

THE RELATIONSHIP BETWEEN NONWORD REPETITION PERFORMANCE
AND SOCIAL BEHAVIORS IN 7- TO 11-YEAR-OLD CHILDREN
WITH LANGUAGE IMPAIRMENT

by

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A thesis submitted to the faculty of

Brigham Young University

in partial fulfillment of the requirements for the degree of

Master of Science

Department of Communication Disorders

Brigham Young University

April 2009

BRIGHAM YOUNG UNIVERSITY

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ABSTRACT

THE RELATIONSHIP BETWEEN NONWORD REPETITION PERFORMANCE AND SOCIAL BEHAVIORS IN 7- TO 11-YEAR-OLD CHILDREN WITH LANGUAGE IMPAIRMENT

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Recent literature has suggested a link between verbal working memory and language impairment (LI) in children. There is limited research, however, about the link between verbal working memory and social behaviors in children with LI. This study was designed to explore the relationship between social behaviors (measured by the Teacher Behavior Rating Scale; Hart & Robinson, 1996) and verbal working memory abilities (measured by a 3-, 4-, and 5-syllable nonword repetition task) in children with LI. Thirty-six children (18 with LI and 18 typically developing) aged 7 to 11 years participated in the study.

Children with LI were rated by teachers as having significantly higher levels of reticence and lower levels of likeability and prosocial behaviors compared to typically developing peers. Children with LI also scored significantly lower on the nonword

repetition task at the 3- and 4-syllable levels. Regression analyses revealed that nonword repetition scores were significant predictors of reticence and prosocial behaviors when examining all children as a group, accounting for 22% and 42% of the variance, respectively. As nonword repetition performance increased, reticence ratings decreased and prosocial behavior ratings increased. Nonword repetition did not significantly predict ratings on reticence or prosocial behaviors when examining language groups separately. Nonword repetition was not a significant predictor of likeability for children in this study. These findings indicate a relationship between nonword repetition performance and social behaviors in children with and without LI.

ACKNOWLEDGEMENTS

Many sources contributed to the completion of this thesis. This study was funded, in part, by a research grant through the McKay School of Education, for which I am truly thankful. I would also like to thank the speech-language pathologists who participated in this study, as well as my fellow researchers: Noel Quist, Emily Jones, Chelsea Voorhees, Dorthy Stott, Veronica Gardner, Lara Goldie, and Jami Potter.

Thank you so much to my outstanding thesis committee. Dr. Westby, it was a privilege to have you on this committee during your stay at BYU. I have thoroughly enjoyed working with you over the last year in the clinic and on this project. Dr. Brinton, thank you for the advice and encouragement during this project and throughout graduate school. You made the hard days worth it. Dr. Fujiki, thank you especially for the hours you willingly dedicated to meeting, editing drafts, answering emails, and guiding me toward this finished product. You have been an exceptional mentor over the years.

Finally, I would like to thank my family members for the love and encouragement they provided throughout this process. They made wonderful practice subjects and even better babysitters. Finally, I would especially like to thank my husband, Matt, and my son, Andrew, for all their help during this process. I can't imagine what it must be like to be married to or born to a graduate student who is working on her thesis, but my boys have been the perfect support system throughout this process.

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Introduction

There is considerable evidence that children with language impairment (LI)¹ have deficits in social competence (Brinton & Fujiki, 1999; Conti-Ramsden & Botting, 2004; Craig, 1993; Fujiki, Brinton, Hart, & Fitzgerald, 1999; Fujiki, Brinton, Morgan, & Hart, 1999; Fujiki, Brinton, & Todd, 1996; Gertner, Rice, & Hadley, 1994; McCabe & Meller, 2004; Redmond & Rice, 1998; Rice, Sell, & Hadley, 1991). These problems include high levels of withdrawal, low levels of sociability, poor emotion understanding, and limited social problem solving. Although these deficits have been documented, researchers have yet to determine the full extent to which impaired language skills result in social problems.

Another line of research has revealed that children with LI often have processing limitations (Archibald & Gathercole, 2006; Bishop et al., 1999; Botting & Conti-Ramsden, 2001; Corriveau, Pasquini, & Goswami, 2007; Dollaghan & Campbell, 1998; Edwards & Lahey, 1998; Ellis Weismer, 1998; Ellis Weismer, Evans, & Hesketh, 1999; Ellis Weismer et al., 2000; Fazio, 1998; Gathercole & Baddeley, 1990; Graf Estes, Evans, & Else-Quest, 2007; Kamhi, Catts, Mauer, Apel, & Gentry, 1988; Leonard et al., 2007; Mainela-Arnold & Evans, 2005; Marton & Schwartz, 2003; McGregor, 2003; Montgomery, 1998, 2000, 2002, 2003, 2004; Montgomery & Windsor, 2007; Sahlen, Reuterskiold-Wagner, Nettelbladt, & Radeborg, 1999; van der Lely & Howard, 1993). Psychological behaviors such as short-term memory, working memory, spatial

¹Both the terms *language impairment* (LI) and *specific language impairment* (SLI) are used throughout the literature when referring to children who have deficits in language despite relatively typical cognitive, sensory, and motor development. In referring to previous studies, I have used the terms used in the original paper. However, I generally used the term LI rather than SLI to avoid the implication that language is the only concern for these children.

processing, serial memory, and auditory processing have all been examined as possible contributors to LI.

Despite the amount of research done in both the areas of social deficits and processing deficits found in children with LI, little research has been done to address the possible connections between the two areas. It is possible that processing deficits underlie both the language deficits and social deficits observed in children with LI. In one of the few studies investigating this question, Donlan and Masters (2000) examined 32 students with typical nonverbal intelligence levels and deficits in speech and language. Verbal and visuospatial short-term memory abilities were measured. Additionally, sociability rating scales were completed for each participant by parents and school staff. These researchers found little relation between language comprehension scores and sociability in their participants. A strong relation was found, however, between sociability skills and serial verbal short-term memory abilities of the children with specific language impairment (SLI). Donlan and Masters suggested that a measure of short-term memory may aid in identification of children with SLI.

In addition to the work done by Donlan and Masters (2000), Javid (2006) explored the possible relationship between social behaviors and working memory. Javid administered a nonword repetition task to 19 children with LI and 19 age- and gender-matched controls. The children's teachers also completed a social behavior checklist. Javid analyzed the data to search for correlations between nonword repetition ability and social behaviors in children. She found that children with LI consistently scored lower on the nonword task and demonstrated decreased social competence compared to typically developing peers. Additionally, nonword repetition task scores were significant

predictors of each social behavior factor (reticence, likeability, and prosocial). The current study was conducted to replicate and extend the findings of Javid (2006) and to provide additional evidence in the search for the relationship between working memory and social behaviors in children with LI. The social behaviors of reticence, likeability, and prosocial abilities were measured in children with and without LI. Additionally, children completed a nonword repetition task to measure verbal working memory. This study was conducted to specifically answer the following research questions:

1. Do children with LI demonstrate differences in social behaviors (reticence, likeability, prosocial) compared to typically developing peers?
2. Do children with LI demonstrate differences in nonword repetition performance compared to typically developing peers?
3. What is the relationship between nonword repetition performance and social behaviors in children with and without LI?

Review of Literature

This review of literature first provides a brief review of the basic components of working memory. Next, nonword repetition abilities in children with and without LI are discussed. Finally, a discussion on the nonword repetition task is presented.

Basic Components of Working Memory

Several different components of human memory have been studied. Two of the most commonly mentioned components are long-term memory (LTM) and short-term memory (STM). Working memory, though sometimes confused with STM, is a concept introduced by Baddeley and Hitch (1974) and later updated by Baddeley (2007).

Working memory refers to temporary memory used in information processing. While STM is considered to be fleeting, working memory is considered to be the component of human memory that allows for problem solving and active retrieval from sensation and LTM.

According to Baddeley's model (Baddeley, 2007; Gathercole & Baddeley, 1993), working memory can be divided into four components (see Figure 1). The first component, known as the visuospatial sketchpad, is responsible for visualizing images and retaining the information necessary to process visual and spatial dimensions. The second component is the phonological loop, responsible for processing and maintaining speech sound information. The third component is the central executive. This component supervises the use of the visual-spatial and phonological information in the sketchpad and phonological loop. Because the central executive is responsible for processing rather than storage, the fourth component—the episodic buffer—has been hypothesized to act as an interface between the central executive, sketchpad, phonological loop, and LTM. The

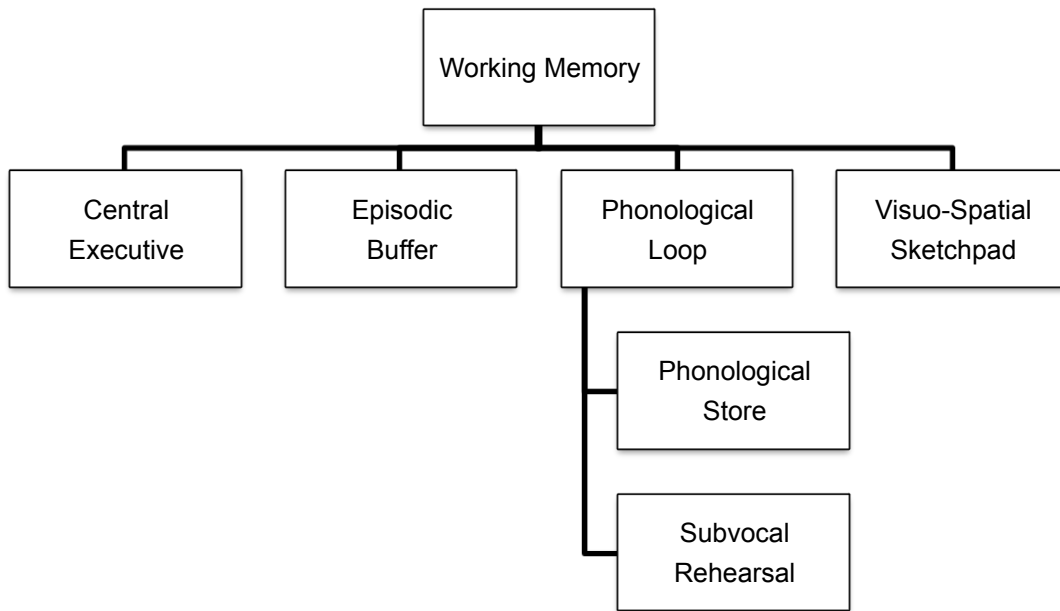


Figure 1. Components and divisions of Baddeley's (2007) working memory model.

episodic buffer provides the storage necessary to problem solve using the other components of working memory.

Because of the importance of the phonological loop in language learning and recall, more detail is relevant to this review. The phonological loop is the verbal and linguistic component to working memory and can be divided into two segments. The first division is known as the phonological store. The phonological store contains phonological information that decays with time. In order to maintain the information found in the phonological store, a process of rehearsal must take place. That rehearsal process comprises the second division of the phonological loop, known as subvocal rehearsal. Subvocal rehearsal can be overt or covert in nature. The rehearsal component is also responsible for recoding nonphonological inputs (i.e., printed words or pictures) into their phonological form to be held in the phonological store. The process of rehearsal must continue to take place if phonological items are to be held longer than about 2 s (Baddeley, 2007; Gathercole & Baddeley, 1993).

Although well-developed and backed by research, Baddeley's model has not escaped scrutiny. Cowan (1998) explained that although deficits in the phonological loop (or verbal working memory) should theoretically translate into massive comprehension deficits, this has not been observed. Rather, the comprehension deficits experienced by individuals with verbal working memory deficits only arise when a sentence is unusually difficult and requires verbatim repetition to be understood. Cowan also disagrees with Baddeley's concept of the phonological store. While Baddeley views the phonological store as speech specific, Cowan believes the phonological store could instead be

explained as a special instance of memory activation that could have many properties in common with other types of memory activation (e.g., sensory, semantic memory).

Verbal working memory is especially pertinent to the study of children with LI since working memory significantly influences language learning and language access. Verbal working memory aids language reception by gathering and holding information while comprehension takes place. Verbal working memory aids language production by maintaining phonological and linguistic information while motor and linguistic planning takes place (Cowan, 1998). Many researchers have turned to nonword repetition tasks when assessing verbal working memory² and the contribution verbal working memory makes to language learning and language access. These tasks require repetition of made-up words, known as nonwords, of varying length. Although used frequently throughout the literature, the use of nonword repetition to measure verbal working memory has not gone without criticism.

One reason that nonword repetition tasks may not be ideal measures of verbal working memory is that nonword repetition tasks may not cover all components of verbal working memory. Conversely, nonword repetition tasks may measure more than just verbal working memory. As explained by Coady and Evans (2008), nonword repetition has been used to measure lexical access, speech production, motor planning abilities, phonological processing, and phonological memory. In the absence of a perfect measure of verbal working memory, however, nonword repetition tasks have served as a viable

²Throughout the literature, the terms *verbal working memory*, *phonological working memory*, and *verbal short-term memory* have been used to describe the processes measured by nonword repetition. For the sake of consistency, I have used only the term verbal working memory throughout this review.

assessment tool for many researchers. Nonword repetition abilities in children both without and with LI will be explored below.

Nonword Repetition Abilities in Children Without LI

In order to understand nonword repetition deficits in children with LI, it is necessary to examine the abilities typically found in children without LI. Several aspects of nonword design have been shown to affect repetition abilities.

Nonword length. Repetition becomes more difficult as word length increases. This phenomenon was first demonstrated with real words in English (Baddeley, Thomson, & Buchanan, 1975). Nonwords have also been shown to be more difficult to repeat with increasing syllable length (Dollaghan & Campbell, 1998; Gathercole, Willis, Baddeley, & Emslie, 1994; Gathercole, Willis, Emslie, & Baddeley, 1991; Roy & Chiat, 2004). Such patterns align well with the concept of verbal working memory wherein rehearsal is required to maintain information in the phonological store. Longer words would take more time to rehearse, and would therefore be more difficult to maintain.

While several researchers have found a steady decline in repetition accuracy as nonword length increases, a few studies have shown interesting conflicts with that pattern. Gathercole et al. (1991) presented a nonword repetition task to 120 students at ages 4, 5, and 6 and were surprised to find that 2-syllable nonwords were repeated more accurately than 1-syllable nonwords; repetition accuracy then declined for 3- and 4-syllable nonwords as predicted. Gathercole et al. (1991) hypothesized that this discrepancy was due to the articulatory difficulty of the 1-syllable nonwords used in the experiment, rather than a general pattern that can be applied to all short nonwords. In a similar study, Gathercole et al. (1994) presented a nonword repetition task to a cross-

sectional group of 612 children between the ages of 4 and 9 years. These researchers observed a consistent decline in repetition accuracy as nonwords increased from 2 to 3 to 4 syllables. When 5-syllable nonwords were presented, however, repetition was more accurate than repetition of 4-syllable nonwords. Gathercole et al. (1994) hypothesized that the “distinctive morphemic constitution” of the 5-syllable nonwords aided repetition (p. 110). The 5-syllable nonwords contained familiar endings such as –atory, –ually, and –ation; these endings made the nonwords more similar to real words and could have contributed to the increased repetition scores at the 5-syllable level.

Lexical contribution to nonword repetition. Similar to the explanation Gathercole et al. (1994) provided for the improvement in nonword scores, several studies have indicated that repetition of nonwords is easier when the stimuli are more word-like. Gathercole, Willis, Emslie et al. (1991) prepared a list of 40 nonword stimuli, comprised of ten 1-, 2-, 3-, and 4-syllable nonwords. The list of nonwords was presented to undergraduate raters who rated how word-like each nonword was, using a scale from 1 (*not like a word at all*) to 5 (*very like a word*). After presenting the items to children at ages 4, 5, and 6, the researchers discovered that the stimuli rated as more word-like were repeated with higher accuracy than the nonwords rated as less word-like. Likewise, Gathercole (1995) found a higher repetition accuracy for nonwords with high word-likeness ratings compared to those with low word-likeness ratings.

As a result of these research studies, Gathercole (1995) hypothesized that nonword repetition of word-like stimuli is influenced more by long-term lexical knowledge rather than verbal working memory. An important critique of these studies pointed out that although there may be a significant relationship between the word-

likeness scores and the repetition scores, it is unclear how close the relationship actually was between the children's familiarity with the stimuli and the word-likeness scores. In other words, although the reviewers rated the scores as more word-like, the children may not have used lexical knowledge to process the nonwords (Snowling, Chiat, & Hulme, 1991). Most researchers avoid nonword stimuli that are word-like, however, in an attempt to measure only the influence of verbal working memory rather than long-term lexical knowledge. Evidence for such practices is presented next.

Phonological contribution to nonword repetition. While some evidence has pointed toward lexical knowledge as a contributor to nonword repetition accuracy, other studies have examined phonological aspects of the nonwords as possible contributors to repetition accuracy. Researchers have acknowledged the possible contribution that articulatory difficulty makes to repetition accuracy, and have aimed to eliminate that variable when designing nonword repetition tasks (Gathercole et al., 1994).

Several different methods have been used to control for phonological contribution. Gathercole et al. (1994) used only legal phoneme combinations (according to the rules of English) in order to rule out the possibility that the repetition accuracy was affected by articulation rather than memory. Several other studies have used nonwords of varying phonotactic probability as stimuli and found that highly-probable patterns of phonemes are responded to more quickly (Vitevitch, Luce, Charles-Luce, & Kemmerer, 1997) and with higher accuracy (Edwards, Beckman, & Munson, 2004; Gathercole, Frankish, Pickering, & Peaker, 1999).

Additionally, some studies have examined phonological contribution in terms of the nonword's neighborhood size. A *neighbor* is defined as a word that differs from the

nonword by only one phoneme. Results in this area are mixed. Some studies have shown that nonwords with more neighbors are recalled better or with shorter latency than those from a less-dense neighborhood (Roodenrys & Hinton, 2002; Vitevitch & Luce, 1998, 1999). However, some debate still exists as to whether the shorter latency of repetition is due to the neighborhood density or instead to the temporal duration of the nonword stimuli (Lipinski & Gupta, 2005; Vitevitch & Luce, 2005).

Nonword repetition and vocabulary skills. Nonword repetition tasks have been shown to be significantly related to vocabulary skills in children (Gathercole, Willis, & Baddeley, 1991). Children with smaller vocabularies tend to perform poorer than children with larger vocabularies on nonword repetition tasks (Edwards et al., 2004; Gathercole et al., 1999). The possible causes of this correlation have also been researched.

Gathercole et al. (1994) found that nonword repetition scores at ages 4 and 5 were predictive of later vocabulary scores. Those who scored higher on the nonword repetition task at age 4 also scored higher on a test of vocabulary 1 year later. Based on those results, Gathercole et al. hypothesized that an ability to learn a new phonological form helps in the acquisition of new words. However, the correlations between nonword repetition and vocabulary scores changed with age. Nonword repetition abilities at ages 5 and 6 were not predictive of vocabulary scores 1 year later, but vocabulary scores at ages 5 and 6 were predictive of nonword repetition abilities 1 year later. Based on those results, Gathercole et al. hypothesized that existing vocabulary knowledge later aids nonword repetition.

Gathercole (1995) provided evidence for vocabulary and nonword correlations using high word-like and low word-like nonwords. In this study, Gathercole found

correlations between repetition scores of low word-like nonwords at age 4 and vocabulary scores 1 year later. In contrast, no correlations were found between vocabulary scores at age 4 and low word-like nonword repetition accuracy 1 year later. Additionally, no correlations were noted between repetition scores of high word-like nonwords at age 4 and later vocabulary scores. In contrast, correlations were observed between vocabulary scores at age 4 and high word-like nonword repetition accuracy 1 year later. According to Gathercole, verbal working memory contributes to vocabulary learning (as evidenced by the predictive abilities of low word-like nonwords on later vocabulary scores), while stored vocabulary knowledge is used to support repetition of high word-like nonwords (as evidenced by the predictive abilities of vocabulary scores on later high word-like nonword repetition accuracy).

The research presented above demonstrates the varying contributions to nonword repetition accuracy in children without LI. Nonwords are generally repeated more accurately when shorter in length, when more word-like, when containing common phoneme combinations, and when the child has greater vocabulary knowledge. These components of nonword design, however, also affect whether lexical contributions or phonological contributions are being measured. The information from this research of children without LI has provided important information about the performance of children with LI. Specifics of nonword design described previously are important when presenting a nonword repetition task to children with LI, since deficits in repetition would be explained differently depending on whether the nonwords measured lexical contributions or phonological contributions.

Nonword Repetition Abilities in Children With LI

Nonword repetition abilities have been shown to be reduced in children with a number of conditions, including stuttering (Hakim & Ratner, 2004), reading disability (Kamhi & Catts, 1986; Kamhi et al., 1988), Down syndrome (Jarrold, Baddeley, & Hewes, 2000), Williams syndrome (Grant et al., 1997), autism (Kjelgaard & Tager-Flusberg, 2001), high levels of lead exposure (Campbell, Needleman, Riess, & Tobin, 2000), and low birth weight (Briscoe, Gathercole, & Marlow, 1998). A significant amount of research, however, has focused on the nonword repetition deficits in children with LI (Archibald & Gathercole, 2006; Bishop, North, & Donlan, 1996; Botting & Conti-Ramsden, 2001; Dollaghan & Campbell, 1998; Edwards & Lahey, 1998; Ellis Weismer et al., 2000; Gathercole & Baddeley, 1990; Gray, 2003; Kamhi & Catts, 1986; Kamhi et al., 1988; Marton & Schwartz, 2003; Montgomery, 2004; Sahlen et al., 1999; Stothard, Snowling, Bishop, Chipcase, & Kaplan, 1998). The following sections summarize many of the findings relating to nonword repetition deficits in children with LI.

Explanations for repetition deficits in LI. Several hypotheses have been presented to explain the nonword repetition deficits in children with LI. One possible explanation for repetition deficits in children with LI is a decreased quality of speech output (Bishop et al., 1996; Howard & van der Lely, 1995; Sahlen et al., 1999; Wells, 1995).

Measurement of nonword repetition accuracy is based on observable speech output. If the child misarticulates or varies articulation enough that the speech output is perceivably different, repetition will be counted as incorrect. Even if the child has an accurate phonological representation, deficits in speech output would lead to decreased repetition accuracy.

Less extensive vocabulary knowledge has also been presented as a possible explanation for nonword repetition deficits in children with LI (Botting & Conti-Ramsden, 2001; Edwards et al., 2004; Nation, Adams, Bowyer-Crane, & Snowling, 1999; Snowling et al., 1991). As explained previously, children with high vocabulary knowledge score better than children with low vocabulary knowledge on measures of nonword repetition when the nonwords are more word-like (Gathercole, 1995). Children with LI who have difficulty acquiring or obtaining vocabulary knowledge will be at a disadvantage during nonword repetition if the nonwords are more word-like.

A third possible explanation for nonword deficits in children with LI is that they have deficits in verbal working memory. Working memory deficit hypotheses include the possibility that children with LI have difficulty with the nature of phonological representations (Edwards & Lahey, 1998; Sussman, 1993), including problems with either the formation of phonological representations with the correct number of syllables and phoneme segments or the holding of such phonological representations in working memory. Another explanation provided by researchers for working memory deficits in nonword repetition is deficits in working memory encoding processes (Adams & Gathercole, 2000; Archibald & Gathercole, 2006; Gathercole & Baddeley, 1990; Sussman, 1993). If children with LI are unable to accurately link the acoustic information from the nonwords to the phonological representation, they will have difficulty accurately repeating the nonwords. Yet another explanation for working memory deficits in nonword repetition is an accelerated phonological decay before output (Archibald & Gathercole, 2006). Children with LI may not be able to hold phonological information of

the nonwords in working memory long enough to encode the information or reproduce the nonword.

In summary, several explanations for nonword repetition deficits in children with LI have been presented. These explanations include decreased quality of speech output, less extensive vocabulary knowledge, and deficits in verbal working memory. These explanations may differ depending on the type of nonwords presented. Nonwords that are more word-like would be more apt to show deficits in vocabulary knowledge, whereas nonwords that are less word-like would be more likely to show deficits in verbal working memory. Decreased quality of speech output could be manifest with either type of nonword presented.

LI identification using repetition tasks. In a meta-analysis of 60 published and unpublished articles using nonword repetition, Graf Estes, Evans, and Else-Quest (2007) explored the use of nonword repetition tasks in distinguishing between children with SLI and children with typically-developing language. Their analysis concluded that nonword repetition tasks overall are able to distinguish between children with SLI and typically developing children. One- or 2-syllable nonwords were more difficult for children with SLI compared to children without language difficulties, and longer nonwords provided an even stronger distinction between children with SLI and their peers.

Nonword repetition tasks have also been shown to have high sensitivity and specificity when attempting to identify children with LI (Gray, 2003) and are good predictors of language test scores (Bishop et al., 1999; Bishop et al., 1996). Overall, nonword repetition tasks have a number of benefits not offered by other measures. As mentioned previously, nonword repetition tasks have been shown to be independent of IQ

(Conti-Ramsden, Botting, & Faragher, 2001; Ellis Weismer et al., 2000), culture (Burt, Holm, & Dodd, 1999; Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000), and gender (Burt et al., 1999). These tasks are also quick and easy to administer. Several researchers have suggested that nonword repetition tasks would be useful as screening or diagnostic measures of LI (Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Montgomery, 2003), and several nonword repetition tests have been published.

Two widely used published nonword repetition tests are the Children's Test of Nonword Repetition (CNRep; Gathercole & Baddeley, 1996) and the Nonword Repetition Test (NRT; Dollaghan & Campbell, 1998). The CNRep is used mostly in the U.K., whereas the NRT is more commonly used in the U.S. (Archibald & Gathercole, 2006). Archibald and Gathercole have outlined key differences in these two tests that may contribute to variations in results depending on which test is administered. For example, the CNRep contains 40 nonwords that range from 2 to 5 syllables in length. Stimuli contain characteristics such as consonant clusters, weak syllables, reduced vowels, and lexical components and morphemes. Nonwords have a natural prosodic pattern. Scoring is done online, and each word is scored either as correct or incorrect. The NRT, on the other hand, contains 16 nonwords that range from 1 to 4 syllables in length. Stimuli contain characteristics such as early-acquired phonemes, equal syllable stress, tense vowels, and no lexical components. Nonwords are scored according to percentage of correct phonemes correctly repeated.

Because of the differences outlined above, Archibald and Gathercole (2006) warned that the CNRep and the NRT may measure different abilities. The CNRep may be more difficult for children with SLI who have lower vocabulary skills, since many of the

stimuli on that test contain actual morphemes that can be accessed using existing vocabulary knowledge. The CNRep may also be more difficult due to the clustered consonants and later-developing phonemes. The NRT, on the other hand, may be more difficult for children with SLI because fewer lexical aspects provide background and knowledge support compared to the CNRep.

Archibald and Gathercole (2006) further explored the performance of children with SLI on the CNRep and the NRT. While the CNRep was better able to identify overall SLI deficits, several deficits measured extended beyond verbal working memory. The NRT, on the other hand, focused on measuring verbal working memory. Thus, for studies that wish to measure verbal working memory without including other variables, the NRT may be more appropriate than the CNRep. In light of such findings, the nonword repetition task used in the present study was patterned after Edwards and Lahey (1998), whose stimuli were based on the NRT.

Working Memory and Social Behavior

The literature discussed in this review has explored the basic concept and components of working memory, an important factor in language processing. Although a perfect measure of verbal working memory has yet to be identified, researchers have frequently turned to nonword repetition tasks to yield assessment data. Research into children's nonword repetition has revealed significant deficits in nonword repetition abilities among children with LI compared to children without LI. Nonword repetition and other processing abilities have been shown to intensify and possibly cause many language problems in children with LI (Leonard et al., 2007). Although less comprehensive, the literature also suggests that processing limitations (i.e., working memory deficits) may also be linked with deficits in social interactions (Donlan &

Masters, 2000; Javid, 2006). In her 2006 study, Javid found that working memory was a significant predictor of social behaviors in both children with LI and typical peers. Specifically, working memory accounted for 28% of the variance in reticence, 18% of the variance in likeability, and 11% of the variance in prosocial behaviors when analyzing all children together. Group specific analyses revealed that children with LI and typical children were affected similarly by working memory for reticence and prosocial behaviors. Group specific analyses also showed that working memory was a significant factor in likeability ratings for typical children but not for children with LI.

This study extends the work of Javid (2006). Children with LI were accepted into the current study with a standard IQ score as low as 70, rather than the cutoff of 85 as used in Javid's study. This increased range was sampled to increase sample size. Despite the inclusion of children with lower IQ scores, only children with a primary diagnosis of LI were included. None of the children sampled had a primary diagnosis of intellectual disability. This study provides further insight into the possible connections between verbal working memory and social interaction deficits in children with LI.

Method

Data for this study were gathered as part of a larger study that focused on emotion understanding in school-age children with and without LI. Permission for research was obtained through the Brigham Young University Institutional Review Board. Written permission was obtained from the participating school districts. Verbal permission was obtained from the principals of the participating schools. Written consent was also obtained from the participating children, their parents or guardians, and their teachers (see Appendix A).

Participants

Participants in this study consisted of 36 children, including 18 children with LI and 18 typically developing children, matched for age and gender. Participants came from eight elementary schools in three Utah school districts. Participants were selected from the 2nd to 5th grades. The socioeconomic status for the participants was measured from block group data from the 2000 census (U.S. Census Bureau, 2003). In the neighborhoods surrounding the eight elementary schools, the mean percentage of families with income levels below the poverty level was 3.6% ($SD = 3.5\%$). Racial distribution of participants included 33 (91.7%) Caucasian children, 2 (5.6%) Hispanic American children, and 1 (2.8%) African American child.

Children with LI. Children with LI were recommended by speech-language pathologists in the participating schools. The group with LI consisted of 12 males and 6 females, ranging in age from 7;1 to 11;0 ($M = 9;3$, $SD = 12.2$ months). In order to qualify for the study, children with LI were required to meet the following criteria:

1. Diagnosis of LI by speech-language pathologist or resource teacher.

2. Current enrollment in speech-language services or resource services for language issues.
3. Standard composite score on standardized language test below 85 (one standard deviation below the mean).
4. Standard score on standardized intelligence test at or above 70 (two standard deviations below the mean), in order to rule out intellectual disability as a basis for language difficulties.
5. No history of severe articulatory impairment or phonological processes.
6. No history of emotional or behavioral problems, cognitive deficits, or neurological problems (i.e., autism) requiring special services, as indicated by school records and placement.
7. Native English speaker.
8. Unremarkable audiological status.

Children with LI were identified with existing intelligence and language test scores, if available. All children were given the Comprehensive Assessment of Spoken Language (CASL; Carrow-Woolfolk, 1999) and the Universal Nonverbal Intelligence Test (UNIT; Bracken & McCallum, 2003) in order to verify proper group placement and to provide consistent language and intelligence measures across subjects.

Typically developing peers. Each child with LI was matched with a typically developing peer from the same classroom. The typical group consisted of 12 males and 6 females, ranging in age from 7;1 to 11;0 ($M = 9;4$, $SD = 13.5$ months). Typically developing children meeting the following criteria were recommended by the classroom teacher:

1. Same gender and age (within 6 months) as the child with LI.
2. Standard composite score on a standardized language test at or above 85 (one standard deviation below the mean).
3. Standard score on a standardized intelligence test at or above 85 (one standard deviation below the mean).
4. No history of severe articulatory impairment or phonological processes.
5. Not enrolled in special services (e.g., resource).
6. Typical performance in language, behavior, and academics as reported by classroom teacher and school placement.
7. No diagnosis of emotional, behavioral, cognitive, or neurological deficits.
8. Native English speaker.
9. Unremarkable audiological status.

Descriptions of the study and consent forms were sent home with the typically developing children meeting the criteria outlined above. The actual participants were selected from those whose parents gave written consent for their child to participate in the study.

Teachers. In addition to the 36 children, 17 teachers were involved in this study. Classroom teachers of the participating children were asked to complete a copy of the Teacher Behavioral Rating Scale (TBRS; C. H. Hart & Robinson, 1996) for each participant. The data from the TBRS provided information about various subtypes of social behaviors (e.g., withdrawal and sociability). Ratings were completed between November 2007 and March 2008, allowing the teachers several months of exposure to the

children before completing the survey. Teachers were compensated with a small monetary gift for completing each form.

Assessment Instruments

Language assessment. The CASL is a test designed to provide an assessment of oral language abilities in individuals aged 3 through 21. The core set of subtests for ages 7 to 10 years was given for this study. Subtests administered included antonyms, syntax construction, paragraph comprehension, nonliteral language, and pragmatic judgment. With a mean standard score of 100 and a standard deviation of 15, scores on the CASL were used to ensure proper group placement for the children with LI (i.e., standard score below 85) and typically developing children (i.e., standard score at or above 85).

Intelligence assessment. The UNIT is a nonverbal intelligence test designed to evaluate general intelligence in ages 5;0 to 17;11 years. The test is administered without the use of spoken language on the part of either the examiner or the student. This test eliminates the linguistic demands prevalent in most intelligence tests, thus making it an ideal measure of intelligence for children with LI who struggle with language. Eight well-known gestures (e.g., pointing, nodding head, shrugging shoulders) are used throughout the administration to communicate instructions and give answers. The student is trained on task procedures by observing the administrator complete an item and then doing a practice item before scoring begins. The core set of subtests for ages 7 to 10 years was administered. Subtests administered included symbolic memory, cube design, analogic reasoning, and spatial memory.

Behavioral assessment. The TBRS is an unpublished questionnaire designed to measure the frequency of a child's specific social behaviors based on the teacher's assessment of the child's current performance. The TBRS provides information regarding

a child's withdrawn behavior (separated into solitary-active withdrawal, reticence, and solitary-passive withdrawal) and sociable behavior (separated into impulse control/likeability and prosocial). After originally being designed for preschool populations, the TBRS was adjusted for school-aged children as described in Fujiki, Brinton, Morgan et al. (1999). In summary, teachers completed TBRS questionnaires for 382 school-age children from 6;4 to 12;6 ($M = 8;10$, $SD = 1;6$). A total of 16 items reflecting withdrawal subtypes and 13 items reflecting sociability subtypes were selected after dropping items with (a) little variance, (b) substantial cross-loadings ($> .40$), or (c) low item-total correlations for factors derived in preliminary analyses.

The TBRS has been shown to have test-retest reliability for school-age children, with Pearson correlations between first and second administration of .70 for reticence, .76 for solitary-active withdrawal, .73 for solitary-passive withdrawal, .74 for likeability, and .71 for prosocial (Fujiki, Brinton, Morgan et al., 1999). The TBRS has also been used to compare social behaviors in children with LI to typically developing peers (Brinton, Fujiki, Montague, & Hanton, 2000; Fujiki, Brinton, Morgan et al., 1999; K. I. Hart, Fujiki, Brinton, & Hart, 2004).

In the current study, teachers were provided with a 74-item TBRS checklist and asked to rate each item using a 3-point scale (0 = *never*, 1 = *sometimes*, 2 = *often*). Only items relating to the child's reticence (off-task behaviors, being shy or fearful of interacting with others), likeability (anger control, acceptance by others), and prosocial behaviors (helping or comforting other children) were used in this study. Four items contributed to the overall composite score for reticence, 5 items for likeability, and 5

items for prosocial. Those items were scattered throughout the 74 items included in the TBRS.

Nonword repetition task. The nonword stimuli for the nonword repetition task were comprised of three 3-syllable, three 4-syllable, and three 5-syllable nonwords (see Appendix B). The 3-syllable and 4-syllable nonwords were originally used by Edwards and Lahey (1998). The 5-syllable nonwords were created for a previous project (Javid, 2006) using guidelines outlined by Edwards and Lahey.

The recordings of the nonwords were produced by a female speaker in a sound-treated booth. The microphone was approximately 6 inches from the speaker's mouth. The nonwords were recorded as digital audio files. These files were then converted into MP3 format and copied onto a CD for administration (Javid, 2006).

Procedures

Each teacher filled out a TBRS form for each child in his or her classroom who participated in the study. Each form took approximately 10 to 15 minutes to complete. The data from the TBRS forms were entered into a spreadsheet file for later analysis.

The nonword repetition task was administered by one of four graduate student researchers during one of two testing sessions comprising the larger study. Each graduate student was trained in task administration procedures and provided with procedural instructions to use during administration. To ensure uniformity, each graduate student met with the author to practice the nonword repetition task administration.

The nonword task took approximately 3 minutes to administer. Participants were first fitted with a combination headphone and microphone. The headphone unit used an insert earphone rather than a closed headphone to prevent any occlusion effects and to represent a more realistic listening environment. The administrator then began audio

recording with the HHB MDP500 Portable Minidisc Recorder. Next, directions were read to the child (see Appendix C). Within the directions, the administrator provided two 1-syllable examples of nonwords and asked the child to repeat them to ensure the child understood the task directions. Last, the administrator set the Sony D-EJ625 portable CD player to a comfortable loudness level and administered the nonword repetition task via the CD player and insert earphones.

Scoring of nonword repetition accuracy was based on the percentage of phones correctly produced. Each individual phoneme was scored as correct or incorrect. Correct scores were given to correct pronunciations and mild distortions. Deletions and substitutions were scored as errors. Additions were also considered errors and were subtracted from the total number of correct phones.

During the session wherein the nonword repetition task was administered, the CASL and UNIT were also administered and the child was given a small prize for participating. Order of administration was randomly varied. Data from the CASL and UNIT test results were entered into a spreadsheet file for later analysis.

Reliability

In order to obtain inter-rater reliability, 10% of the nonword data were randomly chosen and scored by two different research assistants. A comparison of the two results showed 89% accuracy between raters.

Results

Group Differences in Social Behaviors

In order to answer the first research question, 6 one-way analysis of variance (ANOVA) tests were performed. A significance level of .05 was used for all statistical tests. Language group (LI or typical) and gender (male or female) served as the independent variables, while social behaviors (reticence, likeability, and prosocial) were the dependent variables. Means and standard deviations for social behaviors are presented in Table 1. Children with LI were rated by teachers as being significantly more reticent than typically developing children, $F(1, 32) = 19.38, p < .001$. No significant difference in reticence ratings was noted between genders, however, $F(1, 32) = 0.25, p = .27$.

A two-way ANOVA test was performed to see how the data behaved while controlling for each independent variable and to test for interactions between independent variables. A significant interaction effect was noted for reticence between language group and gender, $F(1, 32) = 5.07, p = .03$, indicating a need to consider gender when examining reticence. Females with LI displayed greater amounts of reticence than males with LI. For typically developing children, this trend was reversed; typical females displayed less reticence than typical males. Figure 2 graphically represents the interaction effect.

There were also significant differences between children with LI and typically developing children for both likeability, $F(1, 32) = 24.02, p < .001$, and prosocial behaviors, $F(1, 32) = 10.92, p < .01$. Typically developing children scored significantly higher than children with LI on both subtypes. No significant difference between genders was noted for either likeability, $F(1, 32) = 0.46, p = .50$, or prosocial behaviors, $F(1, 32) = 0.06, p = .82$. Two-way ANOVA tests revealed no significant interaction effects

Table 1

Means (Standard Deviations) for Social Behavior Ratings

Participant Group	Reticence	Likeability	Prosocial
Language Impaired			
Male	3.08 (2.54)	6.75 (2.49)	5.92 (3.15)
Female	5.50 (2.07)	5.83 (2.64)	5.33 (2.58)
Total	3.89 (2.61)**	6.44 (2.50)**	5.72 (2.91)*
Typical			
Male	1.17 (1.03)	9.58 (0.90)	8.58 (2.47)
Female	0.67 (0.82)	9.33 (0.82)	8.67 (2.16)
Total	1.00 (0.97)**	9.50 (0.86)**	8.61 (2.30)*

Note. Reticence rating out of 8 possible. Likeability rating out of 10 possible. Prosocial rating out of 10 possible. For reticence, higher scores indicate higher levels of reticent behavior. For likeability and prosocial, higher scores indicate greater sociability.

* $p < .01$, ** $p < .001$

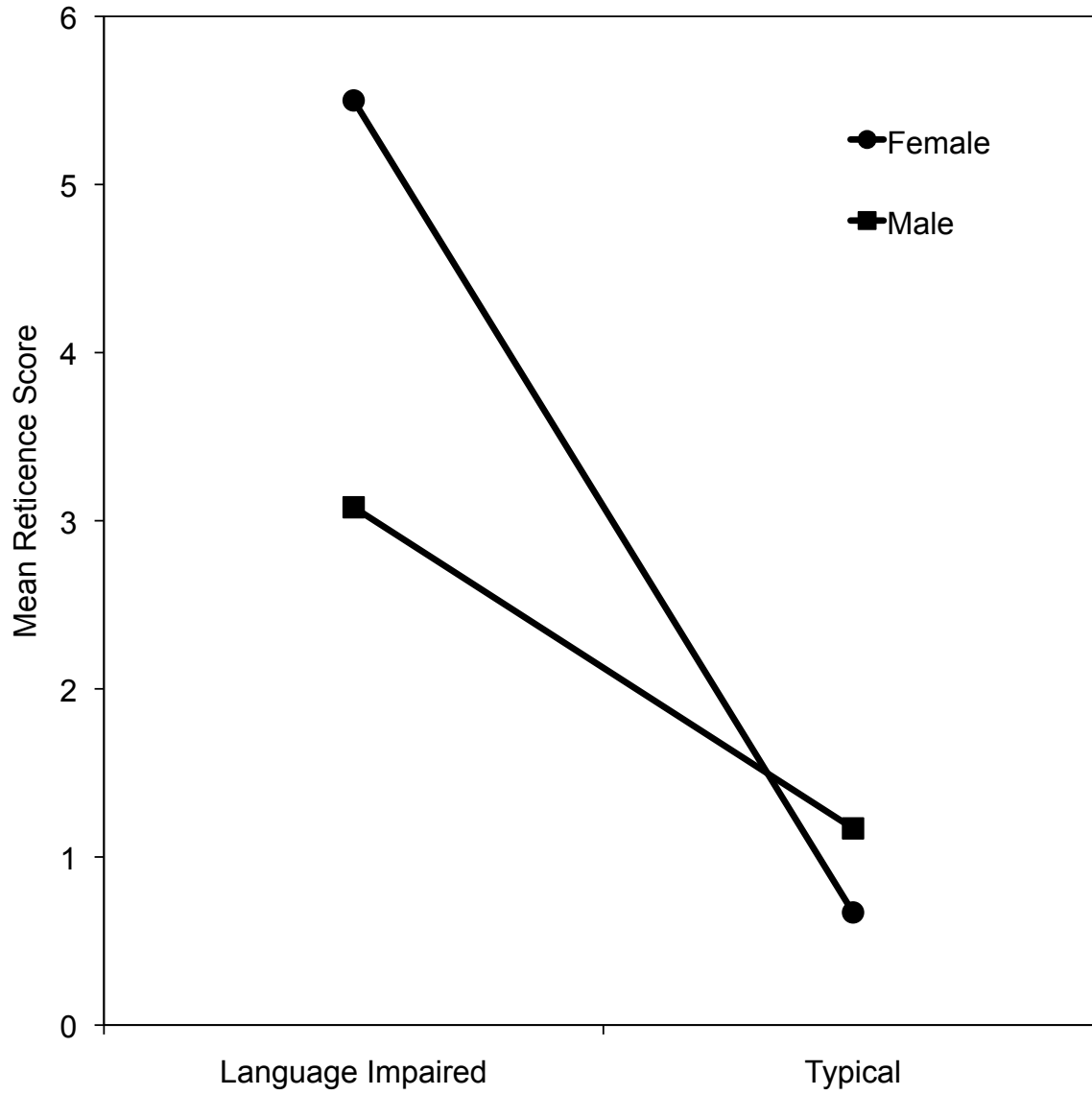


Figure 2. Mean reticence scores differentiated by language group and gender.

between language group and gender for either likeability, $F(1, 32) = 0.25, p = .62$, or prosocial behaviors, $F(1, 32) = 0.12, p = .73$. Each of these observed differences in social behaviors between language groups was consistent with previous findings (Fujiki, Brinton, Morgan et al., 1999; K. I. Hart et al., 2004).

Group Differences in Nonword Repetition Performance

In order to answer the second research question, 6 one-way ANOVA tests were performed. Language group (LI or typical) and gender (male or female) served as the independent variables, while nonword repetition scores (3-syllable, 4-syllable, and 5-syllable) were the dependent variables. Means and standard deviations for nonword repetition scores are presented in Table 2.

Typically developing children performed significantly better than the children with LI on 3-syllable, $F(1, 32) = 4.24, p = .047$, and 4-syllable nonwords, $F(1, 32) = 7.00, p = .01$. The between group differences at 5-syllable level, $F(1, 32) = 4.05, p = .052$, suggested a notable trend, similar to findings at the 3- and 4-syllable levels, and were arguably very close to the significance level of the 4-syllable nonwords. No significant difference between genders was noted for the 3-syllable, $F(1, 32) = 0.14, p = .71$, 4-syllable, $F(1, 32) = 0.36, p = .55$, or 5-syllable nonwords, $F(1, 32) = 0.75, p = .39$. Two-way ANOVA tests showed no significant interaction effects between language group and gender for the 3-syllable, $F(1, 32) = 0.003, p = .96$, 4-syllable, $F(1, 32) = 0.22, p = .64$, or 5-syllable nonwords, $F(1, 32) = 0.09, p = .77$.

Prediction of Social Behaviors by Nonword Repetition Performance

In order to answer the third research question, regression analyses were performed to determine how much of the variance in each social behavior (reticence, likeability,

Table 2

Means (Standard Deviations) for Nonword Repetition Scores

Participant Group	3-Syllable	4-Syllable	5-Syllable
Language Impaired			
Male	17.67 (2.06)	21.17 (2.98)	21.42 (3.73)
Female	17.33 (2.66)	21.33 (3.20)	22.33 (4.27)
Total	17.56 (2.20)*	21.22 (2.96)*	21.72 (3.82)
Typical			
Male	19.08 (1.83)	23.25 (2.86)	24.00 (5.69)
Female	18.83 (2.48)	24.33 (1.03)	25.83 (1.60)
Total	19.00 (2.00)*	23.61 (2.43)*	24.61 (4.74)

Note. Three-syllable score out of 21 possible phonemes. Four-syllable score out of 27 possible phonemes. Five-syllable score out of 36 possible phonemes. Higher scores indicate better performance on the nonword repetition task.

* $p < .05$

prosocial) could be attributed to working memory, as measured by nonword repetition performance. First, regression analyses were performed to determine how much the social behavior could be attributed to working memory for all subjects, without regard to language group or gender. If the overall regression analysis showed that a significant amount of variance could be attributed to working memory, additional regression analyses were also performed to determine how much the social behavior could be attributed to working memory for each group.

Reticence. Regression analysis revealed that 22% of the variance in reticence scores from all subjects could be significantly predicted by nonword repetition performance, $F(3, 32) = 3.04, p = .04$. The regression equation was reticence = $-.075$ (3-syllable) $-.239$ (4-syllable) $-.116$ (5-syllable), indicating a negative relationship. In other words, as nonword scores increased, reticent behavior scores decreased. Higher nonword repetition scores were correlated with lower ratings of reticence.

Regression analyses were performed on the two language groups separately to determine how much variance in reticence scores could be attributed to working memory. Results from the regression analyses showed that although nonword repetition scores accounted for 22% of the variance for children with LI and 3% for typically developing peers, nonword repetition scores were not significant predictors of reticence for either children with LI, $F(3, 14) = 1.34, p = .30$, or typical peers, $F(3, 14) = 0.15, p = .93$, when the groups were analyzed separately. The regression equations were reticence = $.208$ (3-syllable) $-.299$ (4-syllable) $-.230$ (5-syllable) for children with LI, and reticence = $-.080$ (3-syllable) $+.038$ (4-syllable) $-.023$ (5-syllable) for typically developing children. For both language groups, the negative relationships indicate reticence increased as nonword

repetition performance decreased. Therefore, although nonword repetition scores significantly predicted reticence for all subjects, nonword repetition scores did not significantly predict variance in reticence for language groups separately.

Likeability. Regression analysis involving all of the subjects revealed that 17% of the variance in likeability scores of all subjects could be predicted by nonword repetition scores. However, the nonword repetition scores were not significant predictors of likeability $F(3, 32) = 2.23, p = .10$. The regression equation was likeability = $.227$ (3-syllable) + $.222$ (4-syllable) + $.002$ (5-syllable), indicating a positive relationship. As nonword repetition scores increased, likeability ratings also increased.

Prosocial. For prosocial ratings, nonword repetition scores were shown to be significant predictors of prosocial behaviors when comparing all subjects, $F(3, 32) = 7.77, p < .001$. The regression analysis showed that nonword scores accounted for 42% of the variance in prosocial ratings. The regression equation was prosocial = $.573$ (3-syllable) + $.009$ (4-syllable) + $.252$ (5-syllable), indicating a positive relationship. As nonword repetition performance increased, prosocial ratings also increased.

Regression analyses on the two language groups showed that nonword repetition scores did not significantly predict prosocial behaviors in either children with LI, $F(3, 14) = 3.14, p = .06$, or typical peers, $F(3, 14) = 1.54, p = .25$, when examined separately. Nonword repetition accounted for 40% of the variance for children with LI, and 25% for typically developing peers. The regression equation for LI was prosocial = $.688$ (3-syllable) - $.089$ (4-syllable) + $.237$ (5-syllable). For typically developing children the regression equation was prosocial = $.311$ (3-syllable) - $.072$ (4-syllable) + $.212$ (5-syllable). For both language groups, prosocial behaviors increased as nonword repetition

performance increased. Although nonword repetition was a significant predictor of prosocial behaviors in all children, nonword repetition performance was not found to be a significant predictor of prosocial behaviors when looking at the language groups separately.

Discussion

A great deal of research has demonstrated that children with LI have deficits in both social competence (e.g., Brinton & Fujiki, 1999; Craig, 1993; Fujiki, Brinton, Morgan et al., 1999; McCabe & Meller, 2004; Redmond & Rice, 1998; Rice et al., 1991) and processing skills (e.g., Archibald & Gathercole, 2006; Corriveau et al., 2007; Dollaghan & Campbell, 1998; Ellis Weismer et al., 2000; Graf Estes et al., 2007; Leonard et al., 2007; Montgomery & Windsor, 2007) compared to typically developing peers. What have yet to be fully determined, however, are the possible connections between processing skills and social behaviors in children with LI. Preliminary findings suggest that processing skills may be connected to social behaviors in children with LI (Donlan & Masters, 2000; Javid, 2006). This study aimed to more fully explore that possibility.

Social Behaviors

The first research question addressed in this study asked, “Do children with LI demonstrate differences in social behaviors (reticence, likeability, prosocial) compared to typically developing peers?” As has been found in previous research (e.g., Fujiki, Brinton, Morgan et al., 1999), teachers in the current study reported significantly more reticent behaviors in children with LI compared to typically developing peers. These behaviors included staring at other children without interacting, being reserved around other children, being unoccupied even when there is plenty to do, and being fearful when approaching other children.

Teachers also reported lower levels of likeability in children with LI compared to their linguistically typical peers. Children with LI were rated as having more problems related to impulse control, such as controlling their temper in conflicts with peers. The

children with LI were also rated lower in behaviors such as being accepted into ongoing activities and being cooperative during rough and tumble play.

Teachers also reported fewer prosocial behaviors in children with LI compared to children with typically developing language. The children with LI were less often observed offering help to other children having difficulty with a task, sharing materials with peers, or comforting a child who is upset.

The differences between children with LI and linguistically typical children found in this study are consistent with previous findings (e.g., Fujiki, Brinton, Morgan et al., 1999; K. I. Hart et al., 2004; Javid, 2006). These studies have consistently shown higher ratings for reticence and lower ratings for likeability and prosocial behaviors in children with LI. Gender differences in the literature have been less consistent. Similar to the results found in Fujiki, Brinton, Morgan et al. (1999), the current study showed no significant differences between genders for likeability and prosocial behaviors. However, other studies have shown lower ratings of likeability in males with LI compared to females with LI (Javid, 2006) and lower ratings of prosocial behaviors in males (K. I. Hart et al., 2004; Javid, 2006). Gender differences for reticence have also varied among studies. The current study found that typical males had higher ratings of reticence compared to typical females, but that females with LI had higher ratings of reticence compared to males with LI. However, Fujiki, Brinton, Morgan et al. (1999) found no difference between genders for reticence ratings. Despite the differences in gender results, the answer to the first research question is yes, children with LI demonstrate significantly different reticence, likeability, and prosocial behavior ratings compared to typically developing peers.

Nonword Repetition Performance

The second research question addressed asked, “Do children with LI demonstrate differences in nonword repetition performance compared to typically developing peers?” Previous research has repeatedly shown that children with LI perform significantly poorer on nonword repetition tasks compared to typically developing children (e.g., Dollaghan & Campbell, 1998; Edwards & Lahey, 1998; Ellis Weismer et al., 2000). The current study reported similar findings. Children with LI in this study also performed significantly poorer on the 3- and 4-syllable nonword repetition tasks compared to typically developing peers. Children with LI, on average, demonstrated a higher number of phonemic errors during repetition of the 3- and 4-syllable nonwords, including additions, substitutions, and omissions. At the 5-syllable level, a similar trend was noted between language groups. Although significance levels did not fall below .05 for the 5-syllable nonword repetitions, the difference approached significance. Given the similarity of the observed pattern at the three levels of performance, it would be difficult to argue that the differences at the 5-syllable level are not meaningful. Perhaps with a larger sample size, a significant difference would have been found. Nevertheless, both the available literature and the findings of this study at the 3- and 4-syllable level clearly show that children with LI demonstrate decreased performance of nonword repetition compared to typically developing peers.

Relationship Between Nonword Repetition and Social Behaviors

The final research question addressed in this study asked, “What is the relationship between nonword repetition performance and social behaviors in children with and without LI?” In order to answer this question, regression analyses were first performed to examine the relationship between nonword repetition and each social

behavior for the children with LI and their typical peers as a single group. Nonword repetition scores were shown to be significant predictors of reticence and prosocial behaviors for all subjects, predicting 22% and 42% of the variance for reticence and prosocial behaviors, respectively. Nonword repetition scores were not predictive of likeability ratings, however.

When examining language groups separately, nonword scores did not significantly predict any of the social behaviors. Although children with LI demonstrated higher reticence and lower prosocial ratings due to their lower nonword repetition performance, their scores did not differentiate them from their typically developing peers.

The results of this study were similar in several ways to previous findings reported by Javid (2006). Both studies showed that a significant amount of the variance in reticence and prosocial behaviors could be predicted by nonword repetition when examining children with LI and typical peers as a single group. Likewise, neither study showed significant amounts of reticence or prosocial behaviors being predicted by nonword repetition when examining language groups or gender groups separately.

Differences between this study and the previous study were noted in the area of likeability. Unlike the current study, Javid (2006) found that nonword repetition significantly predicted variance in likeability when examining all children as a single group. Additionally, Javid noted that variance in likeability was also significantly predicted by nonword repetition for typical children alone, but not for children with LI alone. These relationships were not replicated in the current study.

In general, the data from this study and the earlier work by Javid (2006) provide evidence that nonword repetition is related to reticence and prosocial behaviors, across

language groups and genders. What is less clear, however, is the relationship between nonword repetition and the social behavior of likeability. While Javid found a significant relationship, the current study did not find a significant amount of likeability being predicted by nonword repetition scores. Conducting the current study with a larger sample size may have produced results similar to those found in Javid's study.

Suggestions for Future Research

This study has contributed to the initial body of literature focusing on the relationship between verbal working memory and social behaviors in children with language impairment. Future research in this area would benefit from several additional measures to provide a more in-depth and comprehensive view of this relationship.

The current study included 36 children ages 7 to 11. Future research would benefit by including a larger number of subjects to produce more reliable results. Additionally, including a broader range of ages would provide a more complete view of social behaviors and verbal working memory throughout childhood. The relationship between verbal working memory and social behaviors may change as children age. Future research would benefit by including age in the analysis to explore this possibility.

In addition to the TBRS used in the current study, additional measures of social behavior would be beneficial to future research. Although the TBRS is a useful measure for quantifying social behaviors, observations in naturalistic contexts would provide an important supplement that would result in a more complete and representative picture of reticence, likeability, and prosocial behaviors in children with LI. Adding data from the home context (e.g., parent checklists, parent interviews, and/or observations in the home) would also benefit future research by demonstrating children's social abilities in a broader range of settings.

Additional measures of verbal working memory would also be helpful to add in future studies. Several measures are available in addition to the nonword repetition task used in the current study. The Auditory Working Memory subtest (Test 9) of the Woodcock-Johnson III (Woodcock, McGrew, & Mather, 2001) requires subjects to manipulate a series of words and digits to form categories while still retaining the correct sequence. The Competing Language Processing Task (Gaulin & Campbell, 1994) requires participants to judge a statement as true or false while also recalling the last word in each sentence. Similarly, the Grammatical Judgment Listening Span Task (Ellis Weismer, 2006) requires subjects to judge the grammatical correctness of sentences while also recalling the last word in each sentence. The various techniques used in these assessments would provide a broader range of information for future research in verbal working memory.

One change to the nonword repetition task itself may also benefit future research. As argued in Snowling et al. (1991), children will use any lexical knowledge to support nonword repetition. As mentioned in the above review of literature, Gathercole et al. (1994) hypothesized that the “distinctive morphemic constitution” of the 5-syllable nonwords presented in their study aided repetition (p. 110). This phenomenon was recognized in the present study. When presented with the nonword /nɪsə'foɪpɪzæl/, several subjects interpreted the word as “Mr. Foipizal,” thus accessing existing lexical support in the production of “mister.” Changing that nonword to be less word-like may have decreased the possibility that children would use lexical support rather than verbal working memory to aid production.

Although the main goal of this study was to link verbal working memory performance with social behaviors, it is likely that several factors influence social behaviors in addition to verbal working memory. Exploration of intelligence levels, emotional competence, and other factors would be important for future research looking to better understand the social behaviors of children with LI.

Implications

Both previous studies and the current study clearly conclude that children with LI demonstrate difficulties in social interactions. Children with LI were rated as demonstrating significantly more reticence and less likeability and prosocial behaviors compared to typically developing peers. Children with LI also performed significantly lower on the nonword repetition task, indicating poorer verbal working memory compared to linguistically typical peers.

When examining the relationship between social behaviors and nonword repetition in children with LI and typical peers, this study showed that nonword repetition accounted for 22% of the variance in reticent behaviors and 42% of the variance in prosocial behaviors. Nonword repetition was not shown to be predictive of likeability behaviors when examining children with LI and typical peers as a single group. Group specific analyses did not produce significant relationships between nonword repetition and either of the language groups. These results for reticent and prosocial behaviors are similar to those found previously (Javid, 2006). It should be noted, however, that regression analysis on the group with LI for prosocial behaviors approached significance. Verbal working memory may have played a more significant role in prosocial behaviors in children with LI than in children with typical language development; a larger sample size may have made a difference in these results.

Overall, this study demonstrated a connection between nonword repetition and social behaviors in children with and without LI. These findings contribute to the growing body of literature suggesting that children with LI have processing limitations that may contribute to other areas of difficulty.

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Appendix A

Consent Forms

Consent to Take Part in Research (for parents of children with LI)

Introduction

This research study is being conducted by Dr. Martin Fujiki, Brigham Young University, to study the ability of children with language impairment to correctly interpret the emotions of other people. Your child was selected because he/she is currently receiving language intervention.

Procedures

I will ask your child to complete the following tasks: (1) listen to a short paragraph read with various emotional tones of voice and judge what emotion is being conveyed, (2) listen to a short story and tell how the main character feels and what he/she should do, (3) look at pictures of facial expressions and tell what emotion is conveyed, and (4) make judgments about how emotion should be expressed in social situations. These tasks will be videotaped. Your child will also be asked to complete a test of nonverbal intelligence, a standardized language test, and a short memory test. Your child's teacher will complete a questionnaire focusing on social skills. This work will take about 2 to 2.5 hours (divided into shorter segments) of your child's time and 10 minutes of your child's teacher's time. All testing will take place in your child's school.

Risks/Discomforts

Your child will miss some class time. I will work closely with your child's teacher to make sure that research activities do not conflict with normal educational activities.

Benefits

There are no direct benefits to participants. It is hoped, however, that the research will help educators work with the social problems experienced by most children with language problems.

Confidentiality

Be assured that your child's participation will be confidential. All materials will be stored in a locked cabinet at BYU. Names will be removed from research materials and neither your name nor your child's name will ever be used in connection with any presentation of this research. All videotapes will be erased.

Compensation

At the end of each segment of work, your child will be offered a small toy, treat, or school supply to keep.

Participation

Participation is voluntary. If you give permission to include your child in the study, he/she will also be asked if he/she would like to participate. Even if you give consent, your child may withdraw at any time without penalty. Also, you may withdraw him/her at any time.

Questions about the Research

If you have any questions concerning the study, please contact me. My phone number and email address are (801) 422-5994, martin_fujiki@byu.edu.

Questions about your Rights as a Research Participant

If you would like to discuss this study with a person not involved in the research, you may contact Dr. Renea Beckstrand, Brigham Young University, 120 B RB, (801) 422-3873 (renea_beckstrand@byu.edu).

I have read, understand, and received a copy of the above consent and of my own free will allow my child to participate in the study.

Signature _____

Date _____

Consent to Take Part in Research (for parents of typical children)

Introduction

This research is being conducted by Dr. Martin Fujiki, Brigham Young University, to study the ability of children with language impairment to correctly interpret the emotions of other people. Your child was selected because I need children without language problems to serve as a comparison group.

Procedures

I will ask your child to complete the following tasks: (1) listen to a short paragraph read with various emotional tones of voice and judge what emotion is being conveyed, (2) listen to a short story and tell how the main character feels and what he/she should do, (3) look at pictures of facial expressions and tell what emotion is conveyed, and (4) make judgments about how emotion should be expressed in social situations. These tasks will be videotaped. Your child will also be asked to complete a test of nonverbal intelligence, a standardized language test, and a short memory test. Your child's teacher will complete a questionnaire focusing on social skills. This work will take about 2 to 2.5 hours (divided into shorter segments) of your child's time and 10 minutes of your child's teacher's time. All testing will take place in your child's school.

Risks/Discomforts

Your child will miss some class time. I will work closely with your child's teacher to make sure that research activities do not conflict with normal educational activities.

Benefits

There are no direct benefits to participants. It is hoped, however, that the research will help educators work with the social problems experienced by most children with language problems.

Confidentiality

Be assured that your child's participation will be confidential. All materials will be stored in a locked cabinet at BYU. Names will be removed from research materials and neither your name or your child's name will ever be used in connection with any presentation of this research. All videotapes will be erased.

Compensation

At the end of each segment of work, your child will be offered a small toy, treat, or school supply to keep.

Participation

Participation is voluntary. If you give permission to include your child in the study, he/she will also be asked if he/she would like to participate. Even if you give consent, your child may withdraw at any time without penalty. Also, you may withdraw him/her at any time.

Questions about the Research

If you have any questions concerning the study, please contact me. My phone number and email address are (801) 422-5994, martin_fujiki@byu.edu.

Questions about your Rights as a Research Participant

If you would like to discuss this study with a person not involved in the research, you may contact Dr. Renea Beckstrand, Brigham Young University, 120 B RB, (801) 422-3873 (renea_beckstrand@byu.edu).

I have read, understand, and received a copy of the above consent and of my own free will allow my child to participate in the study.

Signature _____

Date _____

Consent to Take Part in Research (for teachers)

Introduction

This research study is being conducted by Dr. Martin Fujiki, Brigham Young University, to study the ability of children with language impairment to correctly interpret the emotions of other people. You are being asked to participate because you are the classroom teacher of a child with language impairment.

Procedures

A child with language impairment and a typically developing child in your class are being asked to take perform a series of tasks that measure the ability to read the emotional reactions of other people. They will also be asked to take a test of nonverbal intelligence, a standardized language test, and a short memory test. We are asking you to complete a questionnaire focusing on social skills. You may return the completed questionnaire in stamped, self-addressed envelope that will be provided.

Risks/Discomforts

This questionnaire is 74 questions long and will take about 10 minutes, per child, for you to complete.

Benefits

This research will help educators work with the social problems experienced by most children with language problems.

Confidentiality

Be assured that participation will be confidential. All materials will be stored in a locked cabinet at BYU. Names will be removed from research materials and neither your name nor your students' names will ever be used in connection with any presentation of this research..

Compensation

We will compensate you \$5 per completed questionnaire as a thank you for your participation.

Participation

Participation is voluntary. You may withdraw at any time.

Questions about the Research

If you have any questions concerning the study, please contact me. My phone number and email address are (801) 422-5994, martin_fujiki@byu.edu.

Questions about your Rights as a Research Participant

If you would like to discuss this study with a person not involved in the research, you may contact Dr. Renea Beckstrand, Brigham Young University, 120 B RB, (801) 422-3873 (renea_beckstrand@byu.edu).

I have read, understand, and received a copy of the above consent and of my own free agree to participate in the study.

Signature _____ Date _____

Child's Assent

Introduction

My name is Martin Fujiki. I work at Brigham Young University. I study the way that children learn to tell what other people are feeling. I am working with children in Mrs./Ms/Mr. _____'s class. I would like your help.

What Will Happen (Procedures)

I will ask you to do several things. I will ask you to listen to a story and tell me how a person in the story feels. I will ask you to listen to another story and tell me how a person in the story feels and what he/she should do. I will ask you to look at some pictures of people and tell me how the people feel. I will ask you to tell me what a person should say when certain things happen. I will ask you some questions about things you like. I will videotape you doing some of these things. I will also ask you to take some tests. You will need to point to pictures, answer questions, follow directions, repeat some words, and solve some puzzles on these tests. Your teacher will answer some questions about how you work with others at school. You will do all the work at school. You will work with us two or three times. It will take an hour or less each time.

Possible Problems (Risks)

You will miss some class time. I will work with Mrs./Ms/Mr. _____ to make sure than you do not miss things in class that are really important or really fun.

Good things that will happen (Benefits)

You will get to pick a small toy or prize every time you work with us.

Who will know about this work (Confidentiality)

You, your parents, and your teacher will know that you are working with us. No one else at your school will know. We will not put your name on any of our papers. We will not put your parents' names or your teacher's names on any of our papers. We will keep all of our papers and work locked up in a cabinet at BYU.

What you will get (Compensation)

Every time you work with us, you will get to pick out a small toy or prize.

Working with us (Participation)

You do not have to work with us if you don't want to. You may quit this work any time you want to. You will still get your prize.

Questions

If you have any questions, please ask me. You can also ask your parents or your teacher. If you want to ask someone else questions about this work, you may call Dr. Renea Beckstead. Dr. Beckstead is a professor at BYU. Her number is (801) 422-3873.

I want to take part in this study.

Signature _____

Date _____

Appendix B

List of Nonwords

1. /krʌnə'pɪmɛdi/
2. /næbə'di/
3. /nɪsə'fɔɪpɪzæl/
4. /plæsɪn'ɔʒubl/
5. /pɔɪnə'mɛɪ/
6. /sæblən'tʌsɔʒəlɪm/
7. /tʌʃə'drævl/
8. /trɛlə'nɪm/
9. /bɛfi'ɔʒeɪpl/

Appendix C

Nonword Repetition Task Directions

Listen. You will hear some made-up words. I want you to say exactly what you hear. Let's try a practice word. Are you ready?

/tæs/

/pim/

[If child repeats the first word correctly, say "that was good," and go on to the second word. If child does not repeat correctly, repeat instructions and present the first word again.]

Now you will hear some longer made-up words through these headphones. After each made-up word, I want you to say the word you heard. Say exactly what you hear.

Ready?