Breaking Through the Traditional Second Language Learning Model-- Exploring Different Exposure Approaches for Learners of Different Ages

by

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Abstract

Second language learning has received much widespread attention from researchers, educators and parents. As with first language acquisition, word learning in a second language is a building block for further language development. Whereas many studies on bilingualism indicate that an infant's capacity for vocabulary acquisition seems to extend to two languages from birth (Byers-Heinlein, 2010; Genesee & Nicoladis, 2007; Ng & Wigglesworth, 2007; Reynolds, 1991) and much applied research has been dedicated to teaching second language vocabulary to children and adults, very few studies have directly compared the differences between children's and adult's second language word learning. The effect of age on second language learning is highly controversial. This dissertation aims to address the question of whether early or late is better for learning words in a second language by examining the interaction between age and exposure approach. The current studies are designed to explore different exposure approaches for teaching words in a second language to monolingual learners of different ages. I approach this question by focusing on second language word learning through three studies, each examining one exposure approach for English-speaking monolinguals learning words in a second language (i.e., Mandarin) by: 1) providing translation equivalents; 2) mere exposure to natural second language input with a single event context; 3) mere exposure to natural second language input with multiple event contexts. These three approaches were examined with three different groups of monolingual English-speaking learners: 28-30 months olds, 5-6 year olds and young adults. This dissertation was also interested in whether the effectiveness of these approaches may depend on the native language experience or other cognitive capacities of the learners. Results found that adults responded more accurately and quickly than children, with no difference across exposure approaches. Both groups of children, in contrast, performed differently with different exposure approaches. They were able to successfully fast-map words to the referents only in the Mandarin-only approach with a single event context. Furthermore, adults' foreign language aptitude and working memory were significant correlated with their performance in these laboratory studies of second language word learning.

Chapter 1: Introduction

“If you speak two languages, you're bilingual. If you speak one, you're American” (Schmid, 2010, October 23)”

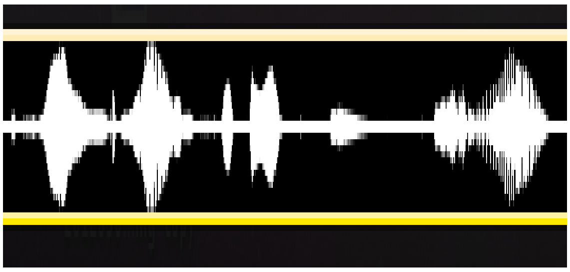
Second language competence is viewed as a vital 21st century skill enabling American workers to compete for jobs in the global economy. However, many global competitors have citizenry and workforces that are multilingual, whereas multilingual American college graduates remain a small minority. According to U.S. Senate Resolution 28 designating 2005 the "Year of Foreign Language Study,” only 9.3 percent of Americans speak both their native language and another language fluently, whereas 52.7 percent of Europeans speak more than one language fluently (S. Res. 28, 2005). Many school systems across the United States have progressively implemented second language programs starting in elementary school. According to a survey conducted by the Center for Applied Linguistics, second language programs in elementary schools increased by nearly 10 percent from 1987 (22%) to 1997 (33%); however, they decreased substantially in elementary schools by 2008 (25%), whereas the disparity between public and private school increased exponentially (Rhodes & Pufahl, 2010). In particular, approximately 25% of public elementary schools and 65% of suburban private elementary schools provide young learners with a second language curriculum (Met, 2003). The report also revealed that many elementary and secondary schools were affected by a shortage of qualified language teachers especially in rural areas with students from low socioeconomic backgrounds. In addition, due to the federal No Child Left Behind (NCLB) education legislation, mathematics and reading instruction has drawn resources away from foreign language education because it was not included in the law's accountability measures.

Ironically, there is widespread recognition of the importance of learning other languages, yet a large number of students, especially those in rural or low SES schools, do not have the opportunity to study a second language.

Currently, both private industry and the U.S. government are seeking higher levels of second language proficiency in their workforce (Pinsonneault, 2008). As a result, many parents and educators are motivated to prepare children early for the future, both to overcome the pressure of academic competition in school and to equip them for the future job market. According to the Fiscal Year 2010 Budget Report from the U.S. Department of Education, 26.3 million dollars were allocated to the Foreign Language Assistance program which provides 3-year competitive grants to State educational agencies to support students, elementary school through college, to attain a superior level of proficiency in languages critical to U.S. national security and economic prosperity, such as Arabic, Chinese, Japanese and Russian. However large this sum may seem, it is still a small amount when compared to that allocated to mathematics and science education (179.0 million) (*Fiscal Year 2010 Budget Summary*, 2009 May 7) and this funding is currently undergoing drastic reduction, according to the Fiscal Year 2012 Budget Summary.

Interestingly, despite the strong drive to teach and learn second languages at an early age, very little research has directly examined the effectiveness of different teaching methods for learners of different ages or the interaction between second language teaching methods and the age of the learner, especially under short-term learning situations. And yet, it is clear that if foreign language programs are going to continue to get funding, they must be highly cost effective and produce results that are tangible both to employers and to federal funding sources. Since words are the building blocks for more complex language and children need to acquire enough words before they begin to combine them into sentences, the main question for this dissertation centers on investigating the effectiveness of different exposure approaches for teaching second language vocabulary to learners at different ages. More specifically, I am interested in whether the same exposure methods are equally effective across toddlers, who are still in the process of acquiring their first language; school-aged children, who are already relatively proficient first language speakers but still have great flexibility in their language-learning skills; and adults, who are argued to "use language to learn" and are considered to be less flexible in their language-learning skills.

Words are the building blocks of language, and this is the initial step for us to learn a new language before we are able to comprehend the meaning of phrases, sentences, and paragraphs. How do children and adults first begin to acquire words from a second language that they have never been exposed to? Image that you hear the unfamiliar sentence below and see the event on the right, how could you map the word "pʰiŋkwɔ" to its meaning?



"kʰankʰan ʈʂɤ kɤ pʰiŋkwɔ"

Figure 1.1. **Example of mapping speech (left side) to referent (right side)**

Similar to first language acquisition, learners must be able to efficiently identify the sound sequence that differs from their native language in terms of its rhythm, phonemes or syntax, and to segment or extract words from the speech stream and eventually map the word to the potential referent based on cognitive constraints, perceptual features and statistical regularities (Bloom, 2000; Hollich et al., 2000; Maguire, Hirsh-Pasek, & Golinkoff, 2006; Markman & Wachtel, 1988; Yu & Smith, 2007).

Alternatively, for learners whose first language has been fully developed, when the above sentence is heard, one may first naturally try to identify it and ask what language it is or what the word or sentence means. Users of this strategy are attempting to get access to L1 to help in ascertaining the meaning. In this case, if translations are provided after the foreign sentence (e.g. "kʰankʰan ʈʂɤ kɤ pʰiŋkwɔ"; "Look at the apple"), it may be possible to facilitate learning by spotlighting the target word and referent from the second language. Or, it may drive attention to the meaning of the sentence in one's native language and interfere with learning the actual word in the second language.

The possibilities described above demonstrate how effective strategies for learning words in a second language may differ for individuals with experiences. In particular, toddlers, who are still in the stage of acquiring their first language, may find it easier to process the second language in the same way as their first language, and go through the bottom-up procedure of segmenting the speech stream and mapping sounds to the objects and events presented together with the sound. For older children and adults, in contrast, "translation" may seem to be an obvious short cut. Motivated by these alternative approaches to second language learning, my dissertation is interested in whether learners at different ages are able to learn words from a fully unfamiliar language with short term exposures to the words and, if they are, which of these exposure approaches might lead to more effective learning.

Thus, this dissertation is composed of three studies to examine the effectiveness of each exposure approach with learners of different ages. Specifically, I examine the extent to which non-native speakers are able to learn minimally presented words when presented via: 1) exposure to natural second language input with provided translation equivalents in a simple context; 2) exposure only to natural second language input in a simple context; and 3) exposure only to the same natural language input in multiple contexts in which the target objects are presented. Furthermore, this study aims to explore whether the effectiveness of these approaches depends on L1 vocabulary knowledge and other cognitive capacities such as verbal/non-verbal IQ, auditory working memory or foreign language aptitude. Although I am using the broad term “second language word learning” in this dissertation, there are many stages of word learning. The stage this dissertation focuses on is relatively short-term “fast mapping” of words to their referents rather than learning the “meaning” of words.

Nonetheless, even with very short-term fast mapping, several cognitive processes must be engaged. The following section (I) reviews literature about underlying cognitive mechanisms that may make second language word mapping possible, and thus provides a road map for the current studies.

I. Cognitive mechanisms underlying second language word learning

When exposed to a second language, learners presumably go through a number of cognitive processes to acquire words, specifically to i) identify that the inputs are different from their native language; ii) segment the target word from the speech stream; and iii) map the foreign word (a new label) to a familiar object.

(i) Language discrimination

When first exposed to a second language, learners must first be able to discriminate this language from their native language (Bosch & Sebastián-Gallés, 2001; Meisel, 2001; Werker & Byers-Heinlein, 2008). Even newborn infants can discriminate languages from different rhythmical classes, and yet they cannot discriminate languages from the same rhythmical class (Nazzi, Bertoncini, & Mehler, 1998). According to phonologists, French, Spanish and Italian are syllable-timed languages, whereas English and German are stress-timed languages (Rouas, Farinas, Pellegrino, & Andre-Obrecht, 2005). Thus, in Nazzi et al.'s study, French newborns could discriminate between English (stressed) and Japanese (non-stressed), but could not discriminate between English and Dutch, which are both stress-timed. For Mandarin, the classification is not definitive but recent works tend to affirm that it is a stress-timed language (Komatsu, Arai, & Sugawara, 2004). However, research has shown that by 4- to 5-months old, infants' sensitivity to the same rhythmical class seems to improve, and they can discriminate their native language from another language within the same rhythmical class, and yet cannot discriminate two unfamiliar languages from the same rhythmical class (Nazzi, Jusczyk, & Johnson, 2000; Werker & Byers-Heinlein, 2008). Thus, because Mandarin and English are categorized in the same rhythmical class, English-speaking toddlers in their second year should be able to easily discriminate between the two languages.

Furthermore, young infants are able to discriminate many speech sounds used across a variety of languages, even those not used in their native language. However, by the time they are 10- to 12-months old, they can only distinguish between phonemes (the smallest unit that distinguishes meaning that are present in their native language), as shown by the fact that English-learning infants no longer discriminate between two allophones of /d/ used in Hindi at this age (Werker & Tees, 1984a). The phonemes distinguishing words vary across languages; for instance, English uses /r/ and /l/ to distinguish words (e.g. rake vs. lake), whereas Japanese does not distinguish these two sounds and treats them as a single phoneme (Werker, Byers-Heinlein, & Fennell, 2009). Nonetheless, the ability to contrast two phonemes in a foreign language may also improve with exposure to the specific language. For instance, through exposure to Mandarin Chinese, 9-month-old English infants end up learning two phonemes (i.e. /tɕʰ/ vs. /ɕ/) that do not exist in English (Kuhl, Tsao, & Liu, 2003).

In summary, infants are born with some initial abilities to discriminate different languages and these abilities improve over the first year of life, which may set up a foundation for learning a second language later in life. Even though the fine speech discriminations of older children and adults are confined to their native language (Werker & Tees, 1984a, 1984b), they also should not have difficulty discriminating a second language from their native language. In terms of the current studies, Mandarin Chinese, which is different from English in many aspects (e.g. phonemes, morphology, syntax) (Lee & Naigles, 2005; Ma, Golinkoff, Hirsh-Pasek, McDonough, & Tardif, 2009; Tardif, 2006), and when it is produced in sentence frames, it should be easily identified as a foreign language by infants/toddlers, older children and adults.

(ii) Segmenting words from the speech stream in an unfamiliar language

Many studies on first language acquisition have demonstrated that monolingual infants are able to segment words from the speech stream in their native language by the age of 8 months through detecting statistical regularities in syllable structures (Aslin, Saffran, & Newport, 1998; Saffran, Aslin, & Newport, 1996), and are able to map meaning to newly segmented words by the age of 17 months (Estes, Evans, Alibali, & Saffran, 2007). In particular, with artificial languages, such as a synthesized speech stream without pauses or other acoustic cues (e.g. golabupadotitupiro…), 8-month-old infants have demonstrated that they are able to segment words based on transitional probabilities from one syllable to the next by listening longer to the non-word sequences (syllables presented in a novel order), in a conditioned head-turn procedure (Saffran, et al., 1996). In addition, 17-month-old infants show a preference for mapping artificial word sequences to objects than for mapping nonword sequences to objects (Estes, et al., 2007). Additional research has demonstrated that information such as transitional probabilities are present in natural infant-directed speech (Swingley, 2005), and that infants might use transitional probabilities to segment words in real life. Although research has shown the benefit of exposure to isolated words in word recognition (Plunkett, 2006) and most first words observed in children's production have been spoken by parents in single-word utterances several months earlier (Brent & Siskind, 2001), infants in their first year have demonstrated segmentation skills in hearing fluent speech (Jusczyk & Aslin, 1995), and 24-month-olds have no difficulty recognizing words in continuous speech (Plunkett, 2006). On the other hand, familiar sentence frames also facilitate word segmentation, and infants interpret words in familiar sentence frames faster than words in isolation (Fernald & Hurtado, 2006; Namy & Waxman, 2000). In fact, half of all child-directed speech in parents' utterances start with simple familiar sentence frames, such as "Look at the___" and "Where's the___" (Cameron-Faulkner, Lieven, & Tomasello, 2003).

Few studies, however, have examined the question of segmentation in a foreign language. In one study by Bijeljac-Babic et al. (2009), French-speaking 20-month-old infants were able to locate the sound patterns of words and segment them when they were presented with English sentences. In particular, after being exposed to target words embedded in various sentence frames (e.g. Look this is a 'chook', Do you want to play with the 'chook'?), infants were able to segment the word by choosing the correct object during the test (e.g. Can you put the other 'chook" in the cup?). This evidence showed that very young children are able to segment words from the speech stream in an unfamiliar language, and lays a foundation for the present studies. In sum, from the very beginning, the learning mechanisms underlying monolingual first language acquisition also seem to be available to support learning a foreign language.

Nonetheless, in Bijeljiac-Babic's study, the foreign language that infants were exposed to (i.e. English) was less distant from their native language (i.e. French) than those used in the current study (i.e. Chinese and English). It has been generally acknowledged that infants' speech perception becomes more language-specific by the end of the first year of life (Werker & Tees, 1984a). Thus, whether it would be easier or harder for infants, older children and adults in my dissertation studies to extract discrete words from sentences in a more distant foreign language is open to question.

(iii) Mapping two words to a single referent

In addition to discriminating between two different languages, another challenge for second language learning is to associate words with referents, because learners need to associate more than one basic-level label (one from each language) with one concept, and therefore go beyond the simple association between a word and a particular referent (Byers-Heinlein, 2010). It has been demonstrated that 19-month-old monolingual infants begin to understand that a new language signals a distinct labeling norm, and this understanding might cue them to accept two labels, one in each language, for a single object (Bhagwat, 2009). These studies suggest that young children could accept two words for a single referent regardless of the experience of learning translation equivalents. Thus, in terms of the current studies, learners may accept foreign labels for familiar objects for which they already have names in their native language.

Overall, as discussed above, monolingual children possess cognitive mechanisms, which could potentially enable them to learn a second language. The questions raised here are: right from the beginning, what is the best exposure approach among the three proposed approaches here for monolingual children to learn a second language? Is merely providing monolingual children with foreign language input sufficient? Should the exposure approach depend on the age of the child? All these questions are addressed in this dissertation.

II. Age of second language learning

One of the most important questions asked by parents and educators alike is what the optimal age is for starting foreign language instruction. Many researchers argue that children who begin second language learning early are more likely than those who begin later to achieve native-like levels of proficiency, and it has been hypothesized that there is a critical period for second language acquisition just as there is for first language acquisition (Abrahamsson & Hyltenstam, 2009; Asher & Garca, 1969; Bylund, Abrahamsson, & Hyltenstam, 2012; Genesee, 1978a; Nikolov & Djigunovic, 2006). The critical period hypothesis has also been restated as the maturational state hypothesis which claims that there is something special about the maturational state of the child's brain, and that language learning abilities decline with maturation regardless of early linguistic experience (Johnson & Newport, 1989). Newport at al. (1990) explained the underlying mechanism undergoing maturational change with the "Less is More" hypothesis, paradoxically suggesting that language learning declines over maturation precisely because cognitive abilities increase. In particular, when exposed to similar linguistic environments, young children and adults perceive and remember complex stimuli differently: young children represent linguistic input with pieces of the complex stimuli due to their immature perceptual and memorial abilities whereas adults process larger chunks of the stimuli at one time, making the analysis harder to perform. Genesee (1978a) reviewed the literature on the optimal age for starting second language instruction from a number of other perspectives. In particular, according to the nativist point of view, early foreign language learning capitalizes on innate language learning mechanisms, with the assumption that the learning process is natural and effortless during this critical period. From a neuropsychological perspective, our brain demonstrates maximum plasticity in early development, which supports the idea of an optimal period for language development. Neuropsychological studies have also showed different patterns of brain activation depending on the age at which a second language is acquired (Kim, Relkin, Kyoung-Min, & Hirsch, 1997; Weber-Fox & Neville, 1996). For instance, Kim et al. (1997) found that the activation sites for native vs. second language tend to be spatially distinct in Broca's area when the second language was not acquired in early childhood with language production tasks. However, a following study conducted by Perani, et al. (1998) using PET found that while no differences were found between the brain activations associated with L1 and L2 in highly proficient individuals in a comprehension task (i.e. listening to stories), regardless of the age of L2 acquisition. They argued that L2 proficiency is more important than age of acquisition as the determinant of patterns of brain activation. In addition, one recent longitudinal study followed 6- to 9-year-old children for three consecutive years, and found that the ERP components in response to foreign language words appeared in an identical order to those for native language acquisition, suggesting that children's brains may be equally prepared to learn both a first and a second language, at least at this age period (Ojima, Nakamura, Matsuba-Kurita, Hoshino, & Hagiwara, 2010).

In addition, there have been disagreements about when the optimum period for acquisition ends. A recent review by Hyltenstam and Abrahamsson (2008), summarized the controversial issue on critical period offset as varying between 5 and 15 years. Specifically, Penfield and Roberts (1959) initially suggested that the critical period ends at the age of 9 due to a reduced cerebral flexibility, whereas Lenneberg

(1967) pointed to puberty as the end of the critical period because of the completion of brain lateralization. However, Krashen (1973) argued that brain lateralization is complete at the age of 5 or earlier. Moreover, Long (1990) postulated the age of 6 as the critical period offset for the acquisition of phonology "in many individuals" and age 12 for the rest, whereas the age of 15 seems to be the offset for morphology and syntax. However, there are indications that the age of 6 or 7 may also be relevant for morphosyntax (Johnson and Newport, 1989) and lexicon (Hyltenstam, 1992). Despite the widely seen evidence asserting that language learning ability deteriorates with age, there are overwhelming findings showing that if one disregards foreign accent phenomena, it is clear that young adults are more efficient language learners than young children (Walsh & Diller, 1979).

The relationship between age and success in second language acquisition therefore is complex and controversial. There is a multiplicity of causal mechanisms and mediating factors underlying the age effects in second language acquisition such as neurobiological and cognitive developments, L1 influence, personality, motivation to learn and so on (Birdsong, 2006).

Furthermore, most studies arguing for the superiority of children over adults hold mostly for pronunciation. For instance, Asher and Garcia (1969) compared Cuban children with American children in their pronunciation of English sentences and found that the younger the child entered the United States, the better his/her acquisition of near-native pronunciation. Abrahamsson & Hyltenstam (2009) examined a large sample of subjects (n=195) who were at different ages at the onset of second language acquisition by having a panel of native speakers evaluate their speech samples. They found that 62% of early L2 learners (age of onset of acquisition ≤ 11 years) were perceived as native speakers whereas only 6% of late L2 learners (age of onset of acquisition ≥12 years) were perceived as native speakers. Kuhl et al (2001) proposed that exposure to a specific language results in neural commitment specifically to the acoustic properties of that language, so infants are better than adults at acquiring the sounds of a second language, because the native-language learning process and thus neural commitment to its patterns, is incomplete (Kuhl, Tsao, Liu, Zhang, & Boer, 2001). Other studies also indicate that the decline in foreign-language phonetic perception is well underway by 9 months, and foreign-language intervention at 9 months would alter phonetic perception (e.g., Mandarin exposure for English native infants results in the infants' learning a native Mandarin phonemic distinction that does not occur in English) (Kuhl, et al., 2003).

Researchers who argue that late learners are more efficient in learning other aspects of a second language point to a more mature level of general cognitive development and positive transfer from a fully developed first language system. For instance, for syntax and morphology, Fathman (1975) reported that older immigrant children in U.S. schools learned faster than younger immigrant students. For comprehension, Asher and Price (1967) controlled the teaching method for adults and children, and found an inverse relationship between age and comprehension of a new language. Studies have also shown in immersion learning contexts that children who have an early start develop and maintain advantages in some, but not all, areas of language skills (Cameron, 2001; Harley, Howard, & Hart, 1995). In particular, young learners show better outcomes for listening comprehension and pronunciation, whereas they learn the grammar more slowly than older learners.

In addition to the interaction between age and different aspects of language, the apparent contradictions in the literature on optimal age could be resolved by distinguishing the “rate of acquisition” and “eventual attainment.” Children are slower at second language acquisition than adults; however, they tend to achieve higher levels of proficiency in the long run (Jarvis, 2009; Krashen, Long, & Scarcella, 1979; Nikolov & Djigunovic, 2006). One longitudinal project started in 1995 examined early and late learners’ rate of acquisition, and found that younger groups showed the slowest rate in initial acquisition, with significantly lower scores at the first testing time, but rapidly increased in later acquisition (Muñoz, 2006b). In other words, high levels of second language proficiency may be best achieved by an early start and long duration of instruction.

In sum, most of the controversial evidence regarding the critical period hypothesis was found in the area of phonology and morphosyntax, whereas the current studies focus on the fast-mapping of words to their referents. Furthermore, the critical period hypothesis should also take “ultimate attainment” versus “short term learning rate” into account, since “early is better” is more likely to hold true for long-term outcomes. It is also important to acknowledge that reaching high levels of second language proficiency involves aptitude, optimal learning styles, motivation, attitude and the appropriate social conditions for learning; it cannot be based solely on critical period. The current studies examine age-related differences in second language word learning in the short term. Since adults, compared to young children, are better in perceiving and storing complex linguistic stimuli and may compare and contrast linguistic patterns and forms in the second language to those in their native language abstractly, as well as to rely on context to guess the meaning of unknown words through their world experience (Pinsonneault, 2008), they may perform better than young children. Alternatively, they may perform worse due to their tendency to process larger chunks of complex stimuli (Newport, 1990). However, whether general cognitive abilities are involved in children's second language learning process is still controversial (Larsen-Freeman & Long, 1991).

In the present studies, I predicted that, when exposed to a fully unfamiliar language, novice adults may rely more on the knowledge of their first language (e.g. world experience, abstract thinking, translation etc.) to learn foreign words, whereas infants/toddlers and older children may benefit less from or even experience interference from translation because they tend to build conceptual associations between words and referents rather than lexical association between foreign words and translations (Comesana, et al., 2009). However, no study so far, to my knowledge, has compared whether the same teaching method worked equally well for younger children compared with older children or adults.

My dissertation thus includes participants from three age groups: 28- to 30-month-olds, 5- to 6-year-olds and young adults (18-20 year-olds). These ages correspond roughly to the classifications of different types of bilinguals on age of exposure to a foreign language: simultaneous acquisition (the onset of acquisition of the second language before the age of three); child second language successive acquisition (the onset of acquisition of the second language between ages of five and ten); and adult second language successive acquisition (the onset of acquisition of the second language after the age of ten) (Meisel, 2004). Thus, each group in my dissertation may represent age-specific models of foreign language acquisition. In particular, 28- to 30-month-olds are considered to be within the critical period/optimal period for language learning, and their learning should be classified in the same way as their first language acquisition. As for 5-6 years old, it has been argued that "significant changes happen around the age of five due to brain maturation (Meisel, 2004, p111). In Meisel's chapter, findings regarding successive L2 acquisition and brain lateralization are presented as evidence for why second language acquisition suddenly gets harder at this age. For instance, she states that functional magnetic resonance imaging (fMRI) suggests a common pattern of activation for both languages acquired during early infancy, but an increasing activation of the right hemisphere can be observed if the onset of acquisition of a language happens after the age of four. Thus child second language acquisition differs in important respects from earlier acquisition and may also differ from late acquisition. For young adults, most researchers would predict that learners have to rely upon other cognitive capacities to develop successive acquisition of the second language since the human language faculty no longer seems to work in the same way as during early childhood (Meisel, 2004). And yet, as we know from the above studies, adult learners may be uniquely prepared to benefit from language teaching strategies that take advantage of these capacities, especially in a short-term learning situation.

Chapter 2: Overview of Current studies

The studies in my dissertation are motivated by the historical development of second language education, political and social needs, as well as the variety of approaches included in different programs for teaching languages to young children. Second language or bilingual ideology in the United States began early--in the 1700s and has shifted according to changing historical events. In particular, from the 1700s to 1880s, the predominant members of US society were immigrant and this promoted linguistic diversity permissively and bilingual or second language instruction was provided in many public and private schools. In 1900, for instance, approximately 4% of elementary schools received some extent of instruction in German (Kloss, 1977, 1998). In the 1880s, there was increasing fear about the importation of foreign ideologies into the United States and this resulted in a call for all immigrants to be assimilated into one culture and one language. Thus, in this restrictive period, monolingual English instruction was emphasized in the public schools. From the 1960s to 1980s, second language/bilingual education was rebirthed due to changes in immigration laws as well as military, commercial and diplomatic factors; however, it remained controversial. Attacks against second language/bilingual education became strong after the 1980s and has continued into the 21^{st} century, despite evidence demonstrating that bilingual programs promoted academic success. One possible reason for this is that bilingual education was much more than a pedagogical tool; it involved complex issues of cultural identity, social class status and language politics. One concern from opposers of bilingual education, for instance, is the belief that a person learns another language by avoiding use of one's native language and that native language proficiency declines. The effectiveness of bilingual education is also questioned, and indeed it is fair to ask what the tangible outcomes are for years of second language instruction (Ovando, 2003).

Such swings in public sentiment about the importance of bilingual education have also prevailed in other countries. In the 18th century, foreign language teaching stated to gain momentum in secondary education in several countries in Europe. However, in most countries, it was only in the 19th century that the systematic teaching of foreign languages began in earnest due to the situation of multilingualism from immigration, and it undertook major reforms in the 1950s and 1960s resulting from the impact of political events. For instance, Russian was regarded as the first and sometimes only foreign language that should be learnt in Eastern Europe in the 1950s and 60s. From the 1970s to 1980s, the Council of Europe was also very active in publishing works by its experts on exploring effective methodology used in schools teaching foreign language (Eurydice, 2001).

Worldwide, second language education has experienced numerous historical shifts and controversial opinions, especially regarding whether and how effectively it was implemented. Different programs varied in their approach as to the inclusion of the native language, such as traditional bilingual programs with extensive instruction in the native language vs. immersion programs with no use of the native language. My dissertation is interested in comparing the short-term effectiveness of different exposure approaches, in controlled laboratory settings. Although it does not focus on long-term curricula or leaning outcomes, it does provide controlled experimental studies that can begin to speak to the question of effectiveness for different approaches at the very earliest stages of second language learning. In particular, it consists of three main studies to examine two possible exposure approaches: the translation approach vs. the immersion approach.

I. Background of translation approach in second language education

Translation as a method in teaching a second language has a long history. It has been stated that translation was the most popular method since the 16th century when teaching Greek to Latin speakers or vice versa, and it became the major method (named the "Grammar Translation Method") for second language teaching in the 19th century when translation was used to understand and learn grammar rules and vocabulary for missionary, scholarly work, and trade (Machida, 2011). Students of the translation method were provided detailed explanations of the foreign grammar in their native languages and bilingual vocabulary lists to learn. It was used well into the 20th century as the primary method of foreign language instruction in Europe and the United States, although it also received challenges and criticism such as the neglect of realistic, natural language (Zimmerman, 1997). Interestingly, this method is still widely used as a traditional approach for teaching second languages nowadays.

Thus, it is not surprising that the translation method is commonly adopted in popular TV programs that purport to teach second language vocabulary to young children (e.g. *Dora the Explorer*, *Ni-hao Kailan*) and that it is used in many curricula for classroom settings. Several models have addressed the issue of cross-language transfer of knowledge and proposed that words in the L2 are mediated through L1 access to the conceptual system in early stages of L2 acquisition. Specifically, if a novice learner hears a word in the L2, the meaning will be accessed via the word in the L1 and the connection from the L1 word to the concept (Bedore, Pena, & Boerger, 2010; MacWhinney, 2005). Based on this model, providing translations seems to facilitate the process of knowledge transference by providing access to L1. In addition, researchers argued for the effectiveness of translation, stating that including translations in class promoted learners' proactive use of their knowledge and previous experience from L1 (Machida, 2011). However, the benefit of introducing the "act of translation" as discussed above was limited to advanced levels of a second language class.

Many research studies on adult's learning strategies have argued that adults tend to use mnemonics, L2-picture association, L2-L1 association, L2-L1 translation and repetition to learn a foreign language (Barcroft, 2009; Schmitt, 2008; Wyra, et al., 2007), with the translation (L1) often provided after the foreign words (L2). Lawson and Hogben (1996) examined the strategies selected by learners during L2 vocabulary learning. Learners were interviewed and asked to attempt to learn L2 words in whichever way they thought would best help them learn the meaning of the new words. The words were presented with the options of example sentences, translations and other related words. The strategies most frequently used were reading related words, simple rehearsal and reading translations (Lawson & Hogben, 1996). One such study revealed the superiority of translation learning in terms of the quantity of words learned (Prince, 1996). In Prince's study, adult learners were assigned to either a translation learning condition in which L2 words (i.e. English) were accompanied by their L1 (i.e. French) equivalent, or a context learning condition in which L2 words appeared in a series of L2 sentences and learners were instructed to guess the meaning of the unknown words. The results showed that adult learners performed better in the translation learning condition than in the context learning condition. However, many of the strategies identified in the above studies could be used only by non-novice learners who already know the second language (e.g. using related words, guessing from sentence context). For beginners who are exposed to a foreign language for the first time, L2-picture/referent association and L2-L1 translation play a key role for word learning (Comesana, et al., 2009).

Nonetheless, child and adult learners are different in many ways, in terms of the sensitive period, attitude, motivation, and general cognitive abilities (Genesee, 1978a; Muñoz, 2006a). Adult learners are able to analyze language abstractly, and compare linguistic patterns and forms in the second language to those in their native language (Pinsonneault, 2008; VanPatten, 2007), whereas child learners may tend to learn foreign words in a more holistic way, just as they learn words in their native language (Byers-Heinlein, 2010; Genesee & Nicoladis, 2007; Ng & Wigglesworth, 2007). The immediate translation of a new word takes away from the child any motivation to think about the meaning of the foreign language word. Therefore, it is important to question whether providing native language translations helps or interferes with learning foreign words for younger children (Study 1).

II. Background of immersion approach in second language education

The immersion approach examined in the current dissertation was based on the idea of "natural inputs" for second language learning. At the end of the 19th century, the direct method was first introduced as the best known of several "natural" methods. It was developed in the United States by L. Sauveur and made famous by M. Berlitz. In contrast with the translation method, it emphasized the priority of relating meaning directly with the target language without the step of translation. In particular, concrete vocabulary was explained with labeled pictures and demonstrations, while abstract vocabulary was taught through the association of ideas (Zimmerman, 1997). However, such methods were not adopted in ordinary schools of America or Europe, but gained an extensive following in private language facilities such as the Berlitz Schools during the 19th century. As mentioned previously, many European countries were influenced by the documents published by the Council of Europe beginning in the 1970s and gradually adopted the communicative approach of teaching second languages. This approach was similar to the idea of "natural inputs," which proposed the importance of being exposed to the target language extensively and avoiding resorting to the mother tongue. In the 1960s, immersion instruction was also developed in Canada by St. Lambert. The fundamental premise of these immersion programs are that people learn a second language the same way as they learn their first language, so second language learning requires contexts where learners are exposed to natural input and they are socially motivated to communicate (Genesee, 1978b, 1983, 1985; Genesee, Holobrow, Lambert, & Chartrand, 1989). From their perspective, a second language is not simply taught as another subject in the curriculum, but rather is the medium through which the curriculum itself is taught. Immersion teachers pretend to be monolingual, using only the target language in their interactions but not forcing the students to use it, so that students feel a strong desire to engage in communications with the target second language. In this type of program, no bilingual skills are required for the teachers, and bilingualism is developed through two separate monolingual instructional routes.

Immersion programs are considered to be an additive bilingual educational experience, because they provide opportunities to acquire an additional language at no expense to the home language and culture. Many studies have provided evidence that in terms of first language development, students in immersion programs had no long-term deficits in academic achievement and no difficulty assimilating new academic knowledge and skills even though they were taught through a second language. For the second language, students in immersion programs were more proficient, especially in speaking and comprehension, than those who were in traditional programs (Genesee, 1978b, 1983, 1985, 1987; Genesee, et al., 1989; Hornberger, Genesee, & Lindholm-Leary, 2008), although they still had deficits when compared t native speakers which gave impetus to the focus-on-form movement.

The alternative forms of immersion currently available vary primarily with respect to the starting point during which the second language is used as a major medium of curricular instruction. The differentiations are often made between early (begin in kindergarten), delayed (begin in grade 4 or 5) and late (begin in grade 7 or 8) immersion (Genesee, et al., 1989; Hornberger, et al., 2008).

Many popular commercial second language software programs in the U.S. to date have claimed to adopt the immersion method to some extent, such as Berlitz, Muzzy and Rosetta Stone. As reported by Dun and Bradstreet (D&B) corporation--one of the world's leading suppliers of business information, services and research--the Rosetta Stone U.S. company made annual revenue of around $252.3 million in 2009. Nonetheless, there is no evidence that these programs can be effective in the ways that in-person immersion programs in the classroom are.

III. Methodology in Current Studies

In order to investigate the effectiveness of the two main exposure approaches for short-term second language word learning, the current studies were conducted under a controlled experimental setting which focused on fast-mapping of vocabulary, and a very initial stage of comprehension. This study will therefore join the ranks of only a few experimental studies examining second language word learning, especially for young children.

One experimental study has investigated French-speaking infants' word learning in English (Bijeljac-Babic, et al., 2009). In this study, Bijeljac-Babic et al. (2009) used an object manipulation task and found French-speaking 20-month-old infants succeeded in learning words in a foreign language (English) with very minimal exposure. In particular, they used eight triads of very distinct novel objects for which infants had no names, and eight pairs of very distinct pseudowords to name the objects. Two objects were presented and named six times using full sentences with the pseudoword embedded and then the experimenter presented a third object, named it, and put it in a cup. Afterwards, infants were tested on word learning by being asked to put the other named object in the cup. Four tests were conducted in the foreign language (English) and four additional tests were conducted in the native language (French), to ensure that infants could perform the task in their native language even if they were not able to perform it when given the foreign language sentences. The findings from this study thus suggest that even in a foreign language, infants are able to locate and segment sentences spoken to them to not only discover the sound patterns of the pseudoword object labels, but also to map novel words onto objects when presented in sentences from an unfamiliar language.

Another experimental study conducted recently demonstrated that monolingual English-speaking toddlers with higher proficiency in their native language are capable of learning words from a foreign language (Koenig & Woodward, 2012). In Koening and Woodward' study, 24-month-old toddlers were first presented with familiar objects with labels in various Dutch phrases during familiarization. After familiarization trials, the experimenter presented a novel word-object pairing as well as a distractor with an equal amount of non-labeling attention in novel label training. Immediately after novel label training, the comprehension was tested by placing the target and distractor objects on either side of a tray. The experimenter requested the object in Dutch and the proportion of correct choices were calculated. Results found children with low English vocabularies responded randomly in tests, whereas children with high English vocabularies performed above chance in response to the Dutch speaker.

However, the current studies address these questions in different ways. First of all, both studies above used isolated objects and explicitly labeled the target objects by looking, pointing, and touching in immediate interaction with the children. The current studies are interested in the learning performance in dynamic events presented in a video with minimal clues about which elements are labeled. Second, it is not clear whether the same results would be found for a language more distant from English than French or Dutch (i.e., Mandarin Chinese) or whether infants would be better or worse at learning foreign words than older children or adults. Moreover, the current studies are more interested in the effects of different exposure approaches on learning performance beyond whether they are simply able to learn words presented in a second language. Lastly, in addition to examining explicit responses, on-line measures of processing efficiency and accuracy for learners of different ages with different exposure approaches are also measured via children's looking patterns, while watching the videos.

Another experimental study relevant to early foreign language exposure involves Mandarin Chinese, but focuses on phoneme perception. In this study, 9-month-old

English-speaking infants were exposed to Mandarin Chinese in 12 sessions, each 25 minutes in duration, and showed significant learning of a native Mandarin phoneme contrast that does not occur in English (i.e. /ʈʂʰ/) vs. /ʂ/), compared with those who were exposed only to English for the same length of time, but this effect was only found via interpersonal interaction with a live person (Kuhl, et al., 2003). As with the previous study, this result demonstrated that mere short-term exposure to a foreign language can facilitate phoneme learning in infants. Again, though, it is not clear whether short-term exposure to Mandarin could drive children/adults to learn foreign words under these same conditions or whether age makes a difference in the learning process.

Mandarin Chinese is the target second language in the current studies, partly because it is distant from the learners' native language—English. Language distance has been suggested to influence foreign language acquisition (Butler & Hakuta, 2004). The Foreign Service Institute (FSI) of the US Department of State has compiled approximate learning expectations for a number of languages based on the length of time it takes to achieve general professional proficiency in speaking and reading ("National Virtual Translation Center," 2007). Languages such as French, Dutch and Spanish are categorized as “languages closely related to English” and it may take 600 class hours to achieve general proficiency. Languages with significant linguistic and/or cultural differences from English, such as Hebrew, Greek and Russian, require 1100 class hours, whereas other languages, such as Chinese, Japanese and Korean, are categorized as languages that are difficult for native English speakers and require

2200 class hours to achieve general proficiency. There is evidence from one simulation study indicating that language distance affects the rate of learning; the greater the distance between two languages, the longer it takes to learn (Butler & Hakuta, 2004). Moreover, McDonald (2000) found that learners of English from a Spanish-speaking background who had begun to be exposed to the language before the age of five were able to perform to native levels on an English grammaticality judgment test, whereas Vietnamese speakers with pre-age-five experience of English were not (McDonald, 2000). In terms of young children's foreign language learning, previous studies have shown that 20-month old French-speaking infants succeeded in learning words in English with minimal exposure (Bijeljac-Babic, Nassurally, Havy, & Nazzi, 2009); thus, it is worth examining the possibility of acquiring a language more distant from English than French, such as Chinese.

In addition to the importance of language distance, Chinese is the most widely spoken language in the world with more than 3 billion speakers. Current interest in learning Chinese is perhaps motivated by the desire to communicate with a large population whose country is exerting increasing economic, political and cultural influences in the world. According to a 2006 survey by the Modern Language Association, over 51,582 students in American study Chinese at some level in college (Weise, 2007 Nov 27) and this number increased by 18.2% in 2009 (Furman, Goldberg, & Lusin, 2010). Furthermore, in a survey of K-12 enrollment in foreign language classes, the American Council on the Teaching of Foreign Languages found that the present number of elementary and secondary school students studying

Chinese could be as much as 10 times higher than in 2000—around 30,000 to 50,000 (Weise, 2007 Nov 27), and elementary schools offering Chinese languages were on the rise between 1997 and 2008, from 0.3% to 3% (Rhodes & Pufahl, 2009). According to The Asia Society, there are Chinese programs in more than 550 elementary, junior high and senior high schools in the United States (Weise, 2007 Nov 27). At the college level, according to the Modern Language Association, enrollment in Chinese-language classes has increased 51% since 2002 (Weise, 2007 Nov 27). One report in USA TODAY (2007) also indicated that the Foreign Language Assistance Program of the U.S. Department of Education, which supports foreign language instruction in elementary schools, immersion programs, curriculum development, professional development, and distance learning, allocated $6.7 million to Chinese instruction in 2006 and an additional $2.4 million in 2007 (Weise, 2007 Nov 27). Chinese is considered one of the critical languages (e.g. Arabic, Russian, Korean and Japanese) by the U.S. Department of State ("Critical language scholarship program," 2011). The continuing increase in the number of Chinese language programs thus provides additional motivation for usiing Mandarin Chinese as the target language.

The experiments in the current dissertation were conducted with a modified version of the looking-while-listening paradigm (LWL) which is similar to the intermodal preferential-looking paradigm (IPLP) developed by Golinkoff and Hirsh-Pasek et al. (Golinkoff et al., 1987). In the original IPLP, infants are first shown a brief "training" scene either in the center of the screen or on both sides of a split-screen video, and then are shown two different scenes in each test trial, one which matches the co-occuring audio and another which does not. Children's understanding of scenes is examined by their eye movements and the amount of time following the scene which matches the speech presented in the audio. In contrast to this, the LWL paradigm generally does not include a training scene and, rather than coding the total looking time to the target averaged over a fixed window, the LWL paradigm incorporates the same sensitive temporal measures used in eyetracking studies by coding children's gaze patterns through frame-by-frame inspection of the time course of looking to the referent (Fernald, Zangl, Portillo, & Marchman, 2008). In the current studies, we combined both IPLP and LWL methods by including a brief training period for each word while also using the looking time measurement from LWL to capture the dynamic looking patterns of participants during the testing phase.

The intermodal preferential-looking paradigm (IPLP) or looking-while-listening paradigm (LWL) has been successfully used to measure young children's word comprehension (Fernald, Marchman, & Hurtado, 2008; Fernald, Zangl, Portillo, & Marchman, 2008; Hirsh-Pasek & Golinkoff, 1996; Marchmam, Fernald, & Hurtado, 2010; Roseberry, Hirsh-Pasek, Parish-Morris, & Golinkoff, 2009). However, there are still some problematic issues underlying data analysis. For instance, for most of the studies conducted by Hirsh-Pasek and Golinkoff with the IPLP, word comprehension was measured by the percentage of looking time spent on the target over the total looking time spent on the screen across the full length of the stimuli (e.g. a 6 second window). Using such a long window may underestimate comprehension accuracy by reflecting a combination of a potentially correct response with visual exploration after the response (Fernald et al., 2008). Thus, instead of coding the gaze information across the full 6 second video clip, Rosseberry, Hirsh-Pasek, Parish-Morris, and Golinkoff (2009) elected to code the first 2 seconds of each test trial. However, there are reasons why this choice may also problematic. Although the first 2 second window selection may solve the problem of visual exploration during the long trial, it does not consider time it takes for initial speech processing and mobilization of eye gaze. The LWL approach attempts to remedy this by analyzing the eye gaze information frame-by-frame and taking into consideration the onset time of target words, such that the looking time window is tailored according to target word onset for each trial. For instance, in Fernald's lab, infants' or toddlers' word comprehension/processing is measured with the mean looking time at the target as a proportion of total time on either target or distracter, averaged over the time window 300ms-1800ms from the onset of the target word. However, it is difficult to ascertain what the particular time window ought to be for measuring the accuracy of a response. In their studies, 300ms has been assumed to be necessary for processing sufficient acoustic input and mobilizing an eye movement; 1800ms has been argued to be the onset of the second of the word repetition in their task and it is less clear that this would be a universal solution for determining a response to the target word.

In a similar vein, Waxman et al. (2009) has examined toddlers' interpretation of novel nouns and verbs under a dynamic event by coding their eye movement frame-by-frame. They calculated, for each child at each frame, the proportion of looks directed toward the target scene across trials to generate a time-course plot of looking behavior. For the purpose of statistical analyses, they calculated the accuracy (for each subject and each trial, the mean proportion of looking time devoted to the target scene) within a particular window. The window began with the onset of the target word and ended three seconds later at which a new test question was initiated. However, their window did not exclude initial time for video/audio processing and eye mobilization. In addition, it is not clear if the 3 second time window is appropriate to estimate their understanding by not including the period of visual exploration after response. Given that different researchers have defined the appropriate windows for accuracy differently, I have summarized several of these studies in Appendix A.

Thus, Fernald et al. (2008) has acknowledged, the determination of the appropriate window onset may vary somewhat from study to study depending on the experimental question and the age of the children in the study. In eye-tracking studies with participants of different ages, this cutoff has varied from 200 – 400 ms (Bailey & Plunkett, 2002; Ballem & Plunkett, 2005), with shorter intervals typically used with adults (e.g., Tanenhaus, Magnuson, Dahan, & Chambers, 2000) and with children older than 24 months (Fernald & Hurtado, 2006; Zangl & Fernald, 2007). However, all those studies use static pictures as the stimuli, and dynamic videos require more attention load and may require a longer time to initiate eye movements. No study, to my knowledge, has provided evidence to justify which window ought to be selected. Thus, in the current studies, the looking time data was analyzed across a number of different levels to justify the determination of the time window for calculating looking behavior accuracy and the validity of using the looking time measurement to estimate learning performance.

First of all, in terms of the time window selection for calculating accuracy, the proportion of looking time toward the target side and proportion of looking time toward the non-target side for each subject in each frame was calculated. Any statistically significant discrepancies between target vs. non-target proportions over time can also build a basis for the time window selection, because they can also take into account supposedly random visual scanning and initial eye mobilizations at the beginning of the trials. Furthermore, by comparing the starting point in the divergence between the average target and non-target looking patterns across the different exposure approaches, we may understand the processing efficiency associated with each approach in addition to accuracy.

Secondly, instead of comparing accuracy against chance level (0.5), the accuracy within the fixed time window was compared to the accuracy prior to target word onset that was set as the baseline window. This measurement reflects the looking behavior in response to target words vs. looking behavior to the videos in the absence of a target word, which is a more direct measure for assessing word learning.

Thirdly, for older children and adults, explicit response behaviors (i.e. pointing for children and button pressing for adults) were also collected to measure accuracy in word learning. By the splitting the trials based on correct vs. incorrect explicit behavior, we can compare looking time trajectories across correct vs. incorrect responses between different responses. It follows, then, that the proportion of looking to target on the trials for which learners give the correct response is predicted to be significantly higher than the trials for which learners give the incorrect response. Furthermore, a correlation between explicit response accuracy and implicit looking time accuracy can be conducted to verify that the looking time measurement reflects the learning performance.

Finally, the reaction times for explicit responses were taken into account to define the offset of the time window. In particular, the looking behavior after an explicit response made is more likely to reflect random visual explorations, and thus should not be included in calculating the accuracy.

Eye movements were coded off-line by using i-Coder software (Fernald et al, 2008). This software allows frame-by-frame coding of the digital videos of children's looking at the stimuli, and measures the latency for the eye to shift from side to side as well as the duration of fixations on each side. The custom software Datawiz (Fernald et al, 2008) was used to convert raw coding files generated by i-Coder into more meaningful numerical data which indicated the gaze patterns to the target ("1"), non-target ("0"), or away/off ("-") for both sides at each frame for every trial, by integrating with information about the side of the target referent on each trial as well as the onsets and offsets of target words.

Research assistants completed a standard training set of four pre-selected tapes (from the Fernald lab at Stanford University) and achieved a criterion of 95% or greater agreement on all 4 tapes before being allowed to code real data. The i-Coder program enables comparison of the response line for each recorded event and marked discrepancies that exceed one frame. The agreement score is based on the percentage of frames on which two coders' judgments agree overall as well as the percentage of frames on which coders agree with only the sequences of frames where shifts occur from eyes-shifting start to finish. After completing the standard tapes, each coder was required to code 4 more tapes from our lab before coding the actual videos in the current studies. Since the standard comparison built in i-Coder program deals with each tape separately, I used Kappa analyses across all tapes to calculate their reliability. Kappa calculations only compare two observations (1 for looking at the target, 0 for looking at the non-target). Accordingly, for a less conservative perspective, both "looking away " and " eye shifting" were recoded as "system missing" and excluded from the comparison; for a more conservative perspective, "looking away" and "eye shifting" were recoded into "0" (not looking at the target side) and thus provided more data to compare. All the coders were required to achieve the criterion of 90% or greater with the conservative Kappa score, compared to a reliable coder with extensive coding experience.

For the actual studies, random pairs of reliable coders coded 10% of randomly selected tapes across different age groups. The reliability between two coders was 99% (less conservative) and 91% (more conservative) with Kappa analyses.

In addition to the measurement of looking time, children's pointing responses were coded on-line by an experimenter who was blind to the stimuli. The experimenter pressed the button box following the children's pointing behavior. Adults' explicit responses were directly entered into the button box. Toddlers were not instructed to point since they had difficulty understanding and following the instructions. Although the measure of explicit responses after processing stimuli could directly provide the answers for participants' accuracy and reaction time in tasks, it is less informative in the on-line processing of speeches before and after target words presented. The measure of looking times, accordingly, provides extra insights with processing efficiency beyond explicit accuracy and reaction time.

The following chapters target each of the different exposure approaches for short-term second language word learning with both explicit response and implicit looking behavior measurements. Specifically, Study 1 (Chapter 3) first examines the effectiveness of traditional approaches to second language word learning by providing translation equivalents. In contrast to the translation approach, Study 2 (Chapter 4) and Study 3 (Chapter 4) stem from the immersion approach, and extend it to an experimental setting. The natural foreign exposure approach has been used successfully by classroom-based immersion program, but it is not clear if it works equally well for infants and older children vs. adults, or if it works in short-term learning situations such as experimental fast-mapping studies. These two studies aim to address these questions and differ in one additional dimension: providing single context vs. multiple contexts to teach the target objects with immersion exposure.

Chapter 3: Study 1: Does providing a native language translation help/interfere with learning foreign words?

Study 1 examined the effectiveness of a traditional approach for second language word learning: providing a native language translation after the foreign words. This approach is motivated by the strategies used by most adults for learning a second language (Barcroft, 2009; Comesana, et al., 2009; Lawson & Hogben, 1996; Prince, 1996; Schmitt, 2008). In addition, in early foreign language teaching programs, L1-L2 translation strategies are also widely used (e.g. *Dora the Explorer*; *Ni-Hao Kailan*). However, no study has directly examined the relative effectiveness of this approach, for different groups of learners. This study therefore examines whether, for learners of different ages, providing the native language translation helps or interferes with learning words in a second language.

Methods

Participants

This study included typically developing monolingual English-speakers of three age groups: 20 toddlers (28-30 months), 20 school-aged children (5-6 years) and 24 college students. There were 1 additional toddler, 2 additional 5- to 6-year-olds and 4 additional adults who participated in the study but were excluded from the final analysis due to equipment error (adult: N=3; children: N=2) and bilingualism (adult: N=1; toddler: N=1).

Video stimuli

The visual stimuli were composed of a set of digitized video recordings, each presenting a Teletubby character (Po) (who had been introduced during the familiarization play phase) performing an action on an object. All of the actions and objects used in the study were familiar to children of the studied ages. Each event took five seconds to complete. The objects used for teaching the four target nouns were "book," "ball," "block" and "apple." These four target words were chosen from the MacArthur Bates Communicative Development Inventories (Fenson, et al., 1994) and were of high frequency for early comprehension and production in the native language.

Audio Stimuli

The audio stimuli were full sentences spoken either in Mandarin or in English. As with Kuhl's study (2009), the target words were embedded in different Mandarin carrier phrases (see Appendix B for the full list of phases). Target words consisted of two monosyllabic and two bi-syllabic words, with one monosyllabic word grouped with one bi-syllabic word within a block, in order to minimize phonetic confusion because infants have difficulty forming word-object associations when presented with novel words with minimal phonological contrasts (Stager & Werker, 1997). In particular, “ping2guo3” (apple) and “shu1” (book) were grouped together, whereas “ji1mu4” (block) and “qiu2” (ball) were grouped together. The translation equivalents were embedded in the corresponding phrases in English. All the audio stimuli were recorded in infant-directed speech by a female native speaker.

Design and Procedure

The current study used a modified version of the looking-while-listening (LWL) paradigm, as described in Chapter 2, which included a training phase followed by the dynamic looking measurement from the LWL paradigm during the test phase of each block. Specifically, participants were trained with multiple presentations of a Teletubby character conducting a familiar action on a familiar object in the center of screen sequentially, with audio recordings that contain target words produced in Mandarin followed by the translation phrase in English. The two different scenes were shown in random order in blocks of eight trials, with the native-language translation always following the foreign language sentences.

Following the training phase, participants’ comprehension of each word was tested in the LWL paradigm, in which two different scenes are shown side by side, one which matched the speech, and one which did not. Each participant was presented with four blocks, and each block included two target words. The experiment was run with PsyScope software controlled by a Macintosh computer. A video record of the participant’s eye movements was sent to a mixer which integrated the video signal with graphic information about participants, trial numbers and stimuli orders.

For toddlers, each test was preceded by a 15-minute warm-up session during which an agent-familiarization phase was conducted in the waiting room. In this phase, an experimenter introduced and played with a Teletubby doll (i.e., Po) together with the child for 5-10 minutes. The purpose of this phase was to ensure participants are familiar with the actor who will be shown performing actions in the videos. This is very important because infants are prepared to pay more attention to changes in familiar agents than unfamiliar agents, and they are more interactive and express more positive affect in the presence of a familiar agent (Kahana-Kalman & Walker-Andrews, 2001). Otherwise, they may not pay attention to the objects that Po performs actions on, even though the objects are being labeled (Fenson, et al., 1994). During this familiarization phase, anther experimenter administered with the caregiver a consent form, a language background questionnaire and the MacArthur Bates Communicative Development Inventories (MCDI) vocabulary checklist During the video session, the caregiver was instructed to close his/her eyes and avoid talking, pointing, or otherwise influencing his/her child's attention throughout the duration of the video. The toddler was then seated on the caregiver's lap 3 feet away from the 25-inch screen in a darkened room. Auditory levels and lighting were also standardized to be approximately 65 dB (± 5dB) and 26 lux (± 3 lux) during the stimuli on, respectively.

School-aged children were first read an assent script that they then signed an while the caregiver was completing the consent form and language background questionnaire. Children were then introduced to Po and told that Po was from another country and speaks a different language than them, and would teach them some words in her language. In order for them to understand the procedure, some practice tests were completed in the play room. The instructions were as follows:

“Today, I want to play a language game with you. We are playing this game because we want to find a good way to teach kids and adults new languages, and we need your help.

This is my friend Po, and she is going to help us. Let’s pretend Po’s a teacher from a different country and is teaching you some words in her home language; you are the student figuring out what she means.

In this game, Po is going to show you some movies of her playing with her things, and at the same time, she’ll talk to you in her language. Remember she is from another country and speaks a different language than you, but you can figure out what she means by listening carefully to her while you watch her.

After you’ve watched some of these movies, Po will check to see if you understand her. To check, she will show you TWO movies at the same time on opposite sides of the screen. She’ll say something in her language that matches only ONE of the movies. It’s your job to figure out which movie matches what she’s saying.

You will know she’s trying to check you when you see two movies side-by-side, and a big question mark at the top. When you see that, tell her which side matches the words by pointing to the screen.

Let’s try some examples with the pictures now. We start with English words. This *is a cow, and this is a pig. Now, what if I say "cow", what should you do? You're right, point to the cow. Great job! Let's try another one, but this time it will be in Po's language. This is a "larp," and this is a "gorp." Now, what if I say "larp"? Good job!"* (see Appendix C).

After warm-up and practice, children were guided to the testing room and seated on a chair 3 feet away from the 25-inch screen. Before the video began, children received a reminder again:

"Do you remember what Po is going to do first? Right, she is going to teach you some words in her language. Then, what are you supposed to do if you see two pictures? Correct, point to the one you think Po is taking about. Ok, are you ready?"

For adults, they were instructed to complete the consent form and a language background questionnaire in the beginning and then given the brief introduction of the study:

"This study is trying to figure out the best way to teach children and adults new words in a foreign language.

First, you are going to see several videos with audio that contain some words produced in a foreign language. Please listen to the audio and watch the video carefully to try to figure out the meaning of the words.

There will then be a test phase where you will see two scenes side by side and hear a phrase in a foreign language that contains one of the words you heard during the "learning" phase.

So, when you see two videos side by side and a question mark on the top, you will respond by pressing a button. In this phase, only one of the videos will match the word that you are being tested on. Your job is to identify the matching scene. Push the button with the arrow that points to the side with the movie that matches. Any questions?"

The video started with a 5 second scene of Po waving his hand, first on the left side and then on the right side of the screen, in order to introduce the character Po to children and to create the expectation that something would appear on each side of the screen. Following Po familiarization, participants were trained with two scenes sequentially, in which Po performed an action on an object. The two scenes differed in the object that Po performed the action on, and each was paired with a corresponding target word embedded in varying carrier phrases. The sentence phrases were produced by a native Mandarin female speaker in infant-directed speech. Each scene lasted 5 seconds and was repeated four times. The two scenes were shown in a pre-chosen random order over a total of eight trials. The training phase was followed by a pair of puppet animations shown simultaneously on both sides of the screen to keep participants' attention, and then by four tests of 10-second events (5-second actions with additional 5-second frozen images), in which two different scenes were presented simultaneously on both sides of the screen. A total of four blocks, following this same structure with both a training phase and a testing phase (see Appendix D), were presented across the entire study. The blocks differed in terms of the target words, the training order, and testing trials. For instance, “apple” and “book” were grouped together and presented in Block1 and Block 3, with the training trials similar across these two blocks (but sequence different), but each block tested words in different conditions. Similarly, “ball” and “block” were grouped, presented and tested in Blocks 2 and 4.

During the test trials, each word was tested in four conditions across two blocks, varying in the action context in which the target objects were presented and by the distractor against which the target objects were contrasted. Specifically, in one trial, both the action context and distractor objects had already appeared in the training phase—familiar context-familiar contrast (a); in one trial, the action context had appeared in the training phase, but the distractor was a new object---familiar context-novel contrast (b); in a different trial, the action context was new, but the distractor object had appeared in the training phase---novel context-familiar contrast (c); in another trial, the action context was new and the distractor was a new object ---novel context-novel contrast (d). For instance, block 1 tested the word “apple” in condition (a) and (d), “book” in condition (b) and (c); block 3 tested the word “apple” in condition (b) and (c), “book” in condition (a) and (d); block 2 tested the word “ball” in condition (a) and (d), “block” in condition (b) and (c); block 4 tested the word “ball” in condition (b) and (c), “block” in condition (a) and (d). The action contexts on both sides were identical (see Appendix E). The order of test trials within each block was counterbalanced across the four blocks.

Furthermore, four different block sequences were generated and participants were assigned randomly to one of the four block sequences, which varied by the order of target word group (group A: apple/book; group B: ball/block): Group ABBA, Group ABAB, Group BABA and Group BAAB.

After watching the video, school-aged children and adults were given a post-study questionnaire on target word recall and recognition. Specifically, they were first asked if they remembered how to say the target words in Mandarin (Po's language) when presented with pictures of the target objects. Then, the experimenter said the target words and asked them to point to the picture that they thought matched; for instance "which one is Ping2guo3"? Participants' production was audio-recorded and scored by two native Mandarin speakers. In addition, their verbal and non-verbal intelligence were measured using the Kaufman Brief Intelligence Test (K-BIT) (non-verbal intelligence is administered only with children). Both children's and adults' auditory working memory was measured using the Woodcock-Johnson Psycho-Educational Battery - (WJ-III®) (Test 9). An additional foreign language aptitude test (Pimsleur Language Aptitude Battery (PLAB), Pimsleur, Reed & Stansfield, 2004) was administered with adult participants to determine how quickly and easily an individual is able to learn a language in a language training program; this aptitude test is relatively stable throughout an individual's lifetime. Appendix F showed examples of the task materials.

Results

Explicit behaviors:

The response and reaction time data was collected by *Psyscope* software for adults and 5- to 6-year-olds when they pressed the button or pointed to make their choices. The accuracy was averaged across 16 test trials for each subject, and the reaction time was examined only for the correct trials. The overall accuracy of adults was 88.7% (*SD* = 12.5%), whereas the overall accuracy of older children was 46.8% (*SD* = 20.5%), as shown in Figure 3.1. A one sample *t*-test revealed that response accuracy was significantly higher than 0.5, $ts(23) = 15.17$, $p < .01$, for adults. A repeated-measures ANOVA with age as a between-subject variable and number of repetitions as a within-subject variable found only an effect of age, $F(2,61) = 2.92$, $p = .062$, $\eta_p^2 = .087$. Neither adults nor 5- to 6-year-olds performed differently between 4 repetitions and 8 repetitions. In terms of reaction time, however, a repeated-measures ANOVA found an effect of repetition, $F(1,42) = 28.06$, $p < .01$, $\eta_p^2 = .40$, and age, $F(1,42) = 14.65$, $p < .01$, $\eta_p^2 = .259$, with no interaction. In particular, adults responded faster than children on the correct trials, and both age groups responded faster with 8 repetitions than 4 repetitions, as shown in Figure 3.2.

Implicit behaviors:

Implicit looking behaviors were analyzed in terms of processing efficiency and accuracy. Processing efficiency was examined with divergence analysis, namely, when the difference score between proportion looking to target and non-target across trials diverges from 0, as well as distractor-initial shift analysis used in previous studies (e.g. Fernald, Zangl, Portillo, & Marchman, 2008). Accuracy was measured as fixation time to the target video as a proportion of total time spent on either target or non-target/distractor video, averaged over a specific window (see below) from target word onset across all trials.

a. Divergence analysis for processing efficiency

For each participant, the proportion of looking time spent on the target and the non-target across all test trials were calculated for each frame of the video. The mean proportion looking to the target vs. non-target was plotted for each age group, as shown in Figure 3.3.

As is apparent in Figure 3.3, the fixation proportions for the target began diverging from the distractor at different points across the three age groups. A paired *t*-test showed the significant difference between the proportion looking to target and non-target beginning at 400 ms for adults, 1833ms for 5- to 6-year-olds and 933 ms for 28- to 30-month-olds, $p < .05$. This result indicated that adults fixated on the target earlier than children and toddlers.

b. Distractor-initial shifts analysis on processing efficiency

Another measure of efficiency was calculated as the mean response latency to shift to the correct referent. This analysis followed methods used in previous studies and was based on those trials where the participants started out on the distractor (Fernald, Zangl, Portillo, & Marchman, 2008). However, for this measurement, there is an assumption that the first look at the target vs. non-target makes a difference and that participants understand target words such that they tend to shift to the correct referent if they initially fixate on the distractor. Otherwise, if participants are not able to identify the meaning of target words, the first look duration may not show a difference between those who start out on the target vs. the distractor.

For adults, the comparison of first look duration by first look direction showed a significant difference, $p < .05$. In those trials for which adults started out at the target, the mean fixation duration was 1132 ms (*SD*=1537 ms), whereas in those trials where adults started at the distractor, the mean fixation duration was 485 ms (*SD* = 472 ms). Adults shifted away from the distractor significantly faster than from the target; this indicates that adults were able to recognize the target words, which demonstrates the validity of an efficiency measurement.

Previous literature also argued that a shift prior to 200-400 ms should be excluded due to initial eye mobilization, and specific cutoffs varied by age, with shorter intervals used with adults and older infants (Fernald & Hurtado, 2006; Tanenhaus, Magnuson, Dahan, & Chambers, 2000; Zangl & Fernald, 2007). In most studies conducted in Fernald's lab on early language comprehension, 300 ms was used for older infants (24-36 months). Since no study, to my knowledge, has examined a reasonable cutoff for video stimuli, I used 400 ms as an estimate for adults based on the mean duration of first distractor-initial looks as well as the time point when the proportion looking to target vs. non-target started to diverge. In addition to excluding very short latencies from the response latency analysis, it is also important to exclude very long latencies that are also unlikely to be in response to the target word (Fernald, Zangl, Portillo,& Marchman,2008). Based on the distribution of the first shift, adults shifted their eyes before 1400 ms in over 95% of the trials, thus shifting after 1400 ms was excluded as suggested by Fernald et al. (2008) that outliers of greater than 2 SD above the mean of the distribution were not included. Such a cutoff for window offset is also reasonable because it is consistent with adults' explicit behaviors, since the mean reaction time for making a choice by pressing buttons was around 1700 ms.

Based on the above factors, eye movements faster than 400 ms and slower than 1400 ms were excluded from the shift analyses on processing efficiency. Results showed that the mean latency for adults to respond to target words within a 400-1400 ms window is 770 ms (*SD* = 351 ms), which was adults' processing efficiency in this second word learning approach.

For 5- to 6-year-old children, the comparison of first look duration by first look direction did not show a significant difference. In those trials in which children started at the target, the mean fixation duration was 647 ms (*SD* = 1020 ms), whereas in those trials where children started at the distractor, the mean fixation duration was 632 ms (*SD* = 852 ms). Therefore, an efficiency measurement based on the distractor-initial trials was not valid for this this age group.

For 28- to 30-month-old toddlers, the comparison of first look duration by first look direction showed a significant difference, $p < .05$. Specifically, in those trials in which toddlers started out at the target, the mean fixation duration was 1334 ms (*SD*

= 1506 ms), whereas in those trials where toddlers started out at the distractor, the mean fixation duration was 950 ms (*SD* = 1067 ms). Toddlers shifted away from the distractor significantly faster than from the target; this indicates that toddlers were able to recognize the target words, which justifies the validity of an efficiency measurement. As the distractor-initial analyses on processing-efficiency for adults, eye shifts earlier than 400 ms were excluded. The distribution of the first look duration revealed that toddlers shifted their first look before 2700 ms on 95% of the distractor-initial trials, thus any shift after 2700 ms was considered as outliners. Results showed that the mean latency for toddlers to respond to target words within a 400-2700 ms window is 893 ms (*SD* = 471 ms).

c. Accuracy

Accuracy was measured as fixation time to the target video as a proportion of total time spent on either target or distractor video, averaged over a specific window from target word onset across all trials. For adults, fixation time to the target video as a proportion of total time spent on either target or distractor video was averaged over the window 400-1400 ms from target word onset. Results showed the mean looking behavior accuracy of adults who were taught second language words in the "translation" approach was 64.1% (*SD* = 12.0%). A One-sample t test revealed a significant difference from chance level, $ts(23) = 5.77$, $p < .01$. For 5- to 6-year-old children, the same time window as processing efficiency analysis was used (between 900 ms and 1900 ms). Results showed the mean looking behavior accuracy of children who were taught second language words in the “translation” approach was 49.3% (*SD* = 10.7%). No difference was found from the chance level. In terms of accuracy for toddlers, the decision for time window was made based on several considerations. Overall, the mean latency for the first eye mobilization from target word onset was around 1200 ms, regardless of where they started out. In addition, the proportion looking to target vs. non-target began to diverge at around 900 ms. Furthermore, another study conducted in our lab using similar video stimuli associated with familiar English speech (e.g. “Look, Po’s got a book”) found that 24- to 36-month-old toddlers who started out at the distractor shifted their first look to the target at around 900 ms (Tardif, Chen, & Kessler, in preparation). This finding provided the evidence that it may take around 900 ms for toddlers to initially process this complex video stimulus even though they had no problem understanding the speech and identifying the target side. Taking this information together, it is reasonable to use 900 ms as the onset of time window in the current study. In order to be consistent with the window durations (1000 ms) used for adults and 5- to 6-year-olds, as well as the arguments in previous literature (Fernald & Hurtado, 2006; Fernald, Zangl, Portillo, & Marchman, 2008; Swingley & Aslin, 2000), the window offset was decided to be 1900 ms. Such window-onset selection was also consistent with toddler’s mean response latency to shift to the target. Results showed the mean looking behavior accuracy of toddlers who were taught second language words in the “translation” approach was 54.1% (*SD* = 12.0%). No difference was found from the chance level.

Figure 3.4 shows an overview of the changes in fixation on the target side at each frame (33-ms interval) by learners of different ages. With all three age groups, Univariate ANOVA found a significant difference between learners of different ages in their implicit accuracy, $F(2,61) = 9.44$, $p < .01$, $\eta_p^2 = .236$. Pairwise comparisons further revealed that adults performed more accurately than both 5- to 6-year-old children and toddlers, $p < .01$, which is consistent with the accuracy measurement for explicit responses. However, no difference was found between toddlers and 5- to 6-year-old children.

In conclusion, providing translation equivalents did not work equally well for learners of all age groups and only adults were able to successfully map a word embedded in a second language speech stream to its referent with short training exposure.

Chapter 4: Study 2: Is mere exposure to second language without translation effective

Given the evidence from Study 1 that translation may interfere with second language word learning, the current study further examined the effectiveness of an alternative exposure approach---immersion (second language only). The immersion approach is commonly used now with younger children in long-term classroom-based second language programs, as discussed in Chapter 2. However, there is very little research on it effectiveness for short-term vocabulary learning. Study 2 further examines if mere exposure to natural second language input without translation, with a single event context, is effective for short-term second language word learning.

Methods

Participants

This study included typically-developing monolingual English speakers in three age groups: 20 toddlers (28-30 months), 20 school-aged children (5-6 years) and 24 college students. There were 7 additional toddlers, 2 additional 5- to 6-year-olds and 4 additional adults who participated in the study but were excluded from the final analysis due to equipment error (adult: N=4; children: N=1; toddler: N=1), fussiness over more than half of the trials (toddler: N=4), bilingual (children: N=1) and low vocabulary in L1 (MacArthur Bates Communicative Development Inventories (MCDI) score lower than 5% percentile) (toddler: N=2).

Video Stimuli

The visual stimuli were composed of a set of digitized video recordings, each presenting a *Teletubby* character (Po), who had been introduced during the familiarization play phase, performing an action on an object. All of the actions and objects used in the study were familiar to children of these ages. Each event took five seconds to complete. The objects used for teaching the four target nouns were “book,” “ball,” “block” and “apple.” These four target words were chosen from the MacArthur Bates Communicative Development Inventories (Fenson, et al., 1994) and were of high frequency for early comprehension and production in the native language.

Audio Stimuli

The audio stimuli were full sentences spoken in Mandarin Chinese. As with Kuhl’s study (2009), the target words were embedded in different Mandarin carrier phrases (see Appendix B for a full list of the phases). Target words consisted of two monosyllabic and two bi-syllabic words, with one monosyllabic word grouped with one bi-syllabic word within a block, in order to minimize phonetic confusion because infants have difficulty forming word-object associations when presented with novel words with minimal phonological contrasts (Stager & Werker, 1997). Specifically, “ping2guo3” (apple) and “shu1” (book) were grouped together, and “ji1mu4” (block) and “qiu2” (ball) were grouped together. All the audio stimuli were recorded in infant-directed speech by a female native Mandarin speaker.

Design and Procedure

The overall procedure was identical to that described in Chapter 3 for Study 1, except that the stimuli presented during the training phase was only in Mandarin. All the trials during the testing phase were identical to Study 1.

Results

Explicit behaviors

As with Study 1, for adults and 5- to 6-year-olds, the response and reaction time data was collected by *PsyScope* software when they pressed a button or pointed to indicate choices. Accuracy was averaged across 16 test trials for each subject and reaction time was examined only for the correct trials. The overall accuracy of adults was 92.9% (*SD* = 10.2%), whereas the overall accuracy of older children was 64.9% (*SD* = 23.3%), with no difference between 4 repetitions vs. 8 repetitions for both age groups, as shown in Figure 4.1. A one-sample *t*-test revealed that response accuracy was significantly higher than chance level (0.5) for both children, $ts(19) = 2.86$, $p < .05$ and adults, $ts(23) = 20.69$, $p < .01$, indicating that both adults and 5- to 6-year-olds performed better than at chance when learning words in a second language even with a very short exposure time to the language. An ANOVA test was conducted to examine the effect of age, showing that the accuracy of adults was significantly higher than that of children, $F(1,42) = 28.28$, $p < .01$, $\eta_p^2 = .402$, regardless of the number of repetitions or overall performance.

However, a repeated-measures ANOVA found the effect of repetition, $F(1,41) = 25.26$, $p < .01$, $\eta_p^2 = .38$, and age, $F(1,41) = 14.24$, $p < .01$, $\eta_p^2 = .258$, for reaction time, with no interaction. In particular, adults (*M* = 1693 ms, *SD* = 613 ms) responded faster than children (*M* = 2627 ms, *SD* = 993 ms) on the correct trials; both age groups responded faster with 8 repetitions than 4 repetitions, as shown in Figure 4.2.

Implicit behaviors

As in Study 1, implicit looking behaviors were analyzed in terms of processing efficiency and accuracy. Processing efficiency was examined with divergence analysis, namely, when the difference score between proportion looking to target and non-target across trials diverged from 0, as well as distractor-initial shift analysis used in previous studies (e.g. Fernald, Zangl, Portillo, & Marchman, 2008). Accuracy was measured by fixation time to the target video as a proportion of total time spent on either target or distractor video, averaged over a specific window from target word onset across all trials.

a. Divergence analysis for processing efficiency

For each participant, the proportion looking time spent on the target and the non-target across all the test trials was calculated at each time frame. The mean proportion looking to the target vs. non-target was plotted for each age group, as shown in Figure 4.3.

As is apparent in Figure 4.3, the fixation proportions for the target began diverging from the distractor earlier for adults than for 5- to 6-year-old children and toddlers. A paired *t*-test shows the significant difference between the proportion looking to target and non-target beginning from 400 ms for adults, $p < .05$, 900 ms (but shortly ending and then again starting at 1833 ms) for 5- to 6-year-olds, $p < .05$, and 833 ms for 28- to 30-month-olds, $p < .05$. This result indicates that adults fixated on the target earlier and longer than children and toddlers.

b. Distractor-initial shifts analysis of processing efficiency

As with Study 1, another calculation of efficiency was measured through the mean response latency to shift to the correct referent which followed the methods used in previous studies and was based on those trials where the participants started out on the distractor (e.g. Fernald, Zangl, Portillo, & Marchman, 2008). However, for this measurement, there is an assumption that the first look to the target vs. non-target makes a difference and that participants understand target words such that they tend to shift to the correct referent if they initially fixate on the distractor. Otherwise, if participants are not able to identify the target words, the first look duration may not make a difference between those who start out on the target vs. the distractor.

For adults, the comparison of first look duration by first look direction with a *t*-test showed a significant difference for adults, $p < .05$. For those trials in which adults started out at the target, the mean fixation duration is 914 ms (*SD* = 1116 ms), whereas for those trials in which adults started out at the distractor, the mean fixation duration is 442 ms (*SD* = 428 ms). Since adults shifted away from the distractor significantly faster than from the target, this result indicates that adults are able to recognize the target words, which justifies the validity of an efficiency measurement. As with Study 1, I excluded very short latencies and very long latencies that are also unlikely to be in response to the target word (< 400 ms or > 1400 ms as described in Study 1) from the response latency analysis. Results show that the mean latency for adults to respond to target words within a 400-1400 ms window is 625ms (*SD* = 274 ms). For 5- to 6-year-old children and 28- to 30-month-old toddlers, the comparison of first look duration by first look direction did not show a significant difference. Therefore, the efficiency measurement based on the distractor-initial trials was not valid.

c. Accuracy

Figure 4.4 shows dynamic looking patterns of learners of different ages across time (33-ms interval). For adults, accuracy was measured as fixation time to the target video as a proportion of total time spent on either target or distractor video, averaged over a 400–1400 ms time window from target word onset across all trials. Results show the mean looking behavior accuracy of adults who were taught second language words in the “single context” approach was 64.3% (*SD* = .10.6%). A one-sample *t*-test revealed a significant difference from chance level, *t*s(23) = 6.58, $p < .01$. For 5- to 6-year-olds, accuracy was calculated based on the 900-1900 ms time window, as Study 1. Results show that the mean looking behavior accuracy of 5- to 6-year-old children who were taught second language words in the “single context” approach was 56.4% (*SD* = 12.5%). A one-sample *t*-test revealed a significant difference from chance level, *t*s(19) = 2.27, $p < .05$. For 28- to 30-month-old toddlers, the 900-1900 ms time window was used as Study 1. Results show the mean looking behavior accuracy of toddlers who were taught second language words in the “single context” approach was 59.4% (*SD* = 9.9%). A one-sample *t*-test reveals a significant difference from chance level, *ts* (19) = 4.26, $p < .01$.

A Univariate ANOVA with age group as the between-subject variable found a marginally significant difference between learners of different ages, $F(2,61) = 2.92$, $p = .062$, $\eta_p^2 = .087$. Pairwise comparisons further revealed that adults performed more accurately than 5- to 6-year-old children, $p < .05$, which is consistent with the accuracy measurement for explicit responses. However, no difference was found between adults and toddlers, or between toddlers and 5- to 6-year-old children.

In conclusion, although adults performed more accurately and efficiently than children, 5- to 6-year-old children, and even toddlers, were able to successfully map a word embedded in a second language speech stream to its referent with very short training exposures which only included the natural second language inputs without any native language translation.

Chapter 5: Study 3: Does providing multiple contexts help with word learning in a second language?

Study 3 was also based on the “immersion” approach, as was study 2; however, in contrast to study 2, multiple situations/contexts, rather than a single context, were provided. This study stemmed from the cross-situational learning paradigm to examine word learning, which results in good word learning for first language acquisition. Several previous studies have shown that multiple examples help children learn subordinate or superordinate category labels (Callanan, 1985, 1989; Liu, Golinkoff, & Sak, 2001; Waxman & Kosowski, 1990). For instance, showing a dog, a horse and a cow as examples of “animals” results in better learning than showing just a cow for 4- and 5-year-old children (Liu, et al., 2001), and these additional exemplars could help rule out compelling alternative hypotheses (Xu & Tenenbaum, 2007). In terms of basic-level labels, infants are sensitive to the co-occurrence frequency of a word-object pairing that appears in different situations (i.e. more than one object in a given situation) and rapidly learn the mappings (Smith & Yu, 2008). In addition, children who experience varied events (i.e. a specific action on multiple objects) are more likely to extend novel words to the target actions by using a comparison process to induce consistency across situations (Childers & Paik, 2009).

However, Maguire et al. (2008) tested 2- and 3-year-olds' ability to extend a novel verb after viewing the repetition of one novel actor compared to four different actors performing a novel action. Both ages were better at learning and extending a novel verb to a novel actor when shown only one actor rather than four different actors (Maguire, et al., 2008). The present dissertation study further examines whether providing multiple actions with a specific object facilitates word learning in a second language.

In summary, the current study was designed based on the evidence that both adults and infants can use statistical information across multiple situations to learn word-object mappings (Smith & Yu, 2008; Yu & Ballard, 2007) and extends the method of the "cross-situational learning" paradigm onto foreign word learning with some modifications. Rather than varying the number of objects (i.e. Childers & Paik, 2009) or actors (i.e. Maguire et al., 2008), this study involves four actions performed on a specific object, compared with one action performed on a specific object in study 2. In other words, multiple situations here refer to different actions on a specific object across situations, rather than a specific object appearing with other competing objects in different situations (i.e. Smith & Yu, 2008; Yu & Ballard, 2007).

Methods

Participants

Similarly to Study 1 and 2, Study 3 also includes typically developing monolingual English speakers within three age groups: 20 toddlers (28-30 months), 20 school-aged children (5-6 years) and 24 college students. There were 1 additional toddler and 3 additional 5- to 6-year-old children who participated in the study but were excluded from the final analysis due to equipment error (children: N=1) and fussiness over more than half of the trials (children: N=2; toddler: N=1).

Stimuli

Dynamic scenes with Po performing an action on an object were also used here. Rather than being presented in a single action context, each object in Study 3 was shown with four different actions. The objects used for teaching the four target nouns were “book,” “ball,” “block” and “apple” and the actions were “biting,” “blowing,” “pushing” and “touching.” All of the accompanying audio was the same as that used in Study 2.

Design and procedure

This experiment was also conducted by using a modified version of the looking-while-listening paradigm (LWL), as in Study 1 and 2. However, instead of presenting identical scenes for a given target object, each target object was introduced in four different contexts, in which different actions were performed on the same object. All equipment and the general procedures were also the same as the previous studies.

Results

Explicit behaviors

For adults and 5- to 6-year-olds, response and reaction time data was collected by *PsyScope* software when they pressed a button or pointed to indicate choices. Accuracy was averaged across 16 test trials for each subject and reaction time was examined only for the correct trials. The overall accuracy of adults was 88.0% (*SD* = 12.8%), whereas the overall accuracy of older children was 57.5% (*SD* = 21.3%), as shown in Figure 5.1. In contrast to study 2, a one-sample *t*-test revealed that response accuracy was significantly higher than 0.5, *ts*(23) = 14.60, $p < .01$, for adults but not 5- to 6-year-old children. A repeated-measures ANOVA with age as the between-subject variable and number of repetitions as the within-subject variable found the effect of age, $F(1,42) = 34.09$, $p < .01$, $\eta_p^2 = .448$, as well as the interaction between age and repetition times, $F(1,42) = 9.53$, $p < .01$, $\eta_p^2 = .185$. As in Study 1 and Study 2, no main effect of repetition times was found. In terms of reaction time, however, a repeated-measures ANOVA found the effect of repetition, $F(1,41) = 29.05$, $p < .01$, $\eta_p^2 = .415$, and age ($F(1,41) = 29.91$, $p < .01$, $\eta_p^2 =.422$, for reaction time, with no interaction. Specifically, adults responded faster than children on the correct trials; for both age groups, they responded faster with 8 repetitions than 4 repetitions, which was similar to Study 1 and Study 2, as shown in Figure 5.2.

Implicit behaviors

As in Study 1 and Study 2, implicit looking behaviors were analyzed in terms of processing efficiency and accuracy. Processing efficiency was examined with both divergence analysis and distractor-initial shifts analysis which followed the methods used in previous studies and was based on those trials where the participants started out on the distractor (e.g. Fernald, Zangl, Portillo, & Marchman, 2008). Accuracy was measured as fixation time to the target video as a proportion of total time spent on either target or distractor video, averaged over a specific window from target word onset across all trials. Both processing efficiency and accuracy were measured based on the specific window.

a. Divergence analysis for processing efficiency

For each participant, the proportion looking time spent on the target and the non-target across all test trials was calculated at each time frame. The mean proportion looking to the target vs. non-target was plotted for each age group, as shown in Figure 5.3.

As is apparent in Figure 5.3, the fixation proportions for the target began diverging from the distractor differently among different age groups. A paired *t*-test showed a significant difference between the proportion looking to target and non-target beginning from 400 ms for adults, 933 ms for 5- to 6-year olds and 2300 ms for 28- to 30-month-olds, $p < .05$. This result indicates that adults fixated on the target earlier and longer than did children and toddlers.

b. Distractor-initial shifts analysis of processing efficiency

As in Study 1 and Study 2, another calculation of efficiency was measured as the mean response latency to shift to the correct referent which followed the methods used in previous studies and was based on those trials where the participants started out on the distractor (e.g. Fernald, Zangl, Portillo, & Marchman, 2008). This measurement was based on an assumption that the first look to the target vs. non-target makes a difference and that participants understand target words such that they tend to shift to the correct referent if they initially fixate on the distractor. Otherwise, if participants are not able to identify the target words, the first look duration may not show a difference between those who start out on the target vs. distractor.

For adults, the comparison of first look duration by first look direction showed a significant difference, $p < .05$. For those trials in which adults started out at the target, the mean fixation duration is 1020 ms (*SD* = 1259 ms), whereas for those trials in which adults started out at the distractor, the mean fixation duration is 504 ms (*SD* = 420 ms). Since adults shifted away from the distractor significantly faster than from the target, this result indicates that adults are able to recognize the target words, which justifies the validity of an efficiency measurement. Based on the same justification as study 1 (although the specific time point varied-- I used the same window across studies in order to be comparable), responses occurring prior to 400 ms and after 1400 ms were excluded. Results show that the mean latency for adults to respond to target words within the 400-1400 ms window is 701 ms (*SD* = 315 ms). Similar to study 2, the comparison of first look duration by first look direction did not show a significant difference for 5- to 6-year-old children and toddlers. Therefore, the efficiency measurement based on the distractor-initial trials was not valid.

c. Accuracy

Figure 5.4 shows an overview of the changes of fixation on the target side at each frame (33-ms interval) by learners of different ages. Results show the mean looking behavior accuracy of adults who were taught second language words in the "multiple contexts" approach was 60.9% (*SD* = 9.8%). A one-sample *t*-test revealed a significant difference from chance level, *ts*(23) = 5.420, $p < .01$. For 5- to 6-year-old children, a time window between 900 ms and 1900 ms was used as in Study 1 and Study 2. Results show the mean looking behavior accuracy of children who were taught second language words in the "multiple contexts" approach was 52.1% (*SD* = 7.8%). No difference was found from the chance level. For 28- to 30-month-old toddlers, accuracy was calculated within a 900 ms-1900 ms window, as in Study 1 and Study 2. Results show the mean looking behavior accuracy of toddlers who were taught second language words in the "multiple contexts" approach was 47.4% (*SD* = 12.7%). No difference was found from the chance level.

In terms of implicit accuracy, a univariate ANOVA with age group as the between-subject variable found a significant difference between learners of different ages, $F(2,61) = 9.83$, $p < .01$, $\eta_p^2 = .244$. Pairwise comparisons further revealed that adults performed more accurately than both 5- to 6-year-old children and toddlers, $p < .01$, which is consistent with the accuracy measurement for explicit responses. However, no difference was found between toddlers and 5- to 6-year-old children.

In conclusion, although the immersion approach worked well for young children to fast-map words from a second language to references in a short term learning situation, providing too much information such as changing contexts may confuse young learners, but not adults.

Chapter 6: Aggregate analysis of three exposure approaches

In order to directly compare the effect of different exposure approaches on second language word learning across different age groups, an aggregate analysis was conducted on a total of 192 subjects. The data analysis was comprised of two main parts: explicit response behaviors and looking behaviors. Table 6.1 shows descriptive statistics for all of the measurements.

Similar to the individual analyses of each study, the button-pressing behavior of adults and the pointing behavior of 5- to 6-year-old children were compared across different exposure approaches to examine the interaction between age and exposure approach for learning words from a second language.

With the learners in all age groups, the looking time dynamics were examined in four ways: first, the total fixation time spent on the screen during the training phase was calculated and compared among each exposure approach to exclude the possibility of low attention during training exposures. Secondly, the processing efficiency was compared among age groups and exposure approaches. The processing efficiency was considered in two ways: first, it was based on divergence analysis which measured when the divergence between the proportions looking to target vs. non-target begins. The difference score between proportion looking to target and non-target across trials for each subject was calculated. One sample *t*-test with Bonferroni corrections were conducted from target word onset, which revealed the time point at which the difference score began to significantly diverge from "0." With the divergence analysis, we can compare how early and how long the learners fixated on the target across the different exposure approaches and age groups; second, based on the efficiency analysis in Fernald's lab, the mean response latency to shift to the correct referent based on those trials where the participants started out on the distractor was calculated. The individual analyses for each study found that only adults showed significant differences in the first look duration between target-initial and distractor-initial trials under all three exposure approaches, thus we only compared the processing efficiency (under the second definition) of second language word learning among different exposure approaches for adults. Third, the accuracy, defined as total looking time to the target side as a proportion of total time spent on either target or distracter side, was calculated both within the target window and for a baseline window. The baseline window began 600 ms prior to target word onset (the average duration of carrier phrases before target word onset was around 800 ms) and ended 400 ms after target word onset (-600 ms to +400 ms) with a 1000 ms interval, and the target window varies by age groups based on the pervious individual analysis. A repeated-measures ANOVA with "time window" as a within-subject variable and "age" and "exposure approach" as between-subject variables was conducted to examine the effect of age and exposure approach on looking behavior in response to target words. In addition to exposure approach, the effect of testing condition was also examined to further understand the performance on word recognition in different contexts.

Finally, the relationship between second language word learning and L1 vocabulary as well as other general cognitive capacities was explored. Specifically, the correlation between the accuracy of second language word learning (both looking behavior and explicit response behavior), scores on the CDI (toddlers), K-BIT verbal and non-verbal IQ (5- to 6-year-olds and adults), working memory (5- to 6-year-olds and adults) and foreign language aptitude (adults) was conducted. In addition, the scores for L1 vocabulary and cognitive capacities were median-split in order to examine the difference between high and low groups in second language word learning.

I. Explicit response behavior across three exposure approaches

For overall accuracy and reaction time, an ANOVA was conducted with age group and exposure approach as between-subject variables. In addition, a repeated-measures ANOVA was also conducted to examine the effect of repetition by age and exposure approach. Results showed the main effect of age, $F(1,126) = 125.76$, $p < .01$, $\eta_p^2 = .500$, and exposure approach, $F(2,126) = 4.66$, $p < .05$, $\eta_p^2 = .069$, for accuracy but only the effect of age, $F(1,124) = 62.87$, $p < .01$, $\eta_p^2 = .336$, for reaction time. Adults responded more accurately and more quickly than children. In addition, pairwise comparisons revealed that children performed significantly better in the “single context” approach than in the “translation” approach. No difference was found between “single context” and “multiple contexts”, as shown in Figure 6.1. This result indicates that providing translations interferes with children’s performance in second language learning. There was no difference in adults' accuracy across different exposure approaches and no difference in reaction time across different exposure approaches both for adults and children.

Furthermore, the repeated-measures ANOVA showed a difference in the effect of exposure approach on the accuracy between 4 repetitions and 8 repetitions, only for children. In particular, with 4 repetitions, children performed significantly better in “single context” and “multiple contexts” than in “translation”, $p < .01$, whereas with 8 repetitions, children performed significantly better in “single context” than in “translation”, $p < .05$, but no difference was found between “multiple contexts” and “translation”, as shown in Figure 6.2. Regarding reaction time, results found the main effect of repetition, which was consistent with individual analysis. The difference across exposure approaches was found only for adults with 4 repetitions, $p < .05$. Specifically, adults responded faster when they were taught second language words with “single context” approach than with “translation” approach after 4 repetitions as shown in Figure 6.3.

In addition to the exposure approaches, it is interesting to examine performance by testing condition. In particular, each target object was tested in both familiar and novel contexts (associated with same or different actions from the training phase), as well as contrasted with both familiar and novel objects (the distractor on the other side was either the object from the training phase or not). A repeated-measures ANOVA for response accuracy was conducted with the test conditions as a within-subject variable (4 levels: familiar context-familiar contrast, familiar context-novel contrast, novel context-familiar contrast, novel context-novel contrast), and exposure approaches and age as between-subject variables. Results showed the main effect of test condition, $F(3,378) = 3.19$, $p < .05$, $\eta_p^2 = .025$, age, $F(1,126) = 115.68$, $p < .01$, $\eta_p^2 = .479$, exposure approaches, $F(2,126) = 3.93$, $p < .05$, $\eta_p^2 = .059$, as well as the interaction between test condition and age group, $F(3,378) = 4.739$, $p < .01$, $\eta_p^2 = .036$. The pairwise comparisons further revealed that 5- to 6-year-old children performed better in "single context" than "translation" only under "familiar context-familiar contrast" and "familiar context-novel contrast" test trials. In addition, 5- to 6-year-old children performed better in "familiar context-novel contrast" and "novel context-familiar contrast" than "novel context-novel contrast" with "single context" and "translation" approaches, $p < .05$; in the "multiple contexts" approach, their accuracy in "familiar context-novel contrast" was significantly higher than all the other test conditions, $p < .05$, as shown in Figure 6.4. No difference was found in test conditions for adults.

Similar to the accuracy analysis, a repeated-measures ANOVA was also conducted for reaction time. Results showed the main effect of test condition, $F(3,333) = 11.53$, $p < .01$, $\eta_p^2 = .094$, and age, $F(1,111) = 10.98$, $p < .01$, $\eta_p^2 = .090$, as well as the interaction between test condition and age group, $F(3,333) = 6.96$, $p < .01$, $\eta_p^2 = .059$. The pairwise comparisons further revealed that 5- to 6-year-old children responded faster in "single context" than "multiple contexts" and "translation" only under "familiar context-familiar contrast" test trials, $p < .05$. In addition, 5- to 6-year-old children responded faster in "novel context-novel contrast" than "familiar context-novel contrast" and "novel context-familiar contrast" with "single context" approach, $p < .05$; they responded faster in "novel context-novel contrast" than all the other test conditions with the "translation" approach, $p < .05$; and they responded faster in " novel context-novel contrast" and "novel context-familiar contrast" than "familiar context-familiar contrast" and "familiar context-novel contrast" in "multiple contexts" approach, $p < .05$, as shown in Figure 6.5. No difference was found in test conditions for adults.

II. Implicit looking behavior across three exposure approaches

First, the total fixation time spent on the screen during the training phase was calculated and compared across each exposure approach to exclude the possibility of low attention. The mean proportion of fixation on the stimuli was 97.8% for adults, 94.8% for 5- to 6-year-old children, and 86.5% for toddlers. An ANOVA was conducted with exposure approach and age group as the independent variables. Results showed that adults allocated more attention to the task than older children, $p < .05$, and older children allocated more attention to the task than toddlers, $p < .01$. However, there were no differences in attention during the training phase among exposure approaches for adults and 5- to 6-year-old children, although the toddlers who were exposed to the "single context" approach (M = 80.4%, SD = 14.1%) spent less time focusing on the task than those who were exposed to "multiple contexts" (M = 87.4%, SD = 10.8%) and "translation" (M = 91.6%, SD = 7.3%), $p < .01$, from the pairwise comparisons.

Second, for each subject at each time point, the difference score between proportion looking to target and non-target across trials was calculated to compare the processing efficiency. As was apparent in the divergence graphs, as shown in Figure 6.6, the difference score began to diverge from “0” at around 400 ms in all three exposure approaches for adults; the difference score began to diverge from “0” at around 900 ms in the “single context” approach and the “multiple context” approach, and around 1800 ms in the “translation context” for 5- to 6-year-old children; the difference score began to diverge from “0” at around 900 ms in the “single context” approach and “translation context,” and around 2300 ms in the “multiple context” approach for 28- to 30-month-old toddlers. Further *t*-tests with Bonferroni corrections were conducted for each exposure approach with each age group. Specifically, multiple *t*-test comparisons at ten frames around the divergence point were corrected by multiplying *p* value by 10. It found the significant time frame for adults at 467 ms in “single context”, $ts(23) = 3.58$, $p^{corrected} < .05$, and 567 ms in “multiple contexts”, $ts(23) = 3.23$, $p^{corrected} < .05$) and “translation”, $ts(23) = 3.14$, $p^{corrected} < .05$; and it found significant time frame for 28- to 30-month-old toddlers at 1100 ms in “single context” approach, $ts(19) = 3.53$, $p^{corrected} < .05$. No significant differences were found with the corrected p-value for 5- to 6-year-old children in any exposure approaches or for toddlers in the “multiple contexts” and “translation” approaches. The results indicate that adults fixated on the target referent faster than children (5- to 6-year-olds and toddlers). In addition, 28- to 30-month-old toddlers fixated on the target referent faster in the “single context” than in “multiple contexts” and “translation” approaches. Finally, in order to examine the processing efficiency under the Fernald lab's definition, an ANOVA was conducted with exposure approach as the independent variable and mean response latency to shift to correct referents as the dependent variable. Results showed a significant effect of exposure approach, $p < .05$; in particular, adults were significantly faster to respond to target words taught in the "single context" approach (M = 906 ms, SD = 170 ms) than those taught in the "translation" approach (M = 1034 ms, SD = 172 ms).

Third, the accuracy of looking behavior was compared among different exposure approaches and age groups. A repeated-measures ANOVA with "time window" (baseline vs. target window) as the within-subject variable and "age" and "exposure approach" as between-subject variables was conducted to examine the effect of age and exposure approach on looking behavior in response to target words. The baseline window began at 600 ms prior to target word onset (the average duration of carrier phrases before target word onset was around 800 ms) and ended 400 ms after target word onset (-600 ms to +400 ms). The target window varied by age groups based on the previous individual analysis. In order to further justify the window selection for each age group for comparison of accuracy among different exposure approaches, I re-analyzed the looking behavior data by collapsing the three exposure approaches.

First of all, the difference score between the proportions looking to target vs. non-target were calculated for each age group. Figure 6.7 shows that across three exposure approaches, the proportion looking to target vs. non-target began to diverge at around 400 ms for adults, and around 900 ms for 5- to 6-year-old children and 28- to 30-month-old toddlers.

In addition, the proportion looking to target across time course was divided by the explicit response behavior. If looking behavior is a reliable measurement for word knowledge, we expect to see the divergence of fixation proportion on the target side between those trials in which learners make the correct response vs. incorrect response. Results showed that for adults, such a difference in the proportion looking to the target side between those who made the correct response and those who made the incorrect response began at around 600 ms; for 5- to 6-year-old children, such a difference in the proportion looking to the target side between those who made the correct response and those who made the incorrect response began at around 900 ms, as shown in Figure 6.8.

Previous research on early word learning using the visual fixation method established a ‘window’ of time during which fixation response or accuracy were examined beginning around 300 ms after the onset of the target word in order to allow the mobilization of eye movement and it has been generally acknowledged that the lower bound of 300-400 ms is an ‘educated guess” (Swingley & Aslin, 2000; Swingley, Pinto & Fernald, 1999). As Fernald et al. (2008) suggested, the determination of appropriate window onset may vary somewhat from study to study, depending on the experimental question and the age of children in the study. In eye-tracking studies with participants of different ages, this cutoff has varied from 200– 400 ms with shorter intervals for adults and older toddlers (Bailey & Plunkett, 2002; Ballem & Plunkett, 2005; Fernald & Hurtado, 2006, Tanenhaus, Magnuson, Dahan, & Chambers, 2000; Zangl & Fernald, 2007). However, all of the studies cited above use static pictures as the stimuli and dynamic video arguably requires more attention load and may require more time to initiate eye movements. Therefore, with the analysis above in current studies, it is reasonable to use 400 ms for adults and 900 ms for 5- to 6-year-old children and toddlers as the window onsets for calculating word learning accuracy with video stimuli.

Regarding the offset of the time window, previous research using static pictures has suggested that the few eye movements occurring after 2000 ms from the target word onset are usually spontaneous re-fixations unrelated to the spoken stimulus (Swingley & Aslin, 2000). Furthermore, in most studies conducted with static pictures in Fernald’s lab, 1500 ms was used as the window interval for accuracy calculation. In the current studies, the stimuli on both sides were dynamic videos which carried information changing over time. Participants were more likely to spend less time fixating on the target side and to shift earlier to the other side. Thus, the window offset used for current studies was set at 1400 ms for adults and 1900 ms for older children and toddlers, with 1000 ms as the interval for all groups. Furthermore, based on the reaction time for explicit responses, the mean reaction time was 1820 ms (*SD* = 636 ms) for adults and 2919 ms (*SD* = 940 ms) for 5- to 6-year-olds. Thus, it is reasonable to select approximately 1400 ms after target words onset for adults and 1900 ms after target words onset for children as the looking time window offset to take into account the muscle movement necessary to press the button or conduct the pointing behavior.

Last but not least, a correlation analysis between explicit response accuracy and implicit looking behavior accuracy was conducted. Results showed that the looking time accuracy within the target windows was significantly correlated with the explicit response accuracy, for both adults (Pearson correlation r = .43, $p < .01$) and 5- to 6-year-old children (Pearson correlation r = .49, $p < .01$).

To sum up, the target window for accuracy was selected as 400-1400 ms for adults and 900-1900 ms for 5- to 6-year-olds and 28- to 30-month-old toddlers. As was found through the individual analysis in previous chapters, the looking behavior accuracy of adults in second language word learning was significantly higher than chance level in all three exposure approaches. In contrast, the looking behavior accuracy of children (both 5- to 6-year-olds and 28- to 30-month-old toddlers) was significantly higher than chance level only in the "single context" approach. The proportion of looking time spent on the target during the baseline window was not significantly different from chance level under any age group or exposure approach. The repeated-measures ANOVA of accuracy with "time window" (baseline vs. target window), "age" and "exposure approach" was conducted to compare between accuracy during target and baseline windows; this analysis showed the looking behavior changes in response to the target words. Results found the main effect of time window, $F(1,183) = 36.25$, $p < .01$, $\eta_p^2 = .165$, and an interaction between age and time window, $F(2,183) = 7.82$, $p < .01$, $\eta_p^2 = .079$. The interaction between exposure approach and time window was marginally significant, $F(2,183) = 2.39$, $p = .094$, $\eta_p^2 = .025$. Further pairwise comparisons showed that the proportion of looking time spent on the target side was significantly higher during the target window than the baseline window in all three exposure approaches for adults. For 5- to 6-year-olds and toddlers, the proportion of looking time spent on target side was significant higher during the target window than the baseline window only when they were exposed to the "single context" exposure approach, $p < .05$, as shown in Figure 6.9.

This finding indicates that adults were able to recognize the target words and their shifted eyes to the correct referents after hearing the words regardless of exposure approach. School-aged children and even toddlers were able to learn words from a second language with only a short exposure time and shifted their eyes to the correct referents in response to the target words, but only when they were taught with the simple "immersion" approach (words were presented in "single context," with only Chinese speech). Further comparison of learning accuracy between exposure numbers (4 repetitions vs. 8 repetitions) was also conducted. The repeated-measures ANOVA for looking behavior accuracy during the target window found a difference between 8 exposures and 4 exposures, but only for adults who were in the "multiple contexts" condition, $p < .05$, as shown in Figure 6.10.

In addition to exposure approach, the effect of testing condition was also examined to further understand the performance on word recognition in different contexts. a repeated-measures ANOVA with test condition as within-subject variables (4 levels: familiar context-familiar contrast; familiar context-novel contrast; novel context-familiar contrast; novel context-novel contrast) found a main effect of test condition, age and exposure approach, $p < .05$. Overall, learners performed significantly better in the test trials under the “novel context-novel contrast” condition ($M = .605$) than in the test trials under the “familiar context-familiar contrast” ($M = .538$) and “familiar context-novel contrast” conditions, $p < .05$, ($M = .552$). The difference between “novel context-novel contrast” and “novel context-familiar contrast” ($M = .567$) was marginally significant, $p = .07$. Pairwise comparison further showed that adults performed significantly better in the “novel context-novel contrast” condition than the “novel context-familiar contrast” condition, but only in the “single context” approach, $p < .05$. No difference in test condition was found in other exposure approaches. The performance of toddlers in the “novel context-novel contrast” condition was significantly than the “familiar-context-familiar contrast” in both “single context” and “translation” approaches, $p < .05$, and also better than the “familiar context-novel contrast” condition in the “single context” approach, $p < .05$. Moreover, toddlers performed significantly better in the “novel context-familiar contrast “conditions than “familiar-context-familiar contrast” in the “single context” approach. For 5- to 6-year-old children, no difference between test conditions was found in any exposure approach as shown in Figure 6.11.

III. General cognitive capacities and second language learning

Is second language word learning performance correlated with learners’ cognitive capacities? As mentioned in previous chapters, I measured the knowledge of L1 vocabulary knowledge (K-BIT vocabulary scale), auditory working memory

(Woodcock-Johnson) and foreign language aptitude (Pimsleur Language Aptitude Battery, PLAB) for adults; vocabulary knowledge (K-BIT vocabulary scale), non-verbal intelligence (K-BIT Matrices subtest) and auditory working memory (Woodcock-Johnson) for 5- to 6-year old children and L1 vocabulary level (MCDI) for toddlers. First of all, there was no difference among the three approach groups on all the behavioral tests, except for adults on the working memory test. In particular, adults who were randomly exposed to Chinese target words through the "multiple contexts" approach received higher scores on the auditory working memory test than those who were in the "single context" and "translation" approaches from the pairwise comparisons, $p < .05$.

Secondly, the correlation between accuracy (both explicit and implicit) and the standard scores (z-score) on the behavioral tests was calculated. Results showed that, for adults, foreign language learning aptitude was significantly correlated with both the accuracy of explicit response ($r = .28$, $p < .05$) and the accuracy of implicit looking behavior ($r = .24$, $p < .05$). In addition, auditory working memory was significantly correlated with accuracy, but only for the implicit looking behavior ($r = .35$, $p < .01$). No correlation was found between reaction time and any cognitive task. Moreover, knowledge of English vocabulary was positively correlated with foreign language learning aptitude ($r = .44$, $p < .01$), suggesting that one's L1 vocabulary knowledge may be related with his/her aptitude in learning a second language (Birdsong, 2006; Hyltenstam & Abrahamsson, 2008; Prince, 1996). We didn't find a correlation between performance in the current second language learning situation and any general cognitive capacities measured (L1 vocabulary knowledge, non-verbal IQ, auditory working memory) for 5- to 6-year-old children, nor did we find any correlations between second language learning performance and L1 vocabulary scores for toddlers, as shown in Table 6.2.

In order to further examine the interaction between exposure approach for short-term second language learning and general cognitive capacities, a median-split on all behavior tasks was used to divide learners into high vs. low groups. An ANOVA was conducted with exposure approach and group as a fixed factor for each behavioral test. The only interaction found was for explicit reaction time with exposure approach and foreign language aptitude level for adults, $p < .05$, and implicit accuracy with exposure approach and non-verbal IQ for 5- to 6-year-olds, $p < .05$. In particular, adults with a high level of foreign language aptitude spent the longest time making their choice if translations were provided during the training, compared with other approaches; whereas those with low levels of foreign language aptitude spent the shortest time making their choice if translations were provided during the training, compared with other approaches, as shown in Figure 6.12. This finding was consistent with another study which revealed that weaker learners, compared with advanced learners, benefited more from translations (Prince, 1996). In addition, the ANOVA on the implicit accuracy with exposure approach and K-BIT non-verbal IQ group as independent variables found a marginally significant interaction between exposure approach and IQ level for 5- to 6-year-old children, $F(2, 54) = 2.72$, $p = .07$. A pairwise comparison was further conducted and found a difference between high and low IQ groups for 5- to 6-year-olds, but only in the “translation” approach, $p < .05$. Also, in the low IQ group, providing translations during second language word exposure interfered with learning performance, $p < .01$. Specifically, children who scored higher in a non-verbal IQ test performed more accurately than those who scored lower in a short-term second language word learning situation, when provided translations during the learning phase. Also, children with lower IQ scores performed worse in the “translation” approach than the “immersion” approach (both single context and multiple contexts) and no difference was found between “translation” and “immersion” conditions for children with higher IQ scores, as shown in Figure 6.13. One possible explanation for the effect of IQ on short-term second language learning could be the strategies children used during the recognition tests. Children in the higher IQ group were able to ignore the irrelevant information on the screen and exclude the wrong possibilities. For instance, during the tests in which a target was contrasted with a novel object, high IQ children may have adopted the exclusion strategy and ignored the distractor side. In this case, the results of the current studies may not reflect word learning, but general inductive reasoning capacity. In order to exclude this possibility, a repeated-measures ANOVA was conducted with exposure approach and IQ group as between-subject variables and test type as within-subject variable. Results showed that the effect of IQ score was only significant during the familiar-contrast tests when the objects in both sides appeared during the exposures. In particular, children with higher IQ performed better than those with lower IQ in the “translation” exposure approach only in familiar context-familiar contrast and novel context-familiar contrast tests. No difference was found between IQ group in “novel contrast” tests, which excluded the possibility that the better performance of higher IQ group in short-term second language word learning tests was attributed to their reasoning capacity and adopted exclusion strategy, as shown in Figure 6.14.

IV. Summary

In sum, adults responded more accurately and more quickly than children in both explicit and implicit measurements, regardless of exposure approach. Implicit looking behavior further revealed that adults were significantly faster to respond to target words taught in the “immersion-single context” approach than those taught in the “translation” approach, although no difference was found in accuracy among different exposure approaches. In addition, providing more exposure improved reaction time but not accuracy for adults, which could be attributed to the ceiling effect on adults’ performance. Children, however, indeed benefited from more exposures during the learning process and performed better with 8 repetitions than 4 repetitions. They also performed differently with different exposure approaches. In particular, both 5- to 6-year-old children and toddlers were able to successfully fast-map a Chinese word to its referent, but only if the word was taught solely in Chinese and presented in a simple action context. Moreover, providing translations interfered, with children’s performance on second language learning, but not with adults.

Furthermore, adults did not show different response patterns, no matter how targets were tested. Children, however, were sensitive to the testing situations and performed successfully only in the “easy” situation in which the target were not confused with the distractors. In particular, they performed better when the targets were contrasted with novel distractors that were not familiarized during training than with familiar distractors that appeared together with targets during training. Such findings may be attributed to the underdevelopment of executive functioning and memory capacity in children compared to adults. When both alternatives in a recognition task include familiar information, children are more likely to show interference effects for these distractors. This finding is consistent with literature on the development of false memories. For instance, according to fuzzy-trace theory (FTT), individuals store in memory two separate representations of events: namely, gist traces which preserve the meaning of the item, and verbatim traces which hold contextual item-specific information. Adults have more enduring verbatim memory for studied material than do younger children, and they can better use the retrieved correct information to edit out similar but non-studied distractors (e.g. Brianerd, Reyna, & Poole, 2000; Ghetti, Qin, & Goodman, 2002).

Finally, the foreign language learning aptitude of adults was significantly correlated with their performance in the current experimental studies. This finding further supports the reliability and validity of the experimental tests in examining second language word learning. School-aged children with different levels of non-verbal IQ scores performed differently when provided with translations.

Specifically, children who scored higher in the non-verbal IQ test performed more accurately than those who scored lower in a short-term second language word learning situation. The possibility that children with higher non-verbal IQ tended to use exclusion strategies during the recognition tests was excluded based on the analysis of testing types. Also, since all exposure approaches included exactly the same test trials, this difference might also be attributed to the processing strategy during training trials; children might have processed information differently when they were exposed to different training approaches. It is possible that translations might drive less attention away from second language inputs for high IQ children, and those children were able to focus on the association between target object and novel label in a second language, rather than the semantic meaning of sentences in their native language. This explanation was supported by the results showing that only children with lower IQ scores performed worse in the "translation" approach than in the "immersion" approach and no difference was found between "translation" and "immersion" conditions for children with higher IQ scores.

In conclusion, this chapter provides evidences for the superiority of the immersion approach with a single context, by directly comparing different exposure approaches through multiple analyses. The comparisons for the type of test trials and the examination of other cognitive capacities that may influence the performances in this second language word learning task are also more informative than the individual analyses in Chapter 3, 4 and 5.

Chapter 7: General Discussion and Conclusion

Inspired by the increasing popularity of “minimal exposure” second language programs available on the television, video, and the internet, the current studies examine two main exposure approaches (immersion vs. translation) for teaching vocabulary words in a second language. The primary objective was to compare different exposure approaches for learning words in a second language through a “fast mapping” study with toddlers, school-aged children and college students. A second objective, in order to carefully evaluate the validity of our claims in the first objective, was to justify the validity of looking time measurements for examining word-learning performance more generally. Only by doing this, it is possible to compare older learners’ implicit knowledge and on-line processing of word learning with toddlers who were not able to explicitly respond to the multiple-choice questions.

I. Do looking time measurements reflect word mapping?

How accurately do younger children perform in a word-mapping test with second language inputs, compared to older children and adults? Although off-line measures that require responses after the offset of the speech stimulus can test learners’ explicit knowledge, word comprehension often occurs during speech processing and it is worth examining implicit measure of accuracy as expressed in looking behaviors towards potential referents. It has been demonstrated that participants' eye movements to still images are closely time locked to relevant information in spoken language comprehension and this paradigm provides a sensitive measure of the time course of lexical activation in continuous speech (Tanenhaus, Magnuson, Dahan, & Chambers, 2000). Tanenhaus et al. (2000) also summarized the reasons for being interested in using eye movement to study language comprehension. For instance, eye movements provide a continuous measure of spoken-language processing without requiring metalinguistic judgments, thus they are well-suited for studies with young children. In fact, both the preferential looking paradigm (Golinkoff et al, 1987) and the looking-while-listening approaches (Fernald, Zangl, Portillo, & Marchman, 2008) have relied on such measures and have been demonstrated to be reliable procedures for exploring how very young children attach spoken words to their referents and have therefore been used in numerous word learning studies for native speakers' early language acquisition (e.g. Fernald & Hurtado, 2006; Hollich, Hirsh-Pasek & Golinkoff et al, 2000; Marchman, Fernald, & Hurtado, 2010; Roseberry, Hirsh-Pasek, Parish-Morris, & Golinkoff, 2009). However, it is not clear whether and how looking time spent on the target referents vs. distractors reflects accuracy in word learning for older learners, or whether it would be equally appropriate for assessing second language word learning.

In answer to this question, we found that the implicit measures of the proportion looking to target were consistent with explicit response behaviors. Specifically, the difference in the proportion looking to the target side between those who made the correct response and those who made the incorrect response began to diverge at around 600 ms for adults and at around 900 ms for 5- to 6-year-old children (Figure 6.8). Such findings indicated that the looking time spent on the target vs. distractor side was consistent with pointing behaviors. In other words, if explicit responses are reliable indicators of the learners' acquiring words, implicit looking behaviors also ought to be valid measures for examining this question, even in older children and adults.

Given the coherence between implicit and explicit measures of accuracy, my next question focused on what the appropriate window for measuring looking behaviors might be. In this dissertation, the determination of the time window for calculating implicit accuracy was somewhat data-driven and the actual window examined varied by age group (see Chapter 6). Previous literature provided a starting point for this decision. Specifically, fixation responses were examined from 200-400 ms after the onset of the target word because programming an eye movement takes approximately 200 ms and the mean latency to fixate a referent is delayed when the visual workspace contains a competitor sharing similar properties with the referent (Swingley & Aslin, 2000; Swingley, Pinto & Fernald, 1999; Tanenhaus, Magnuson, Dahan, & Chambers, 2000). It has been suggested that the determination of an appropriate window onset may also vary somewhat from study to study, depending on the experimental question and the age of children in the study (Fernald et al., 2008). In most studies with young children on word comprehension, the onset of the time window was placed 300-400 ms after the onset of the target word (Bailey &

Plunkett, 2002; Ballem & Plunkett, 2005; Fernald & Hurtado, 2006; Zangl & Fernald, 2007), whereas in eye-tracking studies with adults, shorter intervals such as 200 ms were used (Tanenhaus, Magnuson, Dahan, & Chambers, 2000). However, all studies conducted with the looking-while-listening paradigm to examine word learning used static pictures. Thus, it is the task of the current studies to not only compare the accuracy among different exposure approaches and age groups in second language word learning, but to shed light on using the looking-while-listening paradigm with video stimuli. In the present studies with dynamic videos stimuli, 400 ms and 900 ms after target word onset as the beginning of the time window for calculating accuracy were demonstrated to be reasonable for adults and children respectively. As further evidence for the appropriateness of this window, a clear relation was found between implicit looking behavior accuracy within the target windows and explicit response accuracy for both adults and 5- to 6-year-old children.

In summary, the present dissertation provides evidence that looking time behaviors for older learners indeed reflect their learning performance and that specific time windows ought to be selected to examine the implicit measure of accuracy through looking behaviors for learners of different ages.

II. Do different exposure approaches work equally well for learners of different ages?

Inspired by teaching models widely used in second language learning programs, and particularly L2 vocabulary learning studies, the current studies compared different methods to learn words from a second language which was highly different from their native language for toddlers, school-aged children and adults. Although these methods included minimal instruction and were presented via short-term exposures, they were motivated by approaches to second language education and explicit teaching/learning strategies for second language vocabulary acquisition found in the literature.

Second-language teaching programs are prevalent across the world, and they are targeted at audiences varying from infants to older adults. These programs are generally based on three basic models (Curtain & Dahlberg, 2004; Pinsonneault, 2008). In particular, some schools provide foreign language instruction under the Foreign Language in the Elementary School (FLES) program, in which the second language is taught as its own subject, and the courses are offered sequentially from the early primary grades through high school; Foreign Language Exploratory (FLEX) programs target upper elementary or middle school students who are exposed two or more languages over a short period of time but with little depth. The final model is language immersion which emphasizes that second languages should be learnt in the same way as the first language.

Although the current studies focus on exposure approaches rather than instruction of foreign language *per se*, the findings make intriguing and significant contributions to our understanding of second language word learning. Namely, they provide evidence that even during minimal exposures to second language input, the way in which one is exposed matters for the effectiveness of mapping references onto the target words.

Overall, the current studies found that adults performed better than 5- to 6-year-olds in several ways, such as explicit accuracy and reaction time, processing efficiency of looking behavior, and implicit looking accuracy in all three approaches; in contrast, adults performed better than toddlers on looking accuracy only in the translation and immersion with multiple contexts approaches. There was no difference between toddlers and adults in accuracy with immersion with a single context approach. Furthermore, comparing the two exposure approaches with or without translation under simple single context ("Single Context" and "Translation"), it was revealed that immersion was better than the translation approach in multiple ways. In particular, the explicit accuracy of children's pointing behavior, the processing efficiency of looking behavior for adults, and implicit looking accuracy for both 5- to 6-year-olds and toddlers all showed significantly better results for the immersion than the translation approach. Interestingly, however, the findings showed adults performed equally well in both the immersion and translation situations, whereas children only recognized the words in the immersion situation, which indicated that providing translations interfered with learning performance for second language word acquisition for children, but not for adults, in a short-term learning situation with minimal exposure. Interestingly however, by comparing the two immersion approaches, Single Context vs. Multiple Contexts, it was revealed that both groups of children were only able to successfully map words to referents in the simple context with a single action associated with objects. The finding suggests that second language word learning is not exactly like the first language acquisition for children, since varied events are demonstrated to facilitate first language word mapping by providing the opportunity to compare the consistency across situations (Childers & Paik, 2009). Multiple action contexts associated with target objects may increase attention loads when children are attempting to learn words from a second language. It is also worth emphasizing that the null results for children under the "Translation" and "Multiple Contexts" approach should not be attributed to the task *per se,* because all the testing trials in these two approaches are exactly the same as those in the "Single Context" approach, which are demonstrated to be effective for children to succeed in tasks. In other words, the failures in these two approaches are more likely due to the training contexts. However, individual differences should be acknowledged even though adults generally performed better than children, and learners in the "Single Context" approach generally performed better than those in the other approaches.

The findings in the current studies also provided evidence that toddlers, 5- to 6-year-old children and adults are able to learn words from an unfamiliar language with very short exposure time in dynamic contexts, which involves multiple complicated processes in language acquisition such as discriminating languages, segmenting words from sentences, and mapping new words to familiar referents. This success happened even in dynamic contexts with an agent and action involved, rather than only with isolated objects and even in a language very distant from the structural and prosodic properties of English. Despite the evidence from the perspective of language acquisition, older learners may rely on other cognitive capacities or learning strategies from the previous experiences beyond language acquisition. However, this dissertation could not tease apart these two processes (language acquisition vs. cognitive strategies).

In conclusion, the findings in this dissertation have pedagogical implications for second language education in terms of the benefit of no-translation exposures, especially for younger learners. However, it is also acknowledged that the current studies focus on the very first step of word learning by examining performance in fast-mapping words to referents in an experimental setting with minimal exposure rather than learning the "meaning" of the words.

III. Do native language experiences and other cognitive capacities mediate second language word mapping?

L1 vocabulary of toddlers

The influence of L1 vocabulary in second language word learning has often been attributed to mutual exclusivity constraints during word learning (Markman & Wachtel, 1988; Markman, Wasow, & Hansen, 2003). Whereas monolingual children have shown mutual exclusivity constraints, to what extent do monolingual infants avoid learning two words from different languages? Whether their mutual exclusivity constraint is applied across languages is also of interest in the current studies. One recent study has examined 24-month-old monolingual English-speaking toddlers' ability to learn Dutch words and found only children with high native vocabularies successfully selected the target object for words produced in Dutch (Koening & Woodward, in press). In the current studies, however, neither a correlation between CDI score and looking time accuracy, nor a difference between high vs. low median-split groups was found. One possibility could be the age group selected in the current studies (28-30 months) is at the end of the appropriate age range used for the CDI toddler form (16-30 months), and toddlers in the low CDI group were not really low in their vocabulary (the percentile of mean score is 30%).

Other possible influences on short-term second language word learning for school-aged children and adults: working memory and intelligence

In terms of older children and adults, auditory working memory and intelligence may mediate second language word learning in a short-term situation.

Theoretically, working memory plays an instrumental role in the chunking process of linguistic sequences. In addition, working memory plays an important role in second language learning because it is usually characterized by more controlled processing, thus demanding more cognitive resources and relying more on working memory. In particular, phonological memory, which is one element under the working memory model, has been shown to play a central role in learning new sound patterns, and thus is critical to L2 vocabulary learning (see review Juffs & Harrington, 211; Wen, 2012).

Speciale, Ellis & Bywater (2004) examined the differences in phonological short-term storage capacity affecting learning of foreign language vocabulary in an experimental task with undergraduates and demonstrated the importance of phonological short-term storage capacity in L2 vocabulary learning. Kormos and Safar (2008) examined both working memory capacity measured by a backward digit span task and found the performance on the backward digit span task was significantly correlated with total proficiency in foreign language tests. The auditory working memory task used in the dissertation, the Woodcock-Johnson auditory working memory, involves re-ordering the sequence of randomly dictated words and numbers, and thus reflects the participants' ability to regulate attention in cognitive processing. Attention regulation is critical in the current design since the inputs are composed of complicated visual and auditory stimuli, both relevant and non-relevant for acquiring the target words, and it is impossible to store all the information during a short period of time. The findings in the current studies verified the role of working memory in short-term word mapping task, showing that adults' auditory working memory was positively correlated with implicit receptive word learning accuracy as measured by looking behaviors.

In terms of the role of intelligence in second language learning, previous literature found a low, but significant, correlation between "multiple intelligences" and second language proficiency, and further analysis showed only verbal/linguistic intelligence was found to be a predictor of second language proficiency (Akbari & Hosseini, 2008). Nonetheless, the current studies did not find a relationship between verbal IQ as measured by the K-BIT (Kaufman & Kaufman, 2004), and performance on the second language word learning task, although it did find a role for non-verbal IQ in second language word learning with the translation exposure approach. Specifically, a median-split of non-verbal IQ scores found that children with a higher non-verbal IQ performed better than those with a lower non-verbal IQ in a harder learning situation---when the translations were provided during the word exposure.

Foreign language learning aptitude in adults

The foreign language aptitude test (Pimsleur Language Aptitude Battery, Pimsleur, Reed, & Stansfield, 2004) is designed to predict how well, relative to other individuals, an individual can learn a foreign language in a given amount of time and under given conditions, and contains different sections each testing different aspects of predictive factors such as verbal ability, auditory ability, and motivation. The score used in my dissertation includes the sections of "interest"—measuring interest in learning a foreign language and motivation, "language analysis"---testing the ability to reason logically in terms of a foreign language, "sound discrimination"—measuring auditory ability in terms of ability to learn new phonetic distinctions and to recognize them in different contexts, and "sound-symbol association"—another measure of auditory ability in terms of the ability to associate sounds with written symbols. Thus, the score in the foreign language aptitude test should be correlated with the learners' performance in the current experimental tasks. In the current studies, it was indeed found that foreign language learning aptitude was positively correlated with word learning accuracy for adults (both for explicit responses and implicit looking behaviors), which further verifies the validity of the current experimental design for second language learning.

IV. Conclusion

The current studies were designed to examine the effectiveness of different exposure approaches on second language word learning in a short-term experimental situation, as well as the interaction between exposure approach and the age of learners. Since the tasks only target the initial aspect of word learning in language acquisition by examining the success of mapping a word onto a referent in a dynamic event, we cannot extend the findings onto other broader situations in second language education. However, this dissertation makes a contribution to the methodology of second language word learning for both younger and older learners, as well as a pedagogical implication in one element of second language education—the effect of second language input/exposure. In terms of methodology, the current studies provide evidence for the validity of looking behavior measurements for word-learning performance in learners of different ages (toddlers, school-aged children, and college students) and for the testing of word learning in a second language. In addition, it sheds light on the use of the looking-while-listening paradigm for word learning with dynamic videos as stimuli and proposed the importance of considering different time windows according to the features of stimuli and the age of learners, in order to calculate both processing efficiency and accuracy.

In terms of the effects of exposure for second language word learning, the present dissertation demonstrated that even without explicit teaching instruction, the method of presenting target language input matters for learners, especially for children, if they are able to fast-map words to references. Children who are exposed to only the target second language are more likely to fast-map words to references than those who are provided with the translation equivalents in their native language. In particular, the explicit responses of older children showed that children performed significantly more accurately and were faster to respond in the "immersion" approach than in the "translation" approach. In term of looking behaviors, similar results were found in accuracy, namely both groups of children spent significant longer times looking at the target vs. non-target side, but only in the "immersion" approach. In addition, the dynamic looking changes showed that, on average, the proportion looking to target vs. non-target began to diverge at around the same time for both 28-30 month old toddlers and 5-6 year old children in the "immersion" approach. However, the further *t*-tests with Bonferroni corrections found a significant time frame for 28- to 30-month-old toddlers at 1100 ms in "single context" approach whereas no significant corrected *p*-value was found for 5- to 6-year-old children, which indicated that 28- to 30-month-old toddlers even fixated on the target referent faster than 5- to 6-year-old children in "single context". Even for adults, although no difference was found in accuracy among different exposure approaches, although implicit looking behaviors showed that adults were also significantly faster to respond to target words taught in the "immersion-single context" approach than those taught in the "translation" approach. All the evidence above points to the superiority of the immersion approach over the translation approach.

Nonetheless, several limitations must be acknowledged in the interpretation of the current research findings. One major limitation of the current data is that although children were administered with a post-test and asked explicitly to produce the target Mandarin Chinese words and then point to the correct picture matching what the experimenter said after completing the video task, only very few of them gave answers. Since both receptive and productive vocabulary scores in the post-test for adults were significantly correlated with their explicit response accuracy during the video session, it is worth asking how much children can remember after online processing of second language input.

Another limitation is that the interaction between age, exposure approach and test condition is not fully clearly interpreted. In terms of explicit responses, adults did not perform differently across different test conditions, whereas 5- to 6-year-old children performed better in the "familiar context-novel contrast" and "novel-context-familiar contrast" than the "novel context-novel contrast" condition in the "single context" approach. Implicit looking behaviors showed a further difference in processing test trials involving different contexts and distractors for adults, in that adults performed significantly better in the "novel context-novel contrast" condition than the "novel context-familiar contrast" condition, but only in the "single context" approach. No differences between test conditions were found in any exposure approach for 5- to 6-year-old children with the implicit looking measurement. The performance of toddlers, in contrast, in the “novel context-novel contrast” condition was significantly better than the “familiar-context-familiar contrast” and the “familiar context-novel contrast” condition in “single context” approaches. Moreover, toddlers performed significantly better in the “novel context-familiar contrast “condition than “familiar-context-familiar contrast” in the “single context” approach. Overall, both adults and toddlers performed better when less interfering information was involved and the distractor was less similar, such as when only the target object was familiar and both the distractor and action context had never appeared during training (i.e. “novel context-novel contrast” condition). Such findings could be explained by the effects of distraction on visual selective attention. In particular, there is considerable evidence showing that the allocation of attention differs depending on the particular distribution of features across target and distractors. For example, a target containing a unique feature may be detected easily because preattentive feature analysis can easily capture the target. As distractors are more similar to the target, the potential interference from distractors is high, thus it is harder to sort out the irrelevant information and reject the distractor (Duncan & Humphreys, 1989; Hopf, Boelmans, Schoenfeld, Heinze, & Luck, 2002). However, school-aged children performed worse when less relevant information was involved. A summary of these comparisons is shown in Table 7.1. A final possibility for these differences could be that the number of trials in different conditions was not large enough to examine the real effect of test condition (4 trials in each condition). More testing trials could be added in future studies to check this possibility.

Lastly, the K-BIT non-verbal IQ task was not included in the materials when adults participated in the studies, thus we are not able to examine the correlation between non-verbal IQ and performance in the experimental task on second language word learning. Although this limitation could be minor, since the effect of intelligence on second language word learning is not the main focus of the current studies, it is worth examining in future studies.

In conclusion, previous literature has demonstrated that the immersion approach is more effective than the traditional approach for second language education in classroom settings (Genesee, 1978b, 1983, 1985, 1987; Genesee, et al., 1989; Hornberger, Genesee, & Lindholm-Leary, 2008). The present dissertation provides further evidence for the superiority of the immersion approach, but in short-term second language word learning. Findings revealed that both toddlers and young school-aged children were more able to learn words, even after a very small number of exposures (8) in an “immersion” approach than in a “translation” approach, and providing translations interfered with children’s performance on this second language word-learning task. Such findings also build an empirical foundation for both parents and educators to focus on second language programs which include minimal teaching instruction that include more of an immersion than a translation approach.

Figures

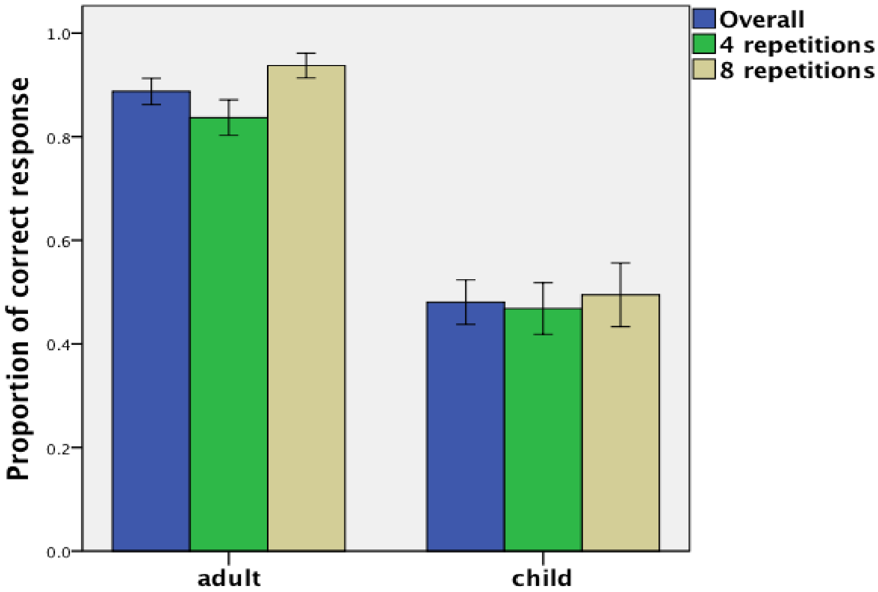


Figure 3.1. Mean Proportion of Correct Explicit Responses by Age and Number of Repetitions (Study 1: Translation)

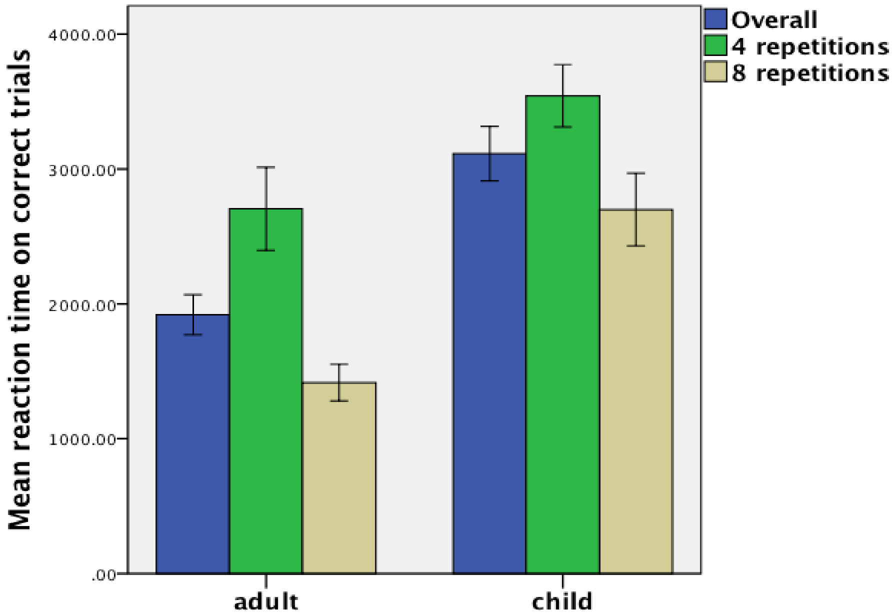
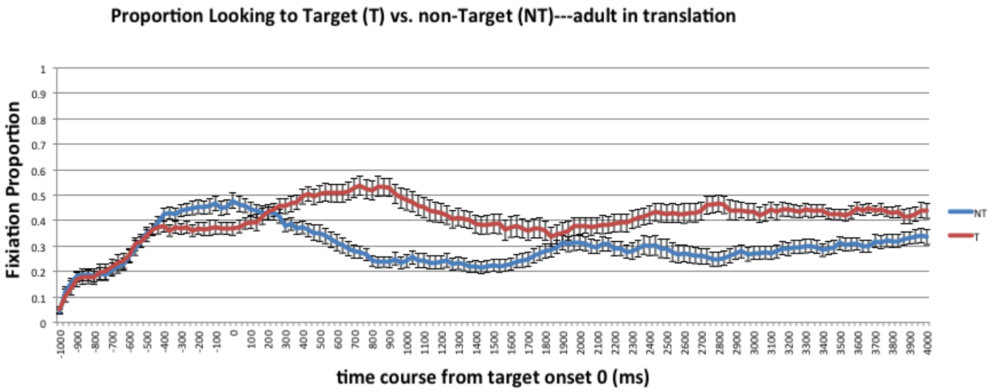
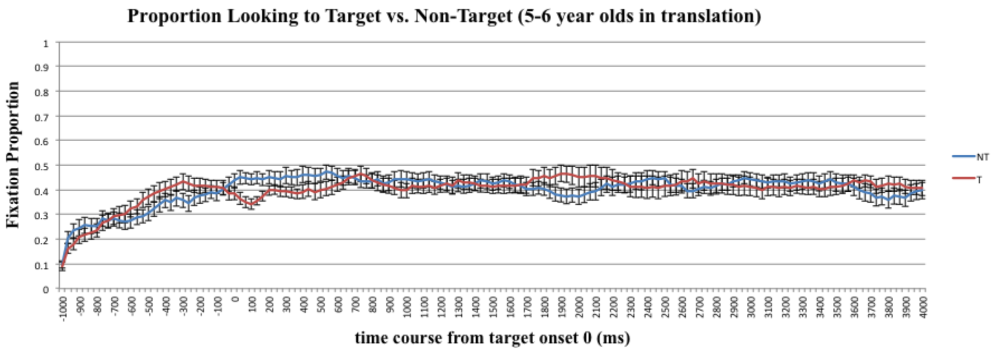


Figure 3.2. **Mean Reaction Time for Correct Explicit Responses by Age and Number of Repetitions (Study3: Translation)**



a)



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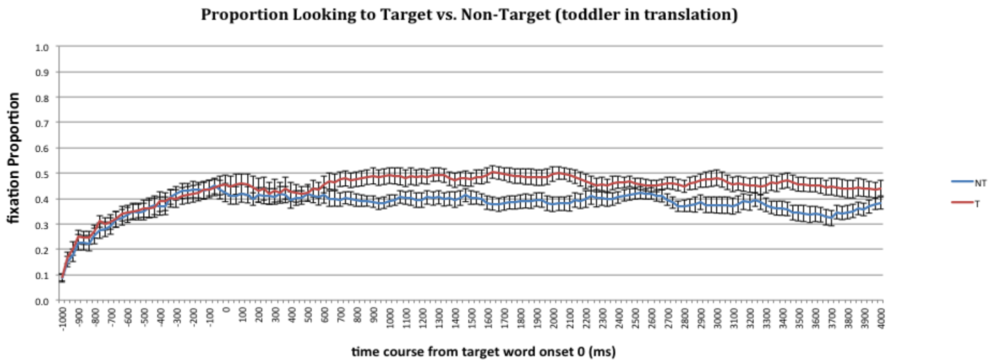


c)

Figure 3.3. **Mean Proportion Looking to Target (T) and Non-Target (NT) in Each Test Trial Frame in Study 1 (Translation) by Age Group (a) Adults; (b) 5- to 6-Year-Old Children; (c) 28- to 30-Month-Old Toddlers)**

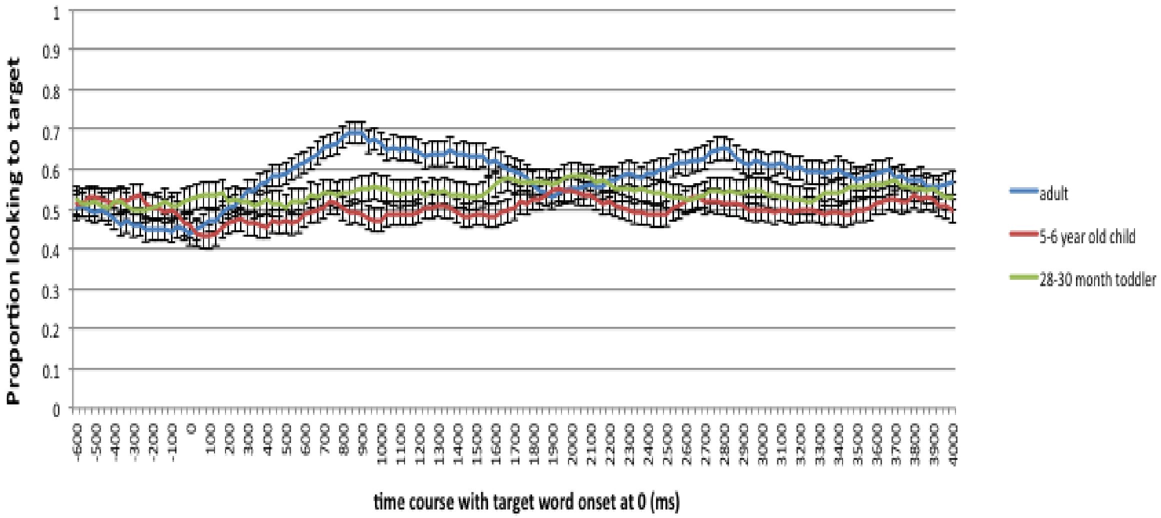


Figure 3.4. **Looking Time Spent on Target Side as a Proportion of Total Looking Time Spent on Either Target or Non-Target Side in Each Test Trial Frame by Age Group (Study1: Translation)**

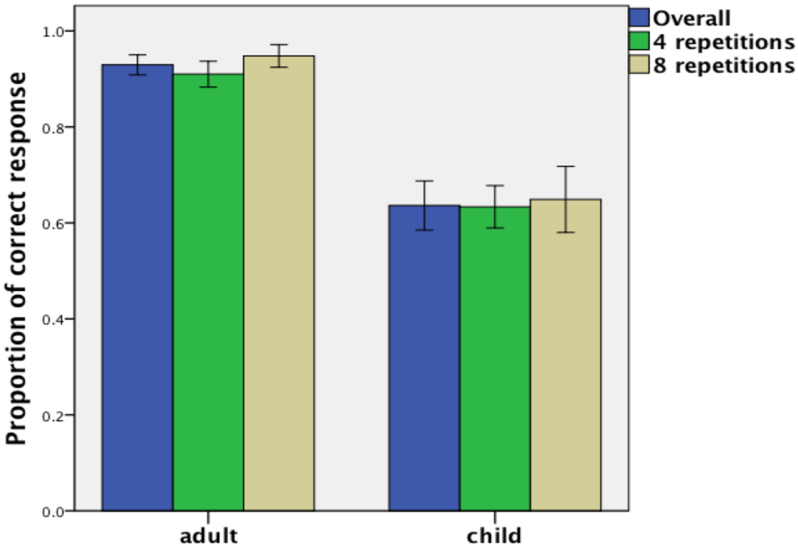


Figure 4.1. Mean Proportion of Correct Responses by Age and Number of Repetitions (Study 2: Single Context)

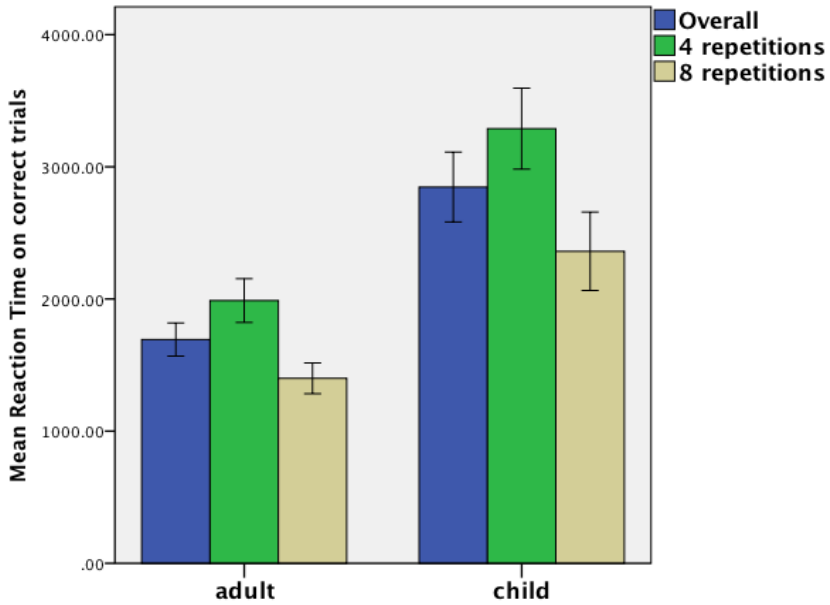
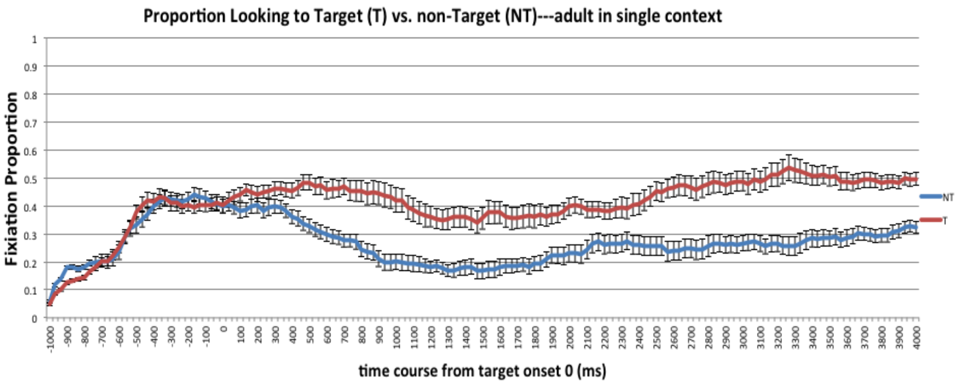
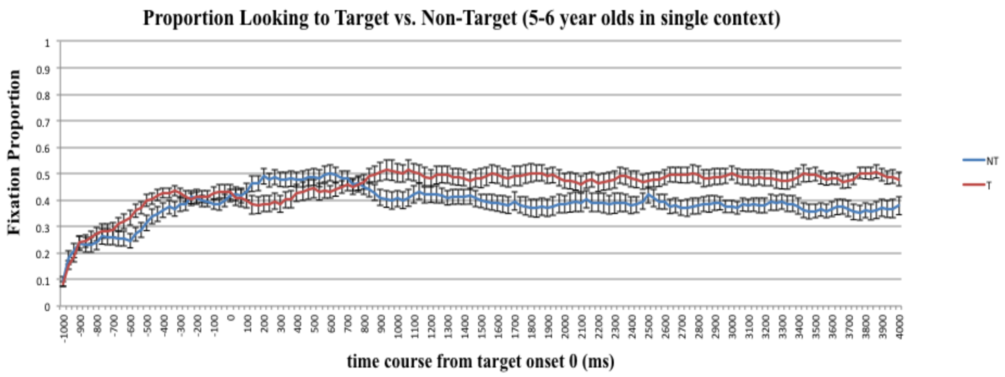


Figure 4.2. **Mean Reaction Time on Correct Explicit Response by Age And Number of Repetitions (Study 2: Single Context)**



a)



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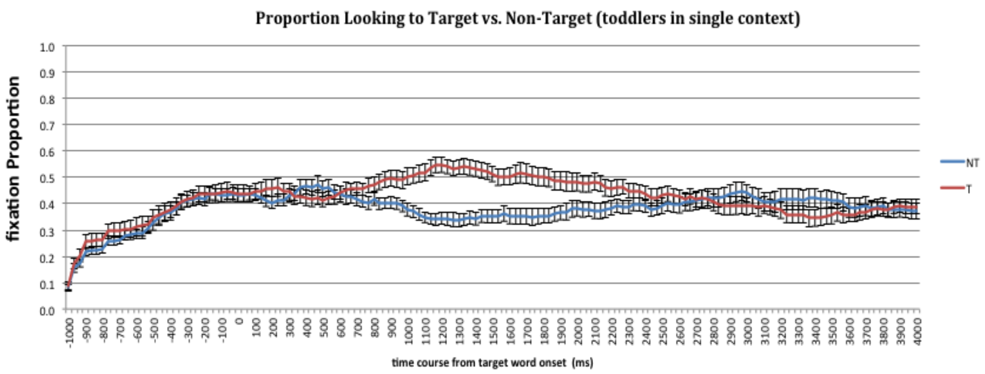


c)

Figure 4.3. **Mean Proportion Looking to Target (T) and Non-Target (NT) in Each Test Trial Frame in Study 2 (Single Context) by Age Group (a) Adults; (b) 5- to 6-Year-Old Children; (c) 28- to 30-Month-Old Toddlers)**

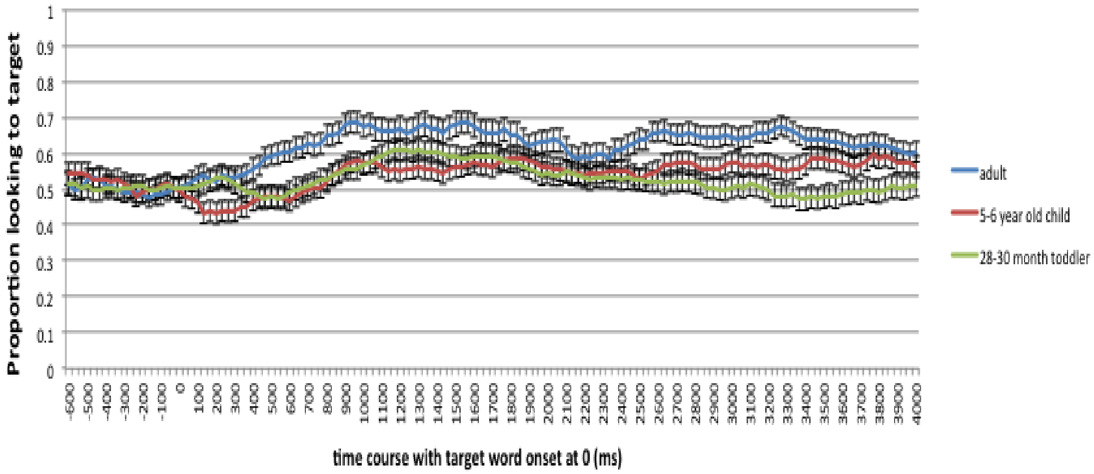


Figure 4.4. **Looking Time Spent on Target Side as a Proportion of Total Looking Time Spent on Either Target or Non-Target Side in Each Test Trial Frame by Age Group (Study 2: Single Context)**

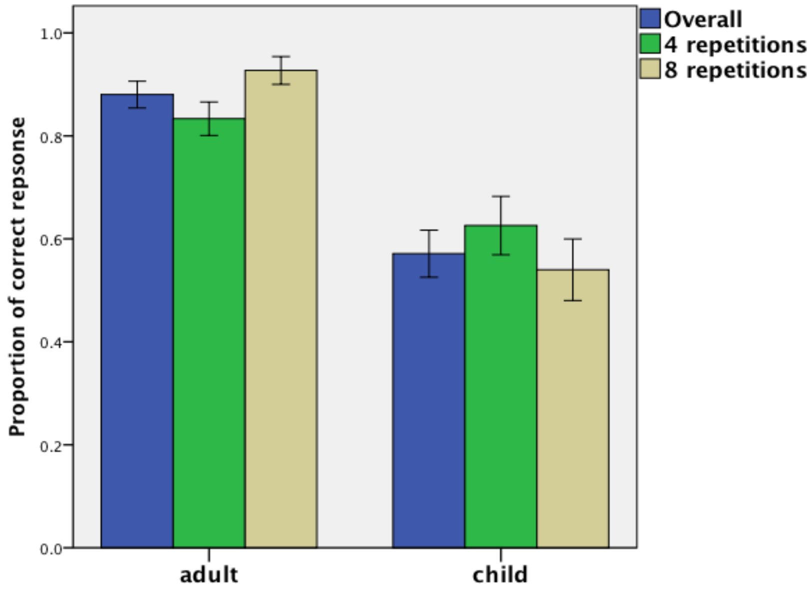


Figure 5.1. **Mean Proportion of Correct Explicit Responses by Age and Number Of Repetitions (Study 3: Multiple Contexts)**

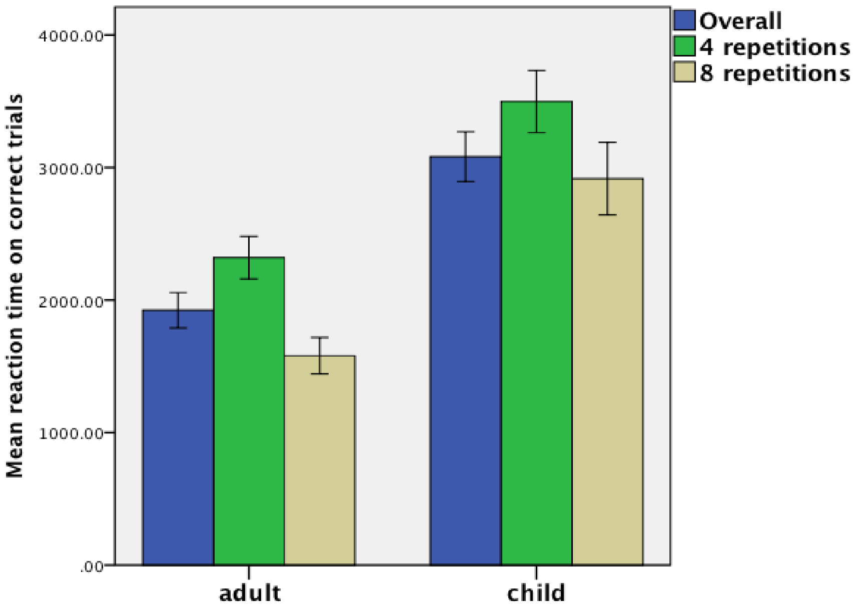
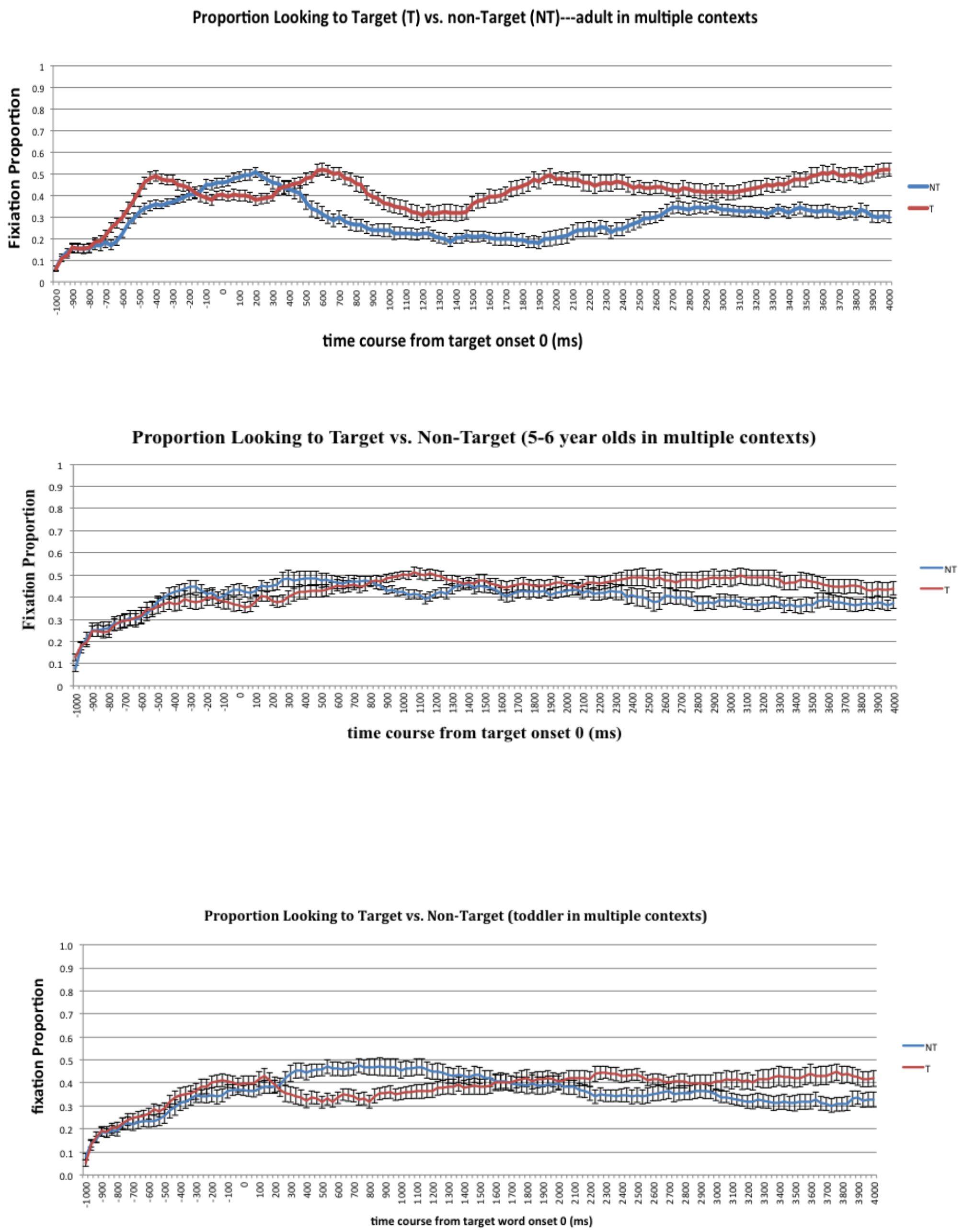


Figure 5.2. **Mean Reaction Time on Correct Explicit Response by Age And Number of Repetitions (Study 3: Multiple Contexts)**



a)

b)

c)

Figure 5.3. **Mean Proportion Looking to Target (T) and Non-Target (NT) In Each Test Trial Frame in Study 3 (Multiple Contexts) by Age Group (a) Adults; (b) 5- to 6-Year-Old Children; (c) 28- to 30-Month-Old Toddlers)**

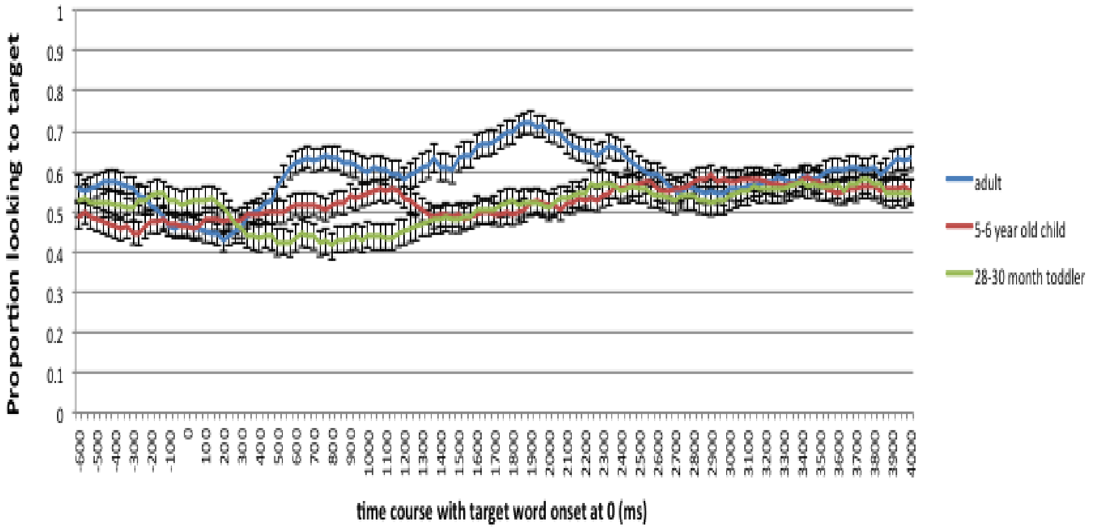


Figure 5.4. **Looking Time Spent on Target Side as a Proportion of Total Looking Time Spent on Either Target or Non-Target Side in Each Test Trial Frame by Age Group (Study 3: Multiple Contexts)**

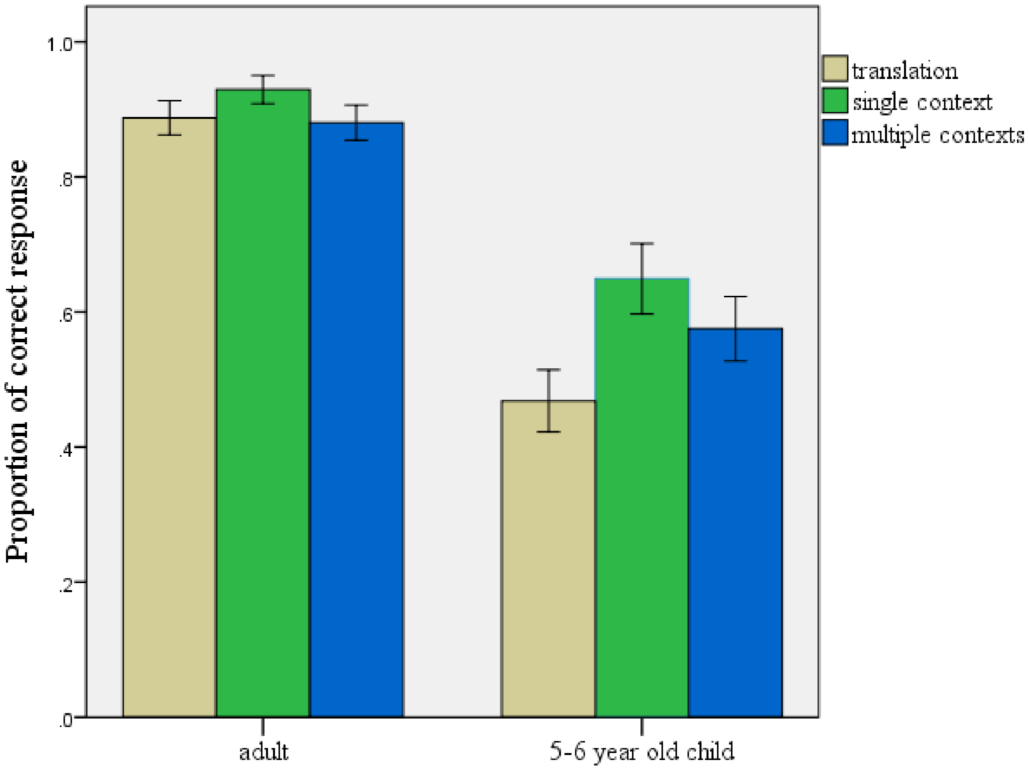


Figure 6.1. **Mean Proportion of Correct Explicit Responses for 5- to 6-Year-Olds and Adults by Exposure Approach**

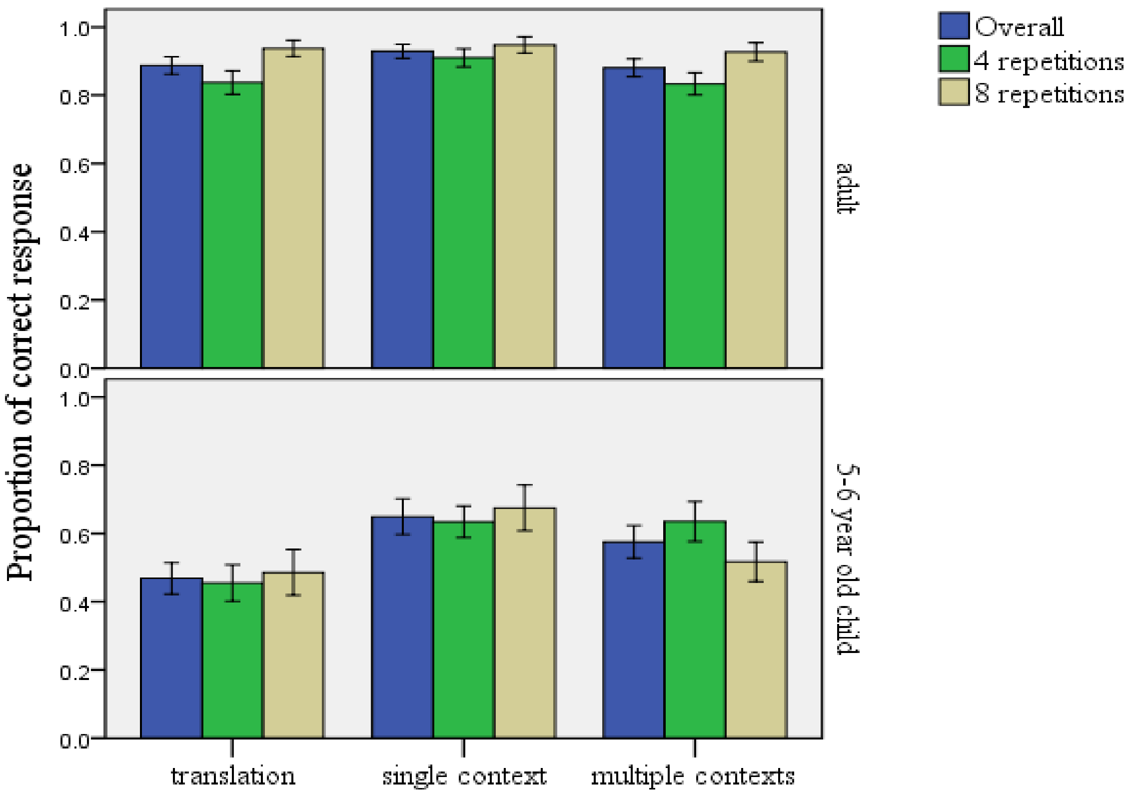


Figure 6.2. **Mean Proportion of Correct Explicit Responses for 5- to 6-Year-Olds and Adults by Exposure Approach and Number of Repetitions**

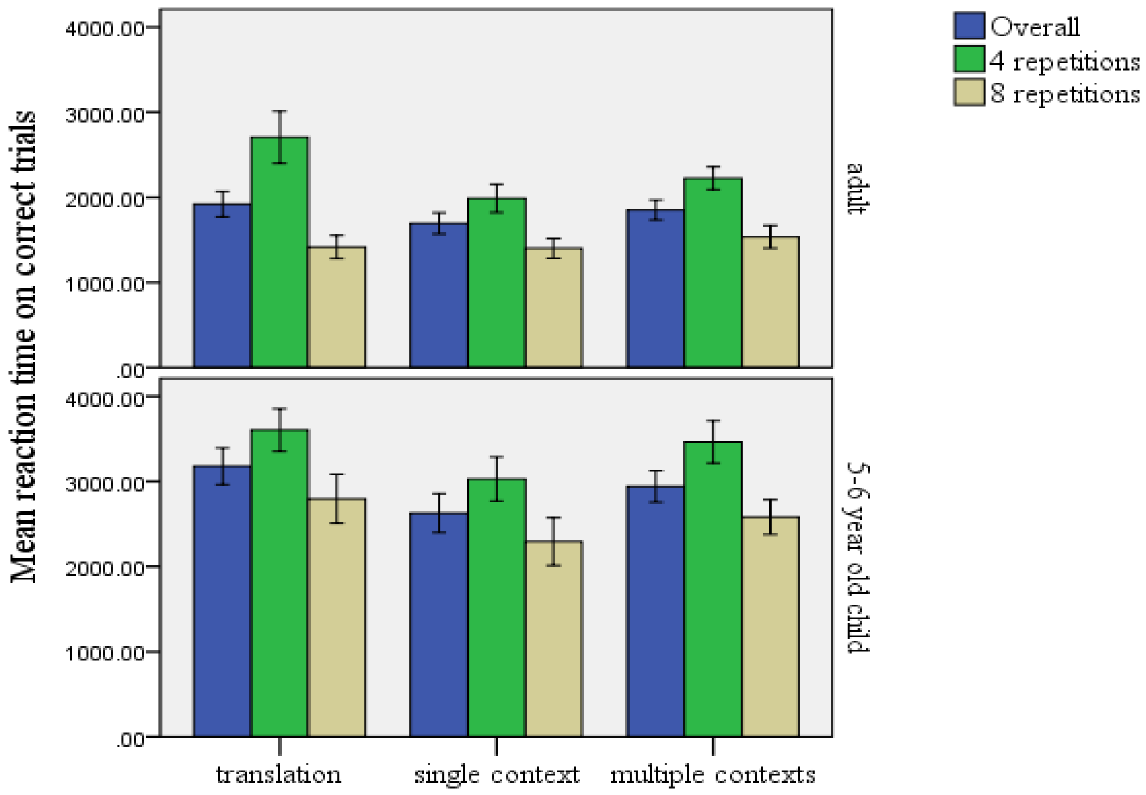


Figure 6.3. **Mean Reaction Time on Correct Explicit Responses by Exposure Approach and Number of Repetitions for Both Adults and 5- to 6-Year-Olds**

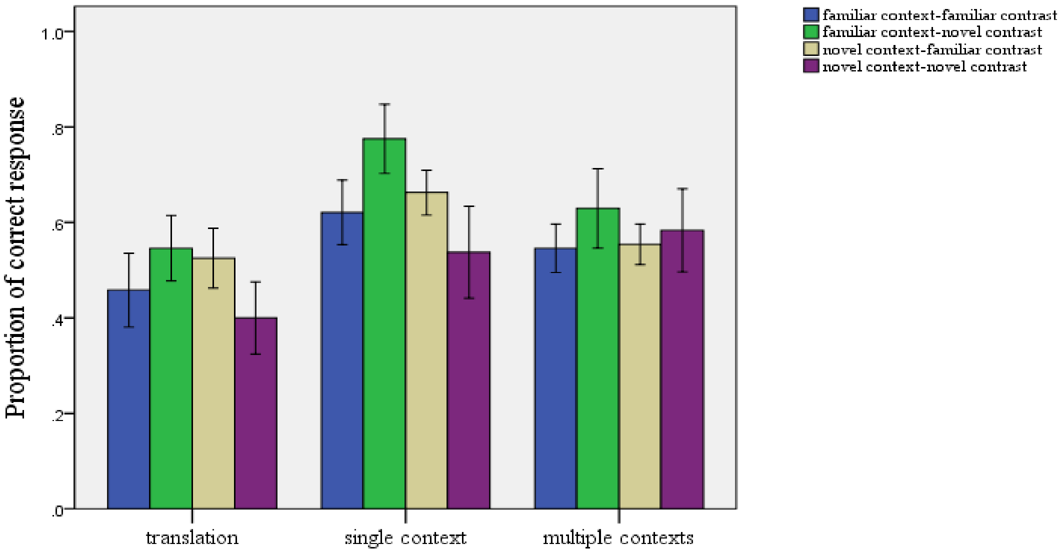


Figure 6.4. **Mean Proportion of Correct Explicit Responses for 5- to 6-Year-Olds by Exposure Approach and Type of Test Trial**

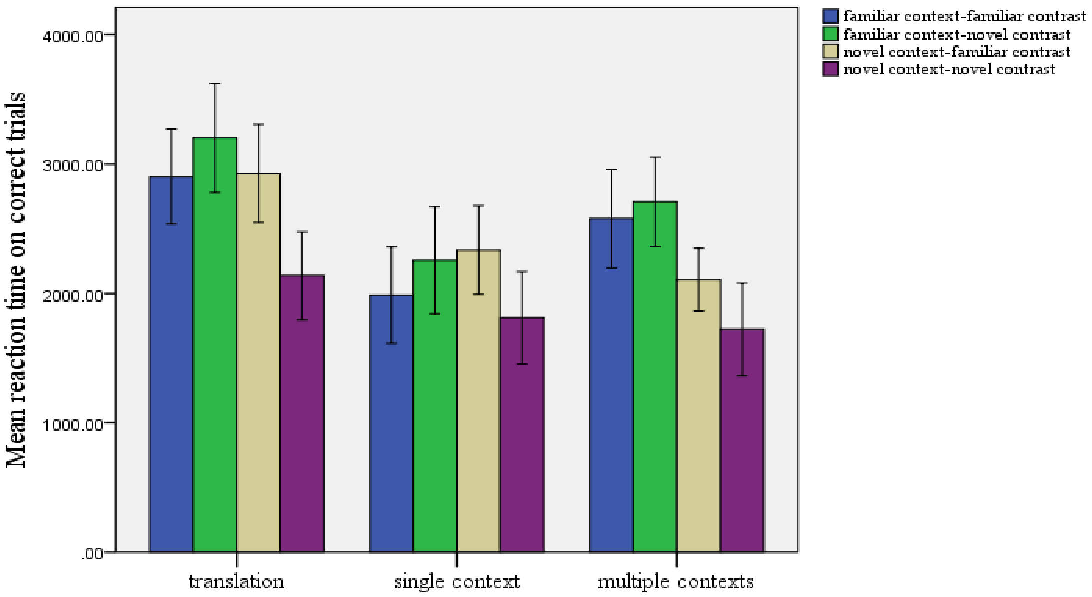


Figure 6.5. **Mean Reaction Time for Correct Explicit Responses for 5- to 6-Year-Olds by Exposure Approach and Type of Test Trial**

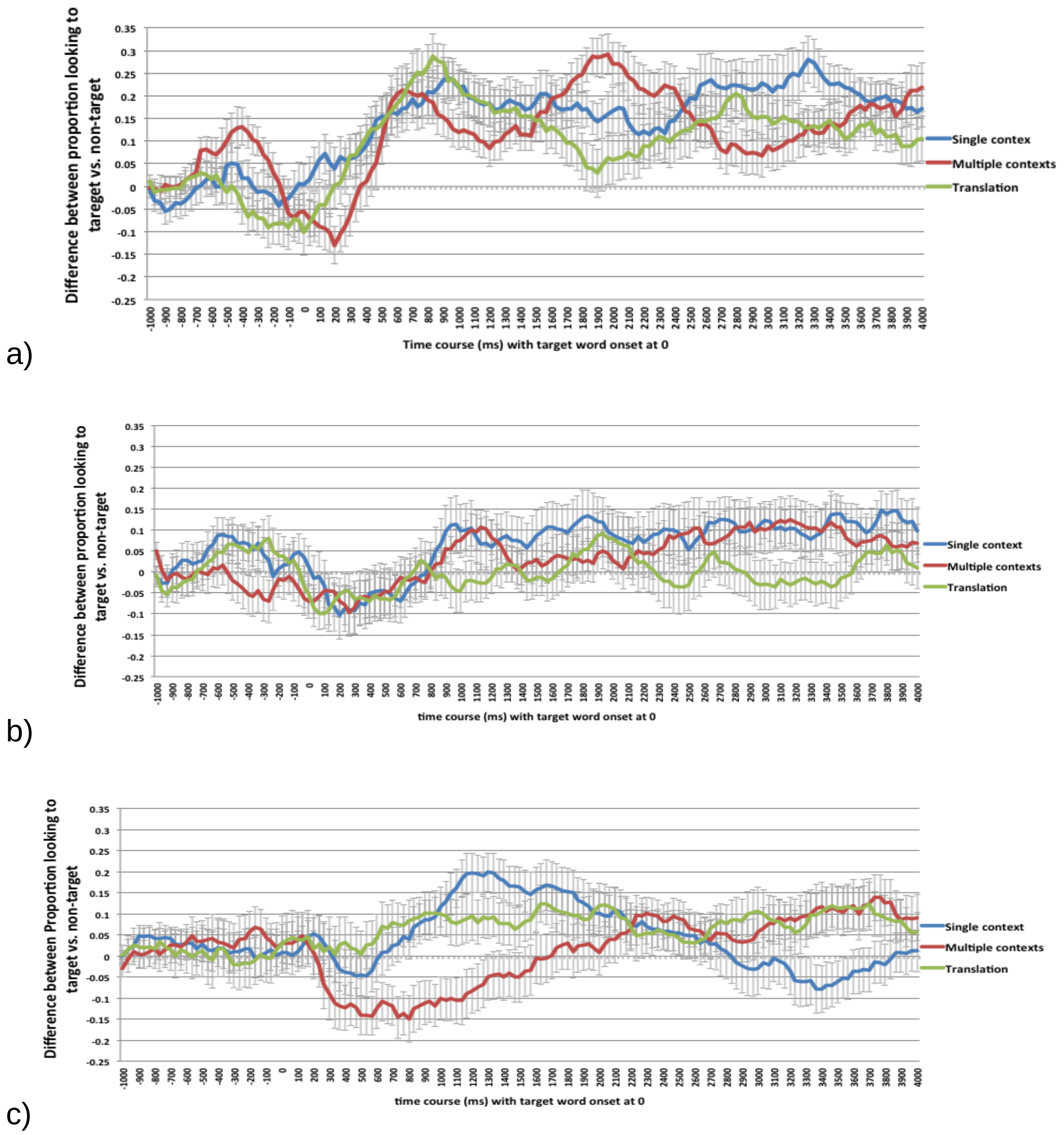


Figure 6.6. **Difference Score between the Proportion of Looking Time Spent on Target Vs. Non-Target Side in Each Frame by Exposure Approach (a) Adults; (b) 5- to 6-Year-Old Children; (c) 28- to 30-Month-Old Toddlers)**

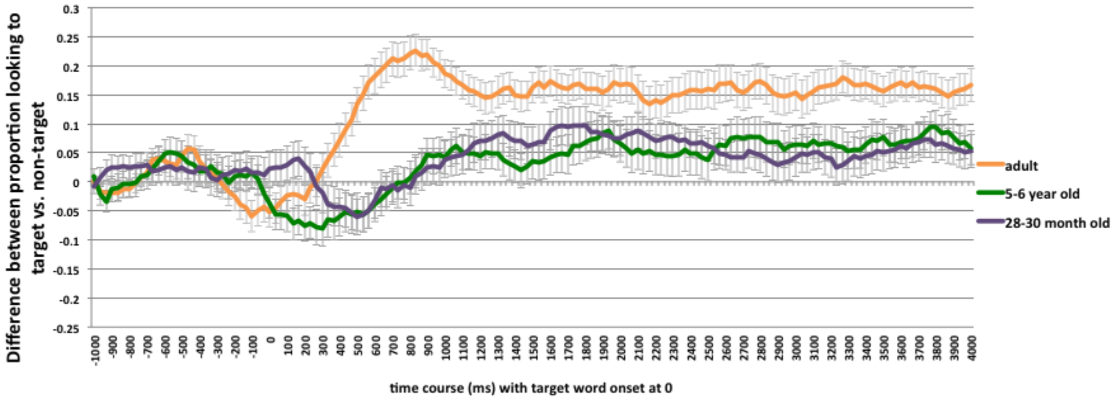
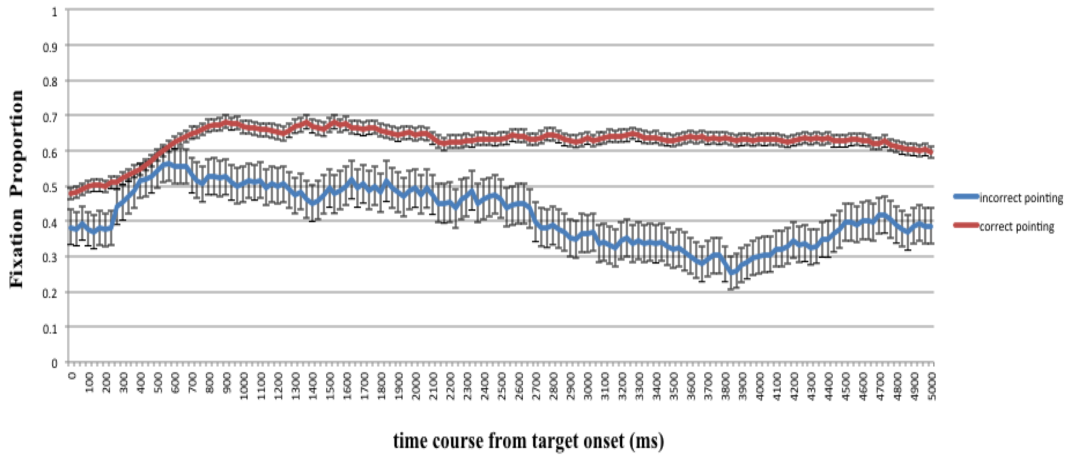
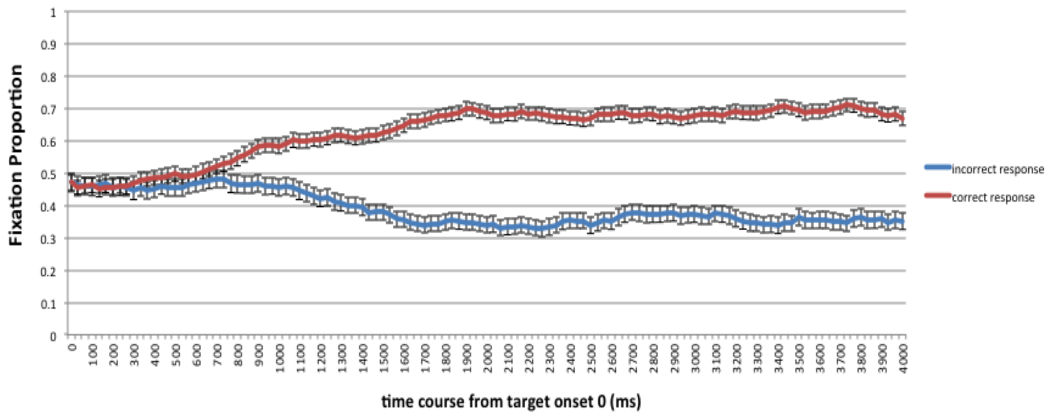


Figure 6.7. **Difference Score between the Proportion of Looking Time Spent on Target Vs. Non-Target Side in Each Frame across Three Exposure Approaches by Age Group**



a)



b)

Figure 6.8. **Looking Time Spent on Target Side as a Proportion of Total Looking Time Spent on Either Target or Non-Target Side At Each Frame by Trials with Either Correct or Incorrect Explicit Response Behavior (a) Adults; (b) 5- to 6-Year-Old Children**

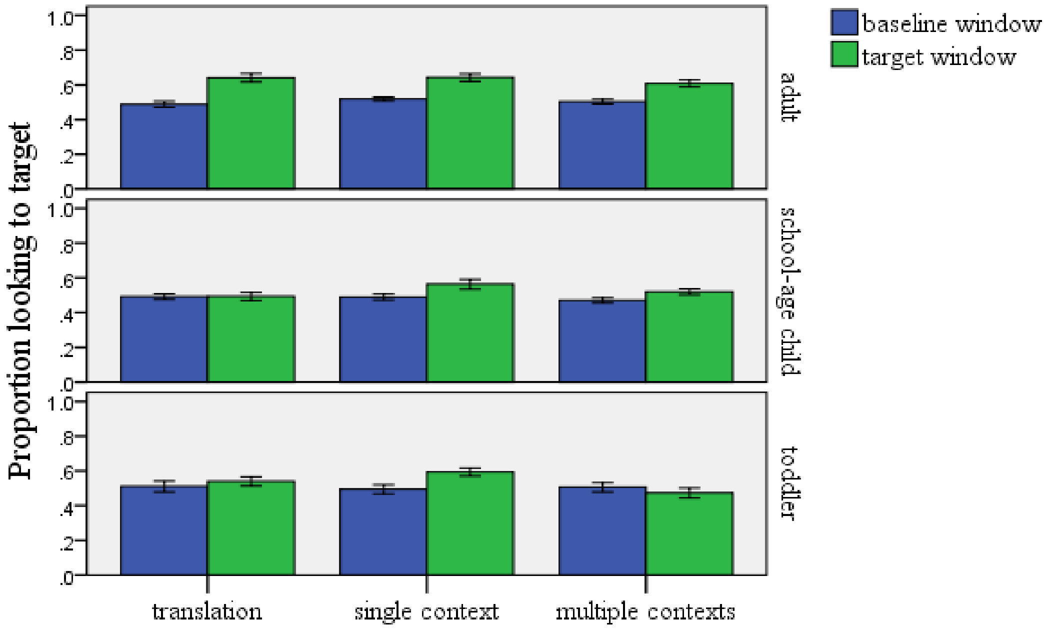


Figure 6.9. **Looking Time Spent on Target Side as A Proportion of Total Looking Time Spent on Either Target or Non-Target Side within Baseline and Target Window by Exposure Approach and Age Group**

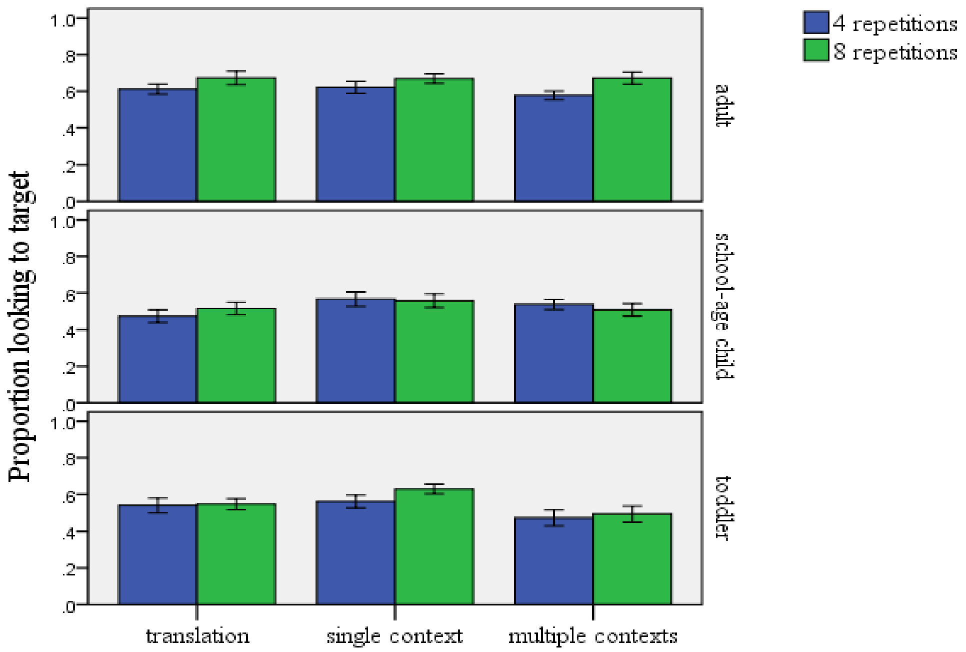


Figure 6.10. **Looking Time Spent on Target Side as a Proportion of Total Looking Time Spent on Either Target or Non-Target Side within Target Window by Repetition, Exposure Approach and Age Group**

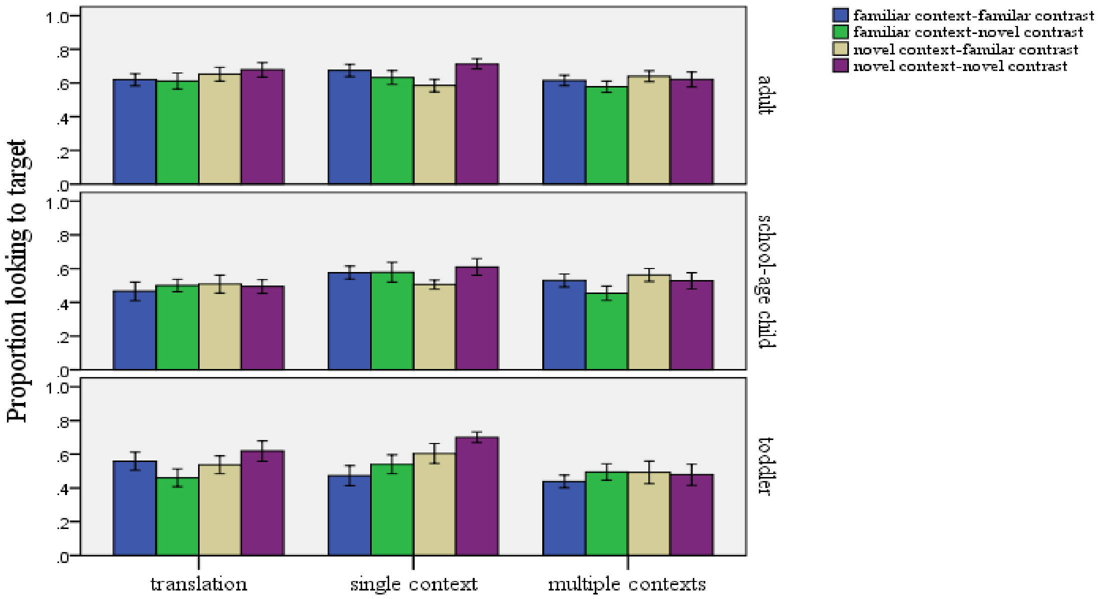


Figure 6.11. **Looking Time Spent on Target Side as A Proportion of Total Looking Time Spent on Either Target or Non-Target Side within Target Window by Type of Time Trial, Exposure Approach and Age Group**

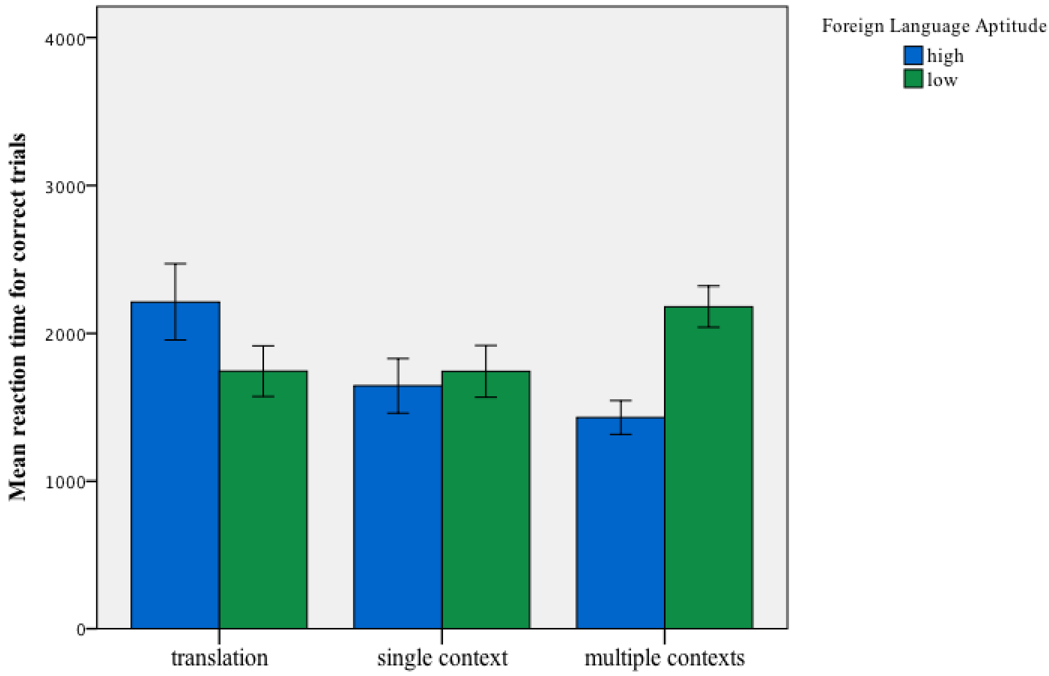


Figure 6.12. **Mean Reaction Time for Correct Explicit Response by Exposure Approach and Foreign Language Aptitude Level**

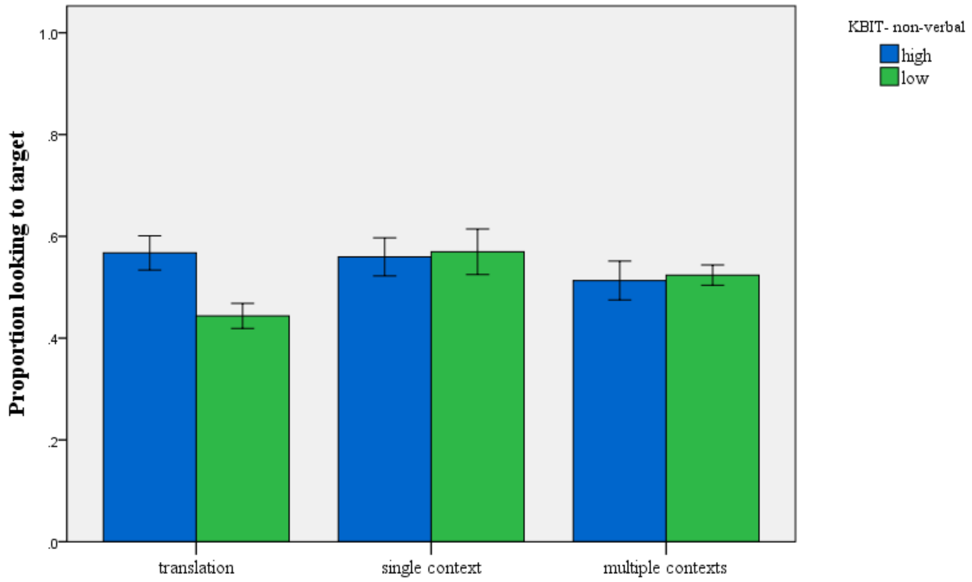


Figure 6.13. **Looking Time Spent on Target Side as a Proportion of Total Looking Time Spent on Either Target or Non-Target Side Within Target Window by Exposure Approach and Non-Verbal IQ Level for 5- to 6-Year-Old Children**

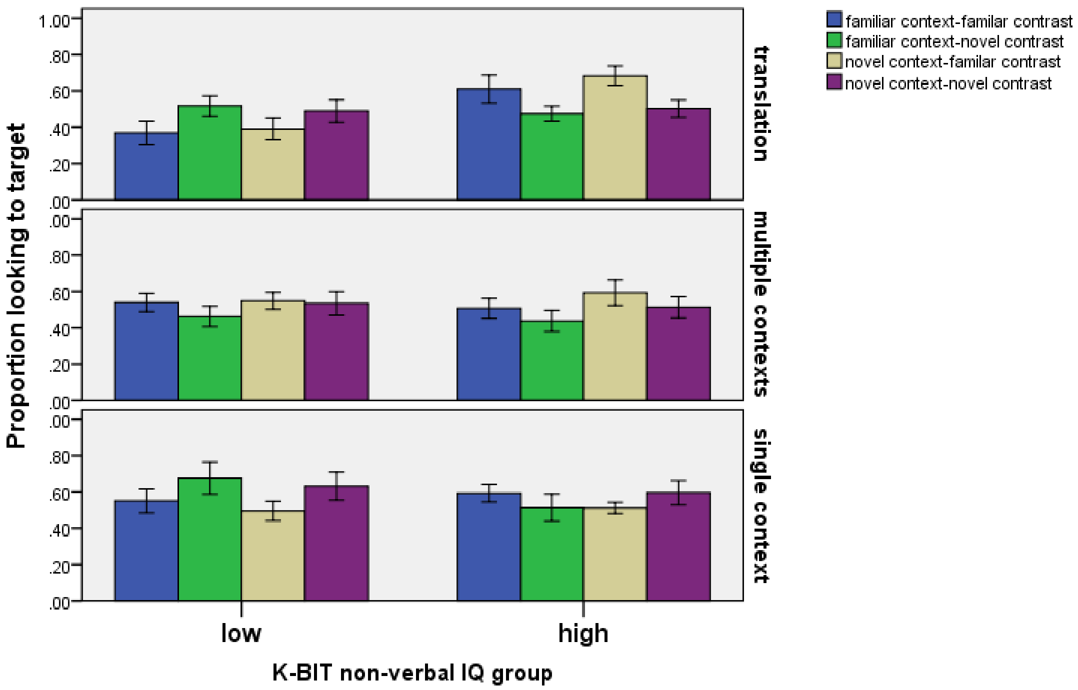


Figure 6.14. **Looking Time Spent on Target Side as a Proportion of Total Looking Time Spent on Either Target or Non-Target Side Within Target Window by Exposure Approach, Non-Verbal IQ Level and Type of Test Trial for 5- to 6-Year-Old Children**

Tables

Table 6.1 Descriptive Statistics by Age and Exposure Approach

	Adults (n=72)						school-aged children (n=60)						Toddlers (n=60)					
	Study 1 (translation)		Study 2 (single contexts)		Study 3 (multiple contexts)		Study 1 (translation)		Study 2 (single contexts)		Study 3 (multiple contexts)		Study 1 (translation)		Study 2 (single contexts)		Study 3 (multiple contexts)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Implicit Accuracy	64.13%	11.99%	64.31%	10.65%	60.85%	9.81%	49.32%	10.71%	56.36%	12.52%	52.06%	7.85%	54.07%	11.99%	59.44%	9.91%	47.40%	12.66%
Explicit Accuracy	88.73%	12.51%	92.93%	10.17%	88.02%	12.76%	46.84%	20.55%	64.92%	23.32%	57.52%	21.33%						
Explicit Reaction Time (ms)	1919.17	727.40	1693.38	613.49	1850.03	559.23	3177.93	964.30	2627.21	993.96	2940.17	824.13						
K-BIT Vocab	50.78	3.397	51.33	3.485	51.23	4.140	19.40	3.789	22.30	2.598	20.60	4.109						
K-BIT Non-verbal							18.95	5.125	22.50	6.186	17.85	5.029						
Working Memory	19.40	6.785	20.04	8.705	25.64	9.708	16.20	8.043	19.65	5.923	15.40	8.500						
Foreign Language Aptitude	58.29	7.975	62.04	5.645	60.43	6.111												
CDI Vocab													83.60	11.320	79.50	11.696	75.40	13.873

Table 6.2 Correlations among Measurements by Age and Exposure Approach

A: Adults

Variable	Implicit Accuracy	Explicit Accuracy	Explicit Reaction Time (ms)	K-BIT Vocab (Zscore)	Working Memory (Zscore)	Foreign Language Aptitude (Zscore)
Implicit Accuracy	-	$.433^{**}$	$-.264^{*}$	.124	$.349^{**}$	$.240^{*}$
Explicit Accuracy	$.433^{**}$	-	-.174	.117	.065	$.275^{*}$
Explicit Reaction Time (ms)	$-.264^{*}$	-.174	-	-.148	-.134	-.079
K-BIT Vocab (Zscore)	.124	.117	-.148	-	.023	$.436^{**}$
Working Memory (Zscore)	$.349^{**}$	.065	-.134	.023	-	.047
Foreign Language Aptitude (Zscore)	$.240^{*}$	$.275^{*}$	-.079	$.436^{**}$	.047	-

B: Children

Variable	Implicit Accuracy	Explicit Accuracy	Explicit Reaction Time (ms)	K-BIT Vocab (Zscore)	K-BIT Non-verbal (Zscore)	Working Memory (Zscore)
Implicit Accuracy	-	$.490^{**}$	-.147	.038	.139	.143
Explicit Accuracy	$.490^{**}$	-	-.134	.213	.184	.090
Explicit Reaction Time (ms)	-.147	-.134	-	.150	.005	-.039
K-BIT Vocab (Zscore)	.038	.213	.150	-	$.311^{*}$	$.337^{**}$
K-BIT Non-verbal (Zscore)	.139	.184	.005	$.311^{*}$	-	.197
Working Memory (Zscore)	.143	.090	-.039	$.337^{**}$	.197	-

C: Toddlers

Variable	Implicit Accuracy	CDI Vocab (Zscore)
Implicit Accuracy	-	.136
CDI Vocab (Zscore)	.136	-

Table 7.1 Significant Differences in Accuracy between Test Conditions with Different Measurements

Comparisons	Measurement
Novel context-novel contrast > Novel context-familiar contrast	Adult implicit looking behavior
Novel context-novel contrast < Novel context-familiar contrast	School aged children explicit responses
Novel context-novel contrast < familiar context-novel contrast	School aged children explicit responses
Novel context-novel contrast > familiar context-novel contrast	Toddlers implicit looking behavior
Novel context-novel contrast > familiar context-familiar contrast	Toddlers implicit looking behavior
Novel context-familiar contrast > familiar context-familiar contrast	Toddlers implicit looking behavior

Appendix

Appendix A: Summary Table of Past Research with Looking Time Windows

Study name	Research questions	Age group	Stimuli	Measurement	Time window	Reasons for selected window
1. Looking while listening: using eye movements to monitor spoken language comprehension by infants and young children (Fernald, Zangl, Portillo, & Marchman, 2008)	Recognition/comprehension of familiar words	18, 24, 36 month English-speaking infants/toddlers	pictures of Isolated object	Looking-while-listening a. Onset-contingency (OC) plot (mean proportion of trials on which children have shifted from initial look (target-initial vs. distracter-initial) b. Proportion looking to target plot c. RT (the latency of first shift (between 333ms and 1800ms) away from the distracter toward the target, ANOVA)	RT: 333-1800ms from the onset of the target word ACC: 300-1800ms from the onset of the target word	300ms assumed to be necessary for processing the initial speech segments and mobilizing an eye movement; 1800ms is the onset of the second noun repetition

				d. Accuracy (mean looking time at the target as a proportion of total time on either target or distracter, averaged over a particular window, ANOVA)		
2. Names in frames: infants interpret words in sentence frames faster than words in isolation (Fernald & Hurtado, 2006)	Faster processing to familiar target words in a familiar sentence frame than to that in isolation	18-month-olds	Picture of objects	Looking-while-listening a. RT (ANOVA) b. Accuracy (tANOVA)	RT: 367-1800ms ACC: 367-1800ms	a. Based on previous analyses of shift distributions for 18- to 21-month-olds (Fernald, Swingley & Pinto, 2001) b. Shifts prior to 367ms were excluded because they occurred before the child had time to process sufficient acoustic input and mobilize an eye movement (Haith, Wentworth & Canfield, 1993) c. No justification for ACC

3. Input affects uptake: how early language experience influences processing efficiency and vocabulary learning (Fernald, Marchman, & Hurtado, 2008)	Study1: Maternal language inputs (at 18 months) influences vocabulary processing speed (at 24 months) Study2: who are faster to interpret a familiar word will be more successful in learning novel object names	Study1: Longitudinal at 18 months and 24 months Study2: 36 month olds	Picture of familiar objects	Looking-while-listening a. RT b. Proportion of trials shifting from distracter to target plot	RT: 300-1800ms	Shifts prior to 300ms were excluded because they occurred before the child had time to process sufficient acoustic input and mobilize an eye movement, shifts>1800ms were excluded as outliers less clearly in response to the target word
4. How vocabulary size in two language srelates to efficiency in spoken word recognition by young Spanish-English bilinguals (Marchman, Fernald, & Hurtado, 2010)	Speech processing efficiency in one language is related to vocabulary size in that language	Bilinguals 30 month old	Picture of real familiar objects	Looking-while-listening a. RT b. Mean proportion shifting to target on distracter-initial trials plot	RT: 300-1800ms	Shifted sooner than 300ms or later than 1800ms were excluded since these early and late shifts are not likely to be in response to the stimulus sentence (Fernald et al, 2008)
5. Twenty four-month-old infants' interpretations of novel verbs and nouns in dynamic	Mapping novel words (with grammatical form) to event category/object category	24-month-old	Video of live actors performing actions on inanimate objects	Familiarization phase; contrast phase; test phase Coding time course of looking behavior Proportion looking to the target	Baseline window: last 3 seconds (4s in total); Response window: onset	The response window closed 3s later because at this point, a new test question was initiated; The results are identical whether selecting the

scenes (Waxman, Lidz, Braun, & Lavin, 2009)				scene, with window as within-subject variable (baseline window vs. response window)	of the novel word to 3s later (8s in total)	first 3s, the last 3s or the full 4s for the baseline window
6. A horse of a different color: specifying with precision infants' mappings of novel nouns and adjectives (Booth and Waxman, 2009)	Mapping novel nouns and adjectives to object categories and properties	14- and 18-month olds	Pictures of familiarization objects	Familiarization phase; contrast phase; test phase Coding time course of looking behavior; multiple comparisons (ANOVA) for each window; found only in the third window, there was significant main effect for condition	Four 1-s windows after offset of the target words (0-1s; 1-2s; 2-3s; 3-4s)	Didn't justify the reason for the window selection
7. Live action: can young children learn verbs from videos? (Roseberry, Hirsh-Pasek, Parish-Morris, & Golin koff, 2009)	Mapping novel verbs from video	30-35 months; 36-42 months	Video + live person social interaction	IPLP: salience; training; testing Proportion looking to target	Over the total 6s window	

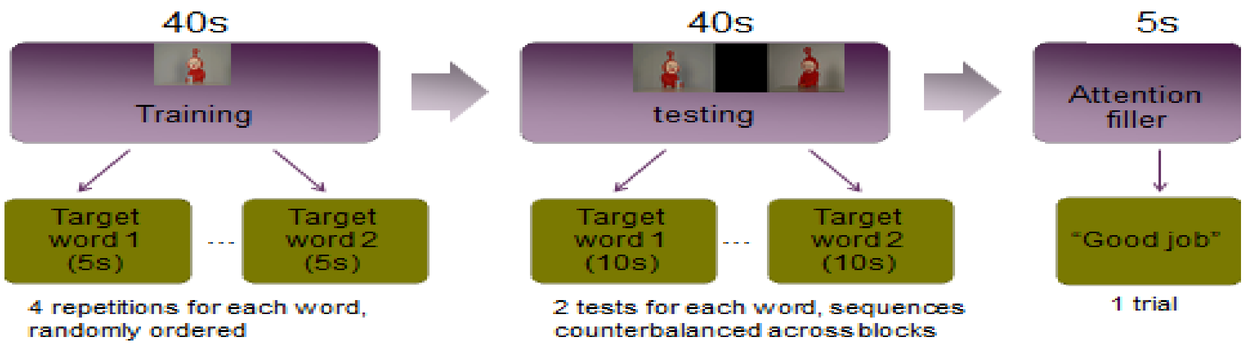
Appendix B: Full List of Sentences

audio inputs (5 s)	*Translation*
咦，看看这个苹果	Hey, look at the apple
喔，他有一个苹果	wow, he’ s got an apple
哇，那是他的苹果	oh, there’ s his apple
嘿，这是一个苹果	oo, this is an apple
咦，看看这本书	Hey, look at the book
喔，他有一本书	wow, he’ s got a book
哇，那是他的书	oh, there’ s his book
嘿，这是一本书	oo, this is a book
咦，看看这个球	Hey, look at the ball
喔，他有一个球	wow, he’ s got a ball
哇，那是他的球	oh, there’ s his ball
嘿，这是一个球	oo, this is a ball
咦，看看这块积木	Hey, look at the block
喔，他有一块积木	wow, he’ s got a block
哇，那是他的积木	oh, there’ s his block
嘿，这是一块积木	oo, this is a block
哪有他的苹果	Where’ s his apple
哪个是苹果	Which one is the apple
哪有他的书	Where’ s his book
哪个是书	Which one is the book
哪有他的球	Where’ s his ball
哪个是球	Which one is the ball
哪有他的积木	Where’ s his block
哪个是积木	Which one is the block

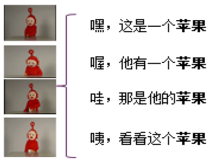
Appendix C: Example of Practice Items

"this is a larp." *"this is a gorp."* *"what if I say "larp?"*

Appendix D: General procedure and Sample of Specific Stimuli in One Block



	Left Side	Center	Right Side	Audio
Character introduction				你好
				你好
Training exposure (8 trials: 5 seconds each) (4 trials for each target word: apple & book) Training trials vary in three exposure approaches: Study 1:  嘿，这是一个苹果 Oo, this is an apple 哇，那是他的苹果 Oh, there's his apple Study 2:  嘿，这是一个苹果 喔，他有一个苹果 哇，那是他的苹果 咦，看看这个苹果				嘿，这是一个苹果
				oo, this is an apple
				喔，他有一本书
				Wow, he's got a book

Study 3: 				哇，那是他的书
				Oh, there’s his book
				咦，看看这个苹果
				Hey, look at the apple
Test (4 trials: 2 for each word; 10 seconds each trial with 5 second video plus 5 second frozen picture) (4 trials vary by the action contexts and the contrasted distractor) Test trials are identical across three exposure approaches				哪个是书?
				哪有他的苹果?
				哪个是苹果?
				哪有他的书?
Attention getter				真棒

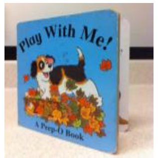
Appendix E: Test Conditions

Target word: apple		**Target side (action)**	
		old	new
Distracter (object)	old	Push apple-push book (a) (block1)	Bite apple-bite book (c) (block2)
	new	Push apple-push cup (b) (block2)	Bite apple-bite cookie (d) (block1)
Target word: book		**Target side (action)**	
		old	new
Distracter side (object)	old	Push book-push apple (a) (block2)	Bite book-bite apple (c) (block1)
	new	Push book-push cup (b) (block1)	Bite book-bite cookie (d) (block2)

Appendix F: Behavioral Task Materials

1. Post-test

A



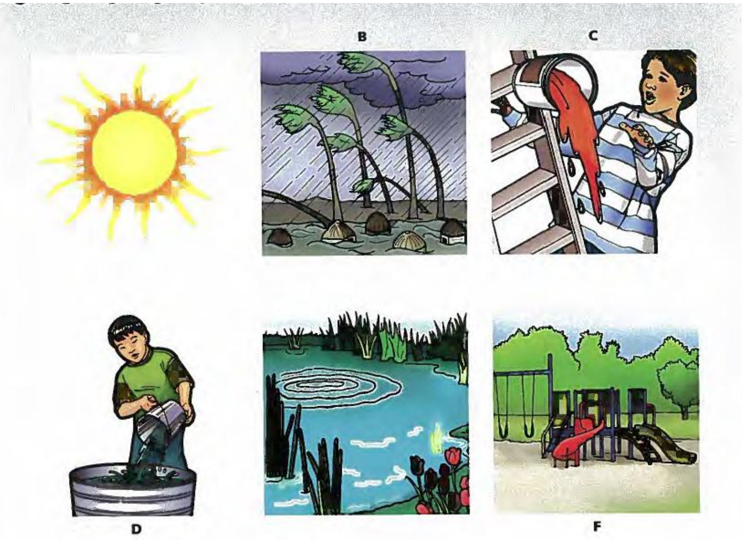
B

C

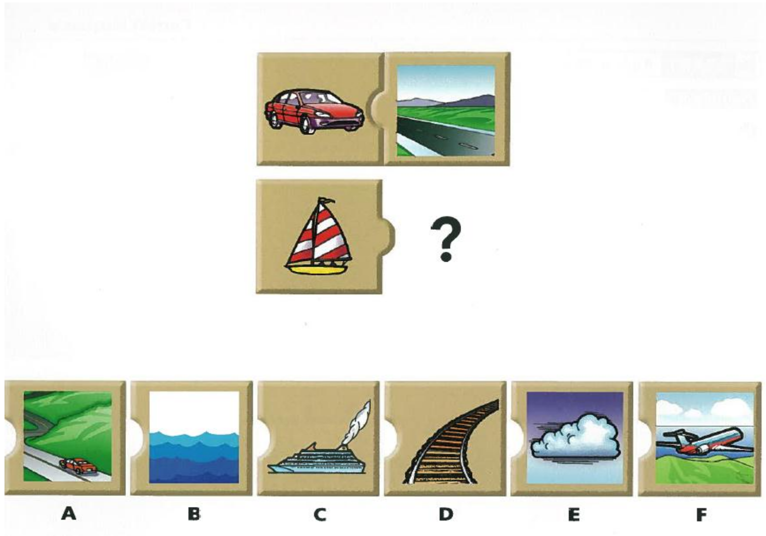
D

1. What are they called in Chinese? Response/Score: A____/____B____/____C____/_____D____/____
2. Which one is “苹果” _________ **C** response____ score___
3. Which one is “球” _________ **A** response____ score___
4. Which one is “积木” ________ **D** response____ score___
5. Which one is “书” ____________ **B** response____ score____
6. What are they called in English? Response/Score: A____/____B____/____C____/_____D____/____

2. Kaufman Brief Intelligence (K-BIT) ---a) verbal; b) non-verbal

a) 

"Storm"

b) 

3. Woodcock-Johnson® III: auditory working memory

Say, **I am going to name some things, like animals or foods, and some numbers, after I say them, you name the things in the same order that I said them. Then you tell me the numbers in the same order that I said them.**

We will begin with one number and one thing. Tell me the thing first, and then tell me the number. Give subject item A. If subject gives the digit first, score the item 0 and say, **Remember, tell me the thing first, then the number. Now try it again.** Repeat item A.

A. 3…dog — A. ______ dog ______ 3

Say, **now I will say more things and numbers. Remember, tell me the thing first and then the number.** Administer item B. If the child says the digits first, score the item 0 and say, **Remember, tell me the thing first, then the number. Now try it again.** Repeat item B.

B. 9…apple — B. ______ apple ______ 9

Administer items 1 – 3. If the subject gives the digit first for any item, score the item 0 and say, **Remember, tell me the thing first, then the number.**

1. shoe…6 — 1. ______ shoe ______ 6
2. 5…bird — 2. ______ bird ______ 5
3. 2…meat — 3. ______ meat ______ 2

Say, **Now I will say more things and numbers. Always tell me the things first in the same order, then tell me the numbers in the same order. When it gets too hard, just tell me anything that you can remember.** Administer Item C. If the child says the digits first, score the item 0 and say, **Remember, tell me the things first, then the numbers. Now try it again.** Repeat item C.

C. 1…cat…milk — C. ______ cat, milk ______ 1

Administer the rest of the items. If the subject gives the digits first for any item, score the item 0 and say, **Remember, tell me the thing first, then the number.**

4. 8…sweater…5 — 4. ______ sweater ______ 8, 5
5. frog…2…hat — 5. ______ frog, hat ______ 2
6. 7…fruit…house — 6. ______ fruit, house ______ 7

4. Pimsleur Language Aptitude Battery: a) sound discrimination; b) language analysis; c) sound-symbol association

2. Sound Discrimination

Listen to the tape…

1 cabin boa	**11 boa friend**	**21 cabin boa friend**
2 cabin boa	**12 boa friend**	**22 cabin boa friend**
3 cabin boa	**13 boa friend**	**23 cabin boa friend**
4 cabin boa	**14 boa friend**	**24 cabin boa friend**
5 cabin boa	**15 boa friend**	**25 cabin boa friend**
6 cabin boa	**16 cabin boa friend**	**26 cabin boa friend**
7 cabin boa	**17 cabin boa friend**	**27 cabin boa friend**
8 boa friend	**18 cabin boa friend**	**28 cabin boa friend**
9 boa friend	**19 cabin boa friend**	**29 cabin boa friend**
10 boa friend	**20 cabin boa friend**	**30 cabin boa friend**

a)

Language Analysis, *continued*

LIST OF WORDS:

gade.................. . ..father, a father
shi..................... ...horse, a horse
gade shir le............Father sees a horse.
gade shir la............Father saw a horse.
be................... ....carrries

Using the above list, figure out how to say each of the statements below. As soon as you decide how to say a statement, look at the four answers given beneath it and choose the one which agrees with yours.

1 Father carries a horse.
[a] gade shir be [b] gade shir ba
[c] shi gader be [d] shi gader ba

2 Father carried a horse.
[e] gade shir be [f] gade shir ba
[g] shi gader be [h] shi gader ba

3 A horse carried Father.
[a] gade shir be [b] gade shir ba
[c] shi gader be [d] shi gader ba

4 A horse carries Father.
[e] gade shir be [f] gade shir ba
[g] shi gader be [h] shi gader ba

The list below contains the same words as the list above and some additional ones. Use this list in figuring out how to say the statements in problems 5 through 15.

gade...............father, a father	**so**.................I, me
shi.................horse, a horse	**wo**...............you
gade shir le.......Father sees a horse	**so shir le**.........I see a horse
gade shir la.......Father saw a horse	**sowle**.............I see you
be..................carries	**so shir lem**.......I don't see a horse

5 You carry me.
[a] sowle [b] sowbe
[c] wosle [d] wosbe

6 You saw Father.
[e] wo gader le [f] so gader le
[g] so gader la [h] wo gader la

7 I carried you.
[a] wosba [b] sowbe
[c] sowba [d] sowla

8 You carried Father.
[e] wo gader ba [f] wo gader be
[g] wo gade ba [h] so gade be

9 You saw me.
[a] sowla [b] wosba
[c] wosla [d] wosle

10 You don't carry a horse.
[e] wo shir lem [f] wo shir bem
[g] wo shir bam [h] wo shi bem

11 You don't see me.
[a] sowlem [b] wosle
[c] wosolem [d] woslem

12 I didn't carry Father.
[e] so gader bam [f] so gade bam
[g] so gader bem [h] so gader lam

13 You saw a horse.
[a] wo shir le [b] wo shir la
[c] wo shir be [d] wo shir ba

14 I didn't see you.
[e] woslam [f] sowlam
[g] sowlem [h] woslem

15 Father doesn't carry a horse.
[a] gade shir bem [b] shir gader bem
[c] gade shi bem [d] gade shir bam

STOP! GO BACK TO CHECK YOUR WORK.

b)

PART 6 SOUND-SYMBOL ASSOCIATION

SAMPLE trapled tarpled tarpdel trapdel	**1** snosfen sonsfen snosnef sonsnef	**2** thurksle thruksle thruskle thurskle	**3** tiksgel tigskel tiskgel tigksel	**4** nimbril minbirl nimbirl minbril
5 thorleg throgle thorgle throleg	**6** rosktrag rostkrag roskstrag rotskrag	**7** afrap arfap afpar arpaf	**8** culther cluther cuthler cluthler	**9** wotner wontner wonter wentnor
10 rielig rigiel riegiel rielieg	**11** tronbleg tornbleg trolbneg torlbneg	**12** clasket calsket clakset calkset	**13** widnt windt witnd wintd	**14** nasperdop napserdop napseprod naspeprod
15 mazordli marzodli madorzli marodzli	**16** cheblogez cheboglez chelbogez chelgobez	**17** filsanter fislanter fislatner filslatner	**18** krimsloder krilsmoder klimsroder klidsmoder	**19** nasfoshun nafsoshun nashfosun nafshosun
20 birilum bririlum birilnum bririlnum	**21** kriblultos krilbultos kirblultos kirlbultos	**22** saferkal sakerfal safekral sakrefal	**23** trazbimen trambizen tranbimez trazbinem	**24** tolandus todandlus toldandus tolandlus

c)

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