RAN tasks.

Theoretical Explanations for the Relation Between RAN and Reading

Although it is generally agreed that there is an established relationship between RAN and reading, the original theoretical stance purported that the tasks were associated indirectly. That is, Geshwind believed that the neural processing implicated in the original RAN color task was similar to that required for reading. Thus, rapid color naming was not necessarily a component of reading[6] but rather RAN and reading relied upon the same processing mechanism for task completion; this would lead to an indirect relation rather than a direct relation between measures (Norton & Wolf, 2012). By accounting for other factors, such as processing motor movements, and using advanced statistical analyses, such as structural equation modeling, later research determined that there is indeed a direct relationship between RAN and reading (McBride-Chang & Manis, 1996; Powell, Stainthorp, Stuart, Garwood, & Quinlan, 2007). RAN is a behavioral measure that reflects many moving parts (i.e., linguistic processing, visual processing, motor movements for articulation, etc.); however, the current debate pertains to determining what processing construct RAN reflects. The three major theoretical views concerning RAN and its relation to reading include 1) RAN as a reflection of a general cognitive processing system, in keeping with the Global Cognitive Processing theory (Kail & Hall, 1994); 2) RAN as a reflection of the phonological processing system, in keeping with the Phonological Processing theory

[6] This would lead to a direct relationship between RAN and reading.

(Wagner & Torgesen, 1987); and 3) RAN as a reflection of lexical processing system, in keeping with the Orthographic Processing theory (Wolf & Bowers, 1999).

Kail and Hall (1994) proposed that RAN and reading are behaviors which are related indirectly because these tasks, along with others (i.e., articulation rate) are regulated by global processing speed. As such, their theory has been named the Global Cognitive Processing theory. According to this position, RAN reflects global processing speed realized through an overarching processing mechanism, which includes but is not limited to gross and fine motor processing, visual processing, and lexical processing. Both RAN and reading are behaviors that require rapid and efficient processing of linguistic information; thus, the speed with which items are named (i.e., RAN) is limited by global cognitive processing. Consequently, individuals with slow global cognitive processing will have slow performance on both RAN and reading tasks. The authors posit that the rapid naming ability is intrinsically reliant upon the global processing mechanism[7]. Using path analysis, these authors found that performance on RAN tasks was predicted by measures of global processing speed[8] (Kail & Hall, 1994; Kail et al., 1999). Under this premise, it would be expected that individuals with impaired cognitive processing secondary to a developmental deficit would have slower rapid naming and reading in addition to a general slowing in processing speed across modalities (e.g., for processing auditory information, motor movements, etc.). Thus, slower RAN performance is secondary to an underlying global cognitive processing deficit (Kail & Hall, 1994; Kail et al., 1999).

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[7] This global cognitive processing mechanism includes executive functions. They posited that efficiency of this processing mechanism is driven by age, not automaticity of access within the brain.

[8] The measures implemented by Kail and colleagues to test global processing speed included the Visual Matching and the Cross-out tasks from the Woodcock-Johnson test of Cognitive Ability.

More recent research has used advanced statistical modeling to account for the causal relationships between factors. Research incorporating structural equation modeling has suggested that RAN and reading have a relationship that is not mediated by domain-general cognitive processing; thus, the constructs underlying RAN and reading tasks are linked directly such that a deficit in one would result in poor performance on the other (McBride-Chang & Manis, 1996; Powell et al., 2007). Children with RAN processing speed deficits have slower processing speed times only for linguistic information when compared to their typically-developing children. When measures of general cognitive processing (i.e., reaction time on a computerized task and the cross-out task on the Woodcock-Johnson Tests of Cognitive Ability), phonological processing, and RAN had been accounted for, RAN continued to make a significant contribution to reading above and beyond general processing speed and phonological processing (Powell et al., 2007). This indicates that the lexical processing construct measured by RAN directly impacts performance on reading tasks.

The most highly debated theoretical position with regard to whether or not RAN is a component of a modular phonological processing unit. The Phonological Processing theory posits that RAN is related to reading because it measures the retrieval speed for phonological information stored in long term memory (Wagner & Torgesen, 1987). Performance on three tasks—RAN, PA, and phonological working memory— tend to be highly associated with each other as well as with reading. The separate underlying constructs that these tasks are measuring are hypothesized to be part of a larger, singular phonological processing mechanism; this mechanism is crucial for reading (Torgesen et al., 1997; Torgesen et al., 1994; Wagner, Torgesen, & Rashotte, 1994).

Phonological processing has a reciprocal, causal, and longitudinal relationship with reading development (Torgesen, et al., 1997; Torgesen et al., 1994; Wagner et al., 1994). Phonological processing skills are relatively stable over time, and impaired phonological processing will inevitably have a long-term negative impact on reading development and performance (Torgesen et al., 1994). Just as poor phonological processing remains stable over time, poor readers in first grade tend to be poor readers in later grades (Stanovich, 1986). This, however, has been a controversial point in the literature as other research has shown that diagnoses of impoverished reading skills are unstable during early elementary school (Shaywitz, Escobar, Shaywitz, Fletcher, & Makuch, 1992). Torgesen and his colleagues have suggested that because individual differences in the processing of phonological information is a consistent long-term characteristic and is directly related to reading performance, the individual tasks that comprise phonological processing are not as meaningful as viewing phonological processing as a singular construct when evaluating children for reading impairment (Torgesen et al., 1994).

As an alternative to the Global Cognitive Processing and the Phonological Processing theoretical positions, Wolf and her colleagues have proposed the Orthographic Processing theory. This viewpoint proposes that RAN tasks measure the efficiency (i.e., both rapid speed and accuracy) with which individuals can recognize orthographic units, emphasizing the role of visual processing and recognition of letters, letter patterns, and whole words stored in the lexicon. Orthographic processing occurs when mental graphemic representations (MGRs), which are visual representations of either whole words or partial words (groups of letters) stored in long term memory and connected to semantic and phonological information, are accessed and retrieved for recognition and/or production (Apel, 2011; Ehri, 1989). The lexical processing reflected in the RAN task is implicated in processing both phonological and orthographic information because rapid and accurate access of visual information would overlap with the stored representations of visual words as well as the names (i.e., phonological constituents) of those stimuli. Bowers and Wolf (1993) view the lexical processing measured by RAN as a lexical midpoint because it requires the integration of information at various levels of processing, including visual perception, lexical access and retrieval, and fine motor movements (i.e., articulation); thus, it is considered to be a behavioral measure that represents a multicomponential cascading system based on efficiency rather than strictly phonological manipulation (see also Wolf & Bowers, 1999). Although this begins to sound similar to the viewpoint held by the global cognitive processing theory, the authors believed that the processing measured by RAN is specific to the lexicon. As supporting evidence for this theory, they asserted that there is a specific slowing in RAN with regard to children with developmental dyslexia, and this slowing is independent of slower processing speed in other cognitive domains including, but not limited to, gross motor movements (e.g., walking, running swimming; Bowers & Wolf, 1993; Wolf & Bowers, 1999).

These researchers propose that slow rapid naming performance may be indicative of a deficiency in the precision in the timing of processes involved in both RAN and reading. Although Bowers and Wolf (1993) agree with Torgesen and his colleagues that processing associated with phonological codes can interfere with reading, orthographic representations that are underspecified with fewer connections and of poorer quality would also slow naming speed (Wolf & Bowers, 1999). For example, a young child may be able to decode, or read by sounding out, the word “yacht” silently in text but may have difficulty with the pronunciation, meaning, and spelling of this word. This is because the connections between the phonological code (i.e., pronunciation), semantic representation (i.e., meaning), and the visual representation (i.e., spelling) are weak and sparse, resulting in a poor quality representation for this word. The ability to name pictured stimuli serially, including both alphanumeric and nonalphanumeric stimuli (i.e., the RAN task), is dependent upon the automatic activation and interaction between phonological, semantic, and orthographic (for individuals who are literate) information stored in long term memory; thus, Bowers and Wolf have acknowledged the complexity of processing that RAN taps into. Because all of these systems are interconnected (see Ehri, 1989), a breakdown in one or more domains would lead to slower, more effortful, less automatic reading (Bowers & Wolf, 1993).

Although all of these cognitive domains are connected, there is some evidence of independence between the phonological and orthographic domains drawn from studies of children with impaired reading. Children with reading impairments have been reported to have poor decoding skills for nonwords, which would be a phonological processing task, while their identification of correctly spelled real words, an orthographic processing task, was comparatively better (Olson, Wise, Conners, & Rack, 1990). As such, the authors stipulated that there must be a divergence between phonological processing and orthographic processing (Wolf & Bowers, 1999).

Current lines of research indicate the lexical processing in RAN tasks and the phonological manipulation in PA tasks are separable constructs that contribute uniquely to reading achievement in children (McBride-Chang & Manis, 1996; Powell, et al., 2007; Wolf & Bowers, 1999). RAN tasks are reflective of the automatic and effortless access to lexical information stored in long term memory. The term “automatic” from a reading perspective means that visual and linguistic (i.e., phonological and semantic) information is processed independent of volition

(LaBerge & Samuels, 1974)[9]. After the second and third grades, good readers are nearly automatic in their reading, whereas impaired readers continue to struggle with automatic, fluent reading. As it applies to reading development, naming speed has been found to be a poor predictor of reading performance for good readers after the second and third grades; however, for poor readers, naming speed is indicative of reading performance through the eighth grade[10] (Wolf & Bowers, 1999). Thus, RAN is an important behavioral measure for identifying young children with potential reading deficits, as well as predicting later reading performance. Importantly, this relationship between RAN and reading does not appear to be due to general intelligence or vocabulary (Bowers, Steffy, & Swanson, 1986; Bowers, Steffy, & Tate, 1988). Rather, RAN tasks are reflective of the rapid and accurate access, retrieval, and integration of information stored in the lexicon. Underdevelopment of the connections within this system would result in slower, more effortful performance on RAN tasks and, consequently, poorer reading fluency and comprehension. Poor RAN performance signals deficits within the lexical system and warns clinicians and researchers to look for potential weaknesses in the future development of the orthographic system (see Wolf & Bowers, 1999, for more discussion).

The Relation Between RAN and Reading for Monolingual Children

Although RAN tasks are important indicators of potential reading ability in young children, few studies have been conducted in languages other than English. While this literature is in need of further development, the current consensus among investigators is that rapid naming tasks have a consistent correlation with reading regardless of language for monolingual children. In German, children with dyslexia in the second through fourth grades were found to have a rapid

[9] This view is contrary to the theoretical framework for RAN laid out by Kail and his colleagues.

[10] This finding has been applied to monolingual English-speaking children only.

naming deficit. Specifically, the RAN digits task was found to be the best predictor of word reading differences between typically-developing children and those with dyslexia (Wimmer, 1993). For Dutch-speaking children, investigators found both RAN and PA deficits in poor readers; remarkably, RAN was the strongest predictor of word reading (de Jong & van der Leij, 1999). Investigators examining Greek have found that both RAN-Objects and RAN-Digits were significantly correlated with later reading fluency in second through sixth grade children (Georgiou, Parrila, Cui, & Papadopoulos, 2013). Clinton, Cristo, and Shriberg (2013) analyzed reading skills in monolingual Spanish-speaking kindergarten children in Colombia. They found that RAN, PA, and orthographic coding were all highly correlated with real and non-word reading, as well as with reading comprehension. RAN has also been found to be significantly associated with second grade Chinese character fluency recognition as well as fourth grade character fluency and accuracy for Taiwanese students (Georgiou, et al., 2008). Overall, these studies demonstrate that RAN is significantly related to reading in monolingual children regardless of language.

The Relation Between RAN and Reading for Simultaneous and Sequential Bilingual Children

Compared with monolingual individuals, simultaneous bilingual adults experience rapid naming deficits, including poorer performance on picture-naming and verbal fluency tasks (Bialystok, 2007). This lack of efficiency on expressive language tasks may be secondary to increased interference and competition between the dual lexical systems in bilingual individuals, which in turn results in slowed executive functioning relative to monolingual adults (Bialystok, 2007, 2009; Bialystok, Luk, & Kwan, 2005). Executive function skills required for fluent processing in bilingual individuals include, but are not limited to, continuous attention to context, judging whether a linguistic switch is necessary, and inhibition of unnecessary linguistic information (Bialystok, 2007, 2009).

Cognitive processing—linguistic processing, in particular—can become more effortful for young ELL children because they are often required to learn a second language in an educational setting where there is little support from their first language. Kohnert and her colleagues have found that young elementary school ELL children are slow and inaccurate when naming pictured items, regardless of language. However, as children gained more control over their lexical systems with increased language experience and general cognitive development, they became faster and more accurate at naming pictures across languages (Kohnert, 2002; Kohnert, Bates, & Hernandez, 1999). Increased control of cognitive processes provides effective and efficient performance in both languages and can be considered essential to adequate performance on RAN tasks.

Although the current research on this line of investigation is limited, researchers have demonstrated that RAN tasks are correlated with reading both within and across languages for bilingual children (see Norton & Wolf, 2012, for an overview). For example, RAN was a significant cross-linguistic predictor of reading across orthographies for Norwegian-Swedish simultaneous bilingual children; thus, performance on the RAN task in Norwegian predicted later reading in Swedish and performance on the RAN task in Swedish predicted later reading in Norwegian (Furnes & Samuelsson, 2011). This means that there is some evidence that performance on RAN tasks is an important cross-linguistic predictor of reading ability. This notion has also been explored in young Spanish-speaking ELL children in the United States.

Lindsey et al. (2003) conducted a longitudinal study of Spanish-speaking ELL children in the U.S. from kindergarten through first grade investigating the relations between oral language and literacy measures. These young children were enrolled in a transitional dual language emersion program where they received literacy training in both Spanish and English. Primarily, the researchers found that Spanish PA and English PA were correlated with measures of word reading and reading comprehension across and within languages. The authors also found that measures of print awareness, RAN Objects, and letter identification were significant cross-linguistic predictors of word identification. RAN Objects, in particular, was significantly correlated with all oral language and literacy measures in this study. Because of the significant cross-linguistic relations between the measures, the authors stated that this evidence supports RAN and PA as general—not language-specific—processes (Lindsey et al., 2003).

Manis et al. (2004) extended their previous longitudinal study (Lindsey et al., 2003) to include Spanish-speaking ELL children from kindergarten through second grade. The authors found that all of the Spanish measures were significantly correlated with English reading in the second grade. Hierarchical regression analyses showed that PA and RAN Objects were significant unique predictors of later English word and letter identification; however, print knowledge in Spanish was the most significant predictor overall. Interestingly, English measures mediated the contribution of Spanish variables to later reading in English. Thus, after accounting for Spanish variables, the strongest English-language measures that predicted later reading were PA followed by RAN (Manis et al., 2004).

The Current Investigations

This dissertation work comprises three studies addressing key issues pertaining to young Spanish-speaking ELL children's performance on oral language and literacy tasks. Specifically, I investigated the longitudinal performance on a RAN Objects test by a group of young ELL children and their monolingual English-speaking peers. Performance on RAN and PA tasks have well-established predictive relations with later reading in both young monolingual and bilingual children (e.g., Manis et al., 2004; Wolf & Bowers, 1999). However, few studies have investigated speed (i.e., duration) and accuracy measures on RAN tasks across languages and across groups of children, or how those RAN measures relate to later word reading. The current work will provide theoretical and practical information about lexical processing in dual language learners.

The first two studies, which are included in Chapter 4, compared RAN performance (i.e., duration and accuracy) across languages within the ELL group as well as performance in English across both groups of children. We also evaluated whether an expanded error coding system would strengthen the original scoring method for a RAN Objects test. Theoretically, this work provides insight into how lexical processing—as measured by RAN performance—is affected by the development of a dual lexical system. Specifically, evidence will shed light on how lexical density and the strength of lexical representations within each lexicon either facilitates or inhibits rapid object naming. According to Gollan and colleagues, the strength and number of connections within the lexicon directly impacts lexical processing efficiency and lexical accessibility (Gollan et al., 2008; Gollan et al., 2002; Gollan et al., 2005; Gollan & Silverberg, 2001). I propose that these lexical factors, as well as environmental constraints, impact lexical processing resulting in unique performance patterns on the RAN task for the monolingual and the ELL children.

The third study included in Chapter 5 evaluated RAN and PA in kindergarten as predictors of later decoding and sight word reading in the second grade for the ELL and the monolingual children. Specifically, RAN duration and two types of RAN errors (i.e., hesitations and additional errors) were used to predict later word reading in the two groups of children.

Although there is a precedent in the literature for using RAN duration as a predictive measure, to date no previous investigations have compared the predictive relations between the RAN errors and word reading for ELL children. This work will support evidence-based practice for clinicians by demonstrating which considerations are most important for identifying ELL children with potential reading deficits. Specifically, considerations include measures (RAN and/or PA), language (Spanish and/or English), and the time of testing during kindergarten. Theoretically, this work aims to speak to differences in RAN error types and RAN duration as measures of lexical processing for young children.

Chapter 3

Methods

Participants

Participant data were compiled from a five-year longitudinal project at the University of Memphis which focused on the impact of dual language acquisition on literacy skills in early school-aged ELLs. The current studies included Rapid Automatic Naming of Objects (RAN Objects) data for 40 Spanish-speaking ELL children (25 boys, 15 girls), ages 58 to 75 months (mean age = 66.3 months or 5.5 years at the beginning of kindergarten), and 26 monolingual English-speaking children[1] (17 boys, 9 girls), ages 60 to 72 months (mean age = 67 months or 5.6 years at the beginning of kindergarten), from Memphis, Tennessee. For the ELL children, parent reports indicated that all children were exposed to Spanish from birth and began learning English as a second language in either preschool or kindergarten. See Table 1 for demographic information. At the time of testing, all children were healthy and had no known speech, language, hearing, or cognitive impairments.

Participants were excluded if they repeated kindergarten (n = 1) or if they had withdrawn from the longitudinal study (n = 9). An additional criterion was included for the group of monolingual children such that any child in this group who could not accurately complete the practice items on the RAN Objects task at all points in time was excluded from this study (n = 2). Data from children who were excluded were not counted in any of the analyses.

[1] Only 21 monolingual children (14 boys, 7 girls) were included in studies 1 and 2 in Chapter 4; the additional 5 monolingual children were included in study 3 in Chapter 5.

Table 1

Demographic Information at Time 1 in Kindergarten

	ELL children ***n* = 40**	**Monolingual children** ***n* = 26**
Mean Age at Time 1	66.3 months	67 months
Gender:		
Boys	25	17
Girls	15	9
Birth Country:		
U.S.	77.5%	100%
Other	22.5%	0%
Preschool Attendance	22.5%	50%
Preschool Language:		
English	48%	100%
Spanish	15%	
Both English & Spanish	37%	
Sibling Order:		
First born or Only child	42.5%	42.3%
≥ *Second child*	55%	50%
No Response	2.5%	7.7%
Mother's Education:		
≤ *Middle School*	42.5%	3.8%
High School	57.5%	61.5%
College	0%	34.7%

Materials

All children were given a battery of tests, which included the *Comprehensive Test of Phonological Processing* (CTOPP; Wagner et al., 1999). The CTOPP is a standardized test used to measure phonological processing skills in monolingual English-speaking children. Test-retest reliability coefficients for the CTOPP range from .70 to .90 for monolingual English-speakers. The RAN Objects subtest, the Elision subtest, and the Sound Matching subtest were administered from the CTOPP for the testing that occurred in English. For the ELL children, tests administered in Spanish were drawn from the *Test of Phonological Processing in Spanish* (TOPPS; Francis, Carlo, August, Kenyon, et al., 2001) and included the Elision and the Sound Matching subtests. The test-retest reliability coefficient for the TOPPS is .83; however, validity and further reliability data were still pending for this test at the time of this study. Because RAN was not included in the TOPPS, this subtest was taken from the CTOPP and administered in both Spanish and English to the ELL children using identical procedures provided in the CTOPP manual (see Wagner, Torgesen & Rashotte, 1999, for procedural information).

The RAN Objects task includes 36 pictured items in a 9 x 4 grid which are arranged in a random order on a single page. Stimuli include the following items: Star, boat, fish, key, chair, and pencil. Participants were required to serially name the items as quickly as possible. At the time of testing, no normed RAN tests in Spanish existed; consequently, Form A of the RAN Objects subtest from the CTOPP was administered at all time points in both English and Spanish.

The Elision and Sound Matching subtests are measures of children's ability to manipulate phonemes, or phonological awareness. The Elision task requires children to omit target sounds in words. For example, a child may be asked "say the word *cat* without the */k/*"; the correct response would be *at*. No picture stimuli were used for this task; as such, it was an auditory task that relied on children's PA and working memory skills, as well as their existing lexical knowledge. All stimuli were presented from a standard recording provided by the CTOPP for testing in English. For the Elision subtest in Spanish, recorded stimuli were not available through the TOPPS. To make administration similar to the English tests, a female, native Spanish-speaker recorded the stimuli. These recorded stimuli were presented for the testing in Spanish.

The Sound Matching subtest requires children to identify the pictured item that shares the same initial sound as the target stimulus from a set of pictured stimuli. The target stimuli were presented via a recording from the CTOPP for testing in English. Recorded stimuli were not available for the TOPPS in Spanish; thus, the same examiner who recorded stimuli in Spanish for the TOPPS Elision task also recorded stimuli for the TOPPS Sound Matching task. These recorded stimuli were used for all testing in Spanish. The Elision and Sound Matching subtests were administered at the beginning and end of kindergarten—Time 1 and Time 2, respectively see Figure 1)—in both English and Spanish.

The *Test of Word Reading Efficiency* (TOWRE; Rashotte, Torgesen, & Wagner, 1999) is a standardized test that measures children's efficiency for reading as many real words (e.g., "have") and nonwords (e.g., "bice") in English as possible within 45 s. Inter-rater reliability coefficients for the TOWRE range from .93 to .96 across both subtests for monolingual English-speakers. All children were administered this test in English during the second grade (i.e., Time 3; see Figure 1) only.

Equipment

Marantz PMD670 solid state professional digital recorders and Isomax E61OP6T2 Countryman headset microphones were used for all recorded data. Headset microphones maintained a consistent mouth-to-microphone distance throughout testing. Microphones were managed by the examiners only; children were assisted with any positioning or adjustments that occurred throughout the testing sessions. Offline scoring was conducted through Sony MDR-NC6 noise cancelling headphones.

All RAN data were analyzed using *Time Frequency Analysis Software Program for 32 bit Windows* (TF32; Milenkovic, 2010). TF32 is a software program used to acoustically analyze speech through frequency waveform. Coders manually manipulated the TF32 cursors along the spectrogram for optimal measurement precision of offline calculations for total test completion time and pause times for each participant.

Test Administration

Testing was conducted during the first quarter upon entry into kindergarten, during the last quarter before completing kindergarten, and as a follow-up during the middle of the second grade. These test points are referred to as Times 1, 2, and 3, respectively. See Figure 1 for a list of tests administered at each test time.

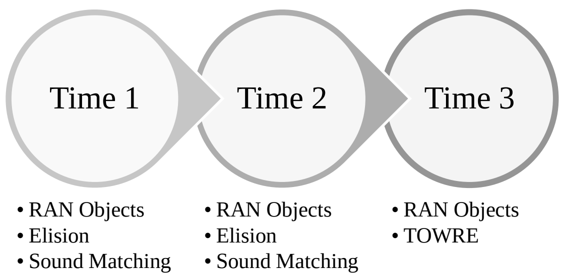

Figure 1. Tests administered at each time point.

Children were tested individually in a relatively quiet location within their schools by trained examiners. All children were from one of two public schools in Memphis, Tennessee. Examiners were native speakers of either English or Spanish and administered tests in their native language. Each child received a battery of tests in only one language per day; thus, testing in English and Spanish did not occur on the same day. The language order in which children were tested—either in English or Spanish—was balanced across all children in the longitudinal project. Approximately half of the ELL children in each school were tested in English first and then in Spanish at Time 1. At Time 2 the sequence was reversed for each child; that is, if they received testing in English first and Spanish second at Time 1, then at Time 2 they received testing in Spanish first and English second. Instructions were provided in the target language, and children were encouraged to speak only that language throughout testing. If a child attempted to use the other language during testing, he was verbally prompted to speak in the target language.

Prior to testing, each child was allowed practice trials to ensure that they could complete the target task. For example, practice trials for the RAN task ensured that children could label the objects used in the RAN task without time pressure. For the CTOPP subtests and the TOWRE, children were presented practice items as directed in the examiners' manuals for each test. If they could not complete the practice trials, then the task was not administered.

For the RAN Objects subtest of the CTOPP, the procedures for the practice portion of the RAN task diverged from the instructions in the manual. For the current studies, the practice trials were expanded to evaluate both receptive and expressive knowledge. Each child was presented with a sheet of paper which contained one set of the six pictured items featured on the RAN test. Practice trials followed an expressive-receptive-expressive sequence, where the child was first asked to name each of the objects. If he accurately named the indicated items in the target language on the first trial, then the child continued on to the test. If the child mislabeled one or more of the pictures in the target language or if he did not provide a label for a picture, then he was given a receptive trial. This required the child to identify the correct picture while the examiner named each object in random order. If the child made an identification error, then the examiner pointed to the target picture and labeled it. Once the child passed the receptive trial, he was given another opportunity to complete the expressive trial. If all of the pictured objects were accurately named, then the child continued on to Form A of the RAN Objects test. If the child was not able to complete the final expressive trial, he was not administered this task.

If a child demonstrated minor difficulties with the last trial on the RAN Objects practice test, the examiners administered extra practice trials at their discretion. Extra practice trials only occurred with the Spanish Time 1 test and the English Time 2 test during kindergarten for ELL children. Children who were allotted extra practice trials were not excluded from these studies.

Once the children passed the practice trials on the RAN Objects task, they were given verbal instructions for the goal of the task. Children were also provided with a visual model from the examiner. This model included the examiner showing each child where he should begin, which line he should continue on to, and where he should end. Due to the difficulty of the task, only Form A was administered at all times for both languages. The serial order of picture presentation was the same at all times and for both languages. All practice trials and testing for all tests administered were recorded for subsequent scoring and analysis.

Scoring

For the RAN Objects task, three trained investigators listened to the recorded data to determine children's accuracy and speed. Error coding included both the original scoring method from the CTOPP and an expanded coding system that I developed. The CTOPP manual describes three types of errors: Substitutions (e.g., producing "table" for the pictured item "chair"), skips (omitting a name completely and continuing to the next picture), and pauses (hesitations longer than 2 seconds; Wagner et al., 1999, pp. 30-31). These errors were coded for both the English and the Spanish RAN object task. See Figure 2 for an example of measuring hesitations[2].

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[2] The word "fish" was produced prior to the first cursor. In between the two cursors there was some ambient noise detected by the sensitive microphone. After the cursor, the word "key" was produced. The total time recorded for this hesitation was 2222.585 milliseconds or 2.22 seconds.

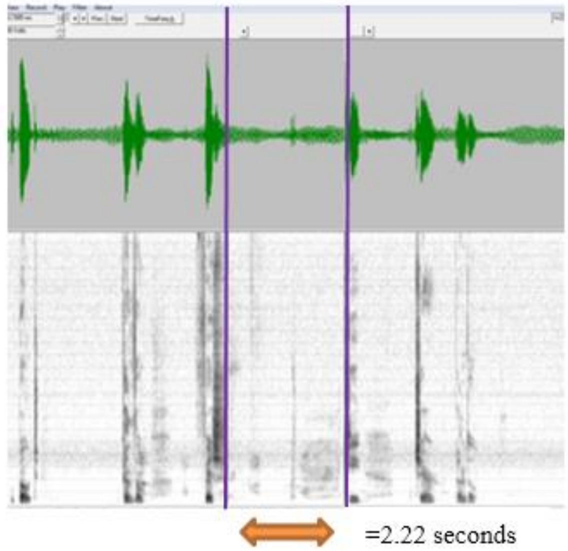

Figure 2. Example of measuring hesitations using TF32 (Milenkovic, 2010).

In addition to the original errors described for the RAN Objects task, the current study included four expanded error codes to more accurately describe the linguistic performance of ELL children. The expanded errors included code-mixing (producing a Spanish word for an English target or vice versa), addition (producing a word for an item that was not pictured on the test, e.g., “star, fish, *bird*, chair” when no bird was present), repetition (naming the same picture more than once), and auto-correction (self-correcting; e.g., saying the word “fish” for the pictured stimulus *key*, realizing the mistake without a prompt from the examiner, and saying something such as “I mean ‘key’”). Because pauses and the other errors could coincide, both were coded in the final analyses; thus, errors that overlapped were double coded. For example, a production of “star, key, table... I mean chair” in response to a picture sequence of *star*, *chair* would be counted as both an addition and an auto-correction. See Table 2 for more information about the error codes.

Table 2

Error Codes Used for Scoring the RAN Objects Task

	Code	Definition	Example
Original Codes	Substitution	Producing an alternate word	"table" instead of "chair"
	Skip	Complete omission	"fish"... chair… "key"
	Hesitation	Acoustic measurement of over 2 seconds	"pencil"… 2+seconds ... "chair"
Expanded Codes	Code-mixing	Producing target in alternate language	"pescado" for "fish"
	Auto Correction	Correcting an error without a prompt	"fish," then correcting to "I mean 'key'"
	Addition	Insertion of a word not pictured	"fish… bird… chair…"
	Repetition	Reproduction of the same word	"key…key…chair"

Rate was defined as the total time to task completion (Wagner et al., 1999, p. 31) and was calculated from the recorded data using the acoustic software program, TF32 (Milenkovic, 2010). The measurement for total time began immediately after the instructions (i.e., after the examiner finished the phrase "ready, set, go") and ended after the final phoneme of the last item on the test (i.e., after the /t/ in "boat"). All times were rounded to the nearest second. Infrequent testing errors occurred within the sample including comments from the investigator or the child losing his place. Each of these inflated individual completion times. To correct for this, the amount of time that a child was off-task or the examiner was speaking was measured and subtracted from the total completion time.

All other data for the Elision subtest, the Sound Matching subtest, and the TOWRE subtests were scored by trained examiners. Raw scores were compiled for each of these tests and used for analyses in these studies. Due to poor completion rates on the Elision subtest at Time 1, a composite PA score was created by combining the raw scores on this subtest with the raw scores on the Sound Matching subtest. The PA composite score was used for all analyses in these studies.

Reliability

Inter-rater reliability for RAN Objects speed and accuracy was calculated by randomly selecting 10% of the total sample. One independent coder measured RAN Objects speed and found that coders were within one second for ELL children across performance in both Spanish and English. For monolingual children's performance on RAN Objects speed, coders were within twenty milliseconds. Inter-rater reliability for accuracy indicated that coders had 94.4%, 84.4%, and 100% agreement for expanded codes, hesitations, and original codes, respectively, for ELL children in English. For accuracy in Spanish, inter-rater reliability was 100%, 87.7%, and 98.1% agreement for expanded codes, hesitations, and original codes, respectively. For monolingual children, inter-rater reliability was found to be 96%, 86.2%, and 97.7% agreement for expanded codes, hesitations, and original codes, respectively. The relatively poorer agreement on hesitations is presumed to be due to the sensitivity of the manual movements of the cursors in the TF32 program.

For the Elision and Sound Matching in both Spanish and English, as well as the TOWRE, the first author verified the scoring with the original recordings obtained during testing. Scoring for these tests was found to be 100% reliable.

Mean Imputation

All children in this study completed multiple tests at multiple time points; however, some were not able to complete testing at various time points. In order to include as much data as possible, mean imputation was completed for missing RAN duration, RAN errors, and PA data, which comprised approximately 9.4% of the total data for these studies. The imputed mean consisted of the average score within each group and language at each point in time. For example, the mean imputed for RAN duration in Spanish was the average of all ELL participants' performance in Spanish only. Mean imputation was used only for the study included in Chapter 5; pairwise omission of participants was used for the analyses in the first and second studies in Chapter 4.

Chapter 4

Study 1: An Exploration of Longitudinal RAN Performance for Young Spanish-Speaking ELL Children

Rationale

RAN is a behavioral measure that reflects efficient lexical access and retrieval processes. Lexical processing is dependent upon the quality of the representations stored in long term memory as well as the speed of lexical access and retrieval, which is physically realized via spreading activation through the lexical association network. That is, numerous strong connections between stored information are required for robust lexical representations, and the strength of these connections enable the rapid spread of activation throughout the lexical system. Spreading activation is representative of the lexical access and retrieval processes, whereby phonological, semantic, morphosyntactic, and orthographic information across lexical entries is activated automatically (e.g., Swinney, 1979). Theoretically, RAN is a unique indicator of processing linguistic information—including semantic, phonological, and orthographic information—stored within the lexicon, and a breakdown in the efficiency of lexical processing would result in slow and inaccurate rapid naming (Wolf & Bowers, 1999).

Although few studies have investigated the relation between RAN performance and dyslexia across languages, the current consensus it that monolingual children with reading deficits tend to have poorer performance on RAN tasks than their monolingual peers who are proficient readers. Additionally, RAN has been identified as the best predictor of reading ability for children with reading deficits in both German and Dutch (de Jong & van der Leij, 1999; Wimmer, 1993). Thus, regardless of language, RAN is an important indicator of reading ability in children. More recently, this line of research has been extended to bilingual and ELL children. A study by

Furnes and Samuelsson (2011) found that RAN was a cross-linguistic predictor of reading ability for young Norwegian-Swedish simultaneous bilingual children. For ELL children, RAN is an important indicator of later reading ability in the second language, English (Lindsey et al., 2003; Manis et al., 2004).

Longitudinal investigations by Manis and colleagues examined the relationships between oral language and literacy measures for Spanish-speaking ELL children from kindergarten through the second grade. They found that RAN Objects was significantly correlated with all oral language and literacy measures in their study. Because of the significant cross-linguistic relations between the measures, the authors state that this evidence supports RAN as a language general—not language-specific—process (Lindsey et al., 2003; Manis et al., 2004). This means that the processing reflected in the RAN task is not bound to a single lexicon; rather, the efficiency with which lexical information is accessed and retrieved seems to be part of a shared, underlying lexical system whereby processing can extend cross-linguistically. It is important to note that children in the Manis et al. studies received literacy training in both Spanish and English, as well as linguistic support from their first language (Spanish) while learning their second language (English). This means that the children in these studies were able to begin developing a second lexicon while maintaining development of their first lexicon. This dual language support during lexical development may have strengthened the connections between lexical knowledge distributed across the lexicons.

Kohnert and colleagues investigated discrete picture naming in children age five through young adulthood using a cross-sectional and a longitudinal study design. Overall, the investigators found that ELL individual became faster and more accurate in both languages with age; however, the participants ultimately had better performance in English when compared with

Spanish (Kohnert et al., 1999). As a follow-up to this study, Kohnert (2002) examined the youngest children one year later. She found that children gained more control over their lexical systems with increased language experience and general cognitive development. However, there was evidence of a linguistic shift to English dominance as indicated by relatively poorer accuracy and slower naming in Spanish while English performance consistently improved; this shift occurred in middle to late elementary school.

A shift in proficiency from the first language to the second language may be the result of bilingual children's access to vocabulary knowledge distributed across the lexicons. According to the *Inhibitory Control* model proposed by Green (1998), there is an increase in the relative activation of the ambient language while the other language is suppressed. This would cause bilinguals to experience easier access and retrieval of words in the target language but increased difficulty for access and retrieval of words in the other language (Gibson et al., 2012). For example, if a young Spanish-speaking ELL child was immersed in an English-only environment (e.g., kindergarten), then his Spanish (i.e., the L1) language would be suppressed in order for him to have more efficient processing in English (i.e., the L2) for linguistic comprehension and expression.

This division of experience with languages inevitably results in less frequent exposure and use of each language for bilingual adults and children. Due to the restricted language experience, connections between lexical information is weaker compared to monolinguals, who are able to build stronger lexical connections secondary to frequency of use. Weaker lexical connections between phonological, semantic, and orthographic representations would result in less efficient lexical processing and poorer access to lexical information; this position is posited by the *Weaker Links Hypothesis* (Gollan et al., 2008; Gollan et al., 2002; Gollan et al., 2005;

Gollan & Silverberg, 2001). Based on this position, this theory would support the hypothesis that impoverished lexical processing would result in slower and possibly less accurate performance on RAN tasks for bilinguals relative to monolinguals. In sum, development of a dual lexical system is complex and impacts processing of lexical information for bilingual children. The accessibility of linguistic information, which is secondary to the strength of lexical information and control mechanisms (e.g., suppression), inevitably influences processing speed and accuracy during RAN tasks.

Methodological Considerations for RAN Tasks

Traditionally, standardized RAN tasks—including the subtest in the *Comprehensive Test of Phonological Processing* (CTOPP; Wagner et al., 1999) and the *Rapid Automatic Naming-Rapid Alternating Stimulus* (RAN-RAS; Wolf & Denckla, 2005)—use error codes to account for excessive hesitations[1], skipped items, substitutions (e.g., production of "key" for the pictured stimulus "chair"), and self-corrections. These tests also measure the total amount of time for task completion, which can be measured using a stop watch during testing. Current research that includes RAN tasks from these tests almost exclusively uses total test time, or naming speed, for evaluating relations between RAN and reading. For clinical assessments, it is reasonable to use total test time because it is a simpler, more efficient metric to measure. This is particularly true when one is collecting data from a large sample; however, this seems a simplistic account of the processing that occurs during the task. The errors produced on the RAN tasks have been theorized to be an indicator of lexical processing efficiency, where the more errors a child produces, the poorer his lexical processing ability (Nicolson & Fawcett, 1990); however, to date this idea has yet to be empirically tested.

[1] Typically defined as exceeding two seconds.

Some investigations have analyzed the importance of the timing components, which include pause time[2] and articulation time[3]. Interestingly, pause time rather than articulation time has been linked to reading outcomes. Pause time for alphanumeric RAN tasks is significantly correlated with both real and nonword decoding accuracy as well as single word and connected text reading fluency (Cutting, Carlisle, & Denckla, 1998; Scarborough & Domgaard, 1998). Longitudinally, pause time in the alphanumeric RAN tasks is related to both phonological and orthographic processing; however, this relationship changes over time. Georgiou and colleagues (2008) found in a longitudinal study that by the third grade pause time is only related to orthographic processing, not phonological processing. Thus, researchers and clinicians must consider the relation between RAN and reading to be a developmental progression and not a static association.

Other errors accounted for in the original RAN scoring procedure are considered to be an integral part of the test for scoring the standardized test; however, they are often ignored during the analysis process. To this author's knowledge, only one investigation has evaluated the relation between reading and RAN errors for monolingual children. Scarborough and Domgaard (1998) found that accuracy for naming items on a rapid object naming task was significantly related to expressive and receptive vocabulary in poorer readers[4]. Thus, accuracy paints an interesting qualitative picture of the lexical information that is being accessed and retrieved. For example, if a child produces the word "table" for the pictured stimulus "chair", it indicates that

[2] Pause time was defined as the total time between the articulations of each word. This encompassed all pauses, including hesitation errors and pauses under two seconds.

[3] Articulation time was defined as the total time required to articulate each word. No pauses were included in this measure.

[4] This was not the case for average readers, nor was this found for the RAN digits or letters task the authors used in their study.

he is accessing a lexical item that is semantically related to the target, and it is not simply a random production. As such, accuracy on RAN measures may be indicative of access and retrieval of deeper semantic knowledge for children with reading impairments.

For children from culturally and linguistically diverse populations, including ELL children, normative data are not currently available for RAN tasks; therefore, it is important to develop a better understanding of how children will perform on these tasks. Practically, due to the complex nature of lexical development in ELL children, it can be expected that they may produce errors that are not accounted for in the original scoring procedure of the RAN tasks. As such, the current investigation included an expanded error coding system to provide a more detailed account of error production for Spanish-speaking ELL children. Theoretically, performance on RAN measures provide insight into how lexical processing is influenced by the quantity and quality of linguistic knowledge represented among the lexicons of bilingual individuals, as well as how this processing is affected by the development of multiple lexicons. The current investigation examined longitudinal RAN performance—both accuracy and speed in Spanish and English for a group of young Spanish-speaking ELL children from kindergarten through second grade.

Questions Guiding this Investigation

1. Upon comparing speed and accuracy performance on the RAN Objects task in Spanish and English, is there evidence of a linguistic shift from Time 1 to Time 3 where ELL children exhibit patterns of change in linguistic processing?

It is hypothesized that as the ELL children gain more experience with their second language, a linguistic shift in lexical processing will occur as they will become faster and more accurate in English than in Spanish on the RAN Objects task over time. As shown in previous research (e.g., Kohnert, 2002), this linguistic shift is expected to occur in middle to late elementary school, which extends past the data collected in the current study; however, it is believed that evidence of the shift's progression will be apparent from the data included in this study. Specifically, it is believed that at the beginning of kindergarten (Time 1) ELL children will initially perform slower and less accurately on the RAN task in English as compared with Spanish. However, by the second grade (Time 3), evidence of a progressive linguistic shift will be apparent, where ELL children will become increasingly more proficient in English than in Spanish. This shift will be indicated by relatively faster and more accurate performance on the RAN task in English as compared with performance in Spanish. In order to effectively answer this first research question, data comprising overall speed and accuracy were analyzed.

2. Will an expanded error coding system quantitatively strengthen the original scoring method by accounting for a greater number of errors produced by ELL children on the RAN Objects task?

Because ELL children have limited experience with English prior to entering kindergarten, it was expected that they would produce quantitatively more errors on the RAN Objects task in English than the task in Spanish at Time 1. It was also anticipated that these children would produce additional error types than those which were conventionally coded for via the CTOPP. Because young ELL children are developing two lexical systems, there is greater potential for lexical interference, particularly in their second language—English. This interference could lead to increased potential for inaccurate retrieval at the semantic level (i.e., substitution or addition errors), inaccurate language retrieval (i.e., code mixing), and/or longer processing time resulting in either pauses or productions of the same pictured item (i.e., hesitations or repetitions). The second question was investigated by comparing the types of errors produced on the task.

Study 1: Results

In order to answer research question one, I explored evidence of a linguistic shift from Spanish to English from kindergarten (Time and Time 2) through the second grade (Time 3). Data comprised both speed and accuracy across languages obtained from the RAN Objects task. Analyses included longitudinal repeated measures analysis of variance (ANOVA) to compare the means of speed or errors over time and across languages.

Speed. A two way repeated measures ANOVA[5] was conducted to measure changes in speed over time and across languages. Mauchley's test of Sphericity indicated that the assumption of sphericity was not met for Time $X^2(2) = .64$, p = .029, nor was it met for the Time x Language interaction $X^2(2) = .64$, $p = .028$. In order to correct for this, the Greenhouse-Geisser correction was used to interpret these results. The Time x Language interaction was found to approach significance, Wilks' Lambda = .66, $F(1.47, 24.98) = 3.53$, $p = .057$, η^2 partial = .17. This interaction revealed that ELL children's completion speed in seconds was dependent upon the language of the RAN task. A paired samples *t*-test revealed that children performed significantly faster in English ($M = 46.84$, $SD = 12.28$) than Spanish at Time 2 ($M = 57.27$, $SD = 14.60$), $t(18) = -4.39$, $p < .001$, $\eta^2 = .52$, and at Time 3 (English: $M = 37.70$, $SD = 10.91$; Spanish: $M = 49.56$, $SD = 88.80$), $t(18) = -6.49$, $p < .001$, $\eta^2 = .70$. No significant difference between languages was found at Time 1 ($p = .652$).

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[5] A two way repeated measures Analysis of Covariance (ANCOVA) was conducted in order to control for the amount of English exposure these ELL children have had while measuring changes in speed over time. English exposure was calculated by combining preschool language (0 = no preschool or Spanish only, 1 = both English and Spanish, 2 = English only) with sibling order (0 = first born or only child, 1 = second born or later). Mauchley's test of Sphericity indicated that the assumption of sphericity was met for Time $X^2(2) = .99$, $p = .611$ and for the Time x Language interaction $X^2(2) = 2.61$, $p = .272$. The ANCOVA produced the same pattern of results as the repeated measures ANOVA, where both Time (Wilks' Lambda = .82, $F(2, 76) = 4.01$, $p = .023$, η^2 partial = .10) and Language (Wilks' Lambda = .87, $F(1, 38) = 5.68$, $p = .022$, η^2 partial = .13) were significant. The ANCOVA also revealed that the Time x Language interaction was significant (Wilks' Lambda = .72, $F(2, 76) = 7.61$, $p = .001$, η^2 partial = .17), providing support for the interpretation of the results from the repeated measures ANOVA.

Significant main effects were found for both time and language. For Time, ELL children became significantly faster at each time point, Wilks' Lambda = .41, $F(1.47, 25.04) = 19.56$, $p < .001$, η^2 partial = .54. Post-hoc analyses using a Bonferroni correction for the pairwise comparison revealed that ELL children became significantly faster overall from Time 1 (M = 58.57, *SE*[6] = 33.46) to Time 3 (M = 43.23, SE = 21.84; $p < .001$)[7], from Time 1 to Time 2 (M = 52.03, SE = 30.21; $p = .010$), and from Time 2 to Time 3 ($p = .003$). A significant main effect for Language was also found, Wilks' Lambda = .34, $F(1, 17) = 33.27$, $p < .001$, η^2 partial = .66, where a post-hoc analysis using a Bonferroni correction for the pairwise comparison revealed that performance in English (M = 47.71, SE = 28.10) was significantly faster than performance in Spanish (M = 54.85, SE = 23.57, $p < .001$).

In sum, ELL children's speed of lexical processing indicated a linguistic shift, where they were initially equally fast at naming pictured objects in Spanish and English at Time 1; however, by the end of kindergarten (i.e., Time 2), these children were significantly faster in English as compared with Spanish. Thus, for speed, ELL children exhibited a more rapid linguistic shift than previously hypothesized per research question one. See Figure 3 for a longitudinal comparison of naming speed across languages.

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[6] Standard error was abbreviated to SE.

[7] Note that RAN speed was in milliseconds for SPSS analyses. RAN speed was transformed to seconds for figures, means, and standard errors.

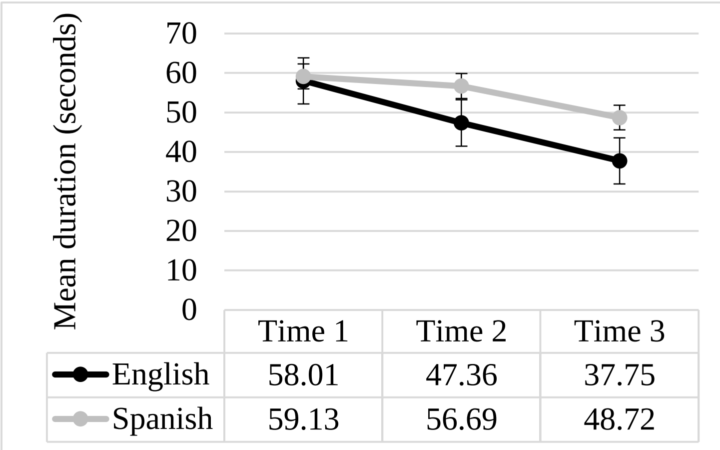

Figure 3. A comparison of ELL naming speed over time in English and Spanish (n = 18).

Error Production: Total Errors. A two way repeated measures ANOVA[8] was conducted to measure changes in the total number of errors—which included the combination of original codes (with hesitations) and the expanded codes—produced within and across languages over time. Mauchley's test of Sphericity indicated that the assumption of sphericity was met $X^2(2)$ = 2.94, p = .230 for Time; however, this assumption was not met for the Language x Time interaction $X^2(2)$ = 7.57, p = .023. In order to account for this violation, the Greenhouse-Geisser correction was used to interpret the results for the interaction.

The repeated measures ANOVA revealed that the Time x Language interaction was not significant, nor was there a significant main effect for Language. Thus, despite initially producing more errors in English than in Spanish at Time 1, there was not a significant difference between the two languages. Although this finding is contrary to the hypothesis for the

[8] A two way repeated measures ANCOVA was conducted to control for English exposure while measuring the changes in the total number of errors produced within and across languages. Mauchley's test of Sphericity indicated that the assumption of sphericity was met for Time $X^2(2)$ = 2.56, p = .278; however, this assumption was not met for the Time x Language interaction $X^2(2)$ = 6.97, p = .031. In order to account for this violation, the Greenhouse-Geisser correction was used to interpret the results of the interaction. The ANCOVA produced a similar pattern of results, where a main effect for Time approached significance (Wilks' Lambda = .77, $F(2, 32)$ = 3.12, p = .058, η^2 partial = .16); however, neither Language (p = .717) nor the Time x Language interaction (p = .750) were significant. The results of the ANCOVA support the interpretation of the repeated measures ANOVA.

first research question, it is unsurprising given the limited average number or errors produced in each language over time. Descriptively, ELL children produced more errors in English than in Spanish at Time 1; however, by Time 2 this pattern was reversed, where fewer errors—but not significantly fewer errors—were produced in English than in Spanish.

For Time, a main effect emerged where ELL children produced significantly fewer errors over time, Wilks' Lambda = .63, $F(2, 34) = 6.55$, $p = .004$, η^2 partial = .28. A Bonferroni post-hoc correction was used to evaluate the pairwise comparison, which showed that children produced significantly fewer errors overall from Time 1 ($M = 5.14$, $SE = .82$) to Time 3 ($M = 2.92$, $SE = .44$, $p = .017$). Error production from Time 1 to Time 2 ($M = 3.25$, $SE = .67$) approached significance ($p = .065$); however, differences in error production from Time 2 to Time 3 did not reach significance.

In sum, ELL children made significantly fewer errors over time. Although the mean difference between the two languages was insignificant, ELL children produced more errors in English than in Spanish at Time 1. By Time 2, these children shifted to producing fewer—but on average not significantly fewer—errors in English than in Spanish. See Figure 4 for a comparison of the total errors produced in each language over time.

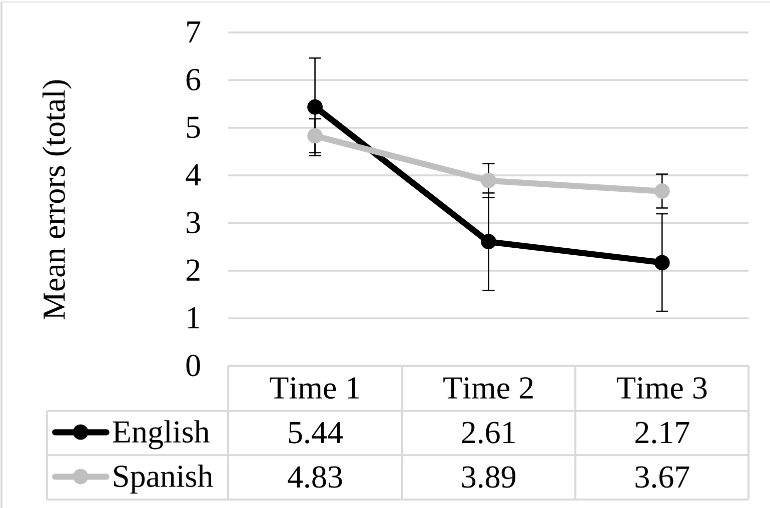

Figure 4. A comparison of the total errors produced over time for ELL children (*n* = 18) in Spanish and English.

Overall, these analyses explored whether performance patterns in speed and accuracy from kindergarten through second grade provided evidence of a linguistic shift in lexical processing efficiency. In general, the data supported our hypothesis, where ELL children became significantly faster in processing lexical items in English than in Spanish over time; however, we found that speed data were a better indicator of this shift, as no statistical difference was found for the accuracy data. Although the accuracy data were not statistically significant, a general descriptive trend indicated poorer performance at Time 1 in English than in Spanish with a rapid shift to the opposite pattern by Time 2. This is indicative of greater efficiency in lexical access and retrieval for their second language, English, as compared with their first language, Spanish, by the end of kindergarten (i.e., Time 2). This shift in speed and accuracy of lexical processing occurred even earlier than previously reported in the literature (i.e., Kohnert, 2002). Proposals regarding the timing and abruptness of this shift are addressed in the Discussion section of Chapter 4. The second research question concerning the use of an expanded error coding system to strengthen the original error coding scheme was subsequently explored via analyses of the percentages of errors produced and paired sample *t*-tests.

Error Production: Expanded Verses Original Coding Errors. A descriptive analysis was completed in order to determine the amount of errors[9] produced at each point in time and across languages. Due to the limited number of errors produced overall, error types were collapsed into three categories for further analysis: Expanded errors, Original errors, and Hesitations. Expanded errors included additions, auto-corrections, code-mixing, and repetitions. The expanded coding system was incorporated in this study in order to account for a larger variety of the types of errors produced by these young children. Original errors (i.e., those listed in the CTOPP test manual) included substitutions and skips. Due to the overwhelming number of 2+ second pauses across languages, these were separated from the original errors and constituted their own category: Hesitations. In order to descriptively compare the quantities of errors represented, percentages were calculated for each category (see Figure 5). Hesitations accounted for 55% to 87% of the total number of errors produced at all times across each language. Notably, ELL children's Hesitations at Time 2 accounted for 82.0% and 87.4% of the errors produced in English and Spanish, respectively. This high percentage of pauses at Time 2 corresponds with a marked increase in accuracy overall as well as faster naming speed in both languages. Thus, it may be that at Time 2 ELL children had improved their ability to monitor and select lexical items, resulting in faster speed and better accuracy for lexical retrieval.

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[9] The error types coded included hesitations, skips, substitutions, repetitions, auto-corrections, code-mixing, and additions.

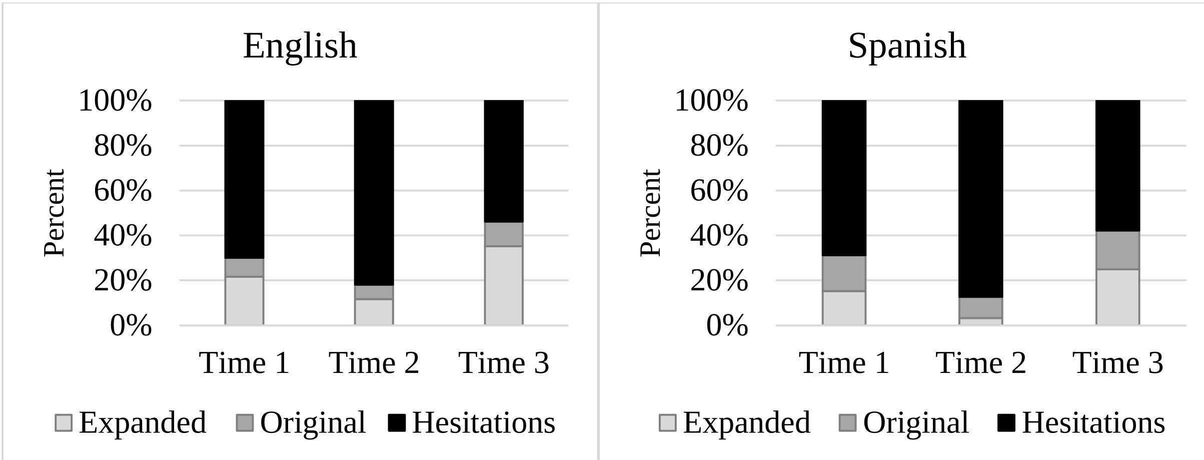


Figure 5. Percentages of error types in English and Spanish across time for ELL children.

To determine whether the expanded error coding system quantitatively strengthened the RAN scoring scheme, the error categories over time were collapsed into their respective composites; thus, they comprised the same error composites used in the descriptive analysis (Expanded, Original, and Hesitations). Two, one sample *t*-tests in each language were used to explore the value of the expanded error coding system. The first set of analyses evaluated the coding systems in English; the second set targeted Spanish.

For English, the first analysis compared the expanded coding system with the combination of the original and hesitations (called "Traditional errors" for the purpose of these analyses), as the combination of the original errors and hesitations is what is prescribed by the examiner's manual for coding the RAN Objects subtest. A paired samples *t*-test showed that the difference between expanded errors (M = 2.08, SD = 5.05) and the traditional errors (M = 7.58, SD = 6.45) was statistically significant, $t(39) = -4.51$, $p < .001$, η^2 partial = .34; thus, more traditional errors were produced overall than expanded errors. This finding was unsurprising as hesitations were the majority error produced; however, clinically, hesitations are notoriously difficult to code in the moment on the RAN tasks. While a child is naming the pictured test stimuli, the examiner is required to track the items on the score sheet, code any of the original errors produced, and monitor the number of seconds in between the test items (i.e., pauses greater than 2 seconds) as well as the total test time. This requires a great deal of coordination on behalf of the examiner; thus, hesitations are seemingly impossible to accurately code for during real-time test administration. For this reason, the next analysis excluded hesitations and compared the expanded errors with the original errors (i.e., skips and substitutions).

A second paired samples *t*-test demonstrated that the difference between the expanded errors (M = 2.08, SD = 5.05) and the original errors (M = .80, SD = 1.09) approached statistical significance, $t(39) = -1.75$, $p = .088$, η^2 partial = .07. When hesitations were excluded, expanded errors were produced as often as the original errors. This means that when clinicians are administering the RAN tasks using the codes discussed in the test manual, we inadvertently ignore other errors (i.e., the expanded errors) that are produced just as often as the original errors in English.

For Spanish, the first analysis compared the expanded error coding system with the traditional error coding system, which was the combination of the original error codes and the hesitations. A paired samples *t*-test showed that the discrepancy between the expanded errors (M = 1.75, SD = 3.54) and the traditional errors (M = 10.6, SD = 7.83) was significant, $t(39) = -6.47$, $p < .001$, η^2 partial = .52; thus, ELL children produced significantly more traditional errors (i.e., hesitations and original errors) than expanded errors. Just as with the *t*-test in English, this finding for Spanish was not surprising given that over 50% of the errors produced in Spanish by the ELL children were hesitations. When the hesitations were removed for the second analysis, a paired samples *t*-test showed that the difference between the expanded errors (M = 1.75, SD = 3.54) and the original errors (M = 1.73, SD = 2.76) was not significant ($p = .959$). Again, ELL children are producing, on average, a similar number of expanded and original (i.e., skips and substitutions) errors in Spanish.

Additional analyses concerning a comparison of the mean number of errors produced by the ELL children across languages and at each point in time can be found in Appendix A.

Overall, the findings support the hypothesis proposed for the second research question, where the expanded error coding system does strengthen the original coding system by quantitatively accounting for a relatively equivalent average number of errors as the original scoring method over time on the RAN Objects task. Although ELL children did not produce significantly more expanded errors than original (i.e., substitutions and skips) or traditional (i.e., hesitations and original errors) errors, excluding these expanded errors from the coding scheme would overlook information that may be important for identifying children with potential language and/or reading deficits (see Scarborough & Domgaard, 1998, or Norton & Wolf, 2012, for more information). Thus, accounting for the expanded error codes is pertinent to capturing an accurate representation of word retrieval errors committed by young ELL children in both Spanish and English.

Study 1: Conclusions

In sum, ELL children's performance on a RAN Objects task was indicative of a shift in lexical processing efficiency where they became faster and more accurate in English than in Spanish over time. However, our hypothesis concerning the shift was only partially supported in that the early proficiency patterns were not pronounced with respect to better performance in their native language and the timing of this shift was surprising. Even at the beginning of kindergarten, young ELL children were not significantly faster or more accurate in Spanish than in English. Also, it is remarkable that this shift occurred much earlier than previously reported by Kohnert (2002); patterns in our data showed a clear transition to better English processing efficiency by the end of kindergarten rather than a progressive shift through middle elementary school. Further consideration of these issues will be addressed in the Discussion section of Chapter 4.

With regard to the expanded error coding system, we found that ELL children produced fewer expanded errors than the traditional errors (i.e., hesitations, skips, and substitutions) prescribed by the CTOPP manual (see Wagner et al., 1999). However, when hesitations were excluded from the analysis, as hesitations are difficult to accurately code in real time, ELL children produced as many expanded errors as original errors (i.e., substitutions and skips). This is clinically significant such that production of these errors may be indicative of language and/or literacy deficits for ELL children. Theoretical and practical implications of these findings for ELL children will be discussed in the Discussion section of Chapter 4. However, as lexical processing can be affected by the development of a dual-lexical system as opposed to a single lexical system, it is important to understand how ELL children’s performance in English on the RAN Objects task compares to that of their monolingual English-speaking peers.

Study 2: A Longitudinal Comparison of RAN Performance for Young Spanish-Speaking ELL Children and Their Monolingual English-Speaking Peers

Rationale

Although findings from the first investigation demonstrated that Spanish-speaking ELL children were not significantly slower or more inaccurate in English as compared with Spanish, previous research has shown that bilingual children have a disadvantage on naming tasks relative to monolinguals (see Bialystok, 2007). When compared with monolinguals, bilingual individuals have slower lexical access and retrieval, which may be due to slower executive function processing or possibly increased cross-linguistic interference and competition within the lexical system (Bialystok, 2007, 2008; Gildersleeve-Neumann, Kester, Davis, & Peña, 2008). Executive function skills required for fluent processing in bilingual individuals include continuous attention to context, judging whether a linguistic switch is necessary, and inhibition of unnecessary linguistic information. Accurate control of these processes is essential for effective and efficient performance in both languages. Investigations by Kohnert and colleagues demonstrated that children are initially slow and inaccurate at a RAN task; however, as general cognitive functioning and language experience increased, children became much more proficient at naming pictured items in each language (Kohnert, 2002; Kohnert et al., 1999).

Lexical access and vocabulary size was investigated in monolingual and bilingual young adults attending college by Bialystok et al. (2008), who found that proficient bilinguals demonstrated better executive control than their monolingual peers. Interestingly, there were no group differences for letter naming fluency (i.e., rapid letter naming), which would have been anticipated as previous research has stated that bilinguals have poorer speeded naming than monolinguals (see Bialystok, 2009). To investigate this null finding further, the authors conducted a second study with bilinguals who were self-reported as high and low proficiency[10], and they used a more demanding letter fluency task that required greater executive control. The authors found that the high proficiency group of bilingual adults performed better than both the monolingual and the low proficiency bilingual groups. Performance on this task was not significantly different for the monolingual group and the low proficiency bilingual group. This finding runs contrary to what may have been expected as—relative to monolinguals—low proficiency bilinguals would experience competition and interference from their dual lexical system, resulting in slower, less accurate performance on the letter fluency task.

With regard to lexical access and retrieval, Bialystok et al. (2008) stated that the reduced processing efficiency in the low proficiency group of bilinguals may be secondary to their smaller vocabularies. Limited vocabulary would result in fewer and weaker connections between lexical representations, causing poor performance on naming tasks. This deficit may be counterbalanced by the supportive role executive functions play in naming tasks, where bilinguals—even those with lower proficiency—would have better executive function skills than their monolingual peers, causing the lack of difference found between the two groups. Because bilinguals have more practice inhibiting non-target lexical competitors, they may be faster at word retrieval than their monolingual counterparts. The authors concluded that adult bilinguals balance their disadvantages in vocabulary with their advantages in executive functioning during naming tasks.

The vocabulary disadvantage for bilinguals may be due to the division of language experience for bilingual adults and children. Because bilingualism necessitates the use of more than one language, bilingual individuals' language experience is divided, and each language is

[10] The high proficiency group was matched with their monolingual peers on English vocabulary scores.

used less frequently than the one language used by a monolingual speaker. Theoretically, this could cause the connections between semantic and phonological information to be weaker in bilinguals than in monolinguals, resulting in weaker vocabulary representations and reduced efficiency of lexical retrieval required for efficient verbal fluency relative to monolinguals (Gollan et al., 2005). Indeed, Kohnert et al. (1999) found that bilingual adults named fewer pictures on a confrontational naming test than monolingual English-speaking adults. This finding may be due to difficulty of lexical access and retrieval, interference from translation equivalents, or both. Either way, performance on tasks requiring efficient lexical processing, such as expressive vocabulary tasks, remains poorer for bilinguals relative to their monolingual peers.

Although monolingual children do not experience lexical interference in the same manner that bilingual children do, monolinguals do not have perfect lexical retrieval and, as such, produce errors when speaking (e.g., Fromkin, 1971). With the added timing pressure of a RAN task, it can be expected that even the most articulate monolingual speaker could produce a label in error, even if this error is subsequently corrected[11]. For monolingual children, several studies have noted the association between RAN speed and reading (see Norton & Wolf, 2012, for a review); however, a single study has investigated the value of the errors produced on the RAN task but only in the context of vocabulary—not reading (Scarborough & Domgaard, 1998). Thus, an exploration of the errors produced on the RAN task by monolingual English-speaking children is warranted so that accurate performance patterns are documented and used for the purpose of identifying potential deficits in spoken and/or written language.

[11] An error correction made by the individual taking the RAN task is called "self-correction" on the *Rapid Automatic Naming-Rapid Alternating Stimulus* test (Wolf & Denckla, 2005).

In my work, Spanish-speaking ELL children exhibited faster speed and fewer total errors produced on a RAN Objects task in English than in Spanish, which was contrary to what was expected given their reported limited experience with English (see Study 1). Based on the extant literature comparing monolinguals to their ELL peers, I anticipated that although ELL children were remarkably fast and accurate in naming pictured objects in English, they would be slower and less accurate on a RAN Objects task than their monolingual English-speaking peers. The current investigation compared RAN performance in English for the ELL group from the previous study to the RAN performance of their monolingual peers. Practically, these results allow researchers and clinicians to gauge differences in performance—including speed and accuracy—across the two groups of children. Theoretically, these findings guide understanding of how lexical processing (in the context of rapid naming) can be influenced by dual lexical development.

Questions Guiding this Investigation

1. Is there a significant difference in longitudinal performance on a RAN Objects task in English for young Spanish-speaking ELL children compared to their monolingual English-speaking peers?

Monolingual English-speaking children were expected to be significantly faster and more accurate at all points in time compared to their Spanish-speaking ELL peers. There were two interrelated reasons for this expectation. First, as ELL children are developing a dual lexical system, they are expected to be experiencing lexical interference, which will impede accurate and rapid performance on the RAN task. Thus, because monolingual children do not have cross-linguistic lexical competition, they will have better performance than their ELL peers. Second, because monolingual children have experience in only one language, their lexical connections (i.e., phonological and semantic knowledge) should theoretically be stronger compared to those of ELL children because of their divided language experience. The accumulated frequency of use in only one language would strengthen lexical connections, resulting in more efficient processing for monolinguals. ELLs, on the other hand, would have divided frequency of use, causing weaker lexical connections within and across both lexicons. As such, the theoretically weaker links among lexical information would cause slower and less accurate processing for ELL children in their second language as compared with monolingual children in their native language. This position would be supportive of the weaker links hypothesis proposed by Gollan et al. (Gollan et al., 2008; Gollan et al., 2002; Gollan et al., 2005; Gollan & Silverberg, 2001). This first research question was explored by examining speed and accuracy (i.e., total errors produced) performance longitudinally on a RAN Objects task in English.

2. Will an expanded error coding system quantitatively strengthen the original scoring method by accounting for a greater number of errors produced by monolingual children on the RAN Objects task?

Although monolingual children do not experience the same complications for lexical access and retrieval as bilingual children, it was believed that monolingual children would produce errors not accounted for by the original scoring method specified by the CTOPP manual. It was deemed plausible that while naming pictured objects, monolingual children could produce errors such as repetitions, auto-corrections[12], or additions; however, it was expected that monolingual children would produce fewer errors—those that would comprise both original and expanded error codes—than their ELL peers. As such, a secondary research question was developed as follows:

[12] Although self-corrections may be coded for according to the RAN-RAS test procedure, the CTOPP was the test used in this study; thus, test protocol followed the instructions provided in the CTOPP manual.

a. Do young Spanish-speaking ELL children produce significantly more errors (i.e., original, expanded, and hesitations) than their monolingual English-speaking peers?

It was hypothesized that ELL children would indeed produce significantly more errors in English than their monolingual peers, regardless of the error type. As young ELL children have less experience with English than Spanish, as well as weaker lexical representations in their English lexicon as compared with their monolingual English-speaking peers, it was anticipated that ELL children would produce a greater number of errors across all of the error categories.

The questions comprising the second research question were investigated by comparing the types of errors produced on the task by 1) the monolingual children only, and 2) across both groups of children.

Study 2: Results

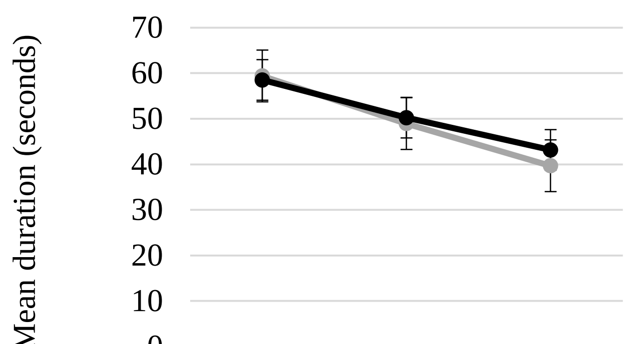
In order to answer the first research question, the English performance of the ELL children was compared to that of the monolingual children from kindergarten (Time 1 and Time 2) through the second grade (Time 3). Data comprised both speed and accuracy in English, obtained only from the RAN Objects task. Analyses included longitudinal mixed between-within repeated measures analysis of variance (ANOVA) to compare the means of speed or errors over time and across groups of children.

Speed. A mixed between-within ANOVA[13] was conducted to measure the changes in speed over time and across groups. Mauchley's test of Sphericity indicated that the assumption of sphericity was met $X^2(2) = 5.40$, $p = .067$ for Time. Interestingly, and in contrast to the extant literature, the Time x Group interaction was not significant ($p = .609$) nor was there a significant main effect for Group. Thus, the group of monolingual children ($M = 50.63$, $SE = 28.05$) was

[13] Also known as a split plot ANOVA.

not significantly faster than the group of ELL children (*M* = 49.33, *SE* = 23.29; *p* = .723). In fact, the amount of time to complete the task was remarkably consistent across the two groups at each time point.

A significant main effect for Time was found, Wilks' Lambda = .48, $F(2, 94) = 32.92$, $p < .001$, η^2 partial = .41, where both groups became significantly faster over time. A post-hoc analysis using a Bonferroni correction for the pairwise comparison showed that overall, children became significantly faster from Time 1 (*M* = 58.95, *SE* = 26.62) to Time 2 (*M* = 49.59, *SE* = 22.57, $p < .001$), from Time 2 to Time 3 (*M* = 41.41, *SE* = 15.71, $p < .001$), and from Time 1 to Time 3 ($p < .001$). Thus, contrary to my hypothesis, both groups of children—regardless of language experience—became significantly faster on the RAN Objects task in English over time. See Figure 6 for a comparison of speed over time for the two groups of children.



	Time 1	Time 2	Time 3
ELLs	59.39	48.93	39.68
Monolinguals	58.52	50.24	43.14

Figure 6. A comparison of naming speed over time for ELL (*n* = 29) and monolingual children (*n* = 20) in English.

Error Production: Total Errors. A mixed between-within ANOVA was conducted to measure the changes in the mean number of total errors produced over time and across groups of children. Total errors consisted of both the expanded codes and the original codes, including the hesitations. For the expanded coding system, code-mixing errors were not included in the Study 2 analyses as monolingual children could not produce this error type[14].

The results from this analysis mirror the results from the speed analysis, where the Time x Group interaction was not significant (p = .799) nor was there a main effect of Group (p = .548). Thus, monolingual children (M = 4.28, SE = .66) did not produce significantly fewer errors than ELL children at any point in time (M = 3.76, SE = .56). In fact by Time 2, ELL children produced fewer errors in English than their monolingual peers; however, this was not found to be a significant difference. This finding was surprising given that ELL children were reported to have limited experience with English prior to entering kindergarten, promoting less stable English lexical representations; thus, they were expected to produce more errors than their monolingual peers.

Mauchley's test of Sphericity indicated that the assumption of sphericity was met $X^2(2)$ = 4.39, p = .111 for Time. A significant main effect for Time was found, Wilks' Lambda = .66, $F(2, 47) = 12.30$, $p < .001$, η^2 partial = .34, where both groups produced significantly fewer errors over time. A post-hoc analysis using a Bonferroni correction for the pairwise comparison showed that, across both groups, children produced significantly fewer errors from Time 1 (M = 5.78, SE = .73) to Time 2 (M = 3.50, SE = .45; p = .007) and from Time 1 to Time 3 (M = 2.78, SE = .46; $p < .001$); no significant difference was found between Time 2 and Time 3 (p = .603). See Figure 7 for a comparison of the total errors produced in each group of children over time.

[14] For this study, the exclusion of code-mixing errors was inconsequential as ELL children only produced this error at Time 1 and Time 3 in Spanish. That is, during the RAN task in Spanish, ELL children code-mixed using English words.

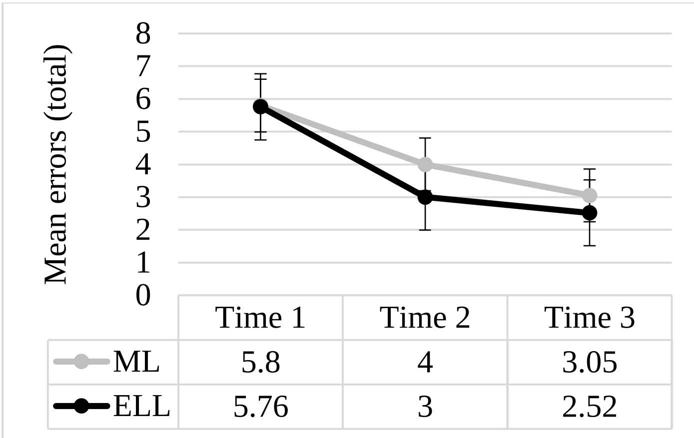


Figure 7. A comparison of the total errors produced in English over time for ELL (*n* = 29) and monolingual children (*n* = 21).

In sum, contrary to our hypothesis, ELL and monolingual children's performance was extraordinarily similar across both speed and accuracy. Although both groups of children became faster and more accurate on the RAN Objects task over time in English, there were no significant group differences at any point in time. In fact, although the difference was not significant, ELL children were actually slightly faster and more accurate at naming pictured items by the end of kindergarten (i.e., Time 2). This may mean that in addition to a rapid acquisition of English lexical processing proficiency, ELL children could have an advantage secondary to their executive function skills. Proposals regarding these findings are addressed further in the Discussion section of Chapter 4. The second set of research questions concerning the use of an expanded error coding system to strengthen the original error coding scheme was subsequently explored via analyses of the percentages of errors produced and paired sample *t*-tests.

Error Production: Expanded verses Original Errors. A descriptive analysis of the error types was conducted in order to account for the amount of errors[15] produced at each time point. Following the procedure in Study 1, error types were divided into three categories for further analyses: Hesitations, expanded errors, and original errors. Because the monolingual children have only one language, the code-mixing error type was not included for either group of children. Percentages were calculated for each category to descriptively compare error types for the monolingual children only (see Figure 8). Hesitations accounted for 67.2% to 81% of the total number of errors produced at all times for the monolingual children. Interestingly, only 1.1% of the errors produced at Time 2 were original errors; thus, these children primarily produced hesitations followed by expanded errors.

In comparison to their ELL peers, monolinguals produced higher percentages of hesitations at each point in time (see Figure 5 in Study 1); thus, ELLs produced more original and expanded errors while monolinguals produced proportionally more hesitations. At Time 2, like their ELL peers, monolingual children produced a high percentage of hesitations than at either Time 1 or Time 3. Thus, although monolingual children were faster (see Figure 6) and more accurate at Time 2 (see Figure 7), they produced a higher percentage of hesitations. This may mean that they have improved their ability to monitor lexical selections; however, accurate retrieval of a lexical item may require more processing time. See Figure 8 for the percentages of error types over time for monolingual children.

[15] The error types coded included hesitations, skips, substitutions, repetitions, auto-corrections, and additions. Code-mixing was not included in these analyses as monolinguals cannot, by definition, code-mix languages.

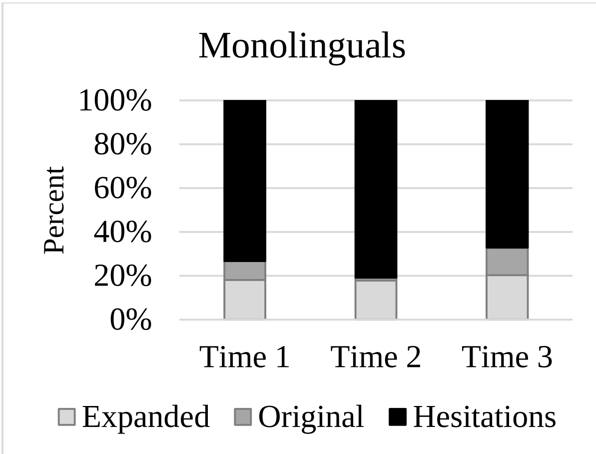


Figure 8. Percentages of error types in English across time for monolingual children.

To determine whether the expanded error coding system quantitatively strengthened the RAN scoring scheme for monolingual children, the error categories over time were collapsed into three composite categories (expanded, original, and hesitations). Following the same procedure as Study 1, hesitations and the original error codes (i.e., skips and substitutions) were also combined into an additional composite, Traditional errors. The explore the value of the expanded error coding system, two paired sample *t*-tests were conducted to compare the means of the error composites.

The first paired samples *t*-test was used to compared the expanded errors with the traditional errors (i.e., hesitations and original errors combined). This test showed that the difference between the expanded errors (M = 2.38, SD = 1.99) and the traditional errors (M = 10.42, SD = 7.82) was statistically significant, $t(20) = -4.95$, $p < .001$, η^2 partial = .55; thus, on average, a greater number of traditional errors were produced than expanded errors. This is not surprising given that monolingual children produced a high percentage of hesitations at all points in time; this pattern resembled the pattern of percent errors produced by the ELL children in English (see Figure 5). Following the analysis procedure from Study 1, the hesitations were excluded from the second analysis so that a comparison between the expanded and original error codes could be made.

A second paired samples *t*-test demonstrated that the difference between the expanded errors (M = 2.38, SD = 1.99) and the original errors (M = .93, SD = 1.63) were statistically significant, $t(20) = 2.40$, $p = .026$, η^2 partial = .22; thus, the monolingual children produced significantly more expanded errors than original errors.

In order to evaluate the differences in errors produced by the monolingual and ELL children, independent samples *t*-tests were conducted. All of the independent samples *t*-tests showed that there were no significant differences between the groups for any of the error composites. Although the independent samples *t*-tests are not significantly different, it is interesting to note that the ELL children produced, on average, fewer errors than the monolingual children overall. This may indicate that because ELL children have better control over their executive functions, they are better able to suppress non-target lexical information upon selection of the lexical item. See Table 3 for means, standard deviations, and significance values.

Table 3

Comparisons of Mean Errors Produced in English Over Time for ELL (n = 40) and Monolingual Children (n = 21)

		Mean	***SD***	***p***
Expanded	Monolinguals	2.38	1.99	.789
	ELLs	2.08	5.05	
Original	Monolinguals	.93	1.63	.715
	ELLs	.80	1.09	
Hesitations	Monolinguals	9.5	7.71	.129
	ELLs	6.78	5.87	
Traditional	Monolinguals	10.42	7.82	.133
	ELLs	7.58	6.44	

Note. Expanded errors included additions, auto-corrections, and repetitions. Code-mixing was not included for the ELL children because monolingual children could not produce this type of error. Original errors included skips and substitutions. The Hesitations composite included hesitations (pauses > 2 sec.). The Traditional errors composite included skips, substitutions, and hesitations.

Additional analyses concerning a comparison of the mean number of errors produced by the monolingual and ELL children at each point in time can be found in Appendix B.

In sum, the hypothesis to the second research question was supported in demonstrating that the incorporation of the expanded error coding system quantitatively strengthens the original coding system in that monolingual English-speaking children produced significantly more expanded errors than traditional errors when hesitations were excluded. This means that when these errors are not accounted for, clinicians are omitting a significant number of errors produced on this RAN task; these errors may be important for the early identification of children with reading impairment. Interestingly, the monolingual children produced a similar average number of error types; that is, the two groups of children did not have significantly different mean number of errors across the error categories. This finding was unexpected given that ELL children were reported to have little experience with English prior to entering kindergarten. Proposals concerning these finding are explored in the Discussion section of Chapter 4.

Study 2: Conclusions

Overall, there was a surprising lack of significant differences between the ELL and monolingual children's speed and accuracy performance on this RAN Objects task in English. Because of their lack of experience with English and increased competition for lexical access and retrieval, ELL children were expected to have significantly slower and less accurate performance in comparison to their monolingual English-speaking peers. This, however, was not the case as ELL children were actually slightly—but not significantly—faster and more accurate than their monolingual peers by the end of kindergarten (i.e., Time 2).

Upon further consideration of the expanded error coding system, I found that monolingual children's error production mirrored that of the ELL peers, where they produced a similar average number of errors across the error composites. Thus, hesitations comprised the majority error produced for both groups of children. With regard to the monolingual children's errors, significantly more expanded errors were produced than the combination of substitutions and skips (i.e., traditional errors). This means that monolingual children are producing a greater number of errors than originally accounted for by examiners on the RAN Objects task. Theoretical and practical implications of these findings for ELL children are discussed in the following Discussion section of Chapter 4.

Chapter 4: Discussion

While it has been well-established that RAN is related to word reading for both monolingual English-speaking children and bilingual children (e.g., Manis et al., 2004; Wolf & Bowers, 1999), few studies have evaluated speed and accuracy performance on a serial RAN task for Spanish-speaking ELL children in comparison to their monolingual English-speaking peers. Performance on RAN tasks provides insight into how lexical processing is influenced by the quality and quantity of linguistic knowledge stored in long term memory, as well as how this processing is affected by the development of a dual lexical system. Findings from these studies are discussed using the *weaker links hypothesis* (Gollan et al., 2008; Gollan & Silverberg, 2001) and a sociolinguistic account as frameworks for explaining lexical processing efficiency for ELL children.

The first study evaluated performance in both English and Spanish for ELL children in kindergarten through second grade. Specifically, performance on a RAN Objects task in both English and Spanish was measured using speed and accuracy. These children were actually significantly faster and more accurate over time in their L2, English, than in their L1, Spanish. This was surprising given that, to our knowledge, these children had limited experience with English upon entry into kindergarten. Although previous research using a RAN Objects task has shown that Spanish-speaking ELL children shift language proficiency from their L1 to their L2 during the middle of elementary school, the timing of this shift in the present study appears to have occurred earlier than has been previously shown (Kohnert, 2002; Kohnert et al., 1999).

The second study compared English performance on the RAN task for Spanish-speaking ELL children with their monolingual English-speaking peers. Overall, previous research reports poorer performance on discrete naming and verbal fluency tasks for bilingual individuals as compared with monolinguals (Bialystok, 2007; 2008; Gildersleeve-Neumann et al., 2008), but these studies did not include rapid serial naming. For the current investigation, it was hypothesized that young monolingual English-speaking children would be significantly faster and more accurate than their Spanish-speaking ELL peers. Surprisingly, we found no monolingual advantage for speed, such that the monolingual children were not significantly faster than their ELL peers as predicted, nor were the monolingual children significantly more accurate than their ELL peers. These results run contrary to what we had predicted, given that the ELL children reportedly had limited experience with English prior to entering a formal academic setting.

An additional metric implemented in these studies included an expanded error coding system, which accounted for a broader range of errors than previously measured in the original scoring system. Traditionally, RAN speed has been used in research as the determinate of task performance; however, accuracy is a component on standardized RAN tests and is believed to be indicative of deficits in word retrieval (see Norton & Wolf, 2012). This expanded system was expected to be particularly important for the ELL children because it would provide a more sensitive measure of RAN performance for this culturally and linguistically diverse group of young children. Due to potentially increased difficulty with lexical access and retrieval for naming pictured stimuli, the expanded error coding system was believed to possibly strengthen the original scoring system by accounting for a greater number of the errors produced by young ELL children than the original scoring system alone.

For both groups of children, the expanded error codes showed a broader qualitative picture of what children are producing during a time-sensitive lexical retrieval task. Consequently, when clinicians administer the RAN Objects subtest using the coding method described in the manual (see Wagner et al., 1999), they are excluding a significant number of errors[16] (i.e., expanded) made during the test. The exclusion of accounting for the expanded errors limits the view of this clinically-relevant information about children's lexical retrieval and hinders the potential value for predicting future language and/or literacy abilities. Descriptively, auto-corrections were produced frequently at all points in time for both groups of children and across languages for ELL children. For example, a child may have produced the following auto-correction on the RAN task in English: "…star, chair, boat—I mean—fish…." Interestingly, the addition code was produced by ELL children only, and they produced it across both languages at each point in time. For example, a child may have produced the word *table* while naming the other pictured items, which is inserting an additional production not pictured on the task. Quantitatively, the ELL and monolingual children produced significantly fewer expanded errors in comparison to the combination of hesitations and the original errors (i.e., "traditional errors"). However, when the hesitations were removed, ELL children produced a similar average of expanded and original errors in both Spanish and English; the monolingual children produced significantly more expanded errors than original errors. This demonstrates that accounting for errors not prescribed by test manuals is clinically and scientifically pertinent for all groups of children, regardless of the languages spoken.

Taken together, these studies show patterns of efficient lexical processing across languages for the ELL children despite the complexity of developing a dual lexical system. We proposed that at the beginning of kindergarten ELL children had limited experience with English; thus, their Spanish lexicon would contain more robust lexical representations due to strong, interconnected lexical information as compared with the English lexicon, which would contain

[16] In comparison to the original errors (i.e., substitutions and skips) produced.

fewer words with limited interconnectivity. Monolingual children would also be expected to have dense lexical neighborhoods with strong lexical connections supporting the robust representations in their English lexicons. The strength and number of connections between lexical information might be expected to affect lexical processing efficiency and lexical accessibility (Gollan et al., 2008; Gollan & Silverberg, 2001), such that the ELL children with fewer, strong connections for frequent items in the L2 would experience facilitation effects for accessing and retrieving lexical items as compared with a denser lexical system. Based on our findings, we propose that low lexical density in conjunction with increased activation of the L2, English, would allow young ELL children to have faster and more accurate performance on the RAN Objects task in English as compared with performance across languages (i.e., their L1) as well as across groups (i.e., their monolingual English-speaking peers).

Lexical Accessibility and Processing

ELL children in this study performed faster and more accurately in English than in Spanish. They also were faster and more accurate in English than their monolingual English-speaking peers. Although both of these findings were unexpected, one possible explanation for these finding stems from a sociolinguistic account. It is possible that a priming effect secondary to environmental context could cause increased activation of the English lexicon relative to the Spanish lexicon, because the ELL children are immersed in an English-only environment. Other studies evaluating lexical structure and access to linguistic information in bilingual children have proposed that this sociolinguistic account—in conjunction with a suppression mechanism—may lead to facilitation of the second language while suppressing the activation of the first language (Gibson et al., 2012; Linck et al., 2009; Oller et al., 2007). Collectively, findings from previous research and the current investigation support Green's (1998) *Inhibitory Control* model, where environmental constraints would suppress the language not frequently used in the environment while simultaneously allowing for greater relative activation for the language primarily used in the environment. For the ELL children in our study, testing took place in an English-only formal educational setting. Thus, we propose that children's L1, Spanish, was suppressed while their L2, English, received greater activation secondary to their immersion in the English environment.

Theoretically, increased relative activation of the L2 and/or suppression of the L1 could lead to facilitation of accurately and rapidly naming items in English while simultaneously inhibiting efficient naming in Spanish. The pressure from immersion in the English-only environment requires ELL children to adapt quickly; thus, relative activation and suppression within the lexical system would better allow ELL children to successfully communicate in their new environment. This bridge between the sociolinguistic account and the cognitive mechanisms is evidenced by these children's performance on the RAN task. Indeed, ELL children in this study were fast and accurate at serially naming pictured objects in English, which supports these theories (i.e., sociolinguistic account and cognitive mechanisms). Observation of the individual error codes also revealed a pattern, providing further supporting evidence. Due to the overall limited number of errors in individual code categories, these data were not reported in the results; however, code-mixing occurred only during the RAN task in Spanish at Time 1 and Time 3. This means that while children were naming items in Spanish, they substituted an English name for a target stimulus item. For example, a child may have produced the following: "silla, estrella, lápiz, fish, llave…" This example demonstrates the increased availability of English lexical items even when the task context required the use of Spanish.

Although these ELL children were more proficient in naming items in English relative to Spanish, these data do not support the weaker links hypothesis (for more discussion see Gollan et al., 2008, and Gollan & Silverberg, 2001). According to this hypothesis, lexical representations with fewer and weaker connections would hinder efficient naming, resulting in slower and less accurate naming on a timed task (i.e., RAN task). Although in our original hypothesis we proposed that the ELL children in this study had weaker lexical representations in English as compared with Spanish, they were actually faster and more accurate on the RAN task in English. This directly contradicts the weaker links hypothesis. If our data supported the weaker links hypothesis, we would expect to see performance patterns showing the direct opposite. That is, because these ELL children had more practice with and exposure to their L1, the more frequent use of Spanish would cause stronger, more abundant lexical connections, resulting in faster and more accurate RAN performance in Spanish. However, in contrast to theory, the data in these studies show better RAN performance in English, their second language rather than in Spanish, their first language.

The Impact of Lexical Density on Processing

An alternative explanation for the unexpected pattern of results is that the ELL children's increased efficiency for processing linguistic information in English may be secondary to the limited lexical information stored in that lexicon. That is, relative to their monolingual peers, these ELL children might be expected to have smaller, sparser phonological neighborhoods and fewer words stored in their English lexicon (see Bialystok et al., 2008). For example, the word *cat* would reside in a dense neighborhood with many other words connected to it at both the semantic and the phonological levels for monolingual English-speaking children (Luce & Pisoni, 1998; Vitevitch, Luce, Pisoni, & Auer, 1999). At the phonological level, words that vary by one phoneme would be more tightly connected with the word *cat* (e.g., *bat, sat, rat, can, cut, cot,* etc.). At the semantic level, *cat* would be associated with words related to *cat* by meaning (e.g., *kitten, collar, purr,* etc.). Compared with their monolingual English-speaking peers, who would have relatively robust lexical representations in their native language, ELL children might be more efficient at accessing and retrieving words in English, specifically because there is less competition in the lexicon for these relatively high frequency words. In contrast, the larger, more densely-packed neighborhoods represented in the monolingual children's lexicons would cause slower, less accurate retrieval. Indeed, receptive vocabulary data for these children demonstrate that ELL children have a lower average standard score on the *Peabody Picture Vocabulary Test-III* (Dunn & Dunn, 1997; *M* = 72.94; *SD* = 12.82) than the monolingual children (*M* = 93.95; *SD* = 10.64). These descriptive data support our proposal that young ELL children may be more efficient processing English lexical items due to less competition in their English lexicons as compared with their monolingual peers.

This proposal is also substantiated by the standard receptive vocabulary scores across languages where ELL children's average standard scores on the *Test de Vocabulary en Imágines Peabody* (Dunn, Lugo, & Dunn, 1997) in Spanish were higher (*M* = 88.06; *SD* = 15.57) those in English. Although ELL children have greater Spanish receptive vocabulary knowledge than English receptive vocabulary knowledge, there is a rapid shift in lexical processing efficiency where—by the end of kindergarten (i.e., Time 2)—these young ELLs may have sufficient experience using active processes, such as a lexical suppression mechanism, to facilitate processing in the L2 relative to the L1, allowing for better performance in their L2 as compared with their L1. Thus, it may be that a combination of lexical priming secondary to immersion, active lexical processes, and/or a less-densely packed L2 facilitates lexical processing in the ELL children's second language, English.

In sum, these studies suggest that lexical processing for ELL children is impacted by both lexical density of the developing dual lexical system as well as the accessibility of lexical information stored in long term memory. Theoretically, the fast and accurate RAN performance in English demonstrates that ELL children may have suppression of their L1 while simultaneously experiencing increased relative activation of their more sparsely-populated L2. Thus, ELL children benefit from sparsely populated lexical neighborhoods in their English lexicons which receive greater relative activation secondary to immersion in the English environment.

Limitations and Future Directions

The task used in the present studies was taken from a well-regarded standardized test, the CTOPP (Wagner et al., 1999); however, other RAN tasks may generate different patterns in performance—including the production of more expanded errors. RAN letters, for example, may produce more code-mixing errors during the RAN task in Spanish because these young ELL children may not be taught their letters in their native language; however, this may also be dependent upon the educational context as this would be true for immersion settings but not necessarily for bilingual settings. Future research should investigate performance on other RAN tasks and account for the potential influence of the environment (i.e., immersion or bilingual setting) on performance.

An additional limitation to these studies includes the sample size. An increased number of children would allow for the potential production of more errors as well as increase the power for statistical analyses. As the sample sizes were small, few errors were produced overall across all points in time. With a greater number of errors, future research should also investigate the relation between the expanded error coding system and later word reading in ELL children. It may be that children who produce more expanded errors, or errors overall, may later be poorer readers. In fact, Scarborough and Domgaard (1998) found that for monolingual English-speaking children who were poor readers, the number of errors that were produced on a RAN Objects task was positively associated with their receptive and expressive vocabulary scores. However, the relation between error production and word reading performance has not been explicitly explored in monolingual or ELL children. In addition to increased sample size, the inclusion of a monolingual group of Spanish-speaking children would provide theoretical insight to the efficiency of lexical processing in Spanish for these two groups of children. That is, it may give credence to the weaker links hypothesis, where ELL children—even with limited English exposure—have divided experience between the two languages; thus, resulting in weaker links for their L1, potentially causing poorer RAN performance.

Chapter 5

Study 3: The Roles of Rapid Automatic Naming and Phonological Awareness in Word Reading for Young Spanish-Speaking English Language Learners

Rationale

RAN is a concurrent and longitudinal predictor of reading success in young children. Alphanumeric RAN (i.e., letter and digit naming) in particular is strongly associated with decoding accuracy and reading fluency through at least the fourth grade (de Jong, 2011; Georgiou et al., 2008). Nonalphanumeric RAN tasks (i.e., object and color naming) are also related to reading; however, the strength and longevity of these relations are not as stable relative to the alphanumeric tasks. In fact, Georgiou et al. (2008) found that the RAN Colors task was predictive of word reading for monolingual English-speaking children through the first grade; however, performance on the RAN Objects task predicted word reading through third grade. Importantly, the relations between RAN tasks and reading have been confirmed for groups of monolingual speakers of languages other than English as well as for sequential and simultaneous bilingual[1] children, including ELL[2] children (Clinton et al., 2013; Furnes & Samuelsson, 2011; Lindsey et al., 2003; Manis et al., 2004).

Another early-developing skill that is related to literacy is phonological awareness (PA). PA is the ability to think about and manipulate the sounds used in oral language. This skill initially develops through oral language when children gain knowledge about the sounds in their ambient

[1] Simultaneous bilinguals are individuals who learned two languages from birth and developed experience in comprehending and speaking both languages over time. Sequential bilinguals are individuals who was immersed in a single-language environment beginning at birth, but who then began learning a second language after the age of three.

[2] The term “ELL” refers to sequential bilingual children in the United States or Canada. These sequential bilingual children, or ELLs, are those who are required to learn English as the primary means for verbal and written communication in the formal academic settings.

language and form phonological categories; however, this skill further develops in conjunction with the refinement of the phonemic categories stored in the mental lexicon secondary to experience with literacy (Apel, Masterson, & Hart, 2007). This means that PA develops from broader manipulation of syllables into manipulation of segmentalized phonemes. This ability to manipulate the individual sounds in words is referred to as phonemic awareness, and it is the more advanced skill under the broader PA umbrella (Carroll, Snowling, Hulme, & Stevenson, 2003; Cunningham, 1990). Both RAN and PA are important predictors of reading in monolingual and bilingual children and contribute to reading comprehension (e.g., Lindsey et al., 2004; Torgesen et al., 1994; Wolf & Bowers, 1999).

Predictors of Word Reading for ELL and Monolingual Children

The ability to rapidly and efficiently identify words—both in sentence context and in isolation—encountered during reading is crucial for reading comprehension. Proficient reading skills are key for long term academic success (Perfetti, 2007); however, it is not yet well understood how second language immersion impacts the development of key literacy skills, including RAN and PA (Oller & Eilers, 2002). Young typically-developing children, regardless of the number of languages they are acquiring, can learn to read and spell without persistent difficulties (e.g., Durgunoğlu, Nagy, & Hancin-Bhatt, 1993; Geva & Siegel, 2000; Geva, Wade-Woolley, & Shany, 1997). However, teaching children to read in a language that they are not proficient in has been identified as a risk factor for potential reading problems (Snow, Burns, & Griffin, 1998). Thus, it is critical that researchers and clinicians improve their understanding of the patterns of predictive relations between early-developing abilities based in oral language, such as RAN and PA, with later reading in young ELL children.

Chiappe and colleagues (2002) explored early oral language and literacy measures used to identify children who are at risk for potential reading impairments in three groups of children: Native English-speaking children, simultaneous bilingual children, and sequential bilingual children (i.e., ELLs who began learning English during preschool). They found that literacy skills, which included spelling, letter identification, and word recognition, developed in a similar pattern across all groups of children. There were significant group differences on the phonological processing tasks (i.e., PA and RAN) in kindergarten, where ELL children performed significantly poorer than the BL and ML groups of children. This gap between the groups closed for the RAN task by the end of kindergarten, whereas it persisted into the first grade for the PA measures. However, both PA accuracy and RAN speed at the beginning of kindergarten were predictive of performance on word recognition at the end of kindergarten (Chiappe, Siegel, & Gottardo, 2002).

In general, PA may be a better predictor of reading ability than any other oral language skill (Durgunoğlu et al., 1993). Currently, the literature contains mixed reports about the trajectories for performance on PA tasks for bilingual children in comparison with monolingual children. Campbell and Sais (1995) reported that bilingual preschoolers have better PA skills than young monolingual children. Wade-Woolley, Chiappe, and Siegel (1998), on the other hand, found that ELL children showed poorer performance than their monolingual English-speaking peers on PA tasks in kindergarten; however, by the first grade both groups of children demonstrated equivalent performance. Another study by Chiappe and Siegel (1999) found that the relation between phonological processing in English and reading ability were similar for young Punjabi-speaking ELL children and their English-speaking monolingual peers. Both groups of children produced similar patterns of errors, demonstrating similar strategies for word recognition during reading.

Overall, previous research has shown consistent associations between PA and reading for all young children regardless of the number of languages spoken (e.g., Durgunoğlu et al., 1993). In fact, PA in Spanish and English were both predictors later of real word reading and nonword reading in English for young bilingual children (Durgunoğlu et al., 1993). Findings for the relationships between RAN and reading, on the other hand, are not as reliable across studies. Lesaux and Siegel (2003) found that RAN in English was not a significant predictor of later word reading in the second grade for ELL children. However, a study by Manis and colleagues (2004) found that RAN speed in both English and Spanish was a significant predictor of later word reading in English for young Spanish-speaking ELL children.

The predictive relations between RAN and phonological processing (i.e., PA) with later word recognition in young monolingual English-speaking children and their ELL peers from first through third grade was evaluated by Geva and colleagues. They found that both groups of children had similar patterns of performance for RAN speed and PA accuracy, where children who had poor performance on the RAN and PA tasks were also poor readers at six months later, as well as one year later. Interestingly, PA was a more significant predictor of word reading performance for the ELL group than for the monolingual children, while RAN was a more important predictor for the monolingual group. The unique variance explained by PA increased over time while the variance explained by RAN decreased over time for both groups of children (Geva, Yaghoub-Zadeh, & Schuster, 2000).

In two longitudinal studies investigating the cross-linguistic relationships between oral language and literacy measures in Spanish-speaking ELL children, both PA and RAN Objects in

English and Spanish were significant predictors of later English word reading. The ELL children in their studies were enrolled in a transitional dual language immersion program where they received support for learning literacy and oral language in both Spanish and English (Lindsey et al., 2003; Manis et al., 2004). Unfortunately, receiving oral language or literacy training/support in their first language is not the norm in the U.S. for ELL children. As such, ELL children must acquire proficiency in oral language while simultaneously learning skills required for literacy in their second language. The efficiency with which ELL children develop these skills directly impacts their long-term academic success, including daily functioning in the classroom as well as performance on standardized testing.

RAN and PA as Cross-Linguistic Predictors of Reading

Early performance on standardized academic tests, including RAN and word reading, may be influenced by cultural and linguistic factors for ELL children. Skills taught at home by parents of Latino ELL children tend to include social skills (e.g., respect) rather than early academic concepts (e.g., letters and numbers) which tend to have greater value in mainstream American households (Roseberry-McKibbin, 2008). As a result, many ELL children in the U.S. may not be introduced to concepts important for long-term academic success until they enter a formal academic setting, typically in their second language. Knowledge obtained prior to entering kindergarten is important because it may impact performance on standardized tests. For example, if a young ELL child, who had no prior exposure to the alphabet or numbers, was administered the alphanumeric RAN task upon entrance into kindergarten, then this measure would be invalid. Thus, using a RAN Objects task may be more plausible for these children, because it is more likely that they would know these objects because they are frequent names used in their environments. The purpose of the RAN task is to measure the speed and accuracy of linguistic processing; information that is unknown would certainly not have a representation in the lexicon and, therefore, cannot be accessed for retrieval.

Although it has been proposed that assessing children who are non-native English-speakers in their L1 is more appropriate, this is not always a possibility due to a limited number of trained professionals who speak the child's L1, limited availability of linguistically and culturally appropriate tests, and the lack of appropriate norms for bilingual children experiencing L1 attrition (Geva et al., 2000). These issues hinder the accurate identification of young ELL children with potential language and learning disabilities. One potential solution to this dilemma is to use assessments that measure a child's capacity for language learning. The abilities present within the child's capacity are called "language-general" abilities[3] and are posited to improve the ability to accurately identify potential language disabilities in young ELL children (Bialystok & Hakuta, 1994; Durgunoğlu, 2002).

Language-general abilities are considered to be processes and/or skills that are not bound to a single lexicon, whereas language-specific encompasses information and/or skills that are restricted to a single lexicon. For example, vocabulary knowledge has been reported to be language-specific, as lexical items represented in a lexicon are dependent upon input from the ambient language in the environment (for discussion of the distributed characteristic see Umbel, Pearson, Fernández, & Oller, 1992). Diagnostic measures that tap into language-general abilities would allow for testing young children in their L1 in order to predict later L2 performance; this method would preclude delay secondary to limited L2 proficiency (Bialystok & Hakuta, 1994; Durgunoğlu, 2002; Nakamoto, Lindsey, & Manis, 2012). PA is not constrained within the more proficient language; thus, PA is able to "transfer" across languages and can be considered a

[3] This is opposed to "language-specific" abilities.

language-general skill (Chiappe & Siegel, 1999; Cisero & Royer, 1995; Durgunoğlu et al., 1993). However, syntactic knowledge is restricted within a specified lexicon; as such, it is considered to be a language-specific process (Durgunoğlu et al., 1993; Verhoeven, 1994). It is possible that testing RAN and PA in Spanish for young Spanish-speaking ELL children could predict later reading performance in English, allowing for the early identification of potential reading impairment. Stronger L1 knowledge would facilitate processing in Spanish, which would theoretically lead to improved RAN performance in Spanish.

The Current Investigation

The current study investigated the longitudinal predictive relationships between the early development of oral language abilities and preliteracy skills during kindergarten with later word reading during the second grade in both monolingual English-speaking children and Spanish-speaking ELLs. Data included RAN duration and accuracy measures and PA accuracy in both English during kindergarten (both Time 1 and Time 2) and word reading measures in the second grade (i.e., Time 3) from the TOWRE in English for ELL and monolingual children. For this study, PA is a composite of both the Elision and the Sound Matching subtests from the CTOPP[4]. See Chapter 3 for further explanation of the methodology used in this study. These measures (PA and RAN at Times 1 and 2) are used to predict word reading—including the Sight Word (i.e., real word) and Decoding (i.e., nonword) reading measures from the TOWRE—accuracy in English for both groups of children in the second grade (Time 3). For ELL children, the cross-linguistic predictive relations were also explored, which included PA and RAN in Spanish with later word reading measures in English.

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[4] Due to limited data secondary to poor performance on the Elision task in both English and Spanish, the two subtests were combined into the PA Composite score for analyses.

The addition of this information to the current literature will provide insight into the cross-linguistic relations between PA, RAN, and word reading, as well as guide practitioners in best practice for assessing potential reading success at an early age for young Spanish-speaking ELL children. Of particular importance is the inclusion of the RAN errors data, which included the number of hesitations produced as well as the number of other errors produced by these two groups of children during the RAN task. Specifically, the other error total comprised the original error codes accounted for on the RAN task (i.e., substitutions and skips) combined with the expanded error codes included in the previous line of research (i.e., addition, auto-correction, code-mixing[5], and repetition). See Chapter 3 for further description of the methodology and error types. No prior investigations have explored the predictive relations between error production on the RAN task and word reading for ELL children[6].

Questions Guiding this Investigation

1. How are RAN and PA measures in kindergarten related to word reading measures in the second grade for monolingual English-speaking children and Spanish-speaking ELL children?
2. For RAN Hesitations, is the combination of these RAN errors and PA accuracy in kindergarten a significant within-language predictor for performance on word reading tasks (i.e., TOWRE sight word reading a decoding) for Spanish-speaking ELL children?

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[5] Code-mixing errors were only included for the ELL children; however, these codes were only produced at Times 1 and 3 when the target language was Spanish.

[6] One previous investigation explored the relation between reading and RAN errors for groups of good and poor readers who were monolingual English-speakers (Scarborough & Domgaard, 1998).

    a. When considering the two groups of children, are the predictive relations among English preliteracy measures and English word reading measures different for the ELLs in comparison with the monolingual English-speaking children?
    b. When considering the task language in kindergarten for the ELLs, are the patterns of predictive relationships different for cross-linguistic predictors (i.e., Spanish preliteracy measures with English word reading) in comparison to within-language predictors (i.e., English preliteracy measures with English word reading)?
3. For RAN Additional Errors, is the combination of these RAN errors and PA accuracy in kindergarten a significant within-language predictor for performance on word reading tasks (i.e., TOWRE sight word reading a decoding) for Spanish-speaking ELL children?
    a. When considering the two groups of children, are the predictive relations among English preliteracy measures and English word reading measures different for the ELLs in comparison with the monolingual English-speaking children?
    b. When considering the task language in kindergarten for the ELLs, are the patterns of predictive relationships different for cross-linguistic predictors (i.e., Spanish preliteracy measures with English word reading) in comparison to within-language predictors (i.e., English preliteracy measures with English word reading)?
4. For RAN speed, is the combination of RAN speed and PA accuracy in kindergarten a significant within-language predictor for performance on word reading tasks (i.e., TOWRE sight word reading a decoding) for Spanish-speaking ELL children?

a. When considering the two groups of children, are the predictive relations among English preliteracy measures and English word reading measures different for the ELLs in comparison with the monolingual English-speaking children?
b. When considering the task language in kindergarten for the ELLs, are the patterns of predictive relationships different for cross-linguistic predictors (i.e., Spanish preliteracy measures with English word reading) in comparison to within-language predictors (i.e., English preliteracy measures with English word reading)?

For ELL children, it was hypothesized that the RAN measures and PA in English and Spanish would be significantly related to later English word reading (both real and nonword) for the ELL children. Both RAN and PA were believed to be language-general abilities, meaning they would be transferable across languages in order to facilitate processing of linguistic information, including the orthographic information found in word reading. Although it was believed that the RAN errors would be significant predictors of later word reading for ELL children, previous investigations had not explored this possibility. As such, no specific hypotheses about the patterns of predictive relationships were made; however, due to the overwhelming number of Hesitations produced relative to the other error types, these were extracted from the total number of errors and comprised their own error group for this study. It was believed, however, that the within-language predictive relationships (i.e., English preliteracy measures with English word reading) would be relatively stronger than the cross-linguistic predictive relationships (i.e., Spanish preliteracy measures with English word reading). This was believed because intra-lexical processing would be more resistant to competition than inter-lexical processing.

For monolingual children, it was hypothesized that both RAN and PA in English would also be significant unique predictors of later word reading in English. Children's ability to rapidly and accurately access and retrieve lexical information, as well as their ability to manipulate phonological information in both oral and written language, was expected to influence later accuracy on real and nonword reading tasks in English. Thus, it was predicted that the groups of ELL and monolingual children would have relatively similar patterns of predictive relationships among the preliteracy and word reading measures in English.

With regard to the relative importance of the preliteracy measures for later word reading, it was hypothesized that PA would be the more important predictor than RAN for both groups of children. However, when comparing the groups of children, it was anticipated that RAN would be a more important factor for the ELL children than for the monolingual children. Because young ELL children are developing two lexicons, it was theorized that competition across the lexicons would result in interference for rapid and accurate retrieval of linguistic information. Thus, accurate word naming could be impacted by children's ability to suppress activated information in the nontarget language. As monolingual children would not be affected by this processing issue, it was hypothesized that RAN would not necessarily be as significant of a predictor for word reading accuracy as compared with the ELLs.

It was also hypothesized that there would be differences in the patterns of predictive relations across the types of reading tasks. The two types of word reading tasks used in this study included real word reading, or sight word reading, and nonword reading, otherwise known as decoding. Because children were required to read nonwords for the decoding task (e.g., *blick*), it was believe that PA would be an especially important predictor for both groups of children. Nonwords require children to actively match-up graphemes with phonemes, which taps into their alphabetic knowledge and, consequently, their PA. As such, children who had good PA skills would be better at decoding nonwords (e.g., Apel et al., 2007). Previous research indicated that ELL children have poorer performance on PA tasks relative to their monolingual peers (Wade-Woolley, Chiappe, & Siegel, 1998). As such, I proposed that PA would be a more important predictor of later decoding for ELL children than for the monolingual children. For sight word reading, children are required to access and retrieve their stored mental graphemic representations[7] (MGRs) for production of the written words. I hypothesized that the speed and accuracy of this retrieval would be a more important predictor of later success on sight word reading for both groups of children.

In sum, it was anticipated that the patterns between predictive relations would differ by the type of reading task as well as by the group of children; no specific predictions were made regarding the relationships between the types of RAN errors with the word reading measures. It was believed that PA would be important for both groups of children across both types of tasks; however, this skill would be the more important predictor of decoding than of sight word reading. For RAN, it was expected that this factor would be more strongly predictive of sight word reading as compared with decoding. Due to lexical competition, I hypothesized that performance on the PA and RAN tasks would be more important indicators of the word reading tasks for the ELL children as compared with the monolingual children.

[7] These visual representations can consist of either whole words or words parts and are created through links between the meaning, the visual representation, and the sounds. The more complete the representation (i.e., the more links and more complete the visual representation), the clearer, more robust the representation. This creates a higher quality representation of the word. Poorer quality words contain fewer links with a less complete visual representation of the word. This causes the MGR to be fuzzy and less complete (see Apel, 2011, for a more detailed description.

Study 3: Results

The first research question concerning the associations between the RAN error types (i.e., Hesitations and Additional errors), RAN speed, PA composite, and the word reading measures (i.e., TOWRE Sight Word reading and Decoding) through correlations. The kindergarten measures (i.e., RAN and PA) were obtained at two points in time—the beginning (Time 1) and end (Time 2) of kindergarten; the word reading measures were collected during the middle of the second grade (Time 3). The RAN errors types included Hesitations and Additional errors, which were treated as separate error categories due to the findings in Chapter 4 where Hesitations were the majority error produced. The Additional errors were those used in Chapter 4 and included both the original error codes (i.e., substitutions and skips) and the expanded error codes (i.e., repetitions, auto-corrections, additions, and code-mixing). See Chapter 3 for further explanation of each of the individual error types. ELLs completed the kindergarten tasks in both English and Spanish, while the word reading tasks were completed in English only; all monolingual children completed these tasks in English only at all points in time.

Correlations[8] for ELL and Monolingual Children. Bivariate Pearson product-moment correlation coefficients were used to analyze the relationships between measures. Differences in correlational patterns among the kindergarten and second grade measures in English for the monolingual and ELL groups emerged. See Table 4 for the monolingual and ELL children's English correlations. For the monolinguals (n = 26), the Additional errors at Time 1 were significantly related to later Sight Word reading (r = -.40, p = .043) and approached significance with second grade Decoding (r = -.34, p = .090). Additional errors were not significantly related at either time point with later word reading type. Hesitations, on the other hand, were

[8] Mean imputation was used for RAN data and PA composites in this study.

significantly related to later Decoding for the ELL children (n = 40) at Time 1 (r = -.33, p = .037) and approached significance at Time 2 (r = -.27, p = .088). Although no significant relations were found for Hesitations at Time 1, monolingual children's Hesitations produced at Time 2 were significantly related to both Sight Word reading (r = -.40, p = .042) and Decoding (r = -.44, p = .026).

For RAN Speed, Time 1 was only significant for Decoding for the ELL children (r = -.35, p = .028); however, RAN speed at Time 2 was significantly related to both Decoding (r = -.42, p = .008) and Sight Word reading (r = -.38, p = .015) for the ELL children. RAN Speed was not related to later word reading for the monolingual children at either time point. For both groups of children, PA at Time 1 was significantly related to both Sight Word reading (monolingual: r = .46, p = .017; ELL: r = .38, p = .015) and Decoding (monolingual: r = .40, p = .045; ELL: r = .37, p = .017). PA at Time 2 was significantly associated with Sight Word reading (r = .64, p < .001) and decoding (r = .63, p < .001) for the ELL children only. In sum, a divergent pattern of relations between the English measures emerged for the two groups of children. For monolingual children, the RAN error types across time and Time 1 PA were significantly related to later word reading. Alternatively, RAN Hesitations, RAN Speed, and PA were significantly associated to later Decoding and Sight Word reading for the ELL children. See the Appendix section for additional within-language correlations for ELL and monolingual children.

Table 4

Correlations Between English Measures for Monolingual and ELL Children

	Time	Sight Word Reading		Decoding	
		ELLs (n = 40)	MLs (n = 26)	ELLs (n = 40)	MLs (n = 26)
RAN Additional Errors	1	-.05	-.40*	-.08	-.34^
RAN Additional Errors	2	-.12	-.07	-.24	-.25
RAN Hesitations	1	-.20	-.13	-.33*	.02
RAN Hesitations	2	-.23	-.40*	-.27^	-.44*
RAN Speed	1	-.23	-.24	-.35*	-.12
RAN Speed	2	-.38*	-.37	-.42**	-.30
PA	1	.38*	.46*	.37*	.40*
PA	2	.64***	.24	.63***	.18

^p < .10. *p < .05. **p < .01. ***p ≤ .001.

Cross-linguistic correlations between kindergarten measures in Spanish with second grade English word reading measures for the ELL children (see Table 5). Similarly to the correlational patterns in English, Spanish RAN Speed at Time 2 was significantly correlated with later Sight Word reading (r = -.37, p = .018) and Decoding (r = -.41, p = .009). PA at both points in time was also significantly related to Decoding (PA Time 1: r = .32, p = .045; PA Time 2: r = .48, p = .002) and Sight Word reading (PA Time 1: r = .38, p = .015; PA Time 2: r = .52, p = .001). Hesitations at Time 2 were also significantly associated with Decoding (r = -.34, p = .031) and Sight Word reading (r = -.32, p = .043). In contrast to the within-language English relations, Additional errors in Spanish at Time 1 approached significance with Sight Word Reading (p = .045). In sum, patterns of cross-linguistic relations between kindergarten measures in Spanish and second grade word reading measures in English were similar to within-language associations for ELL children. See Appendix C for additional cross-linguistic correlations.

Table 5

Correlations Between Spanish Kindergarten Measures and Second Grade English Word Reading Tasks for ELL Children

	Time	Sight Word Reading	Decoding
		ELLs (*n* = 40)	
RAN Additional Errors	1	-.27^	-.15
RAN Additional Errors	2	-.03	-.09
RAN Hesitations	1	-.02	-.16
RAN Hesitations	2	-.32*	-.34*
RAN Speed	1	-.09	-.13
RAN Speed	2	-.37*	-.41**
PA	1	.38*	.32*
PA	2	.52***	.48**

^p < .10. *p < .05. **p < .01. ***p ≤ .001.

Overall, with regard to the first research question, the patterns of cross-linguistic and within-language correlations between RAN Speed and PA with word reading were similar across languages for the ELL children. In contrast, the patterns of associations were different for the two groups of children. For monolingual children, Time 1 RAN error types and PA were significantly related to later word reading; only Hesitations at Time 2 were significantly associated to later Decoding. For ELL children, RAN Hesitations, RAN Speed, and PA were significantly correlated with later word reading.

The second research question addressed the predictive relationships between the kindergarten measures and second grade word reading. Specifically, hierarchical regression models were used to regress word reading on PA and RAN Hesitations. Within each type of reading task (i.e., Decoding and Sight Word reading), regression models in English (i.e., within-language predictive relationships) for two groups of children are presented and compared. Next, the cross-linguistic regression models with English word reading and Spanish predictor variables (i.e., cross-linguistic predictive relationships) for the ELL children are presented and compared to their within-language regression models with all English measures for each reading task. For all hierarchical regression models, Time 1 variables (i.e., PA and RAN) comprised Model 1; Model 2 included the Time 1 variables in combination with the Time 2 variables. Due to the well-established importance of PA to reading (e.g., Apel et al., 2007; Torgesen et al., 1994), PA was entered as the first measure in each step followed by a RAN measure. Preliminary analyses revealed that the assumptions of normality, linearity, multicollinearity, and homoscedasticity were met for all models. Descriptive statistics for the ELL children's measures are included in Table 6 below. See Table 7 for the monolingual children's descriptive statistics.

Table 6

Descriptive Measures for ELL Children

Variables	**Means (Standard Deviations)**	
	English	**Spanish**
PA Time 1	4.38 (3.85)	5.40 (4.11)
PA Time 2	11.68 (6.21)	13.13 (6.47)
Hesitations Time 1	4.03 (3.10)	3.07 (1.93)
Hesitations Time 2	2.63 (2.95)	4.49 (4.49)
Additions Time 1	1.72 (2.75)	1.39 (1.51)
Additions Time 2	.58 (.87)	.66 (1.43)
RAN Speed Time 1	59.43 (14.97)	59.57 (90.48)
RAN Speed Time 2	50.49 (13.78)	62.98 (20.22)
TOWRE Decoding	20.72 (12.64)	
TOWRE Sight Word	45.00 (17.74)	

Table 7

Descriptive Measures for Monolingual Children

Variable	Means (Standard Deviations)
PA Time 1	6.24 (3.70)
PA Time 2	14.04 (6.23)
Hesitations Time 1	4.05 (3.87)
Hesitations Time 2	3.15 (2.71)
Additions Time 1	1.55 (1.28)
Additions Time 2	.92 (1.20)
RAN Speed Time 1	58.52 (16.78)
RAN Speed Time 2	49.85 (16.87)
TOWRE Decoding	16.69 (8.38)
TOWRE Sight Word	45.12 (14.54)

Hesitations

Second Grade Decoding Regressed on RAN Hesitations and PA. ELL and monolingual children's Decoding in second grade was regressed on PA and RAN Hesitations in kindergarten using hierarchical regression. Upon comparing the within-language (i.e., English-English) hierarchical regression models for the two groups of children, differences in the patterns of the significant unique predictors appeared across the groups of children. For ELL children, both models reached significance (Model 1: $F(2, 39) = 4.98$, $p = .012$; Model 2: $F(2, 39) = 6.88$, $p < .001$), and Model 1 accounted for 17% while Model 2 accounted for 38% of the variance in ELL children's second grade Decoding. For the Time 1 variables in Model 1, PA ($p = .034$) in English emerged as a significant predictor of Decoding while Hesitations ($p = .074$) approached significance. After the addition of the Time 2 variables in Model 2, only PA at Time 2 in English was a significant predictor ($p = .001$) for the ELL children. In contrast to their ELL peer's within-language regression model, Model 1 was not significant ($F(2, 25) = 2.16$, $p = .139$) for the monolingual children; however, after the addition of Time 2 variables, Model 2 reached significance[9] ($F(4, 25) = 2.56$, $p = .069$). Model 2 accounted for 20% of the variance in Decoding, and Hesitations at Time 2 was the significant unique predictor ($p = .032$) of later Decoding for monolingual children.

For ELL children, the cross-linguistic regression model was similar to the within-language results. Both Model 1 and Model 2 were statistically significant (Model 1: $F(2, 39) = 3.42$, $p = .043$; Model 2: $F(4, 39) = 3.93$, $p = .010$). While the Spanish kindergarten variables in Model 1 accounted for only 11% of the variance, Model 2 explained 23% of the total variance in Decoding. In Model 1, Spanish PA at Time 1 emerged as the significant unique predictor of later Decoding ($p = .023$), and significance subsequently shifted to Spanish PA at Time 2 ($p = .030$) in Model 2. Hesitations in Spanish were not significant unique predictors in either model. See Table 8 for the ELL and monolingual children's regression models for Decoding.

[9] Due to the small sample size, an adjusted alpha level was used to determine significance.

Table 8

English Decoding in Second Grade Regressed on PA and RAN Hesitations in Kindergarten for ELL and Monolingual Children

			Decoding														
			ELLs: English					**Monolinguals**					**ELLs: Spanish**				
Model	Time	Variable	B(SE)	Β	*p*	Adj R^2	ΔR^2	B(SE)	Β	*p*	Adj R^2	ΔR^2	B(SE)	Β	*p*	Adj R^2	ΔR^2
	1	PA	1.07(.49)	.33	.034			.90(.43)	.40	.049			1.13(.48)	.37	.023		
1		Hesitations	-1.11(.60)	-.27	.074	.17		.07(.41)	.03	.875	.09		-1.56(1.01)	-.24	.131	.11	
	1	PA	.16(.49)	.05	.752			.73(.50)	.32	.156			.19(.57)	.06	.741		
		Hesitations	-.84(.54)	-.21	.126			.49(.45)	.22	.288			-.46(1.03)	-.07	.660		
2	2	PA	1.12(.31)	.55	.001	.38	.23	-.03(.30)	-.03	.910	.20	.17	.79(.35)	.40	.030	.23	.15
		Hesitations	-.16(.58)	-.04	.790			-1.43(.62)	-.46	.032			-.70(.43)	-.25	.112		

Second Grade Sight Word Reading Regressed on RAN Hesitations and PA. Hierarchical regression modeling was used to evaluate the predictive relationships between PA and RAN Hesitations in kindergarten with second grade Sight Word reading for ELL and monolingual children. Divergent patterns of the significant unique predictors—particularly at Time 2—were found between languages for the ELL children and across groups of children. For the ELL children's English predictor variables, Model 1 and Model 2 were both found to reach statistical significance (Model 1: $F(2, 39) = 3.60$, $p = .037$; Model 2: $F(4, 39) = 6.34$, $p = .001$). Model 1 accounted for 12% of the variance in Sight Word reading, and PA emerged as the significant unique predictor ($p = .025$) of second grade Sight Word reading. After the inclusion of the Time 2 variables in Model 2, 35% of the variance was explained in Sight Word reading and significance shifted to PA at Time 2 ($p = .001$) in Model 2. Hesitations were not a significant predictor in ether model.

Similar to their ELL peers, both Model 1 and Model 2[1] were significant (Model 1: $F(2, 25) = 3.38$, $p = .052$; Model 2: $F(4, 25) = 2.42$, $p = .081$) for the monolingual children. Model 1 accounted for 16% of the variance in later Sight Word reading with PA at Time 1 emerging as the significant predictor ($p = .020$). Model 2 accounted for 19% of the variance; however, none of the variables emerged as unique predictors of second grade Sight Word reading for the monolingual children. Thus, unlike the ELL children where Time 2 PA emerged as a unique predictor in the total model, the monolingual children did not have a single unique predictor of later Sight Word reading in the total model.

[1] An adjusted alpha level was used to determine significance.

The cross-linguistic model was found to be similar to the within-language regression model for the ELL children, with the exception of Time 2 RAN Hesitations in Spanish. The cross-linguistic model showed that Model 1 and Model 2 were both found to be statistically significant (Model 1: $F(2, 39) = 3.38$, $p = .045$; Model 2: $F(4, 39) = 4.46$, $p = .005$). Model 1 accounted for 11% of the variance in Sight Word reading, and PA at Time 1 emerged as a significant unique predictor ($p = .013$). After the inclusion of Time 2 variables, Model 2 accounted for 26% of the total variance in Sight Word reading. While PA at Time 2 in Spanish became a significant predictor ($p = .017$), RAN Hesitations approached significance ($p = .078$). See Table 9 for ELL and monolingual children's regression models for Sight Word reading.

Table 9

English Sight Word Reading in Second Grade Regressed on PA and RAN Hesitations in Kindergarten

			Sight Word Reading														
			ELLs: English					Monolinguals					ELLs: Spanish				
Model	Time	Variable	B(SE)	B	*p*	Adj R^2	ΔR^2	B(SE)	B	*p*	Adj R^2	ΔR^2	B(SE)	B	*p*	Adj R^2	ΔR^2
1	1	PA	1.65(.70)	.36	.025	.12		1.81(.72)	.46	.020	.16		1.73(.67)	.40	.013	.11	
		Hesitations	-.76(.87)	-.13	.390			-.41(.69)	-.11	.556			-.91(1.42)	-.10	.523		
2	1	PA	.29(.70)	.06	.683	.35	.26	1.43(.87)	.36	.115	.19	.09	.29(.78)	.07	.710	.26	.18
		Hesitations	-.39(.77)	-.07	.618			.03(.78)	.01	.974			.77(1.42)	.08	.589		
	2	PA	1.69(.44)	.59	.001			.14(.52)	.06	.786			1.20(.48)	.44	.017		
		Hesitations	-.09(.83)	-.01	.918			-1.78(1.09)	-.33	.118			-1.07(.59)	-.27	.078		

Overall, although kindergarten RAN Hesitations and PA measures were important to ELL and monolingual children second grade word reading, the timing and language of testing emerged as important considerations. With the exception of monolingual children's decoding, PA across times and languages remained a consistent predictor of later word reading ability for both groups of children. This indicates that young children's ability to think about and manipulate the sounds used in oral language is a crucial skill for later word reading, regardless of the number of languages a child is learning. With regard to Hesitations, ELL children's Hesitations approached significance; however, this measure was a significant unique predictor—above and beyond PA—of second grade decoding for monolingual children. This means that the number of disruptions in lexical processing produced by the monolingual children is a significant indicator of their later ability to decode nonwords. In sum, our hypotheses were partially supported in that PA was important for both groups of children and across languages for the ELL children; however, in contrast to our original beliefs, Hesitations were actually a more important predictor for the monolingual children than the ELL children. Further consideration of these findings is discussed in the Discussion section of Chapter 5.

Although the number of Hesitations produced on the RAN task contributed to significant models for predicting word reading, these errors are notoriously difficult to accurately code during a clinical evaluation. Thus, the third set of research questions evaluated the predictive relationships between PA and the other errors produced on the RAN task—called Additional errors in this study—with later word reading for monolingual and ELL children. Specifically, I investigated whether these kindergarten variables would have significant within and/or across-language relationships with second grade word reading in English. I then compared English hierarchical regression models across the two groups of children.

Additional Errors

Second Grade Decoding Regressed on RAN Additional Errors and PA. ELL and monolingual children's Decoding in second grade was regressed on PA and RAN Additional errors in kindergarten using hierarchical multiple regression. Across the groups of children and between the languages for the ELL children, the patterns in the timing of testing was found to be different. For the ELL children's PA and RAN in English, both Model 1 and Model 2 were found to be statistically significant (Model 1: $F(2, 39) = 3.75$, $p = .033$; Model 2: $F(2, 39) = 6.00$, $p = .001$). Model 1 accounted for 12% of the variance in Decoding, and PA emerged as the significant unique predictor ($p = .011$). Model 2 accounted for 34% of the variance in Decoding, and PA at Time 2 became the significant unique predictor ($p = .001$). In contrast to the ELL children's regression model, only Model 1 was significant ($F(2, 25) = 3.52$, $p = .046$) and explained 17% of the total variance in later Decoding for the monolingual children; Model 2 was not significant ($p = .110$). Using an adjusted alpha level, Time 1 PA was the significant predictor ($p = .071$) of later nonword reading. RAN Additional errors was not a significant predictor in any of the models for either groups of children.

ELL children's cross-linguistic regression model also demonstrated differences with regard to the timing of testing in comparison to their within-language regression model. For the cross-linguistic model, Model 1 did not reach significance ($p = .101$), which means that the Time 1 Spanish variables alone did not account for a significant amount of the variance in Decoding. With the additional of the Time 2 variables, Model 2 became statistically significant ($F(4, 39) = 2.90$, $p = .036$). Model 2 accounted for 16% of the variance in Decoding, and Spanish PA at Time 2 emerged as the significant unique predictor ($p = .022$) of later English Decoding for ELL children. In line with the within-language and monolingual regression models, the RAN

Additional errors did not emerge as significant unique predictors of later Decoding. See Table 10 for ELL and monolingual children's hierarchical regression models.

Table 10

English Decoding in Second Grade Regressed on PA and RAN Additional Errors in Kindergarten for ELL and Monolingual Children

			Decoding														
			ELLs: English					Monolinguals					ELLs: Spanish				
Model	Time	Variable	B(SE)	B	*p*	Adj R^2	ΔR^2	B(SE)	B	*p*	Adj R^2	ΔR^2	B(SE)	B	*p*	Adj R^2	ΔR^2
1	1	PA	1.36(.51)	.42	.011	.12		.79(.42)	.35	.071	.17		.94(.48)	.31	.056	.07	
		Additional	-.80(.71)	-.17	.268			-1.85(1.21)	-.28	.141			-1.03(1.30)	-.12	.423		
2	1	PA	.32(.52)	.10	.549	.34	.24	.82(.49)	.36	.109	.16	.06	.17(.56)	.06	.762	.16	.13
		Additional	-.35(.63)	-.08	.583			-1.70(1.23)	-.26	.179			-.81(1.23)	-.10	.514		
	2	PA	1.13(.32)	.55	.001			-.01(.29)	-.01	.981			.85(.36)	.44	.022		
		Additional	-1.09(1.96)	-.08	.583			-1.67(1.30)	-.24	.211			-.59(1.30)	-.07	.653		

Second Grade Sight Word Reading Regressed on RAN Additional Errors and PA. ELL and monolingual children's Sight Word reading in second grade was regressed on PA and RAN Additional errors in kindergarten using hierarchical multiple regression. Patterns of predictive relationships in these variables showed that—unlike the previous regression models discussed—the types of variables used were important rather than the timing of the testing across groups of children. For ELL children's within-language regression model, both Model 1 and Model 2 were found to be statistically significant (Model 1: $F(2, 39) = 3.69$, $p = .034$; Model 2: $F(2, 39) = 6.37$, $p = .001$). Model 1 accounted for 12% of the variance in Sight Word reading, and PA at Time 1 emerged as the significant unique predictor ($p = .010$) of second grade Sight Word reading. After the addition of the Time 2 variables, Model 2 accounted for 36% of the variance in Sight Word reading, and significance shifted from PA at Time 1 in Model 1 to PA at Time 2 in Model 2 ($p < .001$). RAN Additional errors was not a significant unique predictor at either time point for the ELL children. Similar to the ELL children, monolingual children's regression model showed that both Model 1 and Model 2 were statistically significant (Model 1: $F(2, 25) = 5.49$, $p = .011$; Model 2: $F(4, 25) = 2.54$, $p = .070$). Model 1 accounted for 26% of the total variance in Sight Word reading. However, in contrast to the ELL children's patterns of unique predictors, both PA ($p = .028$) and Additional errors ($p = .068$) at Time 1 emerged as significant predictors of Sight Word reading for monolingual children. After the inclusion of Time 2 variables in Model 2, the total variance explained decreased to 20%; however, Time 1 PA and Additional errors remained significant predictors of later Sight Word reading (Time 1 PA: $p = .069$; Time 1 Additional errors: $p = .086$).

The patterns of significance in ELL children's cross-linguistic regression model was remarkably similar to their within-language regression model. In the cross-linguistic model, Model 1 and Model 2 were both statistically significant (Model 1: $F(2, 39) = 4.64$, $p = .016$; Model 2: $F(4, 39) = 4.14$, $p = .008$). The Time 1 variables in Model 1 accounted for 16% of the variance in Sight Word reading, and Spanish PA emerged as the significant unique predictor ($p = .021$). After the addition of the Time 2 variables, Model 2 explained 24% of the variance in Sight Word reading and significance shifted to PA at Time 2 ($p = .018$). The RAN Additional errors in Spanish and English were not significant predictors in either model. See Table 11 for the ELL and monolingual children's Sight Word reading regression models.

Table 11

Sight Word Reading in Second Grade Regressed on PA and RAN Additional Errors in Kindergarten for ELLs and Monolinguals

			Sight Word Reading															
			ELLs: English					**Monolinguals**					**ELLs: Spanish**				
Model	Time	Variable	B(SE)	Β	*p*	Adj R^2	ΔR^2	B(SE)	Β	*p*	Adj R^2	ΔR^2	B(SE)	Β	*p*	Adj R^2	ΔR^2
1	1	PA	1.92(.71)	.42	.010	.12		1.61(.68)	.41	.028	.26		1.54(.64)	.36	.021	.16	
		Additional	-.96(1.00)	-.15	.344			-3.79(1.98)	-.33	.068			-2.78(1.73)	-.24	.117		
2	1	PA	.42(.72)	.09	.567	.36	.26	1.60(.83)	.41	.069	.20	.00	.47(.74)	.11	.535	.24	.12
		Additional	-.38(.87)	-.06	.665			-3.73(2.07)	-.33	.086			-2.54(1.65)	-.22	.133		
	2	PA	-1.74(.45)	.61	.000			.02(.49)	.01	.965			1.18(.47)	.43	.018		
		Additional	1.26(2.72)	.06	.646			-.63(2.19)	-.05	.775			.06(1.73)	.01	.973		

Overall, the Additional errors and PA produced significant hierarchical regression models for Decoding and Sight Word reading for the two groups of children. For the monolingual children, although the total model accounted for 20% of the variance in Sight Word reading, only the Time 1 PA and the Additional errors were significant unique predictors[1] of later Sight Word reading. Although both regression models were significant for both groups of children, only Time 1 variables (i.e., both Additional errors and PA) reached significance for the monolinguals whereas significance shifted from Time 1 PA to Time 2 PA only for the ELL children. Thus, while the accuracy of lexical retrieval is a unique predictor of Sight Word reading for the monolinguals, only phonological manipulation (i.e., PA) emerged as a significant unique predictor for the ELLs. In sum, contrary to the hypothesis, the Additional errors produced on the RAN task were more important markers of word reading ability for the monolingual children than the ELL children.

Similarly to the hierarchical regression models using Hesitations and PA, the patterns of predictive relationships for the Additional errors and PA indicated that PA was the most important predictor for later word reading for both groups of children. Thus, the ability to manipulate phonemes used in spoken language is key to predicting later word reading ability. With regard to the accuracy of lexical access and retrieval, the Hesitations produced on the RAN task emerged as more predictive of later word reading than the Additional errors for both groups of children. As such, this may mean that children's ability to efficiently locate an item in the lexicon is a more important indicator of later word reading efficiency than lexical retrieval accuracy, regardless of the number of languages known by a child. When comparing the two groups of children, Hesitations and Additional errors actually emerged as important predictors

[1] An adjusted alpha value was used to determine significance due to the small sample size.

for the monolingual children rather than the ELL children. This was an unexpected finding given that ELL children experience a myriad of lexical competition and interference with respect to lexical processing. It was originally believed that these issues would be predictive of later word reading, given that reading is a language-based task. Further interpretation of these findings is included in the Discussion section of Chapter 5.

The final set of research questions evaluated the predictive relationships among RAN Speed and PA in kindergarten with later word reading measures. Currently, there has been significant debate about the predictive relationship between RAN Speed and later word reading for ELL children. As such, the within- and cross-linguistic predictive relationships between kindergarten PA and RAN Speed with second grade word reading were examined for the ELL children. The ELL children's English hierarchical regression model was then compared to that of their monolingual peers.

RAN Speed

Second Grade Decoding Regressed on RAN Speed and PA. ELL and monolingual children's Decoding in the second grade was regressed on PA and RAN in kindergarten using hierarchical multiple regression. Interestingly, considerable differences in the patterns in the predictive value of the variables emerged across the groups of children as well as the timing of testing across the languages for the ELL children. For ELL children's within-language regression model, Model 1 significantly accounted for 18% of the variance in Decoding, $F(2, 39) = 5.37$, $p = .009$. After the addition of the Time 2 variables, the total model (i.e., Model 2) accounted for 37% of the total variance in Decoding, $F(4, 39) = 6.84$, $p < .001$. In Model 1, PA at Time 1 was statistically significant ($p = .032$) and RAN at Time 1 approached significance ($p = .052$) for the ELLs; however, in Model 2, only PA at Time 2 was a unique predictor ($p = .004$).

In contrast for the monolingual children, neither Model 1 nor Model 2 was found to be statistically significant (Model 1: $F(2, 25) = 2.25$, $p = .129$; Model 2: $F(4, 25) = 1.51$, $p = .237$). Although the models were not significant, it is noteworthy that PA at Time 1 approached significance in both Model 1 ($p = .055$) and Model 2 ($p = .090$). Overall, the total model for the monolingual children accounted for less than 10% of the total variance in Decoding.

For ELL children's cross-linguistic regression model, the timing of the testing emerged as an important factor. Unlike the within-language regression model for these children, Model 1 of the cross-linguistic regression did not quite reach significance ($p = .083$). However, after the addition of the Time 2 variables, Model 2 was found to be statistically significant, $F(4, 39) = 4.51$, $p = .005$, and it accounted for 27% of the total variance in Decoding. Like the within-language model, Time 2 PA was a significant unique contributor ($p = .029$) to later Decoding; however, diverging from the within-language regression model, Time 2 RAN in Spanish also emerged as a significant contributor to later Decoding ($p = .040$). Thus, Time 2 RAN Speed in Spanish was a unique predictor of Decoding while RAN Speed in English was not. See Table 12 for the ELL and monolingual children's hierarchical regression models for Decoding.

Table 12

English Decoding in Second Grade Regressed on PA and RAN Speed in Kindergarten for ELL Children

			Decoding									
			ELLs: English					ELLs: Spanish				
Model	Time	Variable	B(SE)	B	*p*	Adj R^2	ΔR^2	B(SE)	B	*p*	Adj R^2	ΔR^2
	1	PA	1.08(.48)	.33	.032			1.02(.48)	.33	.038		
1		RAN	.00(.00)	-.30	.052	.18		.00(.00)	-.16	.319	.08	
	1	PA	.25(.49)	.08	.617			.16(.52)	.05	.760		
		RAN	.00(.00)	-.16	.273			-6.93x10^-7(.00)	.00	.997		
2	2	PA	1.03(.34)	.50	.004	.37	.21	.76(.34)	.39	.029	.27	.21
		RAN	-8.33x10^-5(.00)	-.09	.577			.00(.00)	-.33	.040		

Second Grade Sight Word Reading Regressed on RAN Speed and PA. ELL and monolingual children's Sight Word reading in the second grade was regressed on PA and RAN in kindergarten using hierarchical multiple regression. Across the two groups of children, the timing of testing was again found to be an important factor—especially for the monolingual children. Interestingly, the patterns of significance in the ELL children's within and cross-linguistic regression models were similar. For the ELL children's within-language regression model, Model 1 significantly accounted for 13% of the variance in later Sight Word reading for the ELL children, $F(2, 39) = 3.91$, $p = .029$, and Time 1 PA emerged as a statistically significant unique predictor ($p = .025$). Model 2 was also significant ($F(4, 39) = 6.52$, $p < .001$) and accounted for 36% of the variance in Sight Word reading, and significance shifted from Time 1 PA to Time 2 PA ($p = .003$). RAN was not a statistically significant unique predictor in either model.

For the monolingual children, Model 1 was found to be significant ($F(2, 25) = 3.85$, $p = .036$). Using an adjusted alpha level, Model 2 was also significant $F(4, 25) = 2.25$, $p = .099$). Model 1 accounted for 19% of the total variation in Sight Word reading for the monolingual children, and PA was found to be the significant contributor ($p = .022$) while RAN did not reach significance ($p = .308$). Model 2 accounted for 17% of the variance in Sight Word reading, which was 2% less variance accounted for than Model 1. For both the Decoding and Sight Word reading for the monolingual children, this decrease in the variance explained was believed to be secondary to the increase in the number of variables included in the model given the small sample size of this group of children. Time 1 PA in Model 2 was again the significant contributor ($p = .066$); thus, significance did not shift to PA at Time 2 like it did for the ELL children. Across both groups of children and at each time point, RAN did not emerge as a significant unique predictor of Sight Word reading.

ELL children's cross-linguistic regression model for Sight Word reading was remarkably similar to their within-language regression model. Both Model 1 ($F(2, 39) = 3.51$, $p = .040$) and Model 2 ($F(4, 39) = 4.82$, $p = .003$) were found to be statistically significant for the cross-linguistic regression model. Model 1 accounted for 11% of the total variance in Sight Word reading, and PA was found to be the significant contributor ($p = .014$) whereas RAN did not reach significance ($p = .426$). When the Time 2 variables were included, Model 2 accounted for 28% of the total variance in sight word reading. In Model 2, Time 2 PA was the significant contributor ($p = .026$) while Time 2 RAN approached, but did not reach, significance ($p = .061$). See Table 13 for ELL and monolingual children's hierarchical regression models.

Table 13

English Sight Word Reading in Second Grade Regressed on PA and RAN Speed in Kindergarten for Children

			Sight Word Reading														
			ELLs: English					Monolinguals					ELLs: Spanish				
Model	Time	Variable	B(SE)	B	*p*	Adj R^2	ΔR^2	B(SE)	B	*p*	Adj R^2	ΔR^2	B(SE)	B	*p*	Adj R^2	ΔR^2
	1	PA	1.63(.70)	.35	.025			1.75(.71)	.44	.022			1.69 (.65)	.39	.014		
1		RAN	.00(.00)	-.17	.263	.13		.00(.00)	-.19	.308	.19		.00 (.00)	-.12	.426	.11	
	1	PA	.38(.70)	.08	.589			1.68(.87)	.43	.066			.50 (.73)	.12	.499		
		RAN	-3.08x10^-5(.00)	-.03	.862			7.792x10^-6(.00)	.01	.973			3.68x10^-5 (.00)	.02	.902		
2	2	PA	1.55(.48)	.54	.003	.36	.25	-.10(.56)	-.04	.867	.17	.05	1.08(.46)	.39	.026	.28	.20
		RAN	.00(.00)	-.11	.511			.00(.00)	-.30	.253			.00 (.00)	-.30	.061		

Overall, substantial group differences between the ELLs and monolinguals were observed with regard to the patterns of predictive relations for Decoding and Sight Word reading. Interestingly, RAN Speed and PA did not influence Decoding for the monolingual children, while the English regression model was indeed significant for the ELL children. This was a different pattern than expected given the extant literature concerning the relations between RAN, PA, and reading for monolingual children (e.g., Wolf & Bower, 1999). It was anticipated that speed of lexical access and retrieval would be crucial for predicting decoding ability for monolingual children; however, this was not the case in this study. In line with previous research investigating the cross-linguistic relationships (e.g., Manis et al., 2004), RAN Speed was an important cross-linguistic predictor of later word reading ability for ELL children. In sum, although the ability to manipulate phonological information is key for identifying later word reading ability for both groups of children, speed of lexical access and retrieval as measured by RAN was more important for ELL children than monolingual children. Potential explanations for these findings is discussed in the Discussion section of Chapter 5.

Chapter 5: Discussion

This line of research supports previous work demonstrating the importance of PA—regardless of language—for word reading in young monolingual and ELL children (Lindsey et al., 2003; Manis et al., 2004; Torgesen et al., 1994). PA was a significant predictor of later word reading in English for both groups of children across all measures of word reading. Our findings for the RAN measures broaden the current understanding of the importance of RAN for predicting later word reading for young monolingual and ELL children. Specifically, our findings demonstrated the importance of using RAN errors as a predictive measure rather than relying only on RAN speed as an indicator of later reading success. This was particularly true for the monolingual children, where the hierarchical regression model using PA and RAN speed was not a significant predictor of later decoding ability. This suggests that the ability to manipulate sounds in language and the accuracy of lexical access and retrieval are more important abilities for predicting later word reading than the speed of lexical processing for young monolingual children. For the ELL children in both languages, the RAN error types as well as RAN speed explained significant variance in isolated word reading, which means that RAN is an important behavioral measure that reflects lexical processing efficiency implicated in word reading tasks. Our data support previous assertions stating that RAN and PA are cross-linguistic predictors, as well as within-language predictors, of later word reading in young ELL children (see Manis et al., 2004).

Previous investigations have demonstrated that PA and RAN are both important predictors for word reading in English for Spanish-speaking ELL and monolingual English-speaking children (Lindsey et al., 2003; Manis et al., 2004; Torgesen et al., 1994; Wagner et al., 1994; Wolf & Bowers, 1999); however, research to date has not compared the predictive relations between RAN error types with later word reading for young children. Evaluation of the causal relations between error production and later word reading allows for both a theoretical and clinical understanding for how lexical access and retrieval is impacted by the development of a dual lexical system for ELL children as compared with monolingual children. The first sets of hierarchical regression models evaluated the combination of PA and two RAN error types (Hesitations and Additional errors) in kindergarten as predictors of second grade English word reading. The final set of hierarchical regression models evaluated PA and RAN duration measures[1] as predictors for later word reading in English for monolingual and ELL children. Findings from these studies are discussed using lexical connectivity and points in lexical processing as a lens for comparisons of the monolingual and ELL children, as well as cross-linguistic comparisons of Spanish and English for the ELL children.

Lexical Strength and Robustness as a Mediator for the Predictive Relation Between RAN and Reading

Prior research has investigated the relationships between RAN speed and word reading in young monolingual and bilingual children. RAN speed is a relatively simple measure to obtain as the examiner is required to time the total time it takes for the participant to complete the task. Previous investigations have found that this RAN measure is significantly predictive of real and/or nonword reading for young monolingual children as well as for young Spanish-speaking ELL children (e.g., Manis et al., 2004; Wolf & Bower, 1999). Given this finding, I hypothesized that RAN duration in both languages would be a significant predictor of later word reading in English. This hypothesis was supported in the current study for ELL children; however, this was not entirely the case for monolingual children. The current investigation revealed that RAN

[1] The kindergarten predictor measures were in English and Spanish for the ELL children and in English only for the monolingual children.

Speed and PA did not explain variance in decoding for the monolingual children; however, the monolingual hierarchical regression model for sight word reading and all of the models for the ELLs were significant. Interestingly, for the monolinguals, only Time 1 PA was a significant unique predictor of Sight Word reading. For the ELL children, Spanish RAN Speed at Time 2 was either significant or approached significance in the Decoding and Sight Word reading models. For Decoding, English RAN Speed was a significant unique predictor at Time 1; however, it was no longer a significant unique predictor after the inclusion of the Time 2 variables. Thus, RAN Speed had significant within- and cross-linguistic predictive relationships with later word reading for the ELL children. However, in comparison to their ELL peers, RAN Speed was not as important of an indicator of word reading—particularly, decoding ability—for monolingual children. Thus, lexical processing speed, regardless of language, is a key early indicator of later reading ability for ELL children but not for monolingual children.

This pattern of relations was surprising because rapid and accurate access to orthographic and phonological information is crucial for success on both of these time-constrained reading tasks, especially for monolingual children. In particular, it was hypothesized that RAN speed, regardless of language, would be an important indicator of later sight word reading. Sight word reading requires the rapid and accurate retrieval of partial or whole word visual representations that are tied closely to the mental lexicon, as they are part of the mental graphemic representation (MGR; Apel, 2011; Apel et al., 2007)[2]. RAN Speed was expected to reflect the processing time required for the accurate retrieval of the linguistic information represented in the written words. Although our findings support that RAN speed across languages is an important contributor to regression models explaining word reading for ELL children, it was not a unique predictor for

[2] A MGR is composed of connections between semantic, orthographic, and phonological information in the lexicon (Apel, 2011; Apel, Masterson, & Hart, 2007).

either group of children nor was it a consistent contributor to significant regression models for monolingual children. In fact, the combination of PA and RAN Speed did not account for significant variance in Decoding for the monolingual children, meaning the ability to manipulate sounds in oral language and the speed of lexical retrieval were not important indicators of decoding ability. As such, accurately predicting decoding ability requires more than an assessment of lexical processing speed and phoneme manipulation, as posited in the Phonological Processing theory proposed by Torgesen et al (see Chapter 2 for more explanation of this viewpoint). The measure of RAN Speed does indeed reflect how rapidly one can access and retrieve lexical information as suggested by Wagner and Torgesen (1987); however, as discovered in our data, predicting success on word reading tasks requires a measure of lexical processing accuracy as well. If the Phonological Processing theory were to be supported, then we would expect that RAN and PA would both be significant predictors of Decoding because the ability to decode nonwords is inherently reliant on lexical processing at the phonological level[3]. As such, from this theoretical viewpoint it would be expected that RAN and PA would reflect the phonological processing involved in this reading task. However, this was not found to be the case in the current study; thus, the data in this investigation would not support the Phonological Processing theory.

For the ELL children, it may be that RAN speed in English was not a predictor of later word reading because these young children did not yet have strong enough connections within the English lexicon for robust lexical representations, which would theoretically improve processing efficiency, resulting in better RAN performance. Poorer lexical connections between the orthographic, phonological, and semantic information would cause inefficient processing for

[3] Lexical processing for nonwords would not be expected at the semantic level because nonwords do not have meanings attached to them.

lexical information, potentially resulting in a limited relationship between sight word reading and RAN duration. However, the significant unique predictive relationships between RAN speed in Spanish with later English word reading could be secondary to tighter, more robust lexical representations in the Spanish lexicon. Upon entrance into kindergarten young Spanish-speaking ELL children were expected to have stronger Spanish language skills than English skills due to their limited L2 proficiency. Thus, RAN speed in Spanish—as opposed to English—may be significantly related to decoding because children's lexical knowledge would be more consolidated and robust in Spanish than in English. These tightly-linked lexical representations would cause more efficient processing of linguistic information in Spanish, resulting in a relation between RAN duration in Spanish with later decoding and sight word reading.

In sum, our findings are in line with investigations by Chiappe and colleagues (2002) and Manis et al. (2004), where RAN speed and PA measured in both Spanish and English in kindergarten were important indicators of later word reading ability for ELL children. Curiously, our findings diverge from previous investigations demonstrating the importance of RAN speed for predicting word reading ability for monolingual children (e.g., Wolf & Bowers, 1999). That is, the nature of the relationship is dependent upon the type of word reading evaluated. Our data showed that these measures were not important markers of later decoding ability; however RAN speed and—in particular, PA—were significant predictors of later sight word reading for monolingual children. Thus, lexical processing speed is important for the retrieval of whole lexical units used in sight word reading rather than phonological codes required for decoding. As shown in our data, the accuracy of lexical access and retrieval in conjunction with phonological manipulation are more important for predicting later word reading than speed of lexical processing for monolingual children.

Importance of Error Production for Predicting Word Reading

In addition to analyses evaluating the predictive relations between RAN duration and word reading, hierarchical regression models were used to analyze the predictive relations between PA and RAN errors (i.e., Hesitations and Additional errors) with second grade word reading (i.e., Decoding and Sight Word reading). These analyses were included because it was hypothesized that accuracy on RAN tasks may reflect the efficiency of lexical access and retrieval, which is implicated in both the RAN Objects task as well as the two reading tasks incorporated in this line of research. Only one prior study has investigated error production in young monolingual children (Scarborough & Domgaard, 1998); no previous investigations have analyzed the predictive relations between RAN errors with later word reading.

Interestingly, hierarchical regression models incorporating PA and either Hesitations or Additional errors were significant for both the monolingual and ELL children. However, the pattern of predictive relations for the monolingual children differed from those of their ELL peers. For the ELL children, the total models for the combination of RAN Hesitations and PA in both English and Spanish explained a significant amount of the variance in both Decoding (English = 38%, Spanish = 23%) and Sight Word reading (English = 35%, Spanish = 26%). Although PA was a consistent unique predictor of both word reading types across languages, Hesitations at Time 1 in English approached significance for being a unique predictor of Decoding. However, for Sight Word reading, Hesitations at Time 2 in Spanish approached significance for being a unique predictor.

For the monolingual children, the total hierarchical regression models that included RAN Hesitations were significant for both Sight Word reading (19% of the variance explained) and Decoding (20% of the variance explained). In fact, Hesitations at Time 2 (in Model 2) was the unique significant predictor of later Decoding accuracy; this significance is above and beyond the variance explained by Time 2 PA and the Time 1 variables.

These findings for Hesitations may mean that the processing time required for accessing written linguistic information in the lexicon is reflected in the number of Hesitations produced on the RAN Objects task. The processing time for lexical information may be impacted by the strength and robustness of the lexical representation, which is reflected in the importance of Hesitations across languages for the ELL children. It may be that Time 1 Hesitations in English are an important indicator of decoding because ELL children's English lexicons are not as consolidated relative to their Spanish lexicons; thus, the lexical access time reflected in the hesitations produced is an indicator of the time required to accurately locate a lexical item. However, Time 2 Hesitations in Spanish were approaching significance because of the rapid shift in processing proficiency from Spanish at the beginning of kindergarten to English at the end of kindergarten (see Chapter 4 for more information about the rapid shift in lexical processing). This proposal is in line with previous research where total pause time duration[4] on alphanumeric RAN tasks was an indicator of later accuracy for reading isolated real and nonwords for monolingual children (Cutting et al., 1998; Georgiou et al., 2008; Scarborough & Domgaard, 1998).

PA and RAN Additional errors explained later Sight Word reading and Decoding for the monolingual and ELL groups. For the ELL children, the total hierarchical regression models were significant for both Sight Word reading (English = 36% of the variance explained, Spanish = 24% of the variance explained) and Decoding (English = 34% of the variance explained, Spanish = 16% of the variance explained), only PA emerged as a significant unique predictor

[4] This is in contrast to articulation time, which is the total duration for the articulation of each stimulus item. Pause time duration would consist of the total time in between articulated words on the task.

across all times and languages within the models. Because RAN Additional errors were not unique predictors, and the models in Spanish accounted for considerably less of the variance in each of the word reading tasks than English, the Additional errors produced on the RAN task may be lexicon-specific and not part of language-general processing, which has been proposed for measures of RAN speed (see Manis et al., 2004, for more discussion).

For the monolingual children, Model 1 for both Decoding and Sight Word reading were significant. For Sight Word reading, Model 2 also reached significance, but the total variance explained decreased from 26% to 20%. This is believed to be secondary to the relatively large number of variables included in the hierarchical regression model compared with the small number of monolingual participants. Again, Time 1 PA was a consistent significant unique predictor of later word reading for the monolingual children. Additionally, the Additional errors at Time 1 also reached significance for Sight Word reading. This may indicate that the accuracy of lexical retrieval reflected in the errors produced on the RAN Objects task in English is important for identifying later word reading success in young children, especially monolingual children.

The predictive relations between the error types and later word reading is suggestive of differences in the points of lexical processing. RAN Hesitations may indicate increased difficulty finding the target lexical item. For example, several lexical items may be activated; however, the retrieval process has not yet begun. On the other hand, RAN Additional errors occur upon the retrieval of a lexical item; however, the selection process has either retrieved the incorrect lexical item (e.g., produced the name of an additional lexical item not pictured on the test), or has been temporarily hindered in fully retrieving a lexical item (e.g., a substitution error where a child produced the name of an alternative lexical item). Because ELL children are developing more than one lexicon, RAN Hesitations may reflect how lexical processing is affected by the ease of lexical access, which could be hindered by competition among the lexical systems. Thus, RAN Hesitations would be a cross-linguistic predictor, as shown in our Sight Word reading hierarchical regression model, because these errors occur selection of a lexical entry. Additional RAN errors, on the other hand, may reflect difficulty after lexical selection. Thus, these errors would be expected to have a significant negative relationship with word reading. This hypothesis is supported by the patterns of predictive relations for the monolingual children, where both RAN Hesitations and RAN Additional errors were contributors to later Sight Word reading and Decoding. Monolingual children who have early issues with lexical access and retrieval for oral language tasks would be expected to have continued problems with the efficiency of later word reading.

Importance of PA for Word Reading

A consistent pattern was that the ability to manipulate phonological information was the most important variable for word reading regardless of language, which is found in previous investigations of monolingual and bilingual children (e.g., Durgunoğlu et al., 1993; Torgesen et al., 1994). PA was a consistent significant predictor of later Sight Word reading and Decoding for ELL children across both languages; however, this consistent relation between PA and word reading types was not the case for the monolingual children. For the monolingual children’s Decoding hierarchical regression model, neither Model 1 nor Model 2 were statistically significant. This finding was unexpected given that PA has such a well-established relation with reading (e.g., Apel et al., 2007; Cunningham, 1990).

The lack of significance between the predictor variables (i.e., PA and RAN duration) with second grade Decoding may be secondary to the exclusion of other variables. One potential contributor to decoding accuracy for monolingual children may be phonological working memory (PWM). PWM is the ability to actively hold and manipulate phonological information—including phonemes and related graphemic information—for a brief period in memory. This capacity is closely tied to PA, and both rely on the quality of the phonological representations stored in the lexicon and are correlated with reading (Hansen & Bowey, 1994; Oakhill & Kyle, 2000). Alternatively, our data showed that processing speed was not the only important factor in word reading accuracy. That is, the errors produced on the RAN task were indicative of processing efficiency required by the word reading task.

In sum, significant differences were found across the two groups of children, as well as between the analyses for RAN errors compared with RAN speed. For the ELL children, significant within- and across-language predictive relationships were found. RAN Speed and RAN Hesitations emerged as significant unique predictors of word reading. Although RAN Additional errors contributed to significant models, these were not unique predictors at any time point for either type of word reading. In contrast, both types of RAN errors (i.e., Hesitations and Additional errors) emerged as significant unique predictors of word reading for monolingual children; however, the timing of the measure was important. In general, Time 1 measures were more significantly related to later word reading accuracy than Time 2 variables. This may be secondary to the small number of monolingual participants in this study. Furthermore, RAN Speed was only important for Sight Word reading, but not for Decoding. Thus, speed of lexical processing was not as important an indicator of later word reading efficiency as accuracy for the monolingual children. The differences in the patterns of predictive relations between the RAN speed and the RAN errors is believed to be due to the robustness of the lexical system. That is, efficiency, or speed and accuracy, of lexical processing is dependent upon the quality of the lexical representations stored in the lexicon. Importantly, PA was a consistent predictor of later word reading for both groups of children and across languages for the ELL children. This means that, consistent with previous investigations, the ability to manipulate sounds in oral language (i.e., PA) is an important factor in the ability to read words, such that PA is a universally important skill for reading, regardless of language (e.g., Manis et al., 2004).

Limitations and Future Directions

Future research should investigate concurrent relations between PA, RAN, word reading, and spelling measures to determine whether the nature of the relations between these measures is dependent upon the strength and robustness of the mental graphemic representations stored in the lexicon. From the current studies it was hypothesized that RAN duration would be directly impacted by the strength and robustness of lexical representations, such that weaker representations would have led to slower RAN durations. It may be that RAN is more strongly related to reading when the mental graphemic representation is robust, leading to increased automaticity of activation during reading (see LaBerge & Samuels, 1974, for more discussion). The robustness of the MGR may be assessed via spelling accuracy.

An issue with the study design is the limited number of monolingual children, which contributed to an overall lack of power for their analyses. However, many of the hierarchical regression models were significant, leading to validation for further investigation of these measures. Future research should incorporate a larger sample size to increase the statistical power.

Chapter 6

General Discussion

Rapid automatic naming is more than a simple picture-naming task; it is an important indicator of potential impairment in the lexical processing system required for efficient reading in young children, regardless of language. The findings in the current work support the importance of RAN as a measure for word reading, clarify differences in performance for young monolingual and Spanish-speaking ELL children, and further the theoretical understanding of lexical processing for children developing a dual lexical system. This work also has implications for clinical practice including best practice measures for the early identification of future potential reading impairment in culturally and linguistically diverse groups of children.

First, this work supported previous research stating that RAN is an important indicator of later word reading for monolingual and ELL children (Furnes & Samuelsson, 2011; Georgiou et al., 2008; Manis et al., 2004). However, this work has expanded on previous research by incorporating both RAN duration and RAN accuracy measures in kindergarten as predictor variables. In our sample of children, speed performance (i.e., duration) on the RAN Objects task in English was not a significant unique predictor of word reading—regardless of the word reading measure—for either group of children. PA, on the other hand, was a significant predictor of later word reading for both groups of children across all measures of word reading. Thus, in support of previous investigations (e.g., Chiappe, Siegel, & Gottardo, 2002; Durgunoğlu et al., 1993), PA was found to be a universally important predictor of later real and nonword reading for children, regardless of the number of languages spoken. Interestingly, RAN duration in Spanish, along with PA in Spanish, contributed to second grade decoding in English for the ELL children. This relation may be secondary to more robust lexical representations in the

Spanish lexicon (as compared to the English lexicon), which would be indicative of the potential development of connectivity between orthographic, semantic, and phonological information stored in the lexicon.

Second, the patterns of relations between word reading and the accuracy of lexical access and retrieval were different across the two groups of children. For monolingual children, the number of Hesitations and Additional errors produced on the RAN Objects task contributed to models that were significantly predictive of later word reading ability. In fact, Time 2 RAN Hesitations were a unique significant predictor above and beyond PA for decoding accuracy for the monolinguals. In contrast, although the RAN errors types contributed to significant models, they were not significant unique predictors of later decoding or sight word reading for the ELLs; however, RAN Hesitations approached significance in each regression model. We proposed that accuracy on RAN tasks are reflective of the various points in the lexical processing required for word reading, where hesitations may demonstrate difficulty with lexical access and the additional errors indicate inaccurate lexical retrieval. Interestingly, when considering the percentages of errors produced on the RAN Objects task, the overwhelming majority of errors produced were hesitations. Expanding on previous work by Scarborough and Domgaard (1998), the current work shows that for monolingual children, difficulty with word-finding (i.e., lexical access) is an early indicator of later word reading ability. As such, RAN errors are an important early indicator of later word reading ability.

Third, differences in performance patterns on the RAN task are indicative of how lexical processing is affected by the quantity and quality of lexical entries. Overall, the patterns in speed and accuracy over time suggested that lexical processing for ELL children is beneficially influenced by both lexical density of the developing dual lexical system as well as the accessibility of lexical information stored in long term memory. The fast and accurate RAN performance in English relative to Spanish, as well as similar performance to their monolingual peers, demonstrates that ELL children are able to access their L2 more easily than their L1. The facilitation effects for English may be due to a general suppression of L1, possibly triggered by the immersion environment, or to greater relative activation of the more sparsely-populated L2 vocabulary, or a combination of both. The more sparsely-populated English lexicon would allow children to be faster at accessing and retrieving lexical information in comparison to their monolingual peers. The greater relative activation in conjunction with the L1 suppression would grant ELL children facilitation for lexical processing required on the RAN task in their L2 relative to their L1; this account supports previous findings by Gibson et al. (2012) and speaks to a rapid shift in lexical processing from L1 at the beginning of kindergarten to the L2 by the end of kindergarten.

Finally, this work has further implications for the clinical and education settings, because processing tasks have been suggested as having the potential to bypass some of the language proficiency issues encountered on standardized assessments (Bialystok & Hakuta, 1994; Durgunoğlu, 2002). Clinicians should carefully consider the performance patterns on this RAN task for young children—including monolingual as well as children from ELL populations. Although RAN performance in English was similar across groups of children, the original scoring system did not account for all of the errors produced by young children, regardless of language(s) spoken. Hesitations, in particular, were a substantial proportion of the errors produced and may be indicative of slowed lexical processing and potential difficulty in accessing lexical items. RAN Hesitations and Additions were significantly predictive of later word reading for monolingual and ELL children, whereas RAN speed was not a significant predictor of word reading for monolingual children. As such, clinicians should consider errors not accounted for on standardized tests, as they are an important metric for indicating potential weaknesses in processing oral and written language for both monolingual and bilingual children. For ELLs, within-language and across-language relations are an important consideration in testing. Although it is not always possible to test these children in their native language, RAN measures in Spanish are predictive of later word reading ability. As such, it is paramount to include testing in the child's native language in order to capture a complete picture of the child's language abilities. Overall, performance on RAN tasks demonstrates a unique avenue into viewing lexical processing for young children. Future research should carefully consider error production on lexical processing tasks when identifying children for potential language and literacy impairments.

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APPENDIX A

Study 1

Completion. The percentage of ELL children who successfully completed the practice items and the RAN task in each language was calculated. See Figure 9 for completion rates for the RAN Objects task. At Time 1 (beginning of kindergarten) approximately the same percentage of ELL children completed the task in both English and Spanish; however, by Time 2 (end of kindergarten) 100% (n = 40) of children were able to complete the RAN Objects task in English, whereas only 87.5% (n = 35) could complete the task in Spanish. ELL children maintained 100% completion in English through Time 3 (middle of second grade). At Time 3 the proportion of children who completed the task in Spanish increased to 92.5% (n = 37); however, it is noteworthy that at Time 3 not all children could complete this task in Spanish.

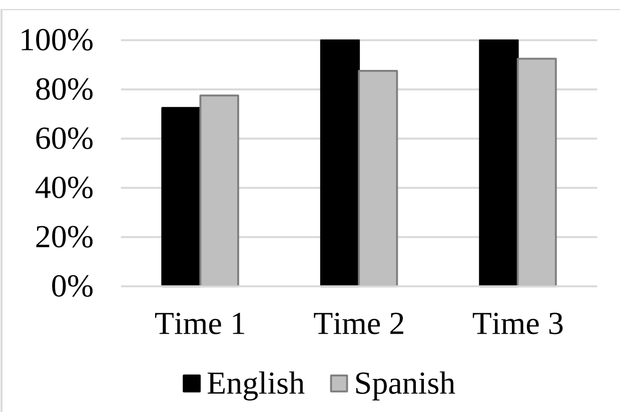

Figure 9. RAN Objects completion rates for ELL children (n = 40).

Error Analyses. In order to determine whether ELL children produced significantly more expanded errors in comparison with the original errors (without hesitations) at each time point, two one-way repeated measures ANOVAs were conducted to compare the original (without hesitations) and expanded errors produced across time in English and in Spanish.[1] Due to the finding that hesitations dominated the percentage of error types produced, they were excluded from these analyses. The purpose of these analyses was to determine whether or not the expanded coding system accounted for a larger variety of the errors produced by young ELL children across time and in each language. See Figure 10 for a comparison of the expanded and original errors (without hesitations) in each language over time.

For English, Mauchley's test of Sphericity indicated that the assumption of sphericity was not met for Time $X^2(2) = .40$, $p < .001$ or for the Error Type x Time interaction $X^2(2) = .39$, $p < .001$. In order to correct for this violation, the Greenhouse-Geisser correction was used to interpret the results for the main effect for Time and for the interaction. The Error Type x Time interaction was not significant ($p = .436$). No significant main effects were found for Time (Time 1: $M = .89$, $SE = .32$; Time 2: $M = .24$, $SE = .07$; Time 3: $M = .61$, $SE = .33$; $p = .098$) or for Error Type (Expanded: $M = .85$, $SE = .39$; Original: $M = .31$, $SE = .08$; $p = .139$). This means that the ELL children produced a similar average number of expanded and original errors at each point in time in English.

For Spanish, Mauchley's test of Sphericity indicated that the assumption of sphericity for Time was met $X^2(2) = .92$, $p = .370$; however, this assumption was not met for the Error Type x Time interaction $X^2(2) = .68$, $p = .008$. In order to correct for this, the Greenhouse-Geisser correction was used to interpret results for the interaction. All results for Time (Time 1: $M = .50$,

[1] A within measures repeated measures ANOVA with 3 measures was conducted to compare the two coding systems at each point in time across languages. Due to a limited sample size ($n = 18$), there was not sufficient power to analyze these data. However, these analyses revealed a main effect for Time (Wilks' Lambda = .45, $F(2,30) = 8.02$, $p = .002$, η^2 partial = .35), where Time 1 ($M = .68$, $SE = .11$) was significantly different that Time 2 ($M = .19$, $SE = .04$). No significant differences were found between Time 1 and Time 3 ($M = .42$, $SE = .11$), or Time 2 and Time 3. There was not a main effect for Language ($p = .600$), nor was the three-way Time x Language x Error Type interaction significant ($p = .714$). Thus, 2 one-way repeated measures ANOVAs were determined to be optimal to compare the error types across time and within each language.

SE = .11; Time 2: *M* = .24, *SE* = .09; Time 3: *M* = .52, *SE* = .15; *p* = .118), Error Type (Expanded: *M* = .41, *SE* = .09; Traditional: *M* = .43, *SE* = .13; *p* = .866), and the Error Type x Time interaction (*p* = .674) were insignificant. Thus, similarly to the patterns observed for English, the ELL children produced a similar average number of expanded and original errors in Spanish.

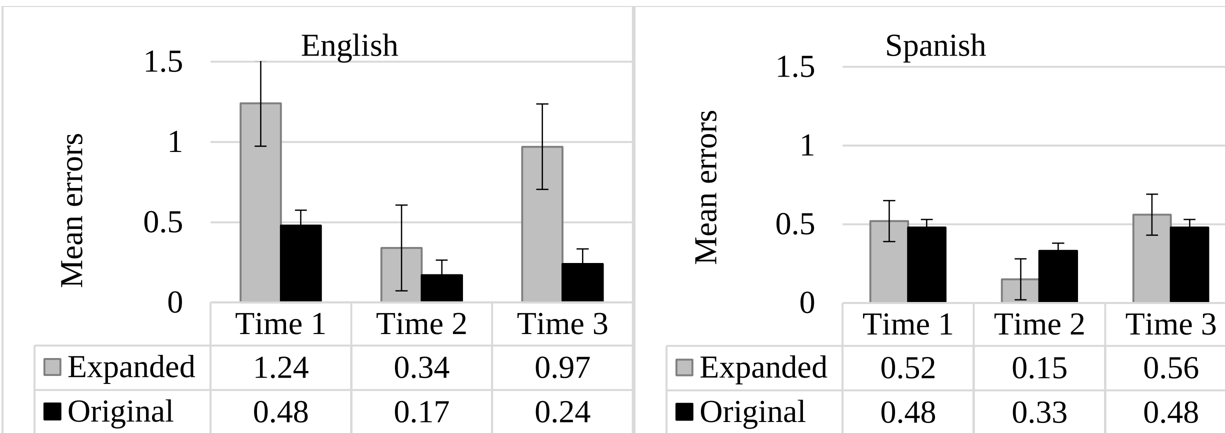

Figure 10. A comparison of expanded and original errors produced over time for ELL children (*n* = 27).

In sum, production of the expanded errors were found to not be significantly different from the original errors in both English and Spanish; however, this indicated that the expanded coding system quantitatively strengthen the original coding system for the RAN Objects task because it captured a similar average number of errors produced as the original coding system. Therefore, the expanded coding system enhances the original system by accounting for a broader scope of the types and number of errors produced by these ELL children. Interestingly, children did not produce significantly fewer errors over time for either language. The following analyses examined the differences among the errors produced across languages.

A paired samples *t*-test evaluated the differences between the error code composites across languages for ELL children. For these analyses, the composites were collapsed across time because the purpose was to determine differences in the errors produced across languages. As such, the error composites comprised the following: Expanded errors, original errors without hesitations, original errors with hesitations, and hesitations. The first analysis showed that the difference between the expanded errors in English (M = 2.08, SD = 5.05) and Spanish (M = 1.75, SD = 3.54) was not significant (p = .516). The second paired samples *t*-test showed that the difference between the original errors (i.e., skips and substitutions) in English (M = .80, SD = 1.09) and Spanish (M = 1.73, SD = 2.75) was statistically significant, $t(39) = -2.32$, $p = .026$, η^2 partial = .12; thus, ELL children produced more original errors in Spanish than in English. The third paired samples *t*-test showed that the difference between the hesitations in English (M = 6.74, SD = 5.95) and Spanish (M = 9.10, SD = 6.81) was statistically significant, $t(39) = -2.60$, $p = .013$, η^2 partial = .15; thus, ELL children produced more hesitations in Spanish than in English. The final paired samples *t*-test showed that the difference between the traditional errors (i.e., skips, substitutions, and hesitations) in English (M = 7.54, SD = 6.52) and Spanish (M = 10.87, SD = 7.74) was statistically significant, $t(39) = -3.32$, $p = .002$, η^2 partial = .22; thus, ELL children produced more traditional errors in Spanish than in English. In sum, ELL children produced a greater number of errors in Spanish than in English, with the exception of the expanded errors.

APPENDIX B

Study 2

Completion. The percentage of ELL and monolingual children who successfully completed the practice items and the RAN task in was calculated. As per the criterion for participating in this study, all monolingual children were able to complete this RAN Objects task during at least times 2 and 3 (see Chapter 3 for participation criteria). At Time 1, 95.2% (*n* = 20) of the monolingual children and 72.5% (*n* = 29) of the ELL children completed this task in English. By Time 2, 100% of the ELL and monolingual children were able to complete the RAN Objects task in English. All children maintained this completion rate through Time 3. See Figure 11 for ELL and monolingual children's completion rates for the RAN Objects task.

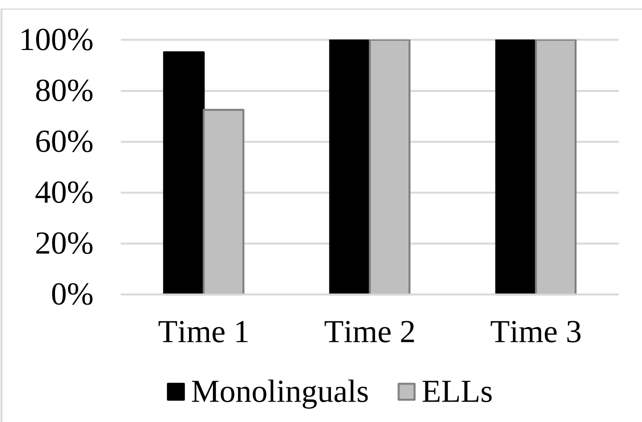

Figure 11. RAN Objects completion rates for ELL (*n* = 40) and monolingual children (*n* = 21) in English.

Error Analyses. In order to account for differences across time and groups, two one-way repeated measures ANOVAs were conducted to compare the original errors (without hesitations) to the expanded errors. Due to the finding that hesitations dominated the percentage of error types produced, they were excluded from the modified total error analyses. The purpose of these analyses was to determine whether or not the expanded coding system accounted for a larger variety of the errors produced by young children.

To compare expanded and original errors for each group of children, a 3 (Time) x 2 (Error Type) x 2 (Group) mixed between-within ANOVA was conducted. Mauchley's test of Sphericity indicated that the assumption of sphericity was met $X^2(2) = 4.44$, $p = .108$ for Time. A significant 3-way interaction was found for Time x Error Type x Group (Wilks' Lambda = .80, $F(2, 39) = 4.75$, $p = .014$, η^2 partial = .20). A between-subjects comparison revealed that there was also a significant main effect for Group, $F(1, 40) = 22.71$, $p < .001$, η^2partial = .36, where a pairwise comparison revealed that ELL children ($M = .58$, $SE = .24$) produced significantly fewer errors overall than their monolingual peers ($M = 2.46$, $SE = .32$, $p < .001$). A significant main effect for Time was found, Wilks' Lambda = .67, $F(2, 39) = 9.44$, $p < .001$, η^2 partial = .33. A Bonferroni post-hoc correction was used for the pairwise comparison for Time, which showed that children produced significantly fewer errors from Time 1 ($M = 2.19$, $SE = .32$) to Time 2 ($M = 1.24$, $SE = .16$, $p = .013$) and from Time 1 to Time 3 ($M = 1.14$, $SE = .25$, $p < .001$); no significant difference was found between Time 2 and Time 3. A main effect was also found for Error Type, Wilks' Lambda = .68, $F(1, 40) = 18.84$, $p < .001$, η^2partial = .32. A Bonferroni post-hoc correction for the pairwise comparison for Error Type showed that significantly fewer expanded error codes ($M = .83$, $SE = .27$) were produced overall in comparison to original error codes ($M = 2.22$, $SE = .24$, $p < .001$).

Overall, the Time x Error Type x Group interaction demonstrated that while monolingual children produced significantly more original errors (without hesitations) than expanded errors at all points in time ($p < .001$), the ELL children showed a different pattern. The ELL children produced a similar number of expanded and original errors across all points in time, meaning there was not a significant difference between the expanded error codes and the original error codes for the ELL children. Interestingly, the interactions also demonstrate that while the monolingual children became consistently more accurate over time (i.e., produced fewer errors over time), the ELL children showed a pattern of marked decline in the number of errors produced from Time 1 to Time 2 with a subsequent increase in the errors produced from Time 2 to Time 3. See Figure 12 for a comparison of the error types over time for each group of children.

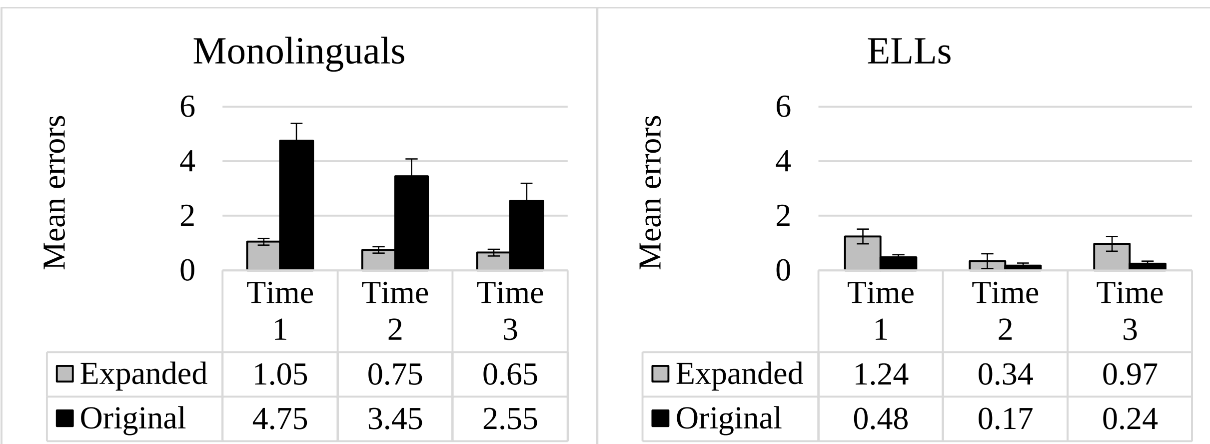

Figure 12. A comparison of expanded and original errors produced over time for ELL (n = 27) and monolingual children (n = 20).

APPENDIX C

Study 3

Correlations. Correlational patterns between English kindergarten measures for ELL and monolingual children are shown in Table 14.

Table 14

Correlations Between English Kindergarten Measures for ELL (Bottom; n = 40) and Monolingual Children (Top; n = 26)

English	Time	1	2	3	4	5	6	7	8
1. RAN Speed	1	1	.63***	.56**	.24	.93***	.54**	-.10	.19
2. RAN Speed	2	.50***	1	.34^	.41*	.48*	.73***	-.19	-.18
3. Additional errors	1	.08	.07	1	.08	.40*	.20	-.17	-.07
4. Additional errors	2	.04	.32*	.09	1	.09	.58**	.03	.08
5. Hesitations	1	.93***	.40**	.10	.14	1	.41*	-.04	.26
6. Hesitations	2	.36*	.86***	.10	.33*	.25	1	-.21	.04
7. PA	1	-.16	-.15	.23	-.14	-.18	-.21	1	.52**
8. PA	2	-.25	-.46**	-.03	-.26^	-.19	-.32*	.52***	1

*** $p \leq 0.001$. ** $p \leq 0.01$ level. * $p \leq 0.05$. ^p approaches significance at <.10 level.

Correlational patterns between the Spanish kindergarten measures for the ELL children are depicted in Table 15.

Table 15

Correlations Between Spanish Kindergarten Measures for ELL Children

Spanish	**Time**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. RAN Speed	1	1							
2. RAN Speed	2	.42**	1						
3. Additional errors	1	.18	-.04	1					
4. Additional errors	2	.09	.50***	.06	1				
5. Hesitations	1	.74***	.61***	.25	.10	1			
6. Hesitations	2	.32*	.37*	.00	.45**	.32*	1		
7. PA	1	.08	-.11	-.10	.02	.20	-.14	1	
8. PA	2	.01	-.18	-.11	-.05	-.07	-.16	.59***	1

*** $p \leq 0.001$. ** $p \leq 0.01$ level. * $p \leq 0.05$. ^p approaches significance at <.10 level.

Cross-linguistic correlational patterns between the kindergarten measures are shown in Table 16 for the ELL children.

Table 16

Cross-linguistic Correlations Between Kindergarten Measures for ELL Children

			English							
		Time	1	2	3	4	5	6	7	8
Spanish	1. RAN Speed	1	.49***	.35*	.09	.04	.34*	.26^	-.13	-.25
	2. RAN Speed	2	.50***	.66***	.13	.19	.41**	.61***	-.27^	-.41**
	3. Additional errors	1	.09	.13	-.11	-.17	.02	.01	-.05	-.08
	4. Additional errors	2	.04	.19	.08	-.11	.30^	.45**	-.14	-.10
	5. Hesitations	1	.34*	.41**	.14	.18	.34*	.31^	.08	.04
	6. Hesitations	2	.26^	.61***	.09	.28^	.31^	.66***	-.02	-.32*
	7. PA	1	-.13	-.27^	.20	-.22	-.11	-.28^	.66***	.62***
	8. PA	2	-.25	-.41**	.12	-.19	-.24	-.30^	.63***	.68***

*** $p \leq 0.001$. ** $p \leq 0.01$ level. * $p \leq 0.05$. ^p approaches significance at <.10 level.

Jessica McMorris (jmcmrris)

From:	Jessica McMorris (jmcmrris) on behalf of Institutional Review Board
Sent:	Tuesday, November 08, 2016 9:52 AM
To:	Jessica McMorris (jmcmrris)
Subject:	Fw: IRB Approval 3554

From: Beverly Jacobik (bjacobik) on behalf of Institutional Review Board
Sent: Friday, January 23, 2015 12:19 PM
To: Linda D Jarmulowicz (ljrmlwcz)
Subject: IRB Approval 3554

Hello,
The University of Memphis Institutional Review Board, FWA00006815, has reviewed and approved your submission in accordance with all applicable statuses and regulations as well as ethical principles.
PI NAME: Linda Jarmulowicz
CO-PI: Kathleen Durant
PROJECT TITLE: Morphophonological Awareness as a Predictor of Literacy Outcomes in Elementary School English-Language Learning Students
FACULTY ADVISOR NAME (if applicable):
IRB ID: #3554
APPROVAL DATE: 1/23/2015
EXPIRATION DATE: 1/23/2016
LEVEL OF REVIEW: Expedited
Please Note: Modifications do not extend the expiration of the original approval
Approval of this project is given with the following obligations:
1. If this IRB approval has an expiration date, an approved renewal must be in effect to continue the project prior to that date. If approval is not obtained, the human consent form(s) and recruiting material(s) are no longer valid and any research activities involving human subjects must stop.
2. When the project is finished or terminated, a completion form must be completed and sent to the board.
3. No change may be made in the approved protocol without prior board approval, whether the approved protocol was reviewed at the Exempt, Exedited or Full Board level.
4. Exempt approval are considered to have no expiration date and no further review is necessary unless the protocol needs modification.
Approval of this project is given with the following special obligations: Approved pending Shelby County School District approval letter.
Thank you,
James P. Whelan, Ph.D.
Institutional Review Board Chair
The University of Memphis.
Note: Review outcomes will be communicated to the email address on file. This email should be considered an official communication from the UM IRB. Consent Forms are no longer being stamped as well. Please contact the IRB at IRB@memphis.edu if a letter on IRB letterhead is required.