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Rhyme: A Tool for Word Learning

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To the Graduate Council:

I am submitting herewith a thesis written by Kristen Elizabeth Thompson Mills entitled "Rhyme: A Tool for Word Learning." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.

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Abstract

To become successful readers, children must be able to recognize how changes in sound correspond to changes in word meaning. Rhymes, which contain minimal pair words that differ in their initial phoneme but share final vowels and codas (e.g., the *cat* in the *hat*), are often used in preschool and kindergarten classrooms as a tool to promote literacy and word learning. Although young language learners can generally discriminate minimal pair words, they often show difficulty when asked to assign them as labels for separate novel objects. The present experiment investigated the role of experience with rhyme on the mapping of minimal pair words to novel objects. Fourteen-month-old infants participated in two conditions, a Rhyme condition and a Repetition condition, administered one week apart. Order of presentation was randomized across participants. In the Rhyme condition, infants were familiarized with a nonsense story that contained 12 target rhyming words (e.g., *fin*, *hin*, *zin*) along with 28 non-rhyming filler words, arranged into rhythmic couplets (e.g., Lat *kin* mo lu *vin*, Pab roo mip fi *nin*). In the Repetition condition, infants were familiarized with a second nonsense story in which the target words repeated (e.g., Lat *rin* mo lu *rin*, Pab roo mip fi *rin*). Following familiarization, infants were presented with two novel object-label pairs (e.g., *bin/gak* paired with Object A and *din/pak* paired with Object B). Learning of these object-label associations was then tested using a Visual Choice Procedure, where both objects appeared simultaneously while a single label was presented in a carrier phrase (e.g., *Look at the bin! Bin!*). Accuracy and reaction time to target were assessed through offline coding of infant eye gaze data. No significant effect was found for Condition or Target Label. Results suggest infants did not sufficiently learn the novel object-

label pairs and perhaps, more referential support or a less cognitively demanding task than the one used in the current study is needed to map minimal pairs.

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Chapter 1

Introduction

Reading is a skill of vital importance in today's society. Early assessment of reading ability is important for the prediction and possible intervention of potential reading deficits. As such, much research has been devoted to understanding and predicting literacy indicators and outcomes (e.g. Mann & Liberman, 1984). Numerous factors have been explored to gauge and predict literacy ability, including measures of intelligence (Bryant, MacLean, Bradley, & Crossland, 1990), socio-economic status (Purcell-Gates & Dahl, 1991), home environment (Bast & Reitsma, 1998), and maternal education (Bryant, et al., 1990).

Government and educational institutions frequently implement new criteria and programs to improve literacy prevalence, such as setting high standards and assessments soon after children enter school (Bodrova, Leong, & Paynter, 1999). There are also numerous organizations devoted to promoting literacy through community outreach (e.g., The National Center for Literacy Education, International Reading Association, The Dolly Parton Imagination Library Program, etc.). But, what does it really require for a child to learn to read? How do children acquire an understanding of what a word is and what it represents? This paper will explore word learning in infants and the potential benefits of rhyme in the service of learning to map sounds to meaning.

Phonological awareness

Phonological awareness can be conceptualized as an umbrella term that encompasses the awareness of onset, rime, phonemes, and syllables within words in spoken language (Anthony & Francis, 2005). An example of phonological awareness is the ability to recognize that *bat* and

boat both share the same initial /b/ sound even though the words mean two different things (Blachman, 2000). Numerous studies have demonstrated that better phonological awareness is associated with a greater reading aptitude (for a review, see Sodoro, Allinder, & Rankin-Erikson, 2002), and higher levels of phonological awareness appear to positively correlate with reading ability later in life (Wimmer, Landerl, Linortner, & Hummer, 1991).

One specific skill included among phonological awareness skills is the ability to recognize how individual sounds function within words to differentiate word meaning. This skill is commonly referred to as *phonemic awareness*. In English, for example, *hat* can become *bat* by changing the initial phoneme. Pairs of words, like *hat* and *bat,* whose meanings are different and unrelated, and whose phonological forms differ by a single phoneme are called minimal pairs. The awareness and understanding of these sounds and sound changes is imperative for young readers, and this awareness is accepted as one of the primary indicators and predictors of literacy ability (e.g., Bradley & Bryant, 1983; Kirby, Parilla, & Pfeiffer, 2003).

Early sensitivities to rhyme and utility as a pre-literacy skill

Sensitivity to rhyme begins early in development. In utero, fetuses are able to recognize recordings of their mother's voice reciting a rhyming story (DeCasper, LeCanuet, Busnel, Granier-Deferre, & Maugeais, 1994). As early as 7 ½ months, infants demonstrate sensitivity to minimal pairs formed from rhyming words (Hayes, Slater, & Brown, 2000). To demonstrate a preference for rhyming words, children minimally need to be able to discriminate the onsets of words, which are the phonemes that differ across rhyming words, and studies have shown children can do this at an early age (e.g., Swingley, 2005; Swingley, 2009). Even before children enter school, they are exposed to rhyme through storybooks, songs, and nursery rhymes. Using a

Conditioned-Head-Turn procedure, Hayes, Slater, & Brown (2000) tested whether 7 ½-month-old infants could discriminate words both within and between rhyming categories. In their task, infants heard a CVC word repeated several times (e.g., *bad*) and then switched to either a rhyming word (e.g., *gad*), or a word in which only the vowel changed (e.g., *bed*). Infants were sensitive to the change in both conditions, demonstrating that infants can discriminate both between and within rhyming categories. Further, evidence that young children are sensitive to such minimal pairs involving changes in rime comes from Glenn and Cunningham (1983) whose research demonstrated that 9-to 18-month-old normally developing children and children with Down's syndrome prefer listening to rhyming stories as opposed to non-rhyming stories in an auditory preference task.

Rhyme has also been used in many preschool and kindergarten classrooms as a fun and interesting tool for learning words and developing categorization skills (e.g., Kleeck & Gillan, 1998; Yopp & Yopp, 2000). Exposure to and knowledge of rhyme also appear to be significant contributors to later reading success (Bradley & Bryant, 1983; Bryant, Bradley, MacLean, & Crossland, 1989; MacLean, Bryant, & Bradley, 1987). Pre-school-aged children can recognize rhyme in a forced-choice procedure (Lenel & Cantor, 1981) and a longitudinal study by Bryant and colleagues (Bryant, et. al., 1990) found that rhyme recognition is correlated with later phonological awareness and may serve as a predictor of later reading success. Further, Gathercole, Willis, and Baddeley (1991) found that rhyme awareness might act as a promoter for literacy in 4-and 5-year-old children when measures including phonological memory, rhyme awareness, non-verbal intelligence, reading measures, and vocabulary were considered. These

authors also suggested there may be an underlying mechanism children use for both rhyme awareness and reading comprehension that could be contributing to the observed correlation.

Linking phonological development with phonological awareness

Phonological awareness is a process that evolves throughout early development. Infants are born with the ability to discriminate many of the sounds found across the world's languages (e.g., Best, McRoberts, & Sithole, 1988; Trehub, 1976). Through experience with their native language, infants perceptually narrow their focus around 10 to 12 months of age (e.g., Werker, 1989; Werker & Tees, 1984), exhibiting an increased ability to discriminate some native language sounds, while demonstrating a decreased ability to discriminate many non-native sounds. For example, English-learning infants maintain two distinct sound categories for the /r/ and /l/ sounds, whereas Japanese-learning infants collapse the two sounds into one category since the /r—l/ distinction is not useful for speaking Japanese (Eimas, 1975). Perceptual narrowing may be beneficial for infants because the awareness of these sound differences may help them to later become successful readers.

Specificity of infants' phonological representations

Some research has suggested that infants begin with very holistic representations for words, or that representations are not composed of discrete consonant-vowel sequences (Jusczyk & Derrah, 1987), while others propose that infants' initial word representations are actually quite detailed (for a review, see Newman, 2008). Over the course of development, infants begin to ignore salient acoustic features of spoken language if they do not provide meaning (e.g., Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992; Werker & Tees, 1984), and less salient features

become highlighted according to the linguistic relevance for the infant (e.g., Kuhl, Stevens, Deguchi, Kiritani, & Iverson, 2006; Narayan, Werker, & Beddor, 2010).

Although infants demonstrate an ability to discriminate language-specific phonemes, they appear to have a difficult time accessing that knowledge during early word learning. For example, although 14-month-olds can discriminate minimal pair words when no nameable objects are present, they show difficulty assigning them as labels to two different novel objects (Stager & Werker, 1997). In contrast, when 14-month-olds are placed in a word-learning task where the stimuli differ by more than one phoneme (e.g. *liff* and *neem*), they display no difficulty mapping those words to novel objects (Werker, Cohen, Lloyd, Casasola, & Stager, 1998).

Werker and colleagues (1998) have suggested that to be successful in a minimal pair mapping task, infants need to have two separate representations for two different sounds. For example, infants need to represent the differences in the sounds (e.g., the initial consonants of *bin* and *din*), as two separate object labels. The developmental framework for Processing Rich Information from Multidimensional Interactive Representations (PRIMIR) (Werker & Curtin, 2005) provides a model for language development that describes the infant's experience with language and its relationship to word learning and forming a lexicon. PRIMIR suggests that similar sounding words (like *bin* and *din*) overlap on multiple features, like the phonetic and indexical dimensions, making them difficult to dissect in the context of an object-label mapping task. This model also suggests that perhaps the difficulty observed in a minimal-pair mapping task is one of attention. Infants possess all of the information necessary to complete this task, but struggle to hone in on just the features that differentiate the two words (Werker & Curtin, 2005).

However, by 17-20 months of age, infants are typically more successful at mapping minimal pair labels to novel objects (Werker, Fennell, Corcoran, & Stager, 2002). Initial interpretation of this research suggested that object-label mapping is too cognitively taxing for younger word-learners and as such they do not have sufficient resources available to attend to the phonetic details in the minimal pair words (Werker, et al., 2002). Further, PRIMIR (Werker & Curtin, 2005) suggests that 14-month-old infants do not have the ability to narrow in on only the phonemic differences between minimal pair words and this attention deficit improves throughout early development. Thus, infants' phonological representations may not be particularly robust at 14-months, but rather develop over the first few years of life as infants figure out how to perceptually weight the various speech cues in their input (Apfelbaum & McMurray, 2011; Galle, Apfelbaum, & McMurray, 2014; Rost & McMurray, 2009; 2010). Interestingly, other recent work has suggested that young infants can be successful at a minimal pair mapping task if they are provided with social and/or referential support (Fennell & Waxman, 2010).

Many studies examining early object-label associations, including the studies described above, have used a Switch paradigm (Werker et al., 1998), in which the infant is habituated to two object-label pairings, then presented with two different types of trials (Same and Switch). During Same trials, the original object-label pairings remain consistent. During Switch trials, the object-label pairings are switched, such that object A is paired with label B and vice versa. An increase in looking time to Switch relative to Same trials is an indicator that the infant noticed a change in the object-label pairing. Although the Switch procedure is one of the most popular methods for gauging infant word learning, other methods such as the Visual Choice procedure, have been used when examining infant mapping of minimal pairs (Ballem & Plunkett, 2005;

Colombo, Mitchell, & Horowitz, 1988; Yoshida, Fennell, Swingley, & Werker, 2009). During a Visual Choice procedure, infants are first trained on two novel object-label pairings and are then visually presented with two objects. Their task is to find the aurally labeled target object. Using components of both the Switch and Visual Choice paradigms Yoshida, et al. (2009) demonstrated that 14-month-olds could learn minimal pair words. In their study, infants were first habituated to the minimal pair words *bin* and *din* paired with novel objects, as is characteristic of the Switch paradigm, and then infant learning was tested with a Visual Choice procedure. Infants succeeded in mapping phonetically similar labels (*bin* and *din*) to two different objects, although infant performance was still quite poor (accuracy of 53%). This study suggests that the testing component of the Switch paradigm is less sensitive than the Visual Choice procedure and masked evidence of learning for minimal pair mapping. Thus, the failure observed in minimal pair mapping in young infants may be partially due to the testing procedures used.

PRIMIR (Werker & Curtin, 2005) proposes that the differences seen in performance from the Switch to the Visual Choice procedure can be attributed to the development of varying ‘developmental filters’ that interact with the task the infant is participating in. The authors suggest that as the infant develops a more robust lexicon, a greater number of phonemes are acquired. This word learning process (the acquisition of phonemes) is thought to be the driving mechanism for directing the infant’s attention to the phonemes that change across minimal pair words. Werker and Curtin (2005) pose that a larger lexicon can enhance performance because past work has noted that infants with larger vocabularies perform better on minimal pair learning tasks (Werker, Fennel, Corcoran, & Stager, 2002).

Another way to examine infant's early phonological representations is through studying their perception of words that are mispronounced. At 12 months of age, infants demonstrate a preference for the correct pronunciation of familiar words (Swingley & Aslin, 2000; Swingley, 2005) and notice onset mispronunciations (e.g., baby → vaby; Swingley & Aslin, 2000), suggesting infants may have a relatively stronger representation for familiar than novel words. In a separate study, Dutch-learning 11-month-olds preferred listening to correct pronunciations of familiar words more so than onset consonant mispronunciations. However, when the consonant mispronunciation was located at the *offset* of the familiar words, infants did not show a listening preference, suggesting a weaker phonological encoding or representation for the unstressed portion of the word (Swingley, 2005).

Mispronunciations are not only noticed in familiar words, but infants also demonstrate sensitivity to mispronunciations of newly learned words. Swingley (2007) pre-familiarized 18-to 20-month-old infants with a bisyllabic novel word within the context of a story then tested recognition of the word and a mispronounced variation of the word, using the Visual Choice paradigm. Two groups of infants were tested: the first group (pre-exposure condition) received exposure to the word used in the story as a label for an object and the second group (control condition) was similarly trained on an object-label paring; however, the label never occurred during the pre-training story. Infants in both the pre-exposed and control conditions demonstrated a preference for the correct pronunciation of the novel word; however, when the novel word was mispronounced, infants who were pre-exposed to the novel word were much more sensitive to the mispronunciation than the control group. This study provides support for the idea that infants demonstrate stronger representations for familiar words than novel words

and further, that the more exposure to a word an infant receives, the stronger the representation for that word becomes.

Many changes can be interpreted as a word mispronunciation. For example, White, Morgan, and Wier (2004) examined 19-month-olds' sensitivity to word mispronunciations by presenting them with a forced-choice procedure in which two objects were presented on a screen and the infants were instructed to look at one of the objects. Across trials, the object label would remain correctly pronounced, or change by one (e.g., place), two (e.g., place and voicing of articulation), or three feature changes (e.g., place, voicing, and manner of articulation). As the number of feature changes increased, the less likely the infant was to treat that word as a correct pronunciation. Minimal pair words may also differ by a single or multiple feature change. A singular feature change may be a change of place, manner, or voicing. A multiple feature change would indicate the minimal pair words differ by some combination of feature changes (e.g., place and manner). This work suggests that a multiple feature change is more salient to an infant than a single feature change and could therefore help the infant notice the phoneme changes that occur across the minimal pair words and better succeed in a minimal pair mapping task.

Current study

In the present study, I explored the possibility that experience with rhyme might improve minimal pair mapping. Fifteen-month-old infants were first familiarized with a nonsense story that contained 12 rhyming words (e.g., *fin, hin, zin* or *lak*, *jak*, *rak*; Rhyme condition) along with 28 non-rhyming filler words, then completed a Visual Choice, minimal pair object-label mapping task, where the target labels (e.g., *bin* and *din* or *pak* and *gak*) and objects were both novel. I

chose to test slightly older infants here since 14-month-olds continue to perform quite poorly even when tested using more sensitive methodologies (Yoshida et al, 2009).

Since the PRIMIR model (Werker & Curtin, 2005) proposes that the information presented to the infants is enough to differentiate the minimal pair, but the difficulty lies in infant attention to word onset, I hypothesized that experience with rhyme may promote access to phonological representations in minimal pair words through increasing the infant's attention to phonetic details at word onsets. Alternatively, experience with word endings (e.g., -*in* or -*ak*) may make word forms familiar enough to the infant, and thus may reduce the cognitive load associated with early minimal pair object-label mapping. Perception of speech sounds could be working with the infant's developing lexicon to aid that infant to pay attention to the phonemes that differ across the two words (PRIMIR; Werker & Curtin, 2005; Curtin, Bayes-Heinlein, & Werker, 2011). Numerous studies have suggested that familiarity with a word enhances infants' access to phonetic detail (e.g., Swingley, 2005). In order to contrast these two potential explanations for any facilitation effect, I designed a control condition where infants received the same nonsense story, but instead of being presented with 12 rhyming words, the same word (e.g., *rin* or *lak*) was repeated (Repetition condition). Thus, if infants were relying on familiarity with the word endings then I expected to see similar performance across the two conditions. Alternatively, if experience with rhyme enhanced infants' ability to attend to the phonetic details at the onset of words, then I expected infants to perform better in the Rhyme condition than the Repetition condition.

Each infant participated in two conditions (Rhyme and Repetition), separated by one week. For example, if the infant participated in the Rhyme condition first, when they returned,

they participated in the Repetition condition. Further, if during the first visit, an infant was taught that *bin* and *din* were labels for objects one and two, then during the second visit, the infant was taught *pak* and *gak* were labels for objects three and four. The *bin* and *din* object labels differed by one feature change (place of articulation), whereas the *pak* and *gak* object labels differed by multiple feature changes (place and manner). Since infants have demonstrated a detailed representation for learned words (Swingley & Aslin, 2000), I also hypothesized that infants would demonstrate better performance in the *pak* and *gak* condition than the *bin* and *din* condition because a multiple feature change should be more perceptually salient to the infant and therefore easier to learn.

Chapter 2

Materials and Methods

Participants

Thirty-two 14.5-to 15.5-month-old infants (*M* = 14.8 months, range: 14-15.6 months) served as participants in this study (17 males and 15 females). Twenty-three infants provided data at two time points, with the remainder providing data at a single time point, for a total of 55 data points included in the final analyses. Seven additional infants were run but were excluded from the analysis on their first visit due to fussiness (6) and experimenter error (1). Three additional infants were run but were excluded from the analysis on their second visit due to fussiness. Four infants participated at time one but never returned for their second visit. Participants were recruited through the Child Development Research Group database maintained in the department of Psychology at the University of Tennessee, Knoxville, and through community outreach initiatives in the greater Knoxville area. All infants were monolingual American English listeners, born full-term with no hearing, vision, or health deficits or delays, as indicated by parental report.

Apparatus

The study was conducted in a dimly lit sound attenuated IAC booth. The internal walls of the booth were draped in black fabric to reduce any potential distracters. Visual stimuli were displayed on a 42-inch television monitor. A digital video camera was mounted below the television monitor to record and relay the infant's behavior to the experimenter in the control room. Auditory stimuli were presented at approximately 65dB via centrally mounted speakers. The experimenter used an in-house software program (WISP; program developed internally in

the Language Learning Lab at the University of Wisconsin) via a Dell computer to control the trials and infants' looking behaviors were recorded in iMovie on a MacMini. The experimenter was blind to the stimuli presented and all videos were coded off-line.

Stimuli and procedure

Prior to testing, all procedures were described to the caregiver who completed a consent form. Infants sat on their caregiver's lap approximately one meter from the television monitor. Caregivers wore circumaural headphones playing lyrical music to prevent the caregiver from hearing what was presented and unintentionally biasing the infant's attention. The experimenter was seated in an adjoining control room and immediately began the experiment, which consisted of three phases: Familiarization, Learning, and Testing. All auditory stimuli were recorded by a monolingual female native American English speaker.

Infants were first presented with the Familiarization phase. Familiarization consisted of a nonsensical story, in which all words were phonotactically probable in English. In each story, there were four, two-sentence couplets with five monosyllabic words per phrase. In the Rhyme condition, each two-sentence couplet had three unique target words. Target words were minimal pair words that rhyme (e.g., *kin*, *vin*, and *nin* from the couplet "Lat *kin* mo lu *vin*, pab roo mip fi *nin*"). The Repetition condition followed the same pattern; the target words remained in the same location (e.g., *rin* from the couplet "Lat *rin* mo lu *rin*, pab roo mip fi *rin*")(see Table 1; Appendix A). Each story was repeated four times during familiarization for a total duration of approximately two minutes twenty seconds. During the presentation of the nonsense story, infants watched an animated cartoon to help maintain their attention.

Following Familiarization, infants participated in a Learning phase. The experimenter initiated each trial when the infant fixated on a pinwheel presented on the television monitor. During Learning, infants were taught two novel object-label pairs. On each trial, six tokens of a single label that varied in intonation (duration varying between 620 ms and 630 ms) were presented with an inter-stimulus interval (ISI) of 600 ms. Total trial length was ten seconds. It should be noted that the target tokens were not included in the familiarization nonsense story and had therefore, never been heard by the infants. Target visual stimuli were computerized novel objects that bounced in an arch pattern across the screen while the target word was aurally presented. The presentation of the label was not yoked with the movement of the objects. Infants were presented with 12 training trials; six for each object-label pair.

Once Learning was completed, participants proceeded to testing. On each trial of the testing phase, infants were presented with pictures of two familiar objects (e.g., *book* and *car* or *doggy* and *baby*) or the two target objects from training (e.g., *bin* and *din* or *pak* and *gak*). On all test trials, objects were presented in the lower left and lower right corners of the screen per the standard protocols for the Looking-While-Listening procedure (Fernald, Zangl, Portillo, & Marchman, 2008) (see Figure 1; Appendix A). Label onset began 2500 ms after the objects were presented to give infants sufficient time to look at both objects. During the novel word test trials (Figure 2; Appendix A), target words from training were aurally presented in a carrier phrase (e.g., “Look at the pak! Pak!”). During familiar word test trials (Figure 3; Appendix A), infants heard one of the familiar labels also presented in a carrier phrase (e.g., “Kitty! Find the kitty!”). Animate objects were paired together and inanimate objects were paired together. Each test trial was 6.5 seconds long.

Each infant participated in two conditions (Rhyme and Repetition), which were administered one week apart. So for example, if the infant participated in the Rhyme condition first, when they returned one week later, they participated in the Repetition condition. Further, if during the first visit, an infant was taught that *bin* and *din* were labels for objects one and two, then during the second visit, the infant was taught *pak* and *gak* were labels for objects three and four. Different familiarization videos, novel objects, and familiar objects were used for each visit to the lab. Testing consisted of 32 trials: 16 target and 16 familiar. Across all conditions, the first two test trials were familiar trials, to orient the infant to the nature of the task, followed by two novel test trials, then a quasi-random order of familiar and novel trials was used for the remaining 28 trials. Order of object-label presentation was counterbalanced across conditions.

Following testing, the caregiver completed a MacArthur-Bates Communicative Development Inventory (MCDI; Fenson, Dale, Reznick, Bates, Thal, & Pethick, 1994) and a questionnaire with basic demographic information. All sessions were recorded and coded off-line. Off-line coding was completed frame by frame (30 frames per second) and in accordance with protocols outlined by Fernald, Zangl, Portillo, & Marchman (2008).

Design for Analysis

A 5-way mixed-model ANOVA was conducted to determine significant interactions and main effects. Condition, Target Label, and Time Order (e.g., infant lab visit one or lab visit two) were analyzed as within subject factors, and Sex and Order of Condition were analyzed as between subject factors. The dependent variables were (1) Accuracy, which was the proportion of time the infant spent looking at the labeled target object during the target window (367 ms to 2000 ms following label onset; see justification for target window criteria in the results section)

and (2) Reaction time (RT), which was the amount of time it took for the infant to fixate on the target object following label onset (trials in which infants were fixated on the target at label onset were not included in the RT analysis). In the case that Time, Sex, and Time Order were not significant, follow-up 2 way mixed-model ANOVAs and *t* tests (all *t* tests were two-tailed) were run to determine the effects of Condition and Target Label on Accuracy and RT. Effect sizes for the ANOVAs were reported as Partial Eta Squared, and effect sizes for the *t* tests were reported as Cohen's *d*. Normality measures were also conducted for all ANOVAs and no significant effects were found, indicative of a normally distributed sample.

Chapter 3

Results

Vocabulary Analysis

MCDI scores were obtained for 31/32 infants who visited the lab. If infants returned for the second visit, MCDI scores were obtained for both visits. Comprehensive vocabulary, as reported by the caregiver, ranged from 9 to 78 words (M = 30.63, SD = 11.839) and spoken vocabulary ranged from 0 to 26 words (M = 8.2, SD = 5.8).

Reliability coding

Reliability coding was conducted to ensure that coding was consistent across coders. Reliability coding criteria for the current study was modeled after criteria set by the Stanford University Language Learning Laboratory (Fernald et al., 2008). Twenty-five percent of the data was coded by a second coder to assess inter-rater reliability and two outcome scores were compared. The first score was an entire-trial agreement score, which reflects the total amount of time that both coders agreed a certain action occurred during a frame (33 ms window). In order to be considered as being in agreement, coders could differ by no more than one frame. The current study had a 97.7% entire-trial agreement score, which is above the standard match criterion of 95%. The second score was a shift-specific agreement score, which reflects the number of frames from the initiation to the end of an eye shift for every trial that the infant shifted eye gaze three or more times. The current study had a 94.8% shift-specific agreement score, which is above the match criterion of 90% used in previous studies.

Accuracy

Two analysis windows were used for each trial. The *baseline window* began at the onset of object presentation and ended 2500 ms later, at label onset. The *target window* began 367ms after label onset and ended 2000 ms after label onset (Figure 4; Appendix B). The target window criterion was chosen based on previous work by Fernald and colleagues (Fernald, et al., 2008). Infants need approximately 367 ms to initiate an eye movement in response to an auditory label (Fernald, et al., 2008), and Fernald's work (Fernald, et al., 2008) suggests that after 2000 ms, eye gaze is no longer associated with the auditory labels.

Accuracy was examined two different ways; first, infant looking behavior was analyzed in the target window and a proportion of looking at each object was calculated. Second, a change in the proportion of looking to the labeled object from baseline to target window was calculated. If infants know, or have learned the object-label association, it was expected they would increase their looking to the labeled object from the baseline to the target window and to show an overall greater proportion of looking to the labeled over unlabeled (distracter) object in the target window.

The 5-way mixed-model ANOVA revealed no main effects of Time, Sex or Order of Condition and so all subsequent analyses were performed collapsing across these variables. To examine the effects of Condition (Rhyme vs Repetition) and Target Label (single vs multiple feature change) on accuracy during the target window, I performed a mixed-model ANOVA. The ANOVA revealed no significant main effects of Condition, $F(1,51) = .372$, $p = .545$, $\eta_p^2 = .007$, or Novel Label, $F(1,51) = .079$, $p = .779$, $\eta_p^2 = .002$. The Condition X Target Label interaction was also not significant, $F(1,51) = .981$, $p = .327$, $\eta_p^2 = .019$.

Over all 16 novel test trials, the mean proportion of fixation to the novel labeled object was 49% (baseline = 51%) in the Rhyme condition, not significantly different from chance [$t(22) = -.424$, $p = .676$, $d = .155$], and the mean fixation to the novel labeled object was 50% (baseline = 49%) in the Repetition, also not significantly different from chance [$t(22) = .286$, $p = .778$, $d = .156$].

A second mixed-model ANOVA was conducted to examine change in accuracy for novel objects from the baseline to the target window. The ANOVA suggested no significant change in accuracy across the two windows regardless of what condition the infant was participating in, $F(1,51) = .038$, $p = .846$, $\eta_p^2 = .001$, or which target labels were being presented, $F(1,51) = .190$, $p = .665$, $\eta_p^2 = .004$. There was also no significant Condition X Target Label interaction, $F(1,51) = .348$, $p = .558$, $\eta_p^2 = .007$ (see Figure 5; Appendix B).

I wanted to confirm that infants could be successful in this task when presented with familiar objects, so I conducted two, one-sample *t* tests to examine accuracy for the *familiar* objects, and the results suggested that infants did recognize the familiar objects in both the Rhyme (M = 57%, $SD = .013$), [$t(27) = 2.655$, $p = .013$, $d = .710$] and Repetition (M = 57%, $SD = .1026$), [$t(26) = 3.641$, $p = .001$, $d = 1.807$] conditions significantly more than what was expected by chance.

A third mixed-model ANOVA was conducted to examine change in accuracy for familiar objects from the baseline to the target window, and the ANOVA revealed that infants show a significant increase in the proportion looking to the labeled familiar object between the baseline and target windows $F(1,51) = 12.229$, $p = .001$, $\eta_p^2 = .202$.

Reaction Time

At the onset of the label, infants may be looking at either the target object or the distracter object. If infants were looking at the target object when the label was presented, they should inhibit switching behavior and maintain eye gaze in the direction of the target. Conversely, if infants were looking at the distracter object at label onset, they should shift their looking to the target object. Reaction time, defined as the time it takes for the infant to fixate on the target object, was calculated for trials where infants were fixated on the distracter or looking away at label onset (Figure 6; Appendix B).

A mixed-model ANOVA was conducted to examine the effects of Condition (Rhyme vs Repetition) and Target Label (single vs multiple feature change) on infant reaction time to shift looking to the labeled novel object. There was no significant effect of Condition, $F(1,47) = 2.573$, $p = .115$, $\eta_p^2 = .052$, or Novel Label, $F(1,47) = .661$, $p = .420$, $\eta_p^2 = .014$; however, there was a significant Condition X Target Label interaction, $F(1,47) = 9.570$, $p = .003$, $\eta_p^2 = .169$. The significant effects observed in this interaction could be attributed to noise, since no main effects were present.

A Pearson Correlation was conducted to examine potential relationships between infant accuracy and reaction time for familiar word labels. As accuracy increased, reaction time significantly decreased for *familiar* objects, $r = -.378$, $p = .005$, suggesting a strong relationship between accuracy and reaction time for familiar words, which was expected because the faster the infant switches to the target object, the longer they are able to look at the target object. A significant correlation was also observed for reaction time to familiar and novel objects, $r = .376$, $p = .009$, which could indicate that there might be some individual differences in overall

processing speed in infants in this sample (Figure 7; Appendix B). However, this result should be interpreted with caution, as no significant learning was observed for novel words. Finally, accuracy and reaction time for *novel* objects were not significantly correlated, $r = -.221$, $p = .132$, such that as accuracy increased, reaction time did not significantly decrease.

Because infants were expected to learn and recognize new words, I expected comprehensive and spoken vocabulary size to be positively correlated with accuracy to familiar and novel words and negatively correlated to reaction time to the two different word types. Since there were no main effects or interactions present, it was important to examine whether or not the infant's comprehensive and spoken vocabulary size affected the way they performed during testing, and previous work has demonstrated this correlation with infants who participated in a Switch procedure (Werker, et al., 2002). Correlation measures suggested that neither comprehensive nor spoken vocabulary size were significantly correlated with novel reaction time, familiar reaction time, or accuracy to familiar or novel words. Comprehensive vocabulary scores for each infants' first and second visits to the lab were also not correlated, $r = -.193$, $p = .366$, which suggests that the caregivers were not very accurate in reporting their infant's vocabulary size and could have introduced some error into the measures of vocabulary size (Figure 8; Appendix B).

I also examined the shift latency from the target to distracter. If the infants learned the object-label pairs then I expected them to demonstrate a faster reaction time shifting from the distracter to the target as opposed to from the target to the distracter. I conducted a paired-samples *t* test which suggested infants did not demonstrate a quicker reaction time from the distracter to the target objects [$t(47) = .488$, $p = .628$, $d = .051$], indicating infants did not learn

the object-label pairs presented (Figure 9; Appendix B). The results also suggested that infants did not demonstrate a quicker shift from the target to the distracter regardless of whether they were participating in the Rhyme [$t(23) = 1.138$, $p = .267$, $d = .150$] or the Repetition [$t(24) = .240$, $p = .813$, $d = .051$] condition.

Chapter 4

Discussion and Conclusions

Methodological Limitations

Recent studies of minimal pair learning have demonstrated that referential support can improve word mapping (Fennell & Waxman, 2010) and that more sensitive testing procedures (e.g., Yoshida, 2009) may better reveal performance that is typically missed in the Switch task (e.g., Stager & Werker, 1997). In the current experiment, I explored the possibility that experience with rhyme facilitates minimal pair object-label mapping in 15-month-old infants. Experience with rhyming words that share word endings with the target words (e.g., *-in* or *-ak*), such as the rhyming words in the familiarization couplets, was predicted to facilitate minimal pair object-label mapping by promoting access to phonological representations through increased infant attention to phonetic details at word onsets. Alternatively, I suggested that experience with rhyme may function to facilitate minimal pair object-label mapping by making the word forms familiar enough to the infants to reduce the cognitive load associated with minimal pair learning. Many studies have suggested that familiarity with words enhances infants' access to phonetic detail (e.g., Swingley, 2005).

To contrast these two potential explanations for any facilitation effect, the current study used a control condition where infants received the same nonsense story as in the rhyming condition, where the same word (e.g., *rin* or *lak*) was repeated (Repetition condition). Therefore, if infants were relying on familiarity of the word endings, similar performance across the two conditions would be observed. On the other hand, if experience with rhyme enhanced infants' ability to attend to the phonetic details at the onset of words, then infants should have

demonstrated higher performance in the Rhyme condition than the Repetition condition. Since accuracy to the novel objects was not significantly different from chance for either the Rhyme or Repetition conditions, it seems likely that my manipulations did not reduce the cognitive load associated with this task. On the contrary, my manipulations may have actually increased the difficulty of the task. During Familiarization, infants listened to a novel artificial language composed completely of nonsense words, thus, the structure used here may have actually increased the cognitive load for infants by making it a more challenging learning environment. Any future extensions of this work should consider using a natural language with nonsense rhyming target words. Using natural language in the couplets that are familiar to the infant could significantly reduce the amount of attention needed during Familiarization and therefore allow the infants to hone in on learning the nonsense target words.

A second potential reason that infants in the current study did not demonstrate learning might be attributed to my experimental design. In the current study, infants received a fixed number of presentations of the object-label pairings. Some prior research examining minimal pair object-label mapping has used a habituation procedure instead of a fixed familiarization. During a habituation procedure, infants receive experience with the object-label pairs until they demonstrate a criterion performance (typically a 50% reduction in looking from the first to the last 3 habituation trials). This allows the learning experience to be individually tailored to each infant.

This type of learning procedure was used by Yoshida and colleagues (Yoshida et al., 2009) to study minimal pair mapping followed by a Visual Choice testing paradigm. The authors presented 14-month-old infants with a maximum of 24 habituation trials followed by 16

testing trials (8 target; 8 filler). Mean accuracy for looking to the labeled object in the target trials was 53%, which was significantly different from chance.

The current study did not use a habituation paradigm because I wanted to ensure that infants in both the Rhyme and the Repetition conditions received the same amount of familiarization with the object-label pairs. Although habituation allows for an individual gauge of learning, it is subject controlled and would not have ensured a fixed amount of exposure to the corresponding Rhyme and Repetition stories. A fixed amount of exposure to the minimal pair object-label pairs was critical for this study because the goal was to provide support for the notion that exposure to rhyme could facilitate early minimal pair mapping.

The difference seen across these two studies could be attributed to these differences in the Learning phases or to the fact that, on average, the infants in the current study received less overall experience with the novel object-label pairs. I chose to give kids 12 training trials of Learning exposure based on the average number of habituation trials used by Yoshida et al. (2009). I tried to provide comparable exposure, but may have inadvertently given the participants less experience with the object-label pairs. Infants in the Yoshida, et al. (2009) study received an average of approximately 42 repetitions of each novel label over an average of 12 habituation trials (range: 8 – 24). Although I presented all infants with 12 Learning trials, my trials were somewhat shorter than those used by Yoshida et al. (2009), and thus infants in the current study were only presented with 36 repetitions of each novel label during fixed exposure. Additional exposure to the object-label pairs during Learning may have led to significant results in the current study.

Previous studies have successfully improved learning of object-label pairs through the use of referential support (Fennell & Waxman, 2010). In the current study, carrier phrases were used during the Testing phase to provide infants with more information regarding the task. For example, during Testing, infants were presented with the carrier phrase, ‘Look at the bin! Bin!’ Including carrier phrases during the Learning phase for the current study (e.g., “Here’s the bin! Look at the bin! This is a bin!”) could have improved object-label mapping because it would have provided infants with even further referential support for the task of mapping the labels to the novel objects. However, prior work has obtained significant results for the minimal pair mapping task in 14-month-olds without carrier phrases (Yoshida, et al., 2009). I chose to exclude referential support during the Learning phase because the infants in the current study were slightly older than the infants who typically fail at this task and thus I would have expected them to be more successful. Further, I was concerned that the addition of carrier phrases during the Learning phase may have masked any type of benefit rhyme could be eliciting.

Unfortunately, the lack of learning in either the Rhyme or the Repetition conditions in the current study prevented me from making any definitive conclusions about the role of experience with rhyme on novel minimal pair mapping. It remains possible that experience with rhyme may function to increase attention to word onsets or reduce cognitive load as a result of increased familiarity with the word forms of the minimal pair words. Future studies will need to be conducted to test this possibility.

Theoretical Implications

Results from the current study suggest that perhaps infants were not able to attend to the differences in the target words in order to perceive them as different enough to map to two

separate novel objects. PRIMIR (Werker & Curtin, 2005) describes a theoretical framework in which different 'planes' emerge as infants gain more language experience and aid the infant in subsequent word learning. According to the PRIMIR model, once infants acquire a Phonemic plane, they should be able to notice the differences between words that are most crucial for distinguishing them. For instance, once infants have acquired a Phonemic plane, they will be able to pick out the initial consonants of *bin* and *din* to map them to different objects. However, before the emergence of a Phonemic plane, the infant is forced to sort through all of the overlapping information in the minimal pair words before they are able to detect the differences. Therefore, infants at 14-months of age may just be lacking the Phonemic plane, which could develop by 17-months of age during which time infants can then map minimal pair words to novel objects.

PRIMIR (Werker & Curtin, 2005) also makes some predictions about a distinction between raw salience and pereptual salience. Raw physical salience would include acoustic, phonetic, and visual characteristics. Perceptual salience would include attentional features like syllable stress. The authors propose that younger (14 months) infants may only be able to utilize raw saliency and are only able to access associative knowledge, whereas older infants (17-18 months) are able to access referential knowledge, indicitave of the use of perceptual saliency. Werker and Curtin (2005) also hypothesized that over the course of development, with specific reference to word learning, infants develop referential word learning, which is hypothetically linked with the emergence of the Phonemic plane.

In contrast to ideas proposed in the PRIMIR (Werker & Curtin, 2005) framework, Rost & McMurray (2009) suggested that the failure seen in differentiating minimal pairs may in fact not be attributed to one's general ability to differentiate phonemes, since mispronunciations of familiar words (e.g., *baby* → *vaby*) is demonstrated by 14-month-old infants. Instead, Rost and McMurray (2009) propose that infant phoneme discrimination may be a needs-based process, meaning that the infant acquires the ability to discriminate certain phonemic contrasts as the infant needs to be able to do so. Rost and McMurray (2009) also suggest that forming of phonetic categories should be taken into consideration when interpreting data from a minimal pair mapping task.

Word categories are often described using the most frequently encrountered exemplar for the group and other words in that category are a slight variation of the exemplar (Rost & McMurray, 2009). For example, a golden retriever may be the examplar for the category of 'dog,' but we are still willing to accept, for instance, dogs of smaller stature or dogs with shorter hair as members of the 'dog category.' The problem seen with categorization of this type is that there is not a *clear* distinction for what is not to be considered as a member of that category. Asking infants to succeed in a minimal pair mapping task in which we ask them to distinguish what is or is not an acceptable member of a specific word category is particularly challenging and may be to blame for the observed failure in 14-month-olds.

Rost and McMurray (2009) emphasize that the difficulty observed in minimal pair mapping may in fact be one of top-down processing for infants and that multi-talker *training* could be a feasable way to improve minimal pair mapping performance. Talker variations in

speech characteristics such as talker type, talker voice, and variation in pitch increase the top-down cognitive demands for the listener. So, the idea is that providing infants *training* with talker variation could increase top-down processing ability, thereby aiding in later minimal pair mapping. Although the current study used multiple intonations of the token presented during Learning, it may not have provided infants with enough exposure to talker variation to exercise top-down processing. Perhaps, providing infants with increased talker variaion and increased exposure length prior to testing may have yielded results indicative of minimal pair mapping.

A final possibility as to why the infants in the current study did not succeed in this task may be that rhyme just simply does not have an affect on infants' ability to succeed in this task. Although rhyme has a demonstrated link to later reading success (Bradley & Bryant, 1983; Bryant, Bradley, MacLean, & Crossland, 1989; MacLean, Bryant, & Bradley, 1987) it may not have provided enough information for the infants to be able to focus on the word onsets. Thus, if infants were not able to attend to the phonemic variations across the minimal pair words, it would be reasonable to assume the infants would not be able to form a word category and display no learning for these words.

Conclusions

Overall, early rhyme awareness has demonstrated a clear link with later reading ability (Wimmer, et al., 1991) and is beneficial for the infant in multiple facets. The current study sought to investigate the utility of rhyme as a facilitator for early word learning in a minimal pair mapping task. I presented 14.5-15.5-month-old infants a brief familiarization followed by 12 Learning trials of exposure to the object-label pairs, then tested minimal pair mapping with a Visual Choice paradigm. Infants did not demonstrate a significant effect of learning in this task.

Failure may be potentially due to a heavy cognitive load or not enough exposure during Learning. Future research should focus on factors that affect minimal pair mapping and work to find methods to further reduce the cognitively taxing nature of the task.

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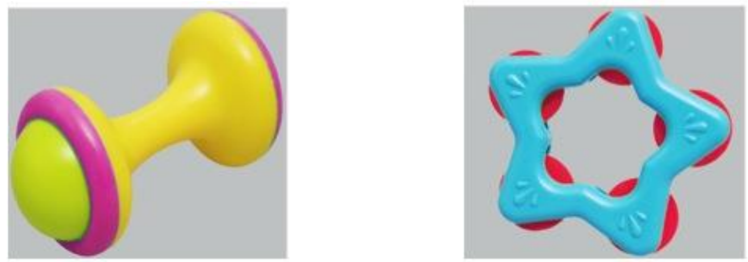
Appendices

Appendix A

Table 1. Auditory Stimuli

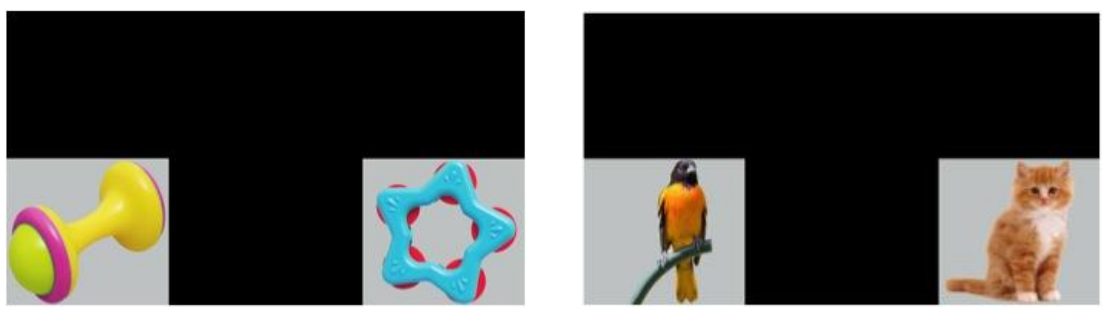
Rhyme (1)	Repetition (1)	Rhyme (2)	Repetition (2)
Lat *kin* mo lu *vin*	Lat *rin* mo lu *rin*	Sem *jak* lu ka *rak*	Sem *lak* lu ka *lak*
Pab roo mip fi *nin*	Pab roo mip fi *rin*	Rep lu tem mo *vak*	Rep lu tem mo *lak*
Dif *lin* ro mi *hin*	Dif *rin* ro mi *rin*	Dem *sak* pi lo *tak*	Dem *lak* pi lo *lak*
Fu wab nil wa *zin*	Fu wab nil wa *rin*	Sep fin kub ni *hak*	Sep fin kub ni *lak*
Dal *min* nu ba *pin*	Dal *rin* nu ba *rin*	Paf *fak* jo ka l*ak*	Paf *lak* jo ka *lak*
Seg lee bik ni *gin*	Seg lee bik ni *rin*	Kug lin rep fu *dak*	Kug lin rep fu *lak*
Dis *fin* lu bo *quin*	Dis *rin* lu bo *rin*	Mit *wak* li tu *mak*	Mit l*ak* li tu *lak*
Mil vo dit tu *sin*	Mil vo dit tu *rin*	Lif tee kaf vo *yak*	Lif tee kaf vo *lak*
Bin/Din	Bin/Din	Pak/Gak	Pak/Gak

Training
Trials
(12)



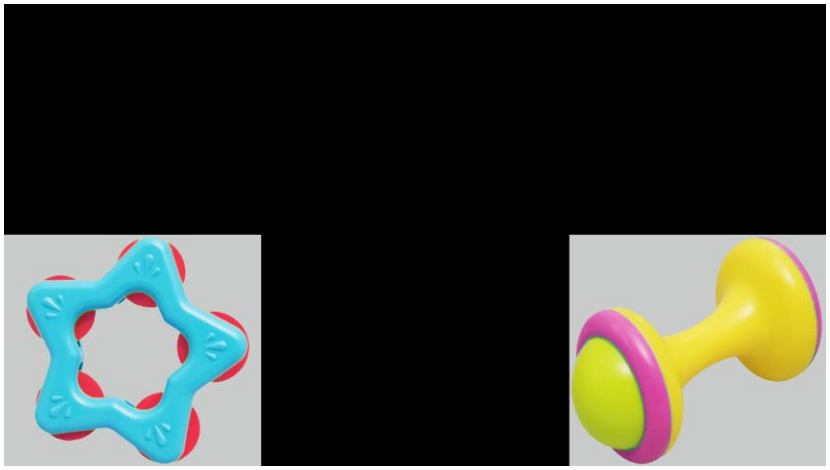
'Bin!' *'Din!'*

Testing
Trials
(32)



'*Look at the bin! Bin!*' '*Find the kitty! Kitty!*'

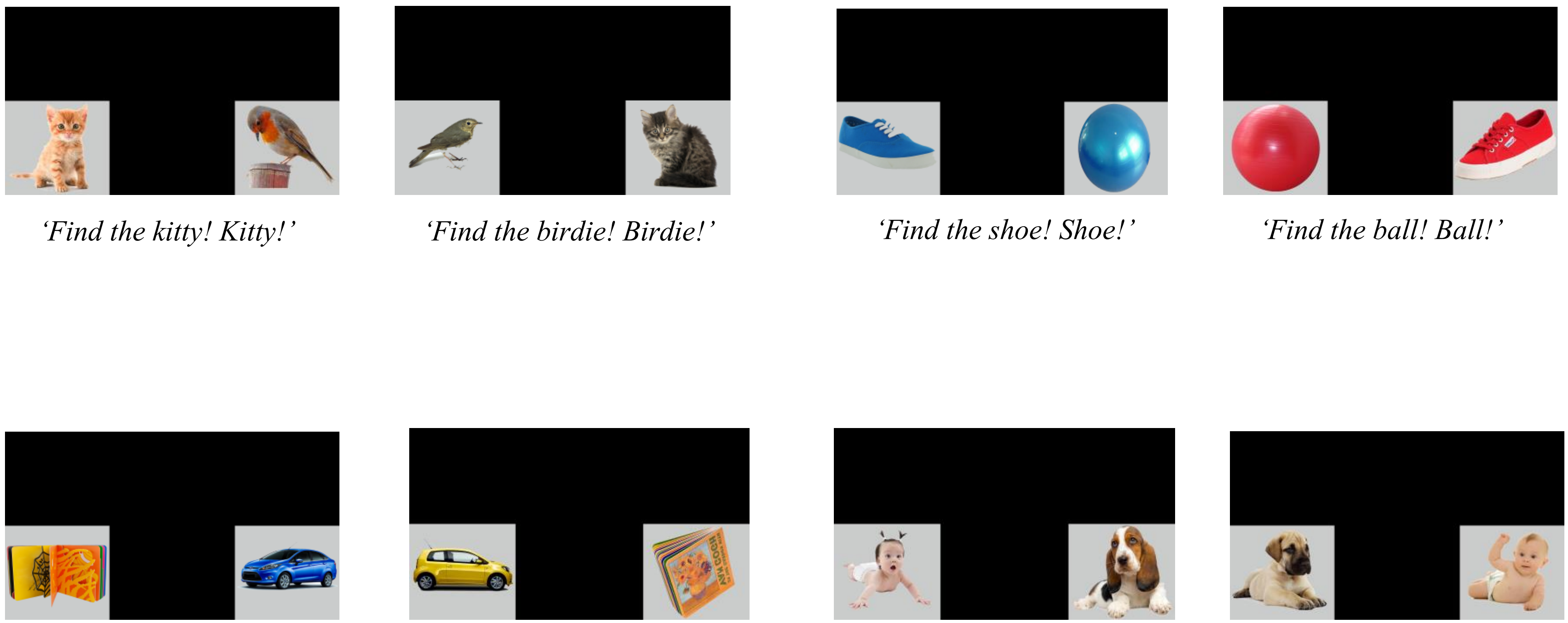
Figure 1. Design



'Look at the bin! Bin!'

'Look at the pak! Pak!'

Figure 2. Novel Learning and Test objects



'Find the kitty! Kitty!'

'Find the birdie! Birdie!'

'Find the shoe! Shoe!'

'Find the ball! Ball!'

'Find the book! Book!'

'Find the car! Car!'

'Find the doggy! Doggy!'

'Find the baby! Baby!'

Figure 3. Familiar Test objects

Appendix B

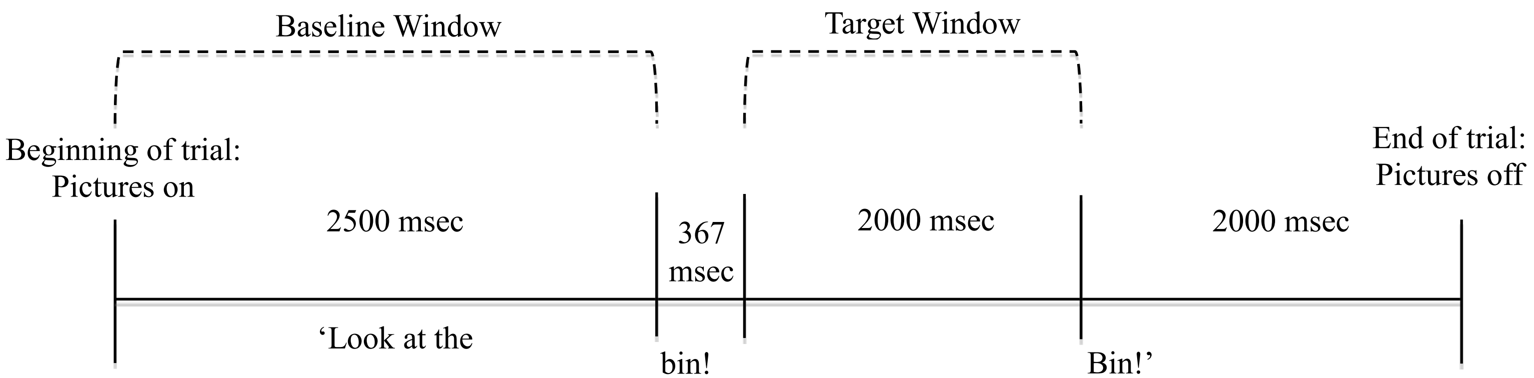


Figure 4. Timeline of a novel Test trial.

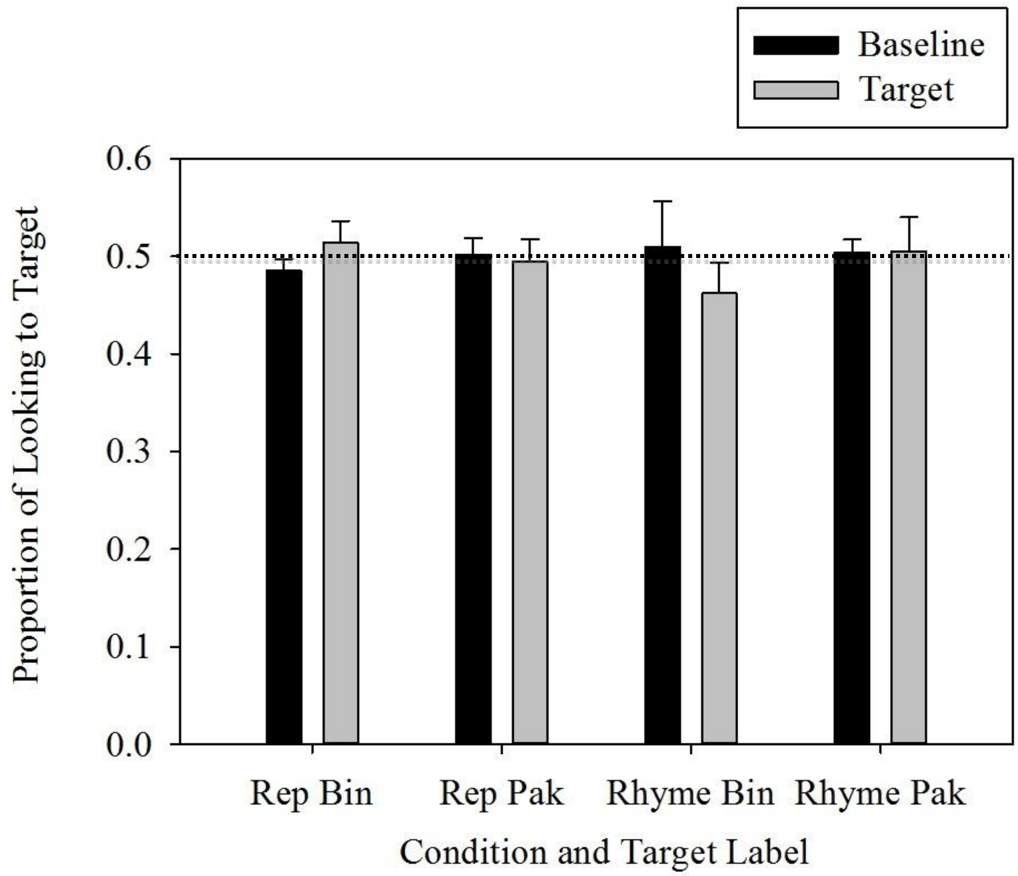


Figure 5. Proportion of time spent looking to the target

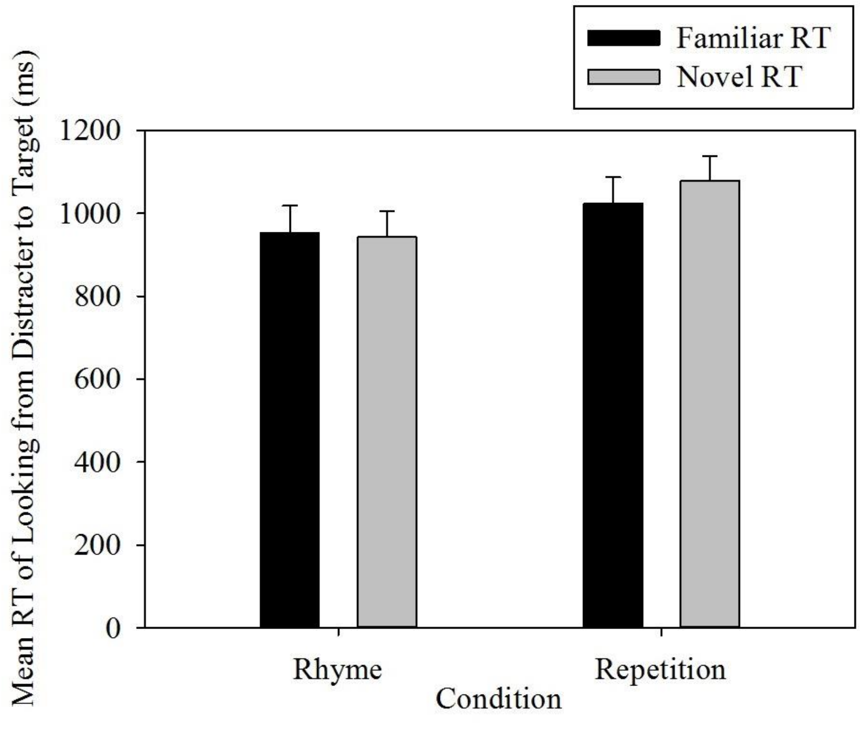


Figure 6. Mean reaction time from the distracter to the target object following label presentation.

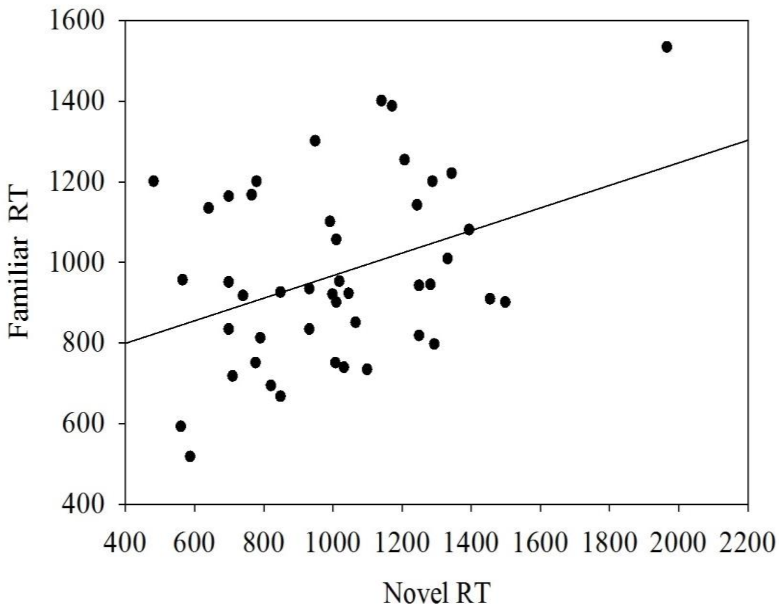


Figure 7. Correlation between familiar and novel reaction time.

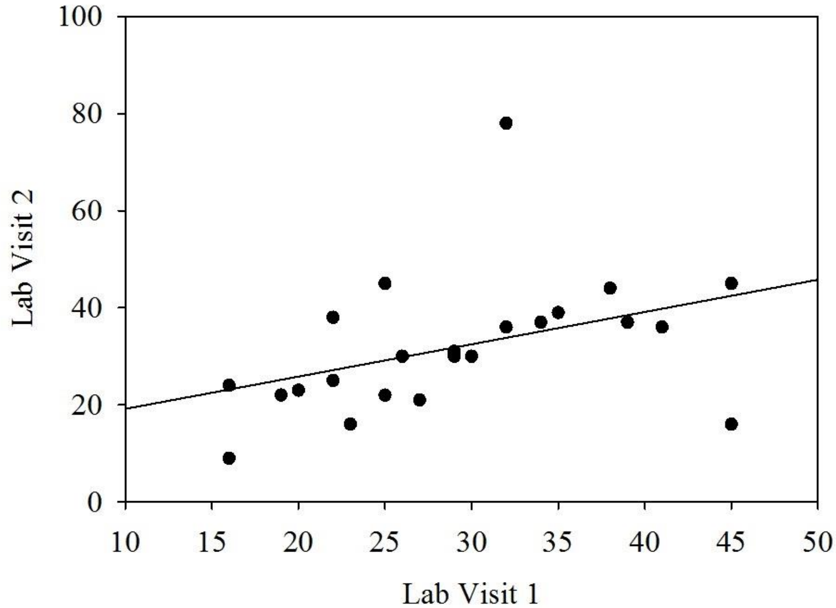


Figure 8. Correlation between comprehensive vocabulary scores from lab visits one and two.

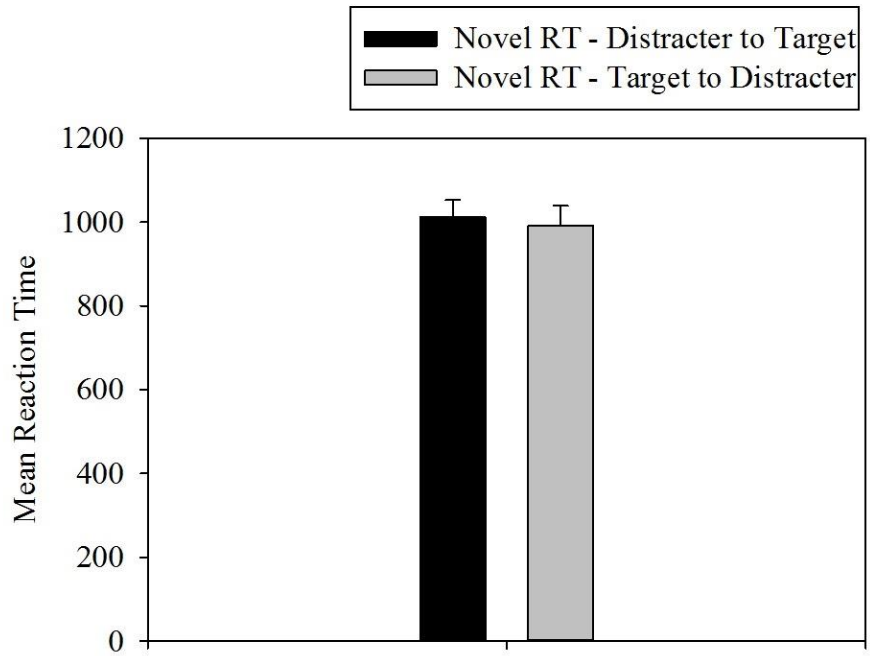


Figure 9. Mean reaction time from the distracter to the target object (black bar) and from the target to the distracter object (gray bar) following label presentation.

VITA

Kristen Elizabeth Thompson Mills was born in Beckley, WV to the parents of David Mills and Diana Thompson. She is the second of three daughters; Heather and Kameron. She attended Coal City Elementary, and graduated from Independence High School in Coal City, WV in 2009. After graduation, she attended Concord Univeristy where she obtained a Bachelor of Arts degree in psychology and sociology, under the mentorship of Dr. Jessica Alexander in May 2012. She accepted a graduate teaching assistantship at the University of Tennessee, Knoxville in the developmental psychology program, to work with Dr. Jessica Hay. Kristen will graduate with a Master of Arts degree in August 2014 and continue her education to pursue a Ph.D. in Speech and Hearing Science at the University of Tennessee Health Science Center under the directorship of Dr. Patti Johnstone and Dr. Mark Hedrick where she will study psychoacoustics and cochlear implant processing.