Word Identification for Children who are Deaf/Hard of Hearing

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Dedication

I dedicate my dissertation to

… my grandma, who always wanted a doctor in the family

… my parents, who always encouraged me and pushed me to try my best

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… my girls, who have taught me my true priorities

Abstract

The purpose of this study was to investigate the effect of incremental rehearsal (IR) on word identification skills with children who are Deaf/Hard of Hearing (D/HH). A single-subject multiple probe, multiple baseline design across three word sets was used to examine if IR increased: (1) word identification of target words, (2) use of target words in sentences, and (3) silent reading performance. The study included five participants with varying degrees of hearing loss in kindergarten through fifth grade. The study was conducted for a period of 7 weeks. Visual analysis showed an increase in level and trend across 3 word sets for 4 out of 5 participants as measured by the number of target words identified correction in isolation and used in sentences. The use of IR increased word identification, use of target words in sentences, and silent reading performance. To establish IR as an evidenced based practice for students who are D/HH, this study needs to be replicated.

Table of Contents

List of Tables

List of Figures

Chapter 1

INTRODUCTION

Of the approximately 6.5 million students between the ages of 3-21 years served under the Individuals with Disabilities Education Act, 78,545 (1.2%) were classified under the heading 'hearing impairment' (U.S. Department of Education, 2013). On average, students who are Deaf/hard of hearing (D/HH) graduate or complete high school with a fourth-grade reading comprehension level (Allen, 1986; Holt, Traxler, & Allen, 1997; Karchmer & Mitchell, 2003; Traxler, 2000). Approximately 20% of individuals with varying degrees of hearing loss graduate from school with a reading level that is at or below second grade (Dew, 1999). Snow, Burns, and Griffin (1998) identified children who are D/HH as at risk for arriving at school with delayed language skills, less prior knowledge, letter knowledge and familiarity with the basic processes of reading when compared with children with average hearing levels. These statistics demonstrate a need for quality research to improve literacy among students who are D/HH.

In this chapter I will provide an introduction to a single subject design study conducted to investigate the effects of Incremental Rehearsal (IR) on word identification for children with varying degrees of hearing loss. As part of the introduction, I will briefly review key terms and outline the development of reading and word identification skills in children with hearing and children with varying degrees of hearing loss. I will conclude with a description of IR.

Key Terms

Reading terms. Throughout this paper the terms ‘word identification’ and ‘word recognition’ are used interchangeably. Both words involve the ability to look at a printed word and identify it. Identifying a word can include producing the word orally, in sign language, or matching the word to a picture or object. ‘Graphemes’ are text-based letters of the alphabet (Ehri & Nunes, 2002). ‘Phonemes’ are the “smallest linguistic unit of sound, each with distinctive features, that can signal a different in meaning when modified” (Owens, 2008, p. 461). ‘Morphemes’ are the smallest meaningful units of words (Owens, 2008).

D/HH terms. ‘Varying degrees of hearing loss’ is used interchangeably with terms such as 'deaf or hard of hearing' and 'hearing loss'. ‘Fingerspelling’ is the visual representation of the letters of the alphabet with using handshapes (Baker, 2010). Total Communication (TC) is used to describe some combination of manual communication and speech (Holcomb, 1970). ‘Pidgin Sign Language’ refers to the use of signs in the syntax of another language (Power & Leigh, 2003). For example, American Sign Language (ASL) has a different syntax than spoken English. Pidgin Sign English uses ASL signs in English word order.

Development of Reading Skills in Children with Hearing

Fountas and Pinnell (2001) proposed a continuum of reading where readers move from emergent, to early, transitional, self-extending, and finally advanced readers. Emergent reading begins as children notice environmental print. Children then recognize that the print is connected to language and eventually learn that print is made up of

words, which are made from strings of letters (Lyons & Pinnell, 2001). Early readers have some degree of letter knowledge, read orally, and recognize high frequency words. Transitional readers typically read silently, are skilled at word identification, read with fluency, and integrate a variety of sources of information. Self-extending and advanced readers read silently and fluently, making connections with the texts while analyzing words. Advanced readers expand their vocabulary and content knowledge through reading (Fountas & Pinnell, 2001).

Samuels (2002) reported that three processes all readers must use include decoding, comprehension, and attention (pp. 168-169). He described reading as a process of simultaneously coordinating word recognition, accessing meaning of words, determining the correct meaning, grouping words grammatically, making inferences, and using background information to understand text (p. 168). For children with typical language acquisition, reading follows a predictive pattern starting with early exposure to literacy that fosters motivation to read. Children then learn about print, receive effective instruction, and have frequent opportunities to practice reading (Snow et al., 1998, p. 4). The ability to read with comprehension is strongly dependent on robust language and word recognition. A delay in language development and word recognition skills can hinder comprehension (Samuels, 2002; Snow et al., 1998).

Development of Word Identification Skills in Children with Hearing

Word identification, also referred to as 'word recognition,' is the means by which readers access print (Beers, 2003). Word recognition occurs automatically for good readers (Caldwell & Leslie, 2009). Garcia and Cain (2014) conducted a meta-analysis to

examine the relationship between word identification and reading comprehension. They found that word identification and comprehension were strongly related across all age groups.

Accurately reading words with automaticity allows readers to focus on comprehension (Samuels, 1997; Samuels, 2002). Identifying words can be achieved through decoding, recognizing root words and affixes, finding smaller words in larger words, knowing words by sight, and using context to extract meaning (Beers, 2003, p. 223). Good readers have a vast bank of words they recognize with automaticity. They are able to apply strategies for determining unfamiliar words and understand that comprehension is the overall goal of reading (Caldwell & Leslie, 2009, p. 96).

Samuels (2002) identified three stages of word recognition: (a) non-accurate stage, (b) accurate but not automatic stage, and (c) accurate and automatic stage (pp. 171-172). Sight word recognition is one early literacy skill that is predictive of overall reading achievement, comprehension, and fluency (Burns, Dean, & Foley, 2004; Jenkins, Fuchs, van den Broek, Espin, & Deno, 2003; Levy, Abello, & Lysysnchuk, 1997; Morris, Bloodgood, & Perney, 2003; Tan & Nicholson, 1997). A lack of automaticity in decoding or word recognition leaves little processing for comprehension (Fleisher, Jenkins, & Pany, 1979). Recognizing words with automaticity is one key component of the reading process (Samuels, 2002; Snow et al., 1998).

Word identification starts as a visual process with printed letters creating a word. Once word identification has been initiated through the visual channel, the linguistic-phonological decoding process is triggered. Phonological decoding entails looking at the

graphemes (printed letter) and determining the correct phoneme (letter sound) that is represented by the grapheme. The process of combining the auditory-linguistic base, visual and phonological process leads to word identification (Snow et al., 1998). The English language does not always follow phonetic rules as it contains irregular spelling patterns (Joseph et al., 2012). "Skilled readers develop both a knowledge of how spelling patterns correspond to possible word pronunciations and a sensitivity, based on experience, to the relative frequency of printed word and subword forms" (Snow et al., 1998, p. 66).

Frequent opportunities and experience builds automaticity in word identification (Schneider & Shiffrin, 1977). Snow et al. (1998) reported that linguistic fluency, knowledge of orthographic units and phonological decoding are complementary to each other and lead to word identification. Children need to change their perception from words being pictures to recognizing that words are made up of letters and those letters represent speech sounds (Snow et al., 1998). Reading comprehension is limited when individuals are not skilled at decoding words (Breznitz & Berman, 2003; Kuhn et al., 2006; Snow et al., 1998).

Reading for Children with Varying Degrees of Hearing Loss

Children with varying degrees of hearing loss are often delayed in word recognition, language, vocabulary, grammar, inferencing skills, and background knowledge and do not have the same competencies as children with hearing (McAnally, Rose, & Quigley, 1999; Paul, 2003; Rose, McAnally, & Quigley, 2004). Schirmer and McGough (2005) examined the National Reading Panel (2000) report in relation to

research conducted with children who are D/HH. Their review of research demonstrated clear gaps in the literature pertaining to reading and reading outcomes for students who are D/HH. Research reviews and implications for practice have been written on vocabulary acquisition (Luckner & Cooke, 2010), reading comprehension (Luckner & Handley, 2008), emergent literacy (Williams, 2004), language and literacy development (Moeller, Tomblin, Yoshinaga-Itano, Connor, & Jerger, 2007), fluency (Luckner & Urbach, 2011), and literacy strategies (Easterbrooks & Stephensen, 2006) for students who are D/HH. These reviews demonstrate the need to reexamine or expand the processes used to develop reading comprehension and fluency among children with varying hearing levels. Reitsma (2009) stated, "Because reading skills of deaf children are generally quite low, extensive individualized instruction and practice are essential in order to increase word identification skills and written language vocabularies" (p. 185). Wang and Paul (2011) emphasized a need for intervention research on instructional literacy practices in the field of Deaf Education.

Reading Performance for Children with Varying Degrees of Hearing Loss

Multiple studies have been conducted comparing the reading performance of participants who are D/HH to participants with normal hearing (Colin, Magnan, Escalle, & Laybaert, 2007; Daigle, Berthiaume, & Demont, 2012; Gaustad & Kelly, 2004; Harris & Moreno, 2004; Most, Aram, & Andorn, 2006; Ormel, Hermans, Knoors, Hendricks, & Verhoeven, 2010; Wauters, Van Bon, & Tellings, 2006). Using different strategies, these studies examined the components of reading and included participants who used alternative modes of communication in a variety of languages. The consistent result

across these studies was that the children with typical hearing performed better than the children with hearing loss. Wauters et al. (2006) reported that reading comprehension was significantly correlated with word identification ($r = .50$, $p < .01$). Students with varying degrees of hearing loss read significantly below expectations for their age and grade. Wauters et al. (2006) suggested "deaf participants would have better reading comprehension scores if their word identification scores were in accordance with their instructional age" (p. 66). Poor word identification skills had a negative effect on reading comprehension for D/HH participants (Wauters, et al., 2006). Word recognition and reading comprehension scores were reported for students who were D/HH and students who were D/HH with cochlear implants (CI) (Vermeulen, van Bon, Schreuder, Knoors, & Snik, 2007). Results for word identification at the elementary level were non-significant, however participants with CIs had better word recognition scores than participants without CIs at the secondary level.

Perspectives on Word Identification for Children with Varying Degrees of Hearing Loss

Paul (1997) synthesized research reports focused on improving reading achievement in students and the implications for increasing the reading skills among students with varying degrees of hearing loss. According to Paul (1997), word identification must be rapid and effortless with comprehension as a reciprocal process with word identification. He reported that there is no single 'best' method for teaching reading or word identification for children who are D/HH and the ability to decode or identify words does not result in reading with comprehension (Paul, 1997). He concluded

that research is needed in the area of reading interventions focused on text-based instruction (i.e., letter knowledge, letter-sound correspondence, syntax, vocabulary), reader-based characteristics (i.e., prior knowledge and metacognition), and task-based variables (i.e., retelling, summarizing, predicting). He also emphasized the need for continually monitoring student progress and assessing the strategies that are being used.

Kelly (2003) stressed the importance of developing automaticity in word identification to support reading comprehension with readers who are D/HH. He outlined considerations for teachers when planning instruction to promote automaticity in deaf readers based on research with hearing and D/HH children. He stated that effective teaching with children who are D/HH should include word recognition, creative and engaging practices, and specific targeted vocabulary with the goal to achieve automaticity. Effective teaching should include feedback, frequent practice, and developmentally appropriate goals. Phonological, orthographic, morphological, logographic, sign, and fingerspelling are all coding systems that individuals who are D/HH can use to decode words (Kelly, 2003). In addition, there needs to be continued research on word identification strategies for individuals who have varying degrees of hearing loss (Kelly, 2003).

Incremental Rehearsal

Incremental rehearsal (IR) is an intervention that has been effective in teaching word identification to struggling readers (Burns, 2007a; Burns, 2007b; Burns & Boice, 2009; Burns & Kimosh, 2005; Joseph, 2006; Joseph, et al., 2012; Nist & Joseph, 2008; Szadokierski & Burns, 2008). IR is a drill-rehearsal model that incorporates frequent

repetition (Burns, Dean, & Foley, 2004). Within IR, new information is learned by dispersing unknown items (10%) with known items (90%), typically on flashcards. Unknown content is introduced one item at a time and rehearsed five to nine times before introducing a second unknown. The flashcards are displayed incrementally so that the time between unknown items becomes increasingly longer. Flashcards may be shown in the following sequence (U = unknown, K= known): U-K1-U-K1-K2-U-K1-K2-K3. With high opportunities to respond and flexibility of content according to student need, IR has been shown to be efficient, effective, and feasible in school intervention settings (e.g., Burns & Boice, 2009). The IR strategy can serve as a low-cost intervention with teacher-made materials specific to the curriculum and individual needs of the learner.

IR is an instructional strategy that has led to increased skills with students without disabilities (Burns & Sterling-Turner, 2010; Codding, Archer, & Connell, 2010; Nist & Joseph, 2008), children with disabilities (learning disabilities, cognitive delays) (Burns, 2005; Burns & Boice, 2009; Burns et al., 2004), and English Language Learners (ELL) (Peterson, et al., 2014). IR has been used as an instructional strategy for teaching children to identify words (Burns, 2007a; Burns, 2007b; Burns & Boice, 2009; Burns & Kimosh, 2005; Joseph, 2006; Joseph, et al., 2012; Nist & Joseph, 2008; Petersen-Brown & Burns, 2011; Szadokierski & Burns, 2008), letter identification (Bunn et al., 2005), letter sound correspondence (DuBois, Volpe, & Hemphill, 2014; Peterson, et al., 2014; Volpe et al., 2011), and math facts (Burns, 2005; Codding et al., 2010).

Petersen-Brown and Burns (2011) examined the use of traditional IR for learning to read words and using IR with an added vocabulary component. Participants were

randomly assigned to one of two groups: (1) IR without vocabulary or (2) IR with vocabulary. The IR without vocabulary procedure used seven unknown words. The first unknown word was presented with eight known words. The unknown word was introduced to the participants and after repeating the word, they were asked to use it in a sentence. The participants would then read the first unknown word, followed by one known word, then the unknown word, followed by two known words, then the unknown word, followed by three known words. This procedure continued until the student had read all eight known words (Petersen-Brown & Burns, 2011). The IR with vocabulary followed the same procedure as IR without vocabulary and included defining the unknown word when it was initially presented. Participants were then prompted to repeat the word, the definition, and use the target word in a sentence (Petersen-Brown & Burns, 2011). Petersen-Brown and Burns (2011) found that participants who participated in the IR with vocabulary were more likely to retain and generalize the target words ($t(59) = -3.26$, $p = .002$).

Incremental rehearsal led to increased skills in reading and math for a variety of different student populations. This strategy may also increase reading skills for children who are D/HH. To date, a study using IR with students who have varying degrees of hearing loss could not be located. The IR procedure uses frequent repetition, which Kelly (2003) identified as an effective practice for children who are D/HH. Studies examining word identification conducted with children who are D/HH often included using the words in a sentence and/or semantic mapping (Andrews, 1988; Andrews & Mason, 1986; Dimling, 2010; Geoffrion, 1981; van Staden, 2013; Wang & Paul, 2011). This resulted in

increased word identification and reading comprehension. IR with an added component of using target words in sentences may be an effective strategy for increasing word identification and reading comprehension for individuals who are D/HH.

The purpose of this study was to determine if Incremental Rehearsal (IR) increases word identification in elementary aged children with varying degrees of hearing loss. In addition, this study explored the use of IR for increasing the use of target words in sentences and reading comprehension. This study addressed three research questions:

1. Is there a functional relationship between incremental rehearsal (IR) and increased levels of word identification with students who are D/HH?
2. Is there a functional relationship between IR and ability to use target words meaningfully in sentences when prompted as measured by independently using the words semantically and syntactically correctly in sentences for students who are D/HH?
3. Is there a functional relationship between IR and increases in silent reading performance as measured by the *Reading Milestones Placement and Monitoring* passages (RMPM; McAnally & Rose, 2012a) with students who are D/HH?

Chapter 2

LITERATURE REVIEW

This chapter provides a review of research related to word identification and interventions with children who have varying degrees of hearing loss. A search was conducted using ERIC via ProQuest, Academic Search Premier via EBSCOhost, ERIC via EBSCOhost, and PsycInfo. The search terms included 'hard of hearing', 'hearing loss' and all forms of the words 'deaf' (e.g., deafness, deafened) or 'hearing impair' (e.g., hearing impaired, hearing impairment). The final search term was 'word identification'. Articles needed to be available in full text, in English, and published in a peer-reviewed journal. ERIC via ProQuest yielded 19 results, Academic Search Premier via EBSCOhost yielded 27 results, PsycInfo yielded 29 results, and ERIC via EBSCOhost yielded 16 results.

A second search was conducted using the same search engines and terms associated with hearing loss. Additional search terms included 'word recognition' and all forms of the word 'read'. ERIC via ProQuest yielded 9 results, Academic Search Premier via EBSCOhost yielded 79 results, ERIC via EBSCOhost yielded 37 results, and PsycInfo yielded 12 results. In total, 228 articles were found via the initial search and inclusion/exclusion criteria were applied.

Inclusion and Exclusion Criteria

Articles selected for review must have included students who were deaf or hard of hearing with a focus on word identification in reading. Articles needed to be intervention studies that directly targeted word identification or measured word identification before

and after, or during the course of the intervention. Articles were not included in this review if they focused on writing and did not include measures of word identification. Articles focused on word identification related to speech intelligibility, speech perception, or lipreading were not included. Articles that examined response latency and did not include word recognition abilities were excluded.

Applying the inclusion and exclusion criteria to the initial pool of articles resulted in a final sample of 13 articles published between 1981 through 2013. Two of the articles are reported jointly as they used the same data set from the same study (Andrews, 1988 and Andrews and Mason, 1986).

Based on the search terms, inclusion criteria, and exclusion criteria 13 intervention studies were reviewed that examined word identification as one of the dependent variables (Andrews, 1988; Andrews & Mason, 1986; Beal-Alvarez, Lederberg, & Easterbrooks, 2012; Dimling, 2010; Ensor & Koller, 1997; Geoffrion, 1981; Hirsh-Pasek, 1986; Reitsma, 2009; Stoefen-Fisher & Lee, 1989; van Staden, 2013; Wang & Paul, 2011; Wauters, Knoors, Vervloed, & Aarnotse, 2001; Wolbers, 2008). With exception of the publications by Andrews (Andrews, 1998 and Andrews & Mason, 1986), none of the articles used the same intervention strategy. The articles varied by the modes of communication used, intervention, and age of participants. Articles were categorized based on communication modality (e.g. sign, finerspeling, audiotry-oral) used as part of the intervention and non-modality related interventions. Manually coded interventions were defined or identified by the use of fingerspelling as an intervention (Hirsh-Pasek, 1986), sign language as an intervention (Andrews, 1988; Andrews &

Mason, 1986; Reitsma, 2009; Stoefen-Fisher & Lee, 1989; Wauters et al., 2001), or a combination of fingerspelling and sign as an intervention (Beal-Alvarez et al., 2012; Dimling, 2010; Geoffrion, 1981; van Staden, 2013). Non-modality related interventions did not incorporate manual communication (sign or fingerspelling) as a component of the intervention (Ensor & Koller, 1997; Wang & Paul, 2011; Wolbers, 2008). These studies include students who used auditory-oral communication, a combination of spoken language and manual communication, or manual communication.

Modality Related Interventions

Fingerspelling intervention. Hirsh-Pasek (1986) proposed the use of fingerspelling as an alternative way for decoding and/or segmenting words for students who are D/HH and used American Sign Language (ASL). The study included 25 students between the ages of 5 and 16 years. Participants in the study were assessed on their sight word vocabulary, fingerspelled vocabulary, and use/understanding of fingerspelled words (e.g., handshapes matched to printed letters of the alphabet). When participants were unable to match a word to the corresponding picture, the researcher prompted the participants to use fingerspelling as a strategy for identifying the unknown words. When participants applied the use of fingerspelling as a strategy, they increased the number of sight words identified. Hirsh-Pasek (1986) concluded that students who are D/HH may be able to use fingerspelling as a strategy for decoding unknown words in a similar way that individuals with hearing utilize phonics for decoding words.

Sign language interventions. Andrews and Mason (1986) implemented a reading intervention for 30 minutes per week over the span of nine months. There were 45

participants from schools for the deaf who used sign language, fingerspelling, and spoken English. All participants were evaluated (pre-test and post-test) on their ability to: (1) fingerspell a letter, a word, and their first name, (2) demonstrate letter identification with fingerspelling, (3) print a letter, word, and their name, (4) read a story, (5) retell a story that was signed by the researcher, and (6) demonstrate recognition of 150 printed words by using the sign equivalent (Andrews & Mason, 1986, p. 212). Word recognition was evaluated by participants' ability to provide the sign equivalent for the printed word.

The participants were assigned to convenience treatment (n = 23) and control groups (n = 22) based on the residential school attended. Participants in the treatment group received a 30 min weekly training session involving word recognition and story-time. The intervention materials included researcher created storybooks and drill cards. Each page of the books contained a picture, two to three words, and a sign. In each training session, the experimenter signed one of the stories and then discussed three to five selected words from the story. Guided reading focusing on the target signs and printed words within the story followed. The participants were each given their own copy of the book. They acted out the story, read it to peers, or reviewed the plot (Andrews & Mason, 1986).

Based on pre/post tests, Andrews and Mason (1986) reported that participants increased their word recognition of drilled words (M = 6.74 to M = 29.39 out of 50), words they were exposed to (M = 8.26 to M = 24.82 out of 50), and novel words (M = 6.04 to M = 19.69 out of 50). The researchers concluded that exposure and word drill demonstrated significant effects on drilled words ($p < .001$), exposed words ($p < .001$),

and novel words ($p < .01$). In a subsequent report, Andrews (1988) compared the treatment and control groups from the original study. The participants in the experimental group were able to read more drilled, exposed, and novel words than the participants in the control groups (Andrews 1988; Andrews & Mason, 1986). In the word recognition task, the experimental group significantly outperformed the control group ($t(1,44)=4.58$, $p < .001$) (Andrews, 1988).

Stoefen-Fisher and Lee (1989) examined the use of picture representations of signs as a method for increasing sight word identification in children who are D/HH. Participants included 20 students between 6 to 8 years of age in Total Communication programs. The Total Communication programs used either Pidgin Sign English or Signing Exact English (Gustason, Pfetzing, & Zawolkow, 1980). The children were presented 14 slides with printed words only (PO) and 14 slides with printed words and a picture representation of a sign of the corresponding word (PS). Upon completion of viewing the slides, students were presented with retention slides with the printed word only. Each participant was administered the PO and the PS condition with a two week gap between administrations. They reported the mean number of words identified following the PO condition was 8.15 out of 14 and PS was 11.30 out of 14. During the immediate retention task, the mean number of words identified in the print only condition was 8.30 and 9.05 in the print plus sign condition. Stoefen-Fisher and Lee (1989) concluded that having a picture of the sign was statistically significant for initially identifying printed words compared to print only. However, the results were not significant between the print only and the print plus sign during the retention tasks. The

researchers recommended additional research to explore multiple exposures to picture representation and the effect on retention.

The effects of using spoken language (Dutch) or spoken language plus Sign Language of the Netherlands (SLN) on word recognition, speech, and accuracy were assessed by Wauters et al. (2001). Sixteen (n = 16) elementary school students who were D/HH participated in this study. Word identification was assessed using a computer-based test (reference not provided). Nine word lists were used during the course of the study, each list contained ten words. Six of the word lists were used during the training sessions and three of the lists contained novel words. All participants were assessed before and after each training period on the ten words targeted and ten words from a different list to evaluate generalization. To assess word recognition a picture appeared on a computer screen with four words surrounding it. The participant had to match the correct typed word to the picture (Wauters et al., 2001).

There were a total of three training periods made up of four training sessions which lasted 15 min. Twenty words (two word lists) were targeted during each period. Ten words were trained in the speech only condition and the other ten were in the speech and sign condition. All participants had training in both conditions. During training a picture would display on the screen and a trainer would voice the word or voice and sign the word. The word would then appear on the screen letter-by-letter. The participants would then voice or sign the word. Finally, the trainer would voice or sign the word again (Wauters et al., 2001).

An average of five additional words were identified between pre and post-test conditions. Differences were statistically significant ($p < .05$)(Wauters et al., 2001). The speech and sign condition was the only condition that demonstrated significant effects ($p < .01$) when the effects of training condition were examined. Researchers reported that training did not generalize to untrained words (p. 37).

Reitsma (2009) examined the use of two different computer-based exercises on spelling and word identification with Dutch children who were D/HH between 7 and 10 years of age ($n = 11$). Participants received instruction in Dutch sign language, spoken Dutch with signs, "and whatever means are available to inform children and communicate with them" (Reitsma, 2009, p. 181). The computer-based exercises consisted of matching a picture (drawings or signs) to three different words, referred to as orthographic sessions, and matching a word to three different pictures (drawings or signs), referred to as semantic sessions. The words targeted during the exercises were words that were part of the participants' sign language vocabulary, but not words that the students recognized in writing as determined by pre-testing. If the participant selected the correct answer, a happy face was displayed on the screen and their selection turned green. Selecting the incorrect answer prompted a sad face to appear on the screen. Participants were tested on reading, spelling, and word identification a few days after each training session.

Reitsma (2009) reported that the percentage correct during the exercise sessions was higher for the semantic sessions (70-95%) than the orthographic sessions (40-75%). No significant difference was found between the use of signs or drawings during the

practice sessions. Based on pre-test information, none of the participants were able to read the words used in the practice sessions. Upon completion, participants were able to read 56% of words, spell 26% of the target words, and identify 78% of the words on a word recognition test. Post-test scores for the orthographic sessions were significantly higher than scores after the semantic sessions ($p < .04$).

Reitsma (2009) concluded that children who are D/HH can learn words through computer-based exercises. On average, participants learned 60% of the words targeted and were able to spell 20% of them correctly.

Sign language and fingerspelling interventions. Geoffrion (1981) modified teaching methods developed by the Exemplary Center for Reading Instruction (ECRI) for targeting word identification skills in students who were D/HH. The ECRI strategy was selected as it could be adapted to meet the needs of individuals with varying degrees of hearing loss. The adaptations included a reduction of the emphasis on oral instruction and increasing the use of signing and fingerspelling. The ECRI strategy required students to complete a task within an intensive drill and practice session. The task included reading a word, spelling it, filling in missing portions of the word, writing the word, using the word in a sentence, and comparing the word to similar words. The modified ECRI strategy included frequent opportunities for the student to sign the word and see it modeled in sign. (Geoffrion, 1981).

Geoffrion (1981) conducted a study with seven third grade students in a Total Communication classroom who had varying degrees of hearing loss. Results indicated that the number of students passing weekly spelling tests increased from 60% prior to the

intervention to 95% once the intervention was implemented. ANOVA results were reported to be statistically significant ($F(1,6) = 9.11$; $p < .02$). Geoffrion (1981) concluded that word identification is just a small portion of the entire reading process and by improving word identification in a short amount of time, more focus can be devoted to improving language and reading comprehension (Geoffrion, 1981).

Dimling (2010) examined the impact of a conceptually-based vocabulary intervention on the recognition, production, and use of multi-meaning words in a multiple baseline across subjects single-case design. The study included participants who were D/HH and used Pidgin sign language ($n = 6$). Recognition, production, and use of multi-meaning words were assessed at pretest, baseline, and intervention phases of the study. Word recognition was assessed by the teacher signing a word or phrase and the student fingerspelling, voicing, or pointing to a printed word that matched the sign. Students orally stated or used a sign that corresponded to a picture card to assess production. To evaluate comprehension students were shown a card containing a target word or phrase accompanied by the signed and spoken word. The participants were then required to use the word in a sentence, provide an example, or point to representations of the word within the classroom.

The intervention used in Dimling's (2010) study consisted of an additional 30 min sign language vocabulary block four days per week. A total of six Dolch words and bridge phrases were targeted each week. Bridge phrases were phrases used in English that needed translation for conceptual understanding in ASL (e.g., fall down). The teacher introduced participants to the target words/phrases in writing, fingerspelling, and

demonstrating the sign, followed by the student repeating it (Dimling, 2010). Following the introduction, the participants created a semantic map exploring the word and possible meanings and examples of the word. Finally, the participants were required to use the word in a sentence (Dimling, 2010).

Dimling (2010) reported that a conceptually-based vocabulary intervention demonstrated an effect across recognition, production, and comprehension of Dolch words and bridge phrases for all participants. Visual inspection of participants' graphs for recognition, production, and comprehension of Dolch words and bridge phrases demonstrated an immediate, positive increase in level from baseline to the intervention condition. The number of Dolch words participants were able to recognize after the intervention ranged from 24-45 words per participant (Dimling, 2010). Students were able to master at least 60% of the Dolch words targeted during the intervention.

Beal-Alvarez et al. (2012) conducted a study to examine the effects of Visual Phonics (International Communication Learning Institute, 1982) and *Foundations for Literacy* (*Foundations*; Lederberg, Miller, Easterbrooks, & Connor, 2011) on acquisition of grapheme-phoneme correspondence (GPCs) for D/HH preschool students and the impact that acquisition of GPCs has on reading words. Participants were three D/HH preschool students with varying degrees of hearing loss, communication modalities (speech and/or sign), and hearing status of parents. At the beginning and end of the year, the participants were given a word decoding test of 13 words. The intervention consisted of hour-long sessions, four days a week, over 23 weeks.

Visual Phonics is "a multisensory instructional tool designed to clarify the sound-symbol relationship between spoken English and print" (Beal-Alvarez, 2012, p. 40). *Foundations* is an emergent literacy curriculum that provides meaningful associations for each phoneme through multimodal input. This curriculum is designed for preschoolers who are D/HH and was used for 1 hour, four days per week. On the first day, a target GPC is introduced through a story. The second day, teachers and children act out the story (semantic association activity). A review of the story and introduction to decoding and blending occurs on the third day. On the final day, activities around phonological awareness are completed (blending, segmenting, and initial sound identification). To determine if there was a functional relation between *Foundations*, Visual Phonics, and the acquisition of GPCs, a multiple baseline design was used. Decoding and word identification were examined by generalization probes.

After instruction, all participants mastered newly learned GPCs. Visual analysis demonstrated a functional relationship between instruction with *Foundations*, supplemented by Visual Phonics. In the word decoding task, participants were able to identify all phonemes in the words and identify 2-4 words that had been taught during the intervention. None of the participants were able to decode or identify novel words (Beal-Alvarez et al., 2012). Use of Visual Phonics was observed on four occasions with one participant using it each time and two participants using it only once.

Beal-Alvarez et al. (2012) concluded that when instruction is provided using a D/HH curriculum designed for preschoolers with Visual Phonics, preschoolers acquired GPCs despite variations in degree of hearing, ability to perceive speech, and receptive

language skills. In addition, while the participants were able to identify all of the phonemes in a novel word, they were not able to blend the phonemes together and identify the word (Beal-Alvarez et al., 2012). The researchers indicated that reading novel words might not be a developmentally appropriate activity for D/HH preschool students.

Van Staden (2013) examined the effects of an intervention using sign language and multi-sensory input on the comprehension and word identification of residential elementary school students with varying degrees of hearing loss in South Africa (n = 64). All participants used South African Sign Language (SASL) and written English. A pre/post-test design was used to examine the differences between the treatment and control groups after nine months of instruction in the areas of word recognition, sight word recognition, receptive and expressive vocabulary, and reading comprehension. Word recognition was evaluated using the Reading and Spelling Test for Primary School Children (*ESSI*) (Esterhuyse, 1997). Sight word recognition, vocabulary, and reading comprehension were measured by researcher created diagnostic instruments based on the *Oxford Reading Tree Series* (Brychta & Hunt, 2011) and the *Peabody Picture Vocabulary Test*, 4th edition (PPVT-4; Dunn & Dunn, 2007).

The control group received classroom instruction using a whole language approach with the *Oxford Reading Tree Series* and curriculum guidelines from the *Elementary Phase Literacy Curriculum of the Department of Education* (National Department of Education, 2002) (van Staden, 2013, p. 311). The experimental group, received instruction three times a week for 45 min sessions. Instruction consisted of: (a)

three to five target vocabulary words used with interactive word wall activities, (b) target vocabulary matched to printed words, SASL signs, fingerspelling, and objects/pictures/actions, (c) definitions and synonyms for the words, (d) words used in sentences, (e) words traced on sandpaper, (f) words practiced in researcher created workbooks, (g) words and their meanings created with clay, (h) vocabulary sorts, (i) sign, print, and picture mapping, (j) flashcard games, and (k) reciprocal reading with comprehension strategies including predicting, questioning, visualizing, summarizing, or retelling (van Staden, 2013, p. 311).

Van Staden (2013) reported no significant difference between the treatment and control groups during pre-tests for age, non-verbal intellectual ability, word recognition, sight word reading, vocabulary, and comprehension. Post-test scores revealed significant differences between the groups for word recognition ($p < .0001$), sight word reading ($p < .0001$), vocabulary ($p < .0001$), and comprehension ($p < .0001$) (van Staden, 2013). The researcher reported large effect sizes for the experimental group in sight words ($r = .94$), word recognition ($r = .92$), vocabulary ($r = .87$), and comprehension ($r = .81$).

Non-Modality Related Interventions

Ensor and Koller (1997) examined the effects of repeated readings on word recognition and fluency rates in adolescents who are D/HH. Forty-two students who attended schools for the deaf and used Total Communication were recruited for this study and randomly divided into treatment and control groups. There were no significant differences in age, hearing loss, mental ability, and reading achievement between the treatment and control group. Participants within each group were divided into one of four

groups that matched their instructional reading level as determined by the *Stanford Achievement Test-Hearing Impaired Edition* (SAT-HI, citation not provided).

Participants read five passages at their determined instructional level using Total Communication over a period of five days. They were videotaped during the initial and final reading. The treatment group read the same passage over all five days. During the three days between the initial and final reading, participants were given 15 min to practice reading with a partner. The control group read the same passage on the initial and final day, however they read different passages in between for 15 min.

Researchers evaluated participants on the their reading rate (words per minute) and miscues. Miscue analysis was calculated two different ways: (a) total accuracy and (b) combined accuracy (Ensor & Koller, 1997). Total accuracy was the number of words accurately identified divided by the total word count and combined accuracy was the number of words accurately identified with researcher determined acceptable miscues over the total word count. The researchers used total accuracy for overall accuracy and combined accuracy as a measure of comprehension. No significant effects between treatment and control groups for reading rate ($p < .86$), reading accuracy ($p < .73$), or combined accuracy ($p < .77$) were reported. Significant effects were reported between pre and post tests for all three factors (reading rate, accuracy, and combined accuracy; p's < .001). The researchers reported that all participants increased rate and accuracy across passages and that the participants in the treatment group had the largest improvement between pre and post measures (Ensor & Koller, 1997, p. 66).

Wolbers (2008) conducted a pre and post-test measures of writing, word identification, and revising/editing to examine the effects of Morning Message (MM), an interactive reading and writing instructional activity, on participants who are D/HH. Total Communication and American Sign Language were the modes of communication used during instruction. Three teachers provided instruction, one at the middle school level and two at the elementary level. A researcher created rubric was used to assess writing samples. Word identification was assessed using the Slosson Oral Reading Test—Revised (SORT-R; Slosson & Nicholson, 1990). To assess revising and editing, participants were given Shay's Newspaper Story (Mariage, 2001). This is a story in need of revising and editing. Students were evaluated based on the changes they made to the story.

Participants demonstrated significant gains in word identification ($t = 6.69$, $p < .000$) after using MM 21 times over eight weeks. Elementary students ($n = 8$) outperformed middle school age students ($n = 8$) in word identification skills after participating in MM. In addition to the gains in word identification, participants also made gains in writing. Wolbers (2008) promoted the use of MM, or guided and interactive writing, for individuals with varying degrees of hearing loss.

Wang and Paul (2011) used a mixed-methods design to examine a technology-based literacy instruction model, *Cornerstones* (http://pbskids.org/lions/cornerstones), on reading outcomes for children who are D/HH. The Carl and Ruth Shapiro Family National Center for Accessible Media and the U.S. Department of Education funded the Cornerstones Project through a Stepping Stones of Technology Innovation for Students

with Disabilities Program. The researchers examined word identification, word knowledge, and story comprehension. This study included students with varying degrees of hearing loss (n = 22) and teachers of the D/HH (n = 5). The participants were in educational programs that used Total Communication, Bilingual-Bicultural, or Oral language.

The quantitative portion of the study conducted by Wang and Paul (2011) used an alternating treatment design between *Cornerstones* and the typical instruction in the classroom. All participants were included in three experiments that were conducted in a counter-balanced format. In the first and third experiment the participants received typical instruction, had a week-long break, and then used *Cornerstones*. In the second experiment, *Cornerstones* was used first, followed by a week-long break and then typical instruction followed. Wang and Paul (2011) assessed word identification by the participants' ability to read target words. Participants were evaluated on their word knowledge by describing the target words they were able to correctly identify. Story comprehension was assessed with literal and inferential short answer questions pertaining to the story. The difference between pre-test and post-test word identification scores, were significantly greater in *Cornerstones* than typical instruction ($p < .05$) in all three experiments (Wang & Paul, 2011). Researchers found no significant difference in scores on word knowledge between *Cornerstones* and typical instruction. Story comprehension in experiments one and two were statistically significant for *Cornerstones* ($p < .05$), but not for experiment three. Wang and Paul (2011) noted carryover from *Cornerstones* into the typical instruction. The teacher participants in the study reported "a richer

instructional environment" resulted from the use of *Cornerstones* (Wang and Paul, 2011, p. 64). Wang and Paul (2011) indicated that carryover effects, assessment fatigue, and a lack of research on effective vocabulary instruction for students who are D/HH may have impacted the results of their study. They concluded that *Cornerstones* is a feasible approach for literacy instruction for students who are D/HH.

Summary

The 13 studies reviewed demonstrated an increase in word identification skills. Several of the studies found that incorporating manual communication (i.e., fingerspelling, sign language, picture representations of signs, Visual Phonics and *Foundations*) increased word recognition (Andrews, 1988; Andrews & Mason, 1986; Beal-Alvarez et al., 2012; Dimling, 2010; Geoffrion, 1981; Hirsh-Pasek, 1986; Reitsma, 2009; Stoefen-Fisher & Lee, 1989; van Staden, 2013;Wauters et al., 2001). Repeated reading (Ensor & Koller), Morning Message (Wolbers, 2008), and *Cornerstones* (Wang & Paul, 2011) also demonstrated increased word identification. Studies conducted by Beal-Alvarez et al. (2012) and Hirsh-Pasek (1986) demonstrated a minimal increase in word identification. Studies that demonstrated significant results in the area of word identification tended to also incorporate vocabulary strategies (Andrews, 1988; Andrews & Mason, 1986; Dimling, 2010; Geoffrion, 1981; van Staden, 2013; Wang & Paul, 2011). With the exception of the study conducted by Wang and Paul (2011) the studies incorporating vocabulary instruction also used some form of manual communication. Based on this review there is a need for research regarding effective word identification interventions for students who use auditory and spoken language.

Stoefen-Fisher and Lee (1989) was the only study that examined retention of word identification skills. Future studies should explore retention to determine the long-term impact of the intervention. Six of the studies reported that they examined reading comprehension (Andrews, 1988; Andrews & Mason, 1986; Dimling, 2010; Ensor & Koller, 1997; van Staden, 2013; Wang & Paul, 2011). Future research should also examine the impact that increased word identification has on reading comprehension. In the study conducted by Wolbers (2008), the elementary aged students demonstrated larger gains in word identification than those in middle school. Future studies may also want to examine the effects of an intervention based on various age-groups.

Schirmer and McGough (2005) stated, "in light of the research that shows greater similarities than differences between the reading processes of deaf and hearing readers, we suggest that future research with deaf readers should investigate the instructional practices found to be effective with normally achieving and disabled readers" (p. 111). For example, incremental rehearsal (IR) and morphology instruction have been successful for increasing word identification for students with hearing (for reviews see Burns, Zaslofsky, Kanive, & Parker, 2012; Reed, 2008). The *What Works Clearinghouse* (WWC; U.S. Department of Education, 2006; U.S. Department of Education, 2006; U.S. Department of Education, 2010) identified the following interventions as having potentially positive effects on word identification: *Phonological Awareness Training plus Letter Knowledge Training* (researcher developed materials), *Reading Mastery* (McGraw-Hill Education, 2002), and *Waterford Early Reading Program* (Waterford Institute, 1999). These interventions are highly dependent on readers having an

established language base and auditory comprehension skills. IR has been shown to be effective with struggling readers in an elementary setting, and may be effective for students who are D/HH.

Chapter 3

METHOD

Reading is a process of simultaneously coordinating word recognition, accessing meaning of words, determining the correct meaning, grouping words grammatically, making inferences, and using background information to understand text (Samuels, 2002, p. 168). Reading words accurately and with automaticity may require direct instruction (National Reading Panel, 2000). Word identification must be rapid and effortless and comprehension is reciprocal with word identification (Paul, 1997). Paul (1997) reported that there is minimal research related to word identification skills with children who are D/HH. There is no single 'best' method for teaching reading or word identification.

Kelly (2003) stressed the importance of developing automaticity in word identification to support reading comprehension with readers who are D/HH. Effective teaching should include word recognition, feedback, frequent practice, and specific targeted vocabulary with the goal to achieve automaticity. There needs to be continued research on word identification strategies for individuals who have varying degrees of hearing loss.

Incremental rehearsal has led to increased skills in reading and math for a variety of different student populations. This strategy may also increase reading skills for children who are D/HH. The IR procedure uses frequent repetition, which was also seen in the previous studies discussed. In addition, the reviewed studies conducted with children with varying degrees of hearing loss often included using the words in a sentence and/or semantic mapping. This resulted in increased word identification and

reading comprehension. IR with an added component of using target words in sentences may be an effective strategy for increasing word identification and reading comprehension for individuals who are D/HH. The purpose of this study is to determine if IR increases word identification in elementary aged children with varying degrees of hearing loss.

Research Questions

1. Is there a functional relationship between incremental rehearsal (IR) and increased levels of word identification with students who are D/HH?
2. Is there a functional relationship between IR and ability to use target words meaningfully in sentences when prompted as measured by independently using the words semantically and syntactically correctly in sentences for students who are D/HH?
3. Is there a functional relationship between IR and increases in silent reading performance as measured by the *Reading Milestones Placement and Monitoring* passages (RMPM; McAnally & Rose, 2012a) with students who are D/HH?

Methods

Participants

Prior to implementing the study, a principal letter of support (see Appendix A), a teacher letter of support (see Appendix B), a parent/guardian letter (see Appendix C), and consent forms (see Appendix D) were drafted and submitted to the researcher's advisor for approval. Subsequently, the Institutional Review Board (IRB) forms were submitted for review. Upon IRB approval, the researcher sent an introductory letter (see Appendix

C) and parental consent form (see Appendix D) to the parents. Participants were recruited from a suburban elementary school in the Twin Cities area. Parents had the option of contacting the researcher or giving the signed consent forms to another teacher within the school. The teacher then gave the names of the participants and consent forms to the researcher. The researcher maintained the signed consent forms and contact information in a secured location. Contact information was destroyed at the completion of the study.

When parents provided written consent, the researcher collected demographic information from the participant's D/HH teacher. Participant assent was given prior to initial data collection and each intervention session. Assent included a verbal response or head nod.

The demographic data forms (see Appendix E), data collection records, and consent forms were coded for each participant. Information reported was used to determine if the participant met the inclusion criteria for this study.

Six students were recruited for this study, ranging in ages from 6 to 11 years. Participants were in kindergarten through fifth grade. To be included in this study participants needed to have a hearing loss documented by an audiologist, 15 or more words that they were not able to read from the first 500 Fry Words (Fry, 1980) at the onset of the study, and nine words that they were able to read from the first 100 Fry Words (to establish known words). Students with cognitive disabilities and visual impairments were excluded from this study. After applying the inclusion and exclusion criteria, five participants were eligible for participation in the study.

Demographic information regarding each participant's date of birth, age of identification of hearing loss, type of hearing loss (conductive, sensorineural, mixed), average degree of hearing loss for each ear, type of amplification used by the child for each ear (hearing aid, cochlear implant, soundfield system, personal FM system, no amplification), frequency of amplification use (all day, four hours per day or less, never), standard scores from expressive (*Expressive Vocabulary Test-2*, Williams, 2007) and receptive (*Peabody Picture Vocabulary Test-4*, Dunn & Dunn, 2007) language testing that occurred in the past nine months, additional documented disabilities, languages child is exposed to at home and school, race, and hearing status of parents were documented for each participant (see Appendix E). See Table 1 for demographic information of participants. Each participant was given a random identification alphabetic code. This code was used on the demographic data and data collection forms. Participants were given fictitious names in this paper (Anne, Matthew, Scott, Jeremy, and Olivia).

Table 1

Participant Demographics for N=5 Participants.

Demographic Variable	Participant				
	Anne	Matthew	Scott	Jeremy	Olivia
Gender	F	M	M	M	F
Age	8	6	8	11	8
Age at Identification	17 mo	4 years	4 years	5 years	1 mo
Type of Hearing Loss	Bilateral, Sensorineural	Bilateral, Sensorineural	Bilateral, Sensorineural	Bilateral, Sensorineural	Bilateral Sensorineural
Degree of Loss					
Right Ear	105+	65	53	35	105+
Left Ear	105+	62	53	41	105+
Type of Amplification					
Right Ear	CI, FM	HA, FM	HA, FM	HA, FM	CI
Left Ear	CI, FM	HA, FM	HA, FM	HA, FM	CI
Amplification Use	all day	all day	all day	all day	all day
Additional Disability	no	no	yes, OT and DAPE	no	no
Primary Language	English	English	English	English	English
Home Language	English	English	English	Spanish	English
Primary Mode of Communication	speech	speech	speech	speech	speech
PPVT-4 SS	103	70	70	58	92
EVT-2 SS	NA	79	75	72	100
Ethnicity	Caucasian	African American	African American	Hispanic	Bi-racial
Hearing Status of Parents					
Mother	hearing	hearing	hearing	hearing	hearing
Father	hearing	hearing loss	unknown	hearing	unknown

Note: CI = cochlear implant; FM = personal FM system; HA = hearing aid; all day = more than 4 hours a day; OT = Occupational Therapy; DAPE = Developmental/Adaptive Physical Education; PPVT-4 =

Peabody Picture Vocabulary Test-4 (Dunn & Dunn, 2007); SS = standard score; EVT-2 = *Expressive Vocabulary Test-2* (Williams, 2007); NA = not available

Measures

Fry words. Fry words are words that are occur frequently in fiction and nonfiction texts (Fry, 1980). Fifty percent of all written English material contains the first 100 Fry words (Fry, 1980). Lists containing Fry words in sets of 100, up to the first 500 Fry words, were used for the initial screening of potential participants.

Target Fry words. Target Fry words were words that the participant was unable to identify in the pre-assessment phase. These words were randomly grouped into three different sets consisting of five words in each set. Each target word was printed in black ink, size 36 Comic Sans font, in the center of a 3 by 5 inch flashcard.

Reading Milestones Placement and Monitoring **(RMPM).** The RMPM is an informal paper pencil test. This test was modeled after the *Test of Silent Contextual Reading Fluency* (Hammill, Wiederholt, & Allen, 2006). The RMPM examines the ability to "recognize individual words, in the context of a sentence, in a series of printed passages that become progressively more difficult in their content, vocabulary, and grammar" (McAnally & Rose, 2012b, p. 1). The passages range from a pre-primer to fifth grade level. Each form contains 17 passages. Each passage consists of a series of printed, capital letters without punctuation or spaces (e.g., T H E G I R L I S T A L L). The task requires the student to read the sentence and place a line between the letters where a space should occur.

The RMPM has evidence of producing reliable and valid scores (McAnally & Rose, 2012b). High reliability was found with immediate alternate forms (r = .89-.94),

delayed alternate forms (r = .83-.92), and test-retest coefficients (r = .85-.94) with 85 students, across 13 states, ranging in age from 6 through 18. Twenty-one of the 85 participants had hearing loss. Criterion-predictive validity was strong (r = .83) when RMPM scores were compared to scores from the *Test of Silent Word Reading Fluency* (Mather, Hammill, Allen, & Roberts, 2004).

Pre-Assessment

Pre-assessment occurred prior to starting the baseline condition. During the pre-assessment, participants were assessed on their ability to read the first 500 Fry words (Fry, 1980). Participants were asked to name words on the page of Fry words. Pre-assessment was conducted to determine nine known words and 15 unknown words for each participant. The 15 unknown words became the target words for each participant and were randomly divided into three sets of five words (Set A, Set B, and Set C).

Words were displayed on a sheet of paper. Each paper had 100 words. Words were divided into columns with 20 words. The researcher also had a copy of the same 100 words on a clipboard. Participants were asked to read the words one column at a time. The researcher pointed to the words and moved to the next word after 5 seconds. Participants read words until there were a total of 15 unknown words and nine known words. If a participant was not able to identify nine known words within the first 100 flashcards, he/she was excluded from the study.

The researcher sat across from the participants and placed the sheet of paper with the words on the table in front of the student. In spoken English, the researcher pointed to the first word and stated, “Tell me this word.” Following the child’s response or after 5

seconds the researcher pointed to the next word. The researcher had a second list with the words. The researcher highlighted the words the participant was able to identify. If the student did not respond within five seconds, the word was not highlighted and considered incorrect.

'Accurate responses' included clearly intelligible spoken production of the word and self-corrections. 'Inaccurate responses' included words that were not intelligible or did not match the printed word. Assessments were terminated after 100 words, 25 minutes, or whenever requested. Assessment of Fry words was completed when a minimum of 15 words were not identified and 9 words were correctly identified.

Design

A single subject multiple probe and multiple-baseline design across sets of words (Gast & Ledford, 2010) was used to evaluate the effect of IR on word identification, accurate use of the target words in sentences, and reading performance over a period of eight weeks. A multiple-baseline design across three sets of words (Set A, Set B, and Set C) was selected to examine whether a functional relationship exists between IR and changes in word identification. Sets of words were selected to account for words that each participant could not identify.

Dependent measures included: (a) number of correctly identified target words, (b) number of target words used correctly in spoken sentences, and (c) reading performance based on RMPM passages. The independent variable was the use of IR as an intervention.

Screening Measures

Screening occurred prior to each intervention session and followed the same procedure used to assess students during baseline. During screening, participants were assessed on the word set being targeted for that intervention session. The participants completed a one-minute RMPM task four times during baseline and once a week when the intervention started.

Baseline Measures

During baseline, participants were assessed using the target Fry words, their ability to use target Fry words in a sentence, and *Reading Milestones Placement and Monitoring* passages (RMPM; McAnally & Rose, 2012a). Baseline measurement of each word set occurred on four different days prior to starting the intervention for word Set A. Participants were assessed on word Set B when they were able to identify 4 or more target words in Set A. Assessment of Set C started when participants were able to identify 4 or more words in Set B. Criteria for a phase change to the next word set occurred when participants were able to identify 4 or more target words in three consecutive sessions during screening.

Each participant had a set of 15 target words that he/she was not able to identify during the pre-assessment. These 15 target words were randomly divided into word sets of 5 words (Set A, Set B, and Set C). The researcher maintained graphs for each word set illustrating the baseline and intervention phases. The session number was located on the horizontal axis and the number of words identified correctly was located on the vertical

axis. A vertical line was drawn on the graph to indicate the end of the baseline phase and the beginning of the intervention phase.

Each participant had three additional graphs indicating the number of target words used correctly in a sentence. The target words were the same words used in the word identification task and separated into the same word sets. The graphs were similar to the word identification graphs with the session number on the horizontal access, a vertical line separating the baseline and interventions phases, and the number of words used correctly in a sentence on the vertical axis.

Phase Change

Acquisition performance criterion was set at 80% (4 out of 5) of target words read correctly in three consecutive sessions for each word set. When a participant met the acquisition performance criterion, the next word set was introduced. When performance criterion for a set of words was met, intervention for the word set was discontinued. The discontinued word set was screened weekly to examine maintenance.

Procedures

The pre-assessment, screening and intervention sessions occurred in a quiet environment away from visual distractions and background noise in the school the participant attended. The participant and the researcher were seated at a table, across from one another.

Baseline

Baseline data were collected on identification of target Fry words, use of target Fry words in a sentence, and performance on RMPM passages. Target Fry words are

words that the participant was unable to identify in the pre-assessment. These words were randomly grouped into three different sets consisting of 5 words. Target words were presented in sets of 5 during baseline and prior to intervention sessions to establish known and unknown words, establish phase changes, and examine the effects of IR on word identification. Using the target word in a sentence was also assessed during baseline and prior to intervention sessions. Each participant had 18 card sets; three card sets of five cards for screening of unknown words and 15 card sets that included an unknown word and nine known words used in the IR intervention phase.

The following instructions were presented using spoken English prior to presenting the cards: “Say the word on the card.” The directions were repeated a maximum of three times within 30 sec. If the participant accurately identified the card, the researcher stated, “Use the word in a sentence”. If the participant used the exact same sentence that the researcher used to introduce the word during the intervention, the researcher prompted, “Please use the word in a different sentence”. The researcher repeated the sentence that the participant verbalized. Based on the participant response, the researcher placed the card in one of three piles: (1) identified correctly and used in a sentence correctly, (2) identified correctly and used incorrectly in a sentence, or (3) not identified correctly. The number of words identified correctly were recorded and graphed at the end of the session. The researcher also graphed the number of words the participant was able to accurately use with the appropriate syntactical and semantic structures in a sentence.

To examine the effects of increased word identification on reading performance, RMPM passages were administered to the participants during four different sessions prior to the intervention. Once intervention started, participants were administered RMPM passages once a week for a period of eight weeks. The researcher used the practice passages located in the RMPM Student Record Forms. Practice passages A and B were used to demonstrate how to complete the RMPM. The researcher and participant completed passages C and D together. The researcher then gave the participant the RMPM Student Record Form, opened the form, and told the participant that he/she had 1 minute to complete as many passages as he/she could. The researcher opened the recording form, started the timer, and told the participant to start.

After 1 minute, the researcher indicated to the student to stop and move to a new task. The researcher scored the RMPM passages by counting the number of lines correctly placed in the passage. Credit was given for a line if it was partially drawn over a letter. If a line was drawn completely over a letter, no credit was given. If the line did not completely separate two letters, the line was extended by the researcher. All forms of self-corrections were accepted (e.g., crossing out a line, scribbling out a line, etc.). The number of correctly placed lines was graphed. All participants alternated between Form A and Form B. Half of the participants started with Form A for the first week, Form B week 2, Form A week 3, Form B week 4, and so on. The other half of the participants started with Form B for the first week, Form A week 2, Form B week 3, and so on. Participants had 1 minute to complete as many passages as they could.

Screening

Screening occurred prior to each intervention session. Screening followed the same procedure used to assess students during baseline as described above.

Intervention

Intervention sessions occurred over 7 weeks for a maximum of 25 minutes per session. The session was terminated or included a rest period whenever requested. At the end of each intervention session, the participant received a ticket for the school wide Positive Behavior Support Program. The child's responses for the target word sets were recorded on a graph by the researcher at the end of the session. Each participant was assigned 15 sets of flashcards, and each set included nine known words and one unknown word.

Introducing a target word. During the intervention condition, one unknown word was introduced and modeled by the researcher. The researcher held up the unknown word printed on a flashcard and said, "This is _____ (insert word). What word is this?" If the participant responded by saying the word correctly, the researcher replied, "Good." The researcher then used the target word in a sentence. The researcher then asked, "What word is this?" If the student correctly identified the word, the researcher said, "Good. Use the word in a sentence." If the participant repeated the same sentence that the researcher used, the researcher prompted the participant to use a different sentence by saying, "Please use the word in a different sentence." If the participant said the word correctly, but used it in a sentence incorrectly, the researcher restated the sample sentence and asked the student to repeat the sentence.

If the participant said the word incorrectly, the researcher restated the word and told the student to repeat it. The researcher continued to show the card and said, “This is ____ (insert word).” If the student was not able to use the word in a sentence, the researcher provided the student with a sentence and asked the student to repeat the sentence.

Incremental Rehearsal. The researcher placed the target unknown word card at the front of the pack of cards. The participant was shown the unknown word, told to read the word, and asked to use it in a sentence. The researcher corrected an inaccurate response by saying, “This is ____”, used the target word in a sentence, and said, “what word is this?” and told the participant to use the word in a sentence. The participant was then shown the second flashcard with a known word displayed and told to say the word, followed by the unknown word, and then two flashcards with known words. The flashcards were displayed in the following sequence (U = unknown, K = known): U-K1, U-K1-K2, U-K1-K2-K3, U-K1-K2-K3-K4 and so on. Participants were not asked to use known words in a sentence. A new known word was added until nine known items had been displayed and the participant had 10 opportunities to identify the unknown word.

The participant was prompted to use the unknown word in a sentence each time it appeared. The intervention session ended if the participant was not able to identify the unknown word on three consecutive displays. If a participant had fewer than three errors, a second IR sequence was introduced with a new unknown word from the set. This pattern was repeated until all 5 words in the set had been introduced and practiced (see Table 2). If a participant was unable to identify a former known word during the

intervention phase, the researcher told the participant the word. This did not impact the number of words the participant identified correctly during screening and did not count as one of the three consecutive displays of an unknown word that would result in ending the intervention session. This word remained as a known word.

Table 2

Intervention Session Outline.

Format for Intervention Session
Screening
IR sequence for first target word: U-K1, U-K1-K2, U-K1-K2-K3, U-K1-K2-K3-K4 and so on
IR sequence for second target word: U-K1, U-K1-K2, U-K1-K2-K3, U-K1-K2-K3-K4 and so on
IR sequence for third target word: U-K1, U-K1-K2, U-K1-K2-K3, U-K1-K2-K3-K4 and so on
IR sequence for fourth target word: U-K1, U-K1-K2, U-K1-K2-K3, U-K1-K2-K3-K4 and so on
IR sequence for fifth target word: U-K1, U-K1-K2, U-K1-K2-K3, U-K1-K2-K3-K4 and so on

Note: U= unknown, K = known.

Inter-Observer Agreement

The baseline data collection and intervention sessions were video recorded. The participant identification letter and session number were displayed prior to starting each session to match with data collection forms. The video recordings focused on the researcher and the materials and included the child's voice. The recordings were viewed by the researcher and a graduate student to conduct inter-observer agreement (IOA) and examine the fidelity of implementation of the intervention. The graduate student was a doctoral candidate in the Special Education Department. All recordings will be deleted one year after completion of the study.

The video recordings were kept on a computer hard drive in a locked drawer at the participant's school or at the University of Minnesota. The researcher and graduate student viewed the video recordings in a private office at the University of Minnesota to conduct IOA and examine fidelity. The researcher trained a graduate student on scoring

and fidelity procedures. To conduct IOA for the screening, the researcher described the process to the graduate student. The graduate student then watched two of the screening videos and recorded the number of words the participant was able to accurately identify and use in a sentence on a Google document form prepared for scoring purposes. The researcher and graduate student were in 100% agreement. The graduate student then randomly selected screening sessions and scored 25% of them for number of target words identified and target words used correctly in sentences. Agreement was calculated by Agreement/Agreement+Disagreement x 100. Screening IOA was 93.5%.

Inter-observer agreement was also calculated for the RMPM. The researcher met with a graduate student and demonstrated how students were to complete the RMPM passages. The researcher provided a typed list of RMPM scoring procedures. The researcher demonstrated how to score the RMPM passages using the practice passages that the participants had completed. The researcher and graduate assistance independently scored two RMPM sheets and were at over 80% agreement. The graduate assistant then independently scored 25% of the RMPM passages. Agreement was calculated by Agreement/Agreement+Disagreement x 100. Inter-observer agreement for the RMPM passages was 92.3%.

An intervention fidelity checklist was created (see Appendix F) and randomly applied to 25% of the intervention sessions across participants. A graduate student who was familiar with IR procedures completed the fidelity checklist. Fidelity of implementation ranged from 96-100%, with a mean of 98.8%.

Social Validity

Participants provided information on social validity through the use of a student survey. Participants were asked to respond to four questions related to the intervention. Each question had three options for responding: (1) a picture of a thumb's up indicating 'liked' or 'yes', (2) a sideways thumb indicating they 'kind of liked' or 'kind of', and (3) a thumb's down indicating 'did not like' or 'no'. All questions and options for responses were read to the participants. Participants circled or drew a line through the thumb that represented their answer. Ratings are addressed in the results section.

Summary

This study examined the effect of IR conducted over a period of 7 weeks on word identification skills with 5 students ranging in ages from 6 to 11 years and had documented hearing loss. Measures used to determine the effectiveness of IR on word identification skills included the appropriate use of the target words in sentences, and silent reading performance. A single subject multiple probe and multiple-baseline design across sets of words (Gast & Ledford, 2010) was used to examine the relationship of new words acquired through IR training and target words used in sentences and silent reading scores. Inter-observer agreement and administration fidelity checks ranged from 92 to 100%.

Chapter 4

RESULTS

The purpose of this study was to determine if IR increases word identification in elementary aged children with varying degrees of hearing loss. After each screening session, the number of words participants correctly identified and the number of words participants were able to use appropriately in sentences were graphed using a multiple baseline across word sets design (Gast & Ledford, 2010). See Table 3 for a summary of the collective data across all participants. The researcher reviewed the word identification and use of words in sentences data for the following features through visual analysis: level, trend, variability, and immediacy of effect (Kratochwill et al., 2010). Tau-U estimates were calculated (Vannest, Parker, & Gonen, 2011) as measures of treatment effect size.

Data Analysis

Data were analyzed over four dimensions: (1) level, (2) trend, (3) variability, and (4) Tau-U. Visual analysis of changes in level, trend, and variability were used to examine the frequency of words identified and correct use of target words in sentences. Relative level change and Tau-U were calculated as measures of intervention effects.

Level. Level refers to the scale of the data in terms of the stability and change between phases of the study. If IR increased word identification there was an increase in level for each word set. An increase in level corresponded to an increase in the number of target words the participant identified during screening.

A relative level change was conducted for the baseline and intervention phases of each word set. To calculate the relative level change, the median of the baseline data and intervention data for each word set was calculated. If there was not a middle data point (median), the average between the two middle data points was used. The median value of the baseline phase was subtracted from the median value of the intervention phase. The direction (positive or negative) was reported (Gast & Spriggs, 2010). A positive change is one indicator of the effectiveness of the intervention.

Trend. The trend line is the slope of data points across time (Gast & Spriggs, 2010). An increase in trend corresponded to the number of target words identified correctly and target words used in sentences continuing to grow once the intervention phase started. Increasing trend was a second dimension of change contributing to the possible effectiveness of IR.

Variability. Variability refers to the fluctuation or instability of the data (Gast, 2005; Kratochwill et al., 2010). Variability was analyzed by visual analysis and by calculating the range of the data in each phase (Range = maximum value – minimum value). The variability of the data was the third dimension used to examine the potential effects of IR.

Tau-U. Tau-U is an index for analyzing single-case research data that controls for trend during baseline (Parker, Vannest, Davis, & Sauber, 2011; Vannest & Ninci, 2015). Vannest and Ninci (2015) recommended the following categorization of effect size (ES) for Tau-U: small change (0.20), moderate change (0.20 to 0.60), large change (0.60 to

0.80), and very large change (0.80 and above) (p. 408). Tau-U was the fourth dimension examined to determine the effectiveness of IR as an intervention.

Intervention Results

Anne. Figure 1 illustrates the data for Anne. The weighted average across the three word sets for words identified correctly was Tau-U = 0.94 ($p < 0.001$) and for target words used in sentences was Tau-U = 0.90 ($p < 0.001$). These scores indicate a large to very large change from baseline to intervention. During baseline, words identified correctly were relatively low across word sets A and B with no variability. The baseline for word set C was variable, with a range from 0 to 3 words identified. After staggered introduction of the intervention, words identified correctly improved across all word sets. Anne was not able to use any target words correctly in sentences across all word sets during baseline. Following staggered introduction of the intervention, target words used in sentences improved across all word sets. The relative level change from baseline to intervention was positive across all word sets for words identified correctly and target words used correctly in sentences. Anne identified 15 target words and used 14 of those words in sentences over 18 intervention sessions. The average session length for Anne was 9 min.

Word Set A. During the Set A baseline phase, Anne did not identify any target words correctly ($M = 0.0$). During the intervention phase, Anne's mean accuracy for words identified correctly increased from 0.0 to a mean of 3.2 words. There was an immediate effect from 0 words identified at the final baseline probe to 1 word identified at the first intervention probe. Anne demonstrated an upward trend during intervention

increasing from 1 to 5 words identified correctly. Performance criterion (4 or more target words on three consecutive sessions) was met after 6 sessions. The average number of words Anne was able to identify during maintenance was 4. Tau-U for words identified between baseline and intervention was 1.00 ($p < 0.05$), which is considered a very large change (Vannest & Ninci, 2015).

When asked to use the target words in sentences, Anne was not able to use the target words in sentences during baseline. Between the baseline and intervention phase, there was a change in level from 0.0 to 2.8. When the intervention phase began there was not an immediate effect in Anne's ability to use target words in sentences. After two intervention sessions, Anne demonstrated an increasing trend from using 2 target words to 4 target words in sentences. During maintenance, Anne used an average of 3.8 target words in sentences. The use of target words in sentences from baseline to intervention was a large change (Tau-U = .83; $p < 0.05$).

Word Set B. Anne had a mean accuracy of 0.0 words identified during baseline. Anne did not immediately identify words when intervention started. After two intervention sessions, there was an increasing trend from 2 words identified correctly to 5 words identified correctly. Performance criterion was met after 8 sessions. The average number of words that Anne was able to identify during maintenance was 5 words. Tau-U for words identified between baseline and intervention was .88 ($p < 0.05$), a large change from baseline to intervention.

Anne did not use the target words correctly in sentences for baseline. During the intervention phase, there was a change in level to 2.8 ($M = 0.0$ to $M = 2.8$). There was not

an immediate effect in Anne's ability to use target words in sentences. After two intervention sessions, Anne demonstrated an increasing trend from using 2 to 5 target words in sentences. During maintenance, Anne was able to use an average of 4 target words in sentences. The use of target words in sentences from baseline to intervention was a large change (Tau-U = .88; $p < 0.05$).

Word Set C. Anne was able to identify an average of 1.0 word during baseline and 2.5 words during intervention, demonstrating a change in level. There was an increasing trend during baseline, with 2 consistent data points prior to implementing intervention. Anne did not reach performance criterion for word set 3 because the school year ended and the researcher was no longer able to collect data. As a result, Anne does not have maintenance data for word set 3. There was an increase of 1 to 2 words identified between baseline and intervention. There was an increasing trend from 2 to 4 words identified. Tau-U for words identified between baseline and intervention was .94 ($p < 0.05$). This is considered a very large change between baseline and intervention (Vannest & Ninci, 2015).

Anne did not use target words correctly in sentences during baseline and 2.5 target words during intervention, demonstrating a change in level. There was an immediate effect in Anne's ability increasing from 0 target words used correctly during baseline to 1 target word used correctly during intervention. There was an increasing trend during intervention from 1 to 4 target words used in sentences. The use of target words in sentences from baseline to intervention was a large change (Tau-U = 1.00; $p < 0.05$).

RMPM. During baseline the average RMPM score for Anne was $M = 7.7$ and $M = 9.8$ across intervention for all word sets. Figure 6 presents the RMPM data for each participant.

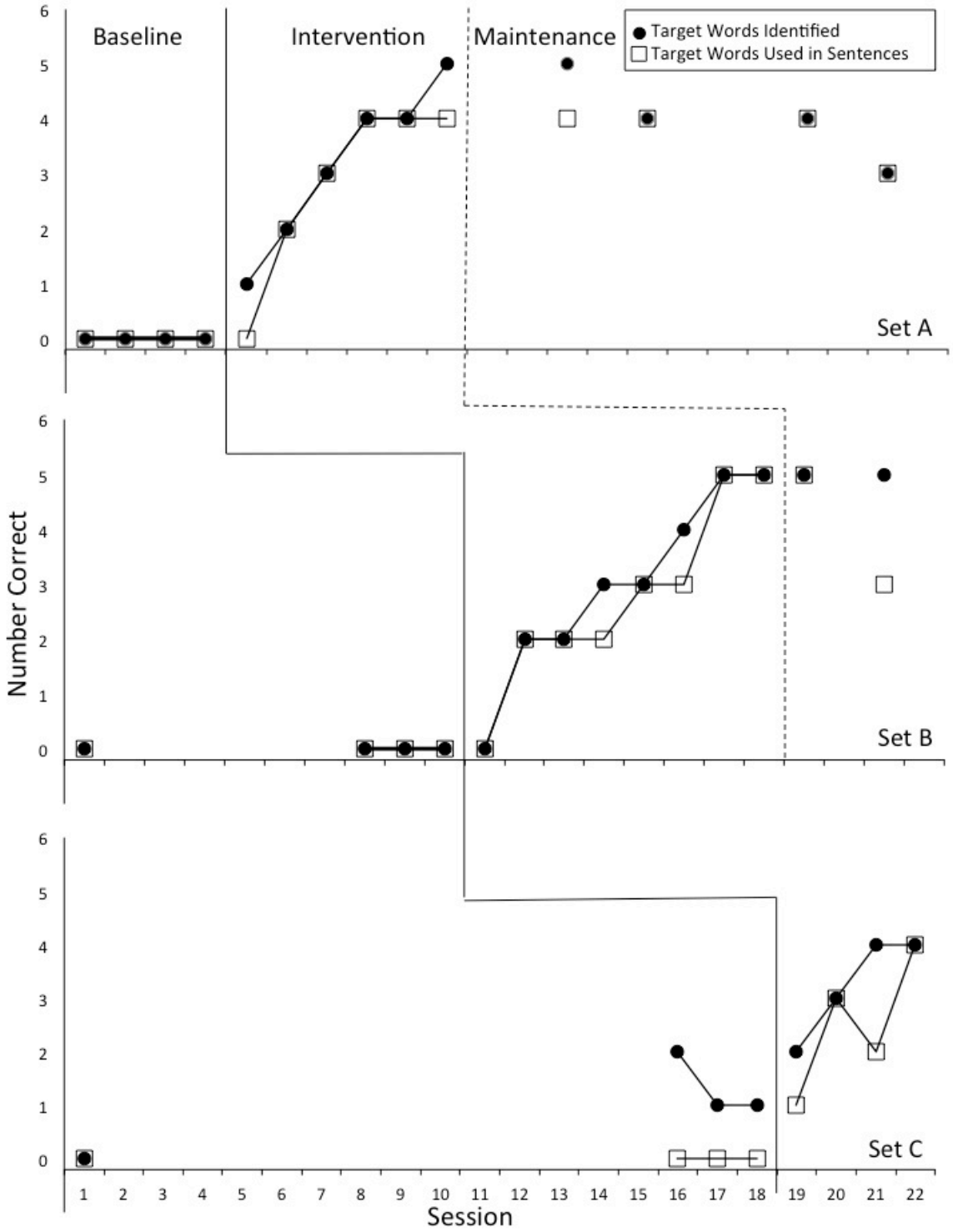

Figure 1. Graph of words identified and words used correctly in sentences across three word sets for Anne.

Matthew. Figure 2 illustrates the data for Matthew. When controlling for baseline trend, the weighted average across all three word sets for words identified correctly was Tau-U = 0.70 ($p < 0.01$) and for target words used in sentences was Tau-U = 0.63 ($p < 0.05$). These are considered large changes from baseline to intervention (Vannest & Ninci, 2015). The relative level change from baseline to intervention was positive across all word sets for words identified correctly and target words used correctly in sentences. During baseline for word sets A and C the data for words identified correctly were variable with an increasing trend. The range for word set A was 0 to 3 and 0 to 4 for word set C. Matthew was not able to identify any words during baseline for word set B. After introduction of the intervention, words identified correctly improved across word sets A and B, but was variable for word set C. During baseline for target words used correctly in sentences, words used correctly were relatively low across word sets A and B with little variability. Word set C had a range of 0 to 3 target words used correctly during baseline with an increasing trend. Upon staggered introduction of the intervention, target words used correctly improved across word sets A and B, but continued to be variable for word set C. Matthew identified 14 words and used 9 of those words in sentences over 12 intervention sessions. Due to technological difficulties with the video recoding equipment, the average session length was not available for Matthew.

Word Set A. During the baseline phase, there was a mean of 1.0 word identified correctly. When intervention was initiated, there was a positive change in level ($M = 1.0$ to $M = 4.7$). There was an immediate effect from 3 to 4 words identified correctly. Matthew demonstrated an increasing trend during baseline from 0 to 3 words identified

and an upward trend during intervention increasing from 4 to 5 words. Performance criterion was met in three sessions. The average number of words Matthew was able to identify during maintenance was 4.2 words. Tau-U for words identified between baseline and intervention was .58 ($p = ns$) when controlling for baseline trend. This suggests a moderate change between baseline and intervention, however due to the increasing trend during baseline the results are not significant.

Matthew demonstrated a mean of 0.3 when asked to use the target words in sentences. During the intervention phase, there was a change in level ($M = 0.3$ to $M = 3.3$). There was an immediate effect in Matthew's ability to use target words in sentences from 1 word to 3 words. There was an increasing trend during baseline. Matthew demonstrated a variable trend fluctuating between 3 and 4 target words used correctly in sentences during intervention. During maintenance, Matthew was able to use an average of 1.6 target words in sentences. Tau-U for target words used in sentences between baseline and intervention was .75 ($p = ns$) when controlling for baseline trend. This suggests a moderate change between baseline and intervention. Due to the increasing trend during baseline the results are not significant.

Word Set B. The mean accuracy of words identified during baseline was 0. After intervention started, there was a change in level ($M = 0.0$ to $M = 3.6$). Matthew was immediately able to identify words once intervention started from 0 to 1 word identified. There was an increasing trend during intervention from 1 to 5 words identified. Matthew met performance criterion after five sessions. The average number of words that Matthew

was able to identify during maintenance was 4.8 words. The use of target words in sentences from baseline to intervention was a large change (Tau-U = 1.00; $p < 0.05$).

Matthew demonstrated a mean of 0.0 when asked to use the target words in sentences. During the intervention phase, there was a change in level ($M = 0.0$ to $M = 3.6$). There was an immediate effect in Matthew's ability to use target words in sentences from 0 during baseline to 1 word during intervention. Matthew demonstrated an increasing trend from using 1 word to 5 target words in sentences. During maintenance, Matthew was able to use 4 target words in sentences on average. Tau-U for words used in sentences between baseline and intervention was 1.00 ($p < 0.05$), which is considered a very large change (Vannest & Ninci, 2015).

Word Set C. Matthew's baseline data had a mean of 1.3 words identified. The mean for intervention was 4.0, demonstrating a change in level from baseline. An increasing trend was present during baseline for target words identified. There was no immediate effect in Matthew's ability to identify target words. The data during intervention varied, ranging from 2 to 5 words identified correctly. Matthew reached performance criterion after four sessions. The mean number of words identified during maintenance was 3.5. Tau-U for words identified between baseline and intervention was .50 ($p = ns$) when controlling for baseline trend. This suggests a moderate change between baseline and intervention, however due to the increasing trend during baseline the results are not significant.

Matthew was able to use an average of 0.8 target words correctly in sentences during baseline and 1.3 target words during intervention, demonstrating a change in level.

There was an increasing trend during baseline. There was not an immediate effect in Matthew's ability to use target words correctly from baseline to intervention. The data during intervention was variable, ranging from 0 to 2 target words used correctly in sentences. Tau-U for target words used in sentences between baseline and intervention was .13 ($p = ns$) when controlling for baseline trend. This suggests a lack of change between baseline and intervention. The use of IR for this word set does not appear to have increased Matthew's ability to use target words in sentences.

RMPM. During baseline the average RMPM score for Matthew was $M = 6.3$, $M = 7.5$ during intervention across all word sets with a mean of 9.5 ($M = 9.5$) during maintenance. Figure 6 presents the RMPM data for all participants.

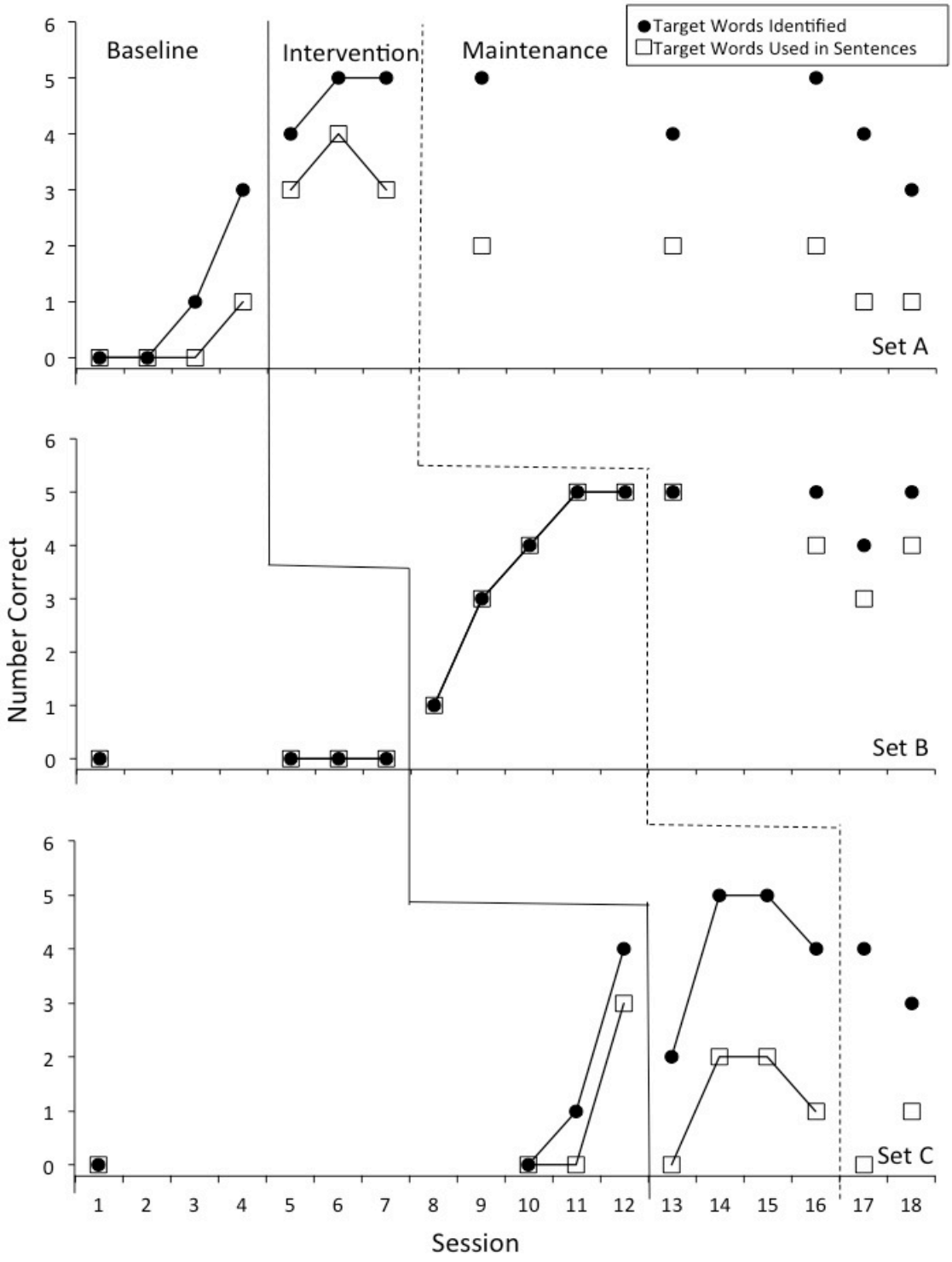

Figure 2. Graph of words identified and words used correctly in sentences across three word sets for Matthew.

Scott. Figure 3 illustrates the data for Scott. When controlling for baseline trend, the weighted average across all three word sets for words identified correctly was Tau-U = 0.84 ($p < 0.01$) and for target words used in sentences was Tau-U = 0.86 ($p < 0.01$). These are considered large changes from baseline to intervention (Vannest & Ninci, 2015). The relative level change from baseline to intervention was positive across all word sets for words identified correctly and target words used correctly in sentences. During Scott's baseline, words identified correctly and target words used in sentences were relatively low across word sets with little variability. Upon staggered introduction of IR, overall words correct and target words used in sentences improved across word sets. Scott learned to identify 15 words and use 12 of those words in sentences over 16 intervention sessions. Scott's sessions lasted an average of 12 minutes.

Word Set A. During the baseline phase, Scott had a mean accuracy of 0.8 words identified. After intervention started, there was a change in level ($M = 0.8$ to $M = 3.7$). There was an immediate effect from 1 word identified to 4 words identified. There was an upward trend during baseline that had stabilized prior to the intervention. Scott demonstrated a variable upward trend during intervention. Performance criterion was met after seven sessions. The average number of words that Scott was able to identify during maintenance was 4.8 words. Tau-U for words identified between baseline and intervention was .89 ($p < 0.05$) when controlling for baseline trend. This is considered a large change (Vannest & Ninci, 2015).

Scott demonstrated a mean of 0.0 when asked to use the target words in sentences. During the intervention phase, there was a change in level ($M = 0.0$ to $M = 2.7$). There

was an immediate effect in Scott's ability to use target words in sentences from 0 to 1. Scott demonstrated an increasing trend during intervention from using 1 target word in a sentence to using 5 target words in sentences. During maintenance, Scott was able to use an average of 4.3 target words in sentences. The use of target words in sentences from baseline to intervention was a large change (Tau-U = 1.00; $p < 0.01$), which is considered a very large change (Vannest & Ninci, 2015).

Word Set B. Scott had a mean accuracy of 0.8 words identified during baseline. After intervention started, there was a change in level ($M = 0.8$ to $M = 3.5$). There was an upward trend during baseline that had stabilized prior to the intervention. Scott demonstrated an immediate effect once intervention started from 1 word identified during baseline to 2 words identified. There was an increasing trend from 2 words identified to 5 during intervention. Scott met performance criterion for this word set in six sessions. The average number of words that Scott was able to identify during maintenance was 4.5 words. Tau-U for words identified between baseline and intervention was .87 ($p < 0.05$) when controlling for baseline trend. This is considered a large change (Vannest & Ninci, 2015).

Scott demonstrated a mean of 0.2 when asked to use the target words in sentences during baseline. During the intervention phase, there was a change in level ($M = 0.2$ to $M = 2.2$). Scott was able to identify 1 word immediately prior to intervention resulting in an increasing trend during baseline. There was no immediate effect in Scott's ability to use words in sentences between baseline and intervention. Scott demonstrated an increasing trend from using 1 to 3 target words in sentences. During maintenance, Scott was able to

use a mean of 3 target words in sentences. The use of target words in sentences from baseline to intervention when controlling for baseline trend was a large change (Tau-U = .80; $p < 0.05$), which is considered a large change (Vannest & Ninci, 2015).

Word Set C. Scott was able to identify an average of 0.8 words during baseline and 4.3 words during intervention, demonstrating a change in level. There was an upward trend during baseline that stabilized prior to the intervention. There was an immediate effect in Scott's ability to identify target words from 1 word during baseline to 4 words during intervention. There was an increasing trend during intervention from 4 to 5 words identified. Performance criterion was met in three sessions. The mean number of words identified during maintenance was 5. Tau-U for words identified between baseline and intervention was 1.00 ($p < 0.05$).

Scott was able to use an average of 0.8 target words correctly in sentences during baseline and 3.0 words during intervention, demonstrating a change in level. There was an upward trend during baseline that stabilized prior to the intervention. There was an immediate effect in Scott's ability to use target words correctly from baseline (n = 1) to intervention (n = 2). There was an increase in trend during intervention from 2 target words used in sentences to 4 target words. Tau-U for words identified between baseline and intervention was .75 ($p = ns$) when controlling for baseline trend. This suggests a large change between baseline and intervention, however due to the increasing trend during baseline the results are not significant.

RMPM. During baseline the average RMPM score for Scott was *M* = 6.0, *M* = 10.4 during intervention across all word sets, and *M* = 11.0 during maintenance. Figure 6 presents the RMPM data for all participants.

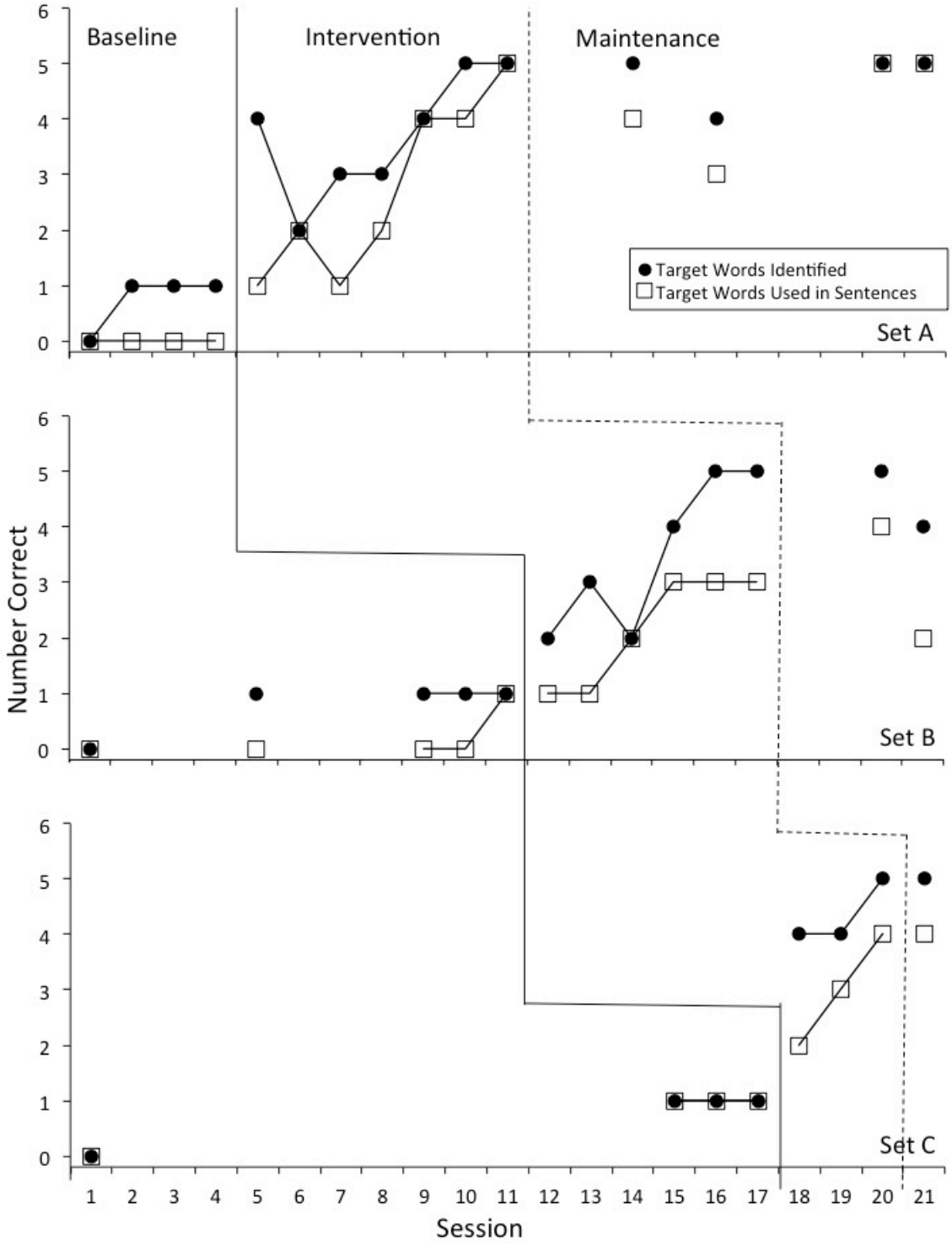

Figure 3. Graph of words identified and words used correctly in sentences across three word sets for Scott.

Jeremy. Figure 4 illustrates the data for Jeremy. The weighted average across the three word sets for words identified correctly was Tau-U = 1.00 ($p < 0.001$) and for target words used in sentences was Tau-U = 1.00 ($p < 0.001$). These scores indicate a large to very large change from baseline to intervention. The relative level change from baseline to intervention was positive across all word sets for words identified correctly and target words used correctly in sentences. Baseline data for word sets A and B was relatively low across word sets with little variability for words identified and target words used in sentences. There was variability in the baseline data for word set C. Upon implementing IR as an intervention, words identified correctly and target words used in sentences improved across word sets. Jeremy identified 15 words and use all 15 of those words in sentences over 12 intervention sessions. Jeremy's intervention sessions lasted an average of 8.5 min.

Word Set A. During the baseline phase, Jeremy had a mean accuracy of 0.5 words identified. After intervention started, there was a change in level ($M = 0.5$ to $M = 4.7$). There was an immediate effect from 0 words identified to 4 words identified. Jeremy demonstrated a stable trend during baseline and an upward trend during intervention increasing from 4 to 5 words identified correctly. Performance criterion was met in three sessions. The average number of words that Jeremy was able to identify during maintenance was 5 words. Tau-U for words identified between baseline and intervention was 1.00 ($p < 0.05$), which is considered a very large change (Vannest & Ninci, 2015).

Jeremy demonstrated a mean of 0.5 when asked to use the target words in sentences. During the intervention phase, there was a change in level ($M = 0.5$ to $M =$

4.7). There was an immediate effect in Jeremy's ability to use target words in sentences from 0 to 4 words. Jeremy demonstrated a stable trend during baseline and an upward trend during intervention from 4 to 5 target words. During maintenance, Jeremy was able to use a mean of 5 target words in sentences. The use of target words in sentences from baseline to intervention was a large change (Tau-U = 1.00; $p < 0.05$).

Word Set B. The mean accuracy for Jeremy of words identified during baseline was 0. After intervention, there was a change in level ($M = 0.0$ to $M = 4.3$). Jeremy was immediately able to identify words once intervention started from 0 to 5 words identified correctly. There was a variable trend during intervention from 3 to 5 words correctly identified. Jeremy met performance criterion in six sessions. Jeremy was able to identify an average of 5 words during maintenance. Tau-U for words identified between baseline and intervention was 1.00 ($p < 0.05$), which is considered a very large change (Vannest & Ninci, 2015).

Jeremy did not use target words in sentences during baseline. During the intervention phase, there was a change in level ($M = 0.0$ to $M = 4.3$). There was an immediate effect in Jeremy's ability to use target words in sentences from 0 during baseline to 5 words during intervention. Jeremy demonstrated a variable trend from using 3 to 5 target words in sentences. During maintenance, Jeremy was able to use a mean of 5 target words in sentences. The use of target words in sentences from baseline to intervention was a large change (Tau-U = 1.00; $p < 0.05$).

Word Set C. Jeremy's baseline data had a mean of 1.6 words identified. The mean for intervention was 4.3, demonstrating a change in level from baseline. Baseline data

was variable during baseline. There was an initial increasing and then decreasing trend prior to implementing intervention. There was an immediate effect in Jeremy's ability to identify target words. During intervention there was an increasing trend from 4 to 5 words identified correctly. Performance criterion was met in three sessions. The mean number of words identified during maintenance was 5. Tau-U for words identified between baseline and intervention was 1.00 ($p < 0.05$), which is considered a very large change (Vannest & Ninci, 2015).

Jeremy was able to use an average of 1.4 target words correctly in sentences during baseline and 4.3 target words during intervention, demonstrating a change in level. Between baseline and intervention there was an immediate increase in target words used during sentences. Data during intervention displayed an increasing trend from 4 to 5 words used correctly in sentences. The use of target words in sentences from baseline to intervention was a large change (Tau-U = 1.00; $p < 0.05$).

RMPM. During baseline the average RMPM score for Jeremy was $M = 14.8$, $M = 18.3$ during intervention across all word sets, and $M = 20$ during maintenance. Figure 6 presents the RMPM data for all participants.

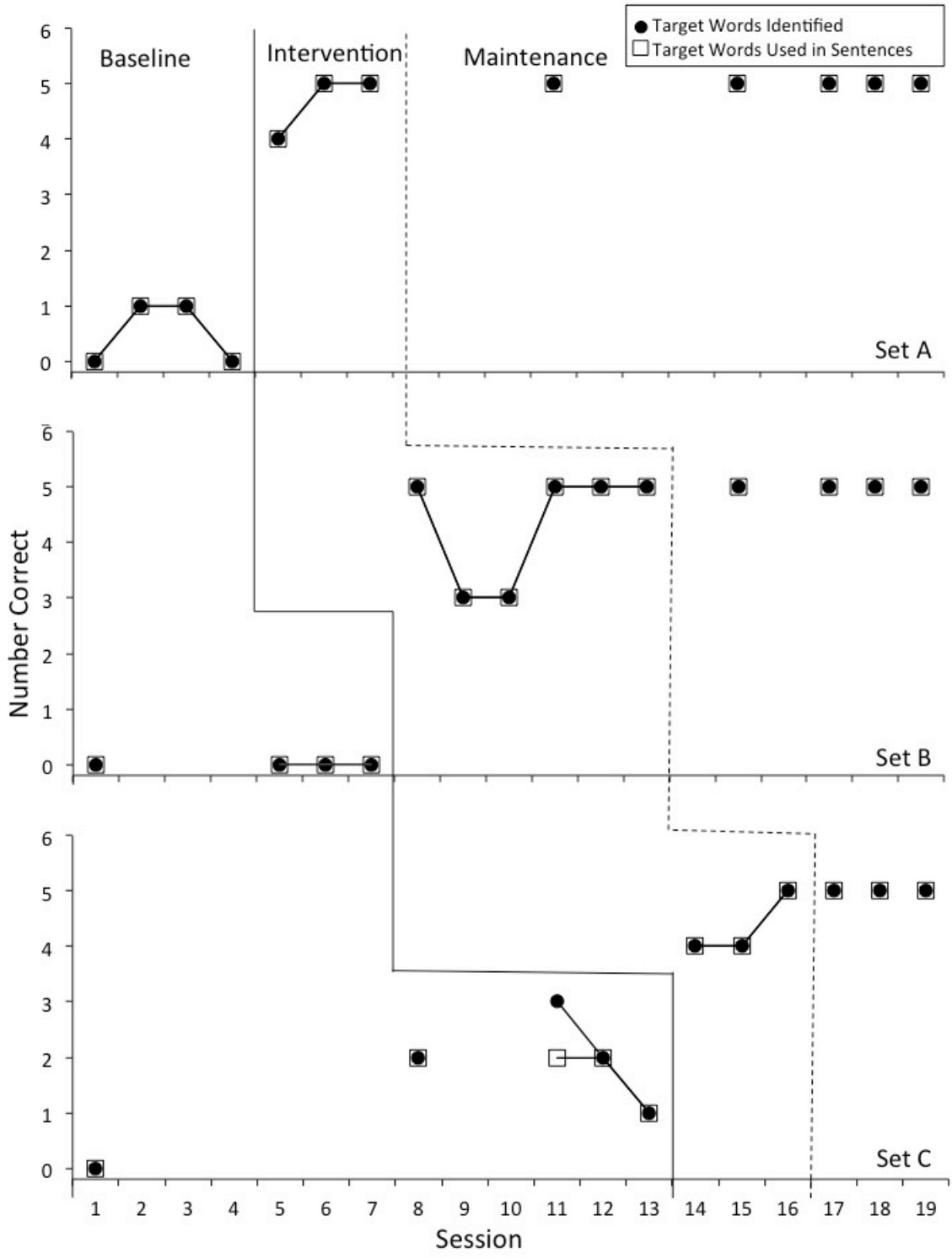

Figure 4. Graph of words identified and words used correctly in sentences across three word sets for Jeremy.

Olivia. Figure 5 illustrates the data for Olivia. When controlling for baseline trend, the weighted average across all three word sets for words identified correctly was Tau-U = 0.86 ($p < 0.001$). The weighted averaged for target words used in sentences was Tau-U = 1.00 ($p < 0.001$). These are considered large to very large changes from baseline to intervention (Vannest & Ninci, 2015). The relative level change from baseline to intervention was positive across all word sets for words identified correctly and target words used correctly in sentences. During Olivia's baseline, words identified correctly and target words used in sentences were relatively low across word sets with little variability. Upon staggered introduction of IR, overall words correct and target words used in sentences improved across word sets. Olivia identified 15 words and used 14 of those words correctly in sentences over 11 intervention sessions. Intervention sessions for Olivia lasted an average of 8.6 min.

Word Set A. During the baseline phase, Olivia had a mean accuracy of 0.3 words identified. After intervention started, there was a change in level ($M = 0.3$ to $M = 4.3$). There was an immediate effect from 1 to 4 words identified. Olivia was able to identify one word immediately prior to intervention resulting in an increasing trend during baseline. Olivia demonstrated an upward trend during intervention. Performance criterion was achieved in three sessions. Olivia identified an average of 5 words during maintenance. Tau-U for words identified between baseline and intervention was .75 ($p = ns$) when controlling for baseline trend. This suggests a large change between baseline and intervention, however due to the increasing trend during baseline the results are not significant.

Olivia demonstrated a mean of 0.0 when asked to use the target words in sentences. During the intervention phase, there was a change in level (M = 0.0 to M = 4.3). There was an immediate effect in Olivia's ability to use target words in sentences from 0 to 4. Olivia demonstrated an increasing trend during intervention from using 4 to 5 words in sentences. During maintenance, Olivia was able to use an average of 5 target words in sentences. The use of target words in sentences from baseline to intervention was a large change (Tau-U = 1.00; $p < 0.05$).

Word Set B. Olivia had a mean accuracy of 0.3 words identified during baseline. After intervention started, there was a change in level (M = 0.3 to M = 4.3). Olivia was able to identify 1 word immediately prior to intervention resulting in an increasing trend during baseline. Olivia demonstrated an immediate effect once intervention started from 1 to 2 words identified during baseline. There was an increasing trend from 2 to 5 words identified. Olivia met performance criterion in four sessions. Olivia identified an average of 4.3 words during maintenance. Tau-U for words identified between baseline and intervention was .81 ($p = ns$) when controlling for baseline trend. This suggests a large change between baseline and intervention, however due to the increasing trend during baseline the results are not significant.

Olivia did not use target words in sentences during baseline. During the intervention phase, there was a change in level (M = 0.0 to M = 3.0). There was an immediate effect in Olivia's ability to use target words in sentences between baseline and intervention. Olivia demonstrated an increasing trend from using 1 to 5 target words in sentences. During maintenance, Olivia was able to use an average of 4.8 target words in

sentences on average. The use of target words in sentences from baseline to intervention was a large change (Tau-U = 1.00; $p < 0.05$).

Word Set C. Olivia did not identify target words during baseline and identified 4.0 target words during intervention, demonstrating a change in level. There was an immediate effect in Olivia's ability to identify target words from 0 words during baseline to 2 words during intervention. There was an increasing trend during intervention from 2 to 5 words identified. Olivia achieved performance criterion in four sessions. The mean number of words identified during maintenance was 5. Tau-U for words identified between baseline and intervention was 1.00 ($p < 0.05$), which is considered a very large change (Vannest & Ninci, 2015).

Olivia was able to use an average of 0.8 target words correctly in sentences during baseline and 3.0 target words during intervention, demonstrating a change in level. There was an immediate effect in Olivia's ability to use target words correctly from baseline (0) to intervention (2). There was an increase in trend during intervention from 2 to 4 target words used in sentences. The use of target words in sentences from baseline to intervention was a large change (Tau-U = 1.00; $p < 0.05$).

RMPM. During baseline the average RMPM score for Olivia was $M = 9.5$, $M = 11$ during intervention across all word sets, and $M = 8$ during maintenance. Figure 6 presents the RMPM data for all participants.

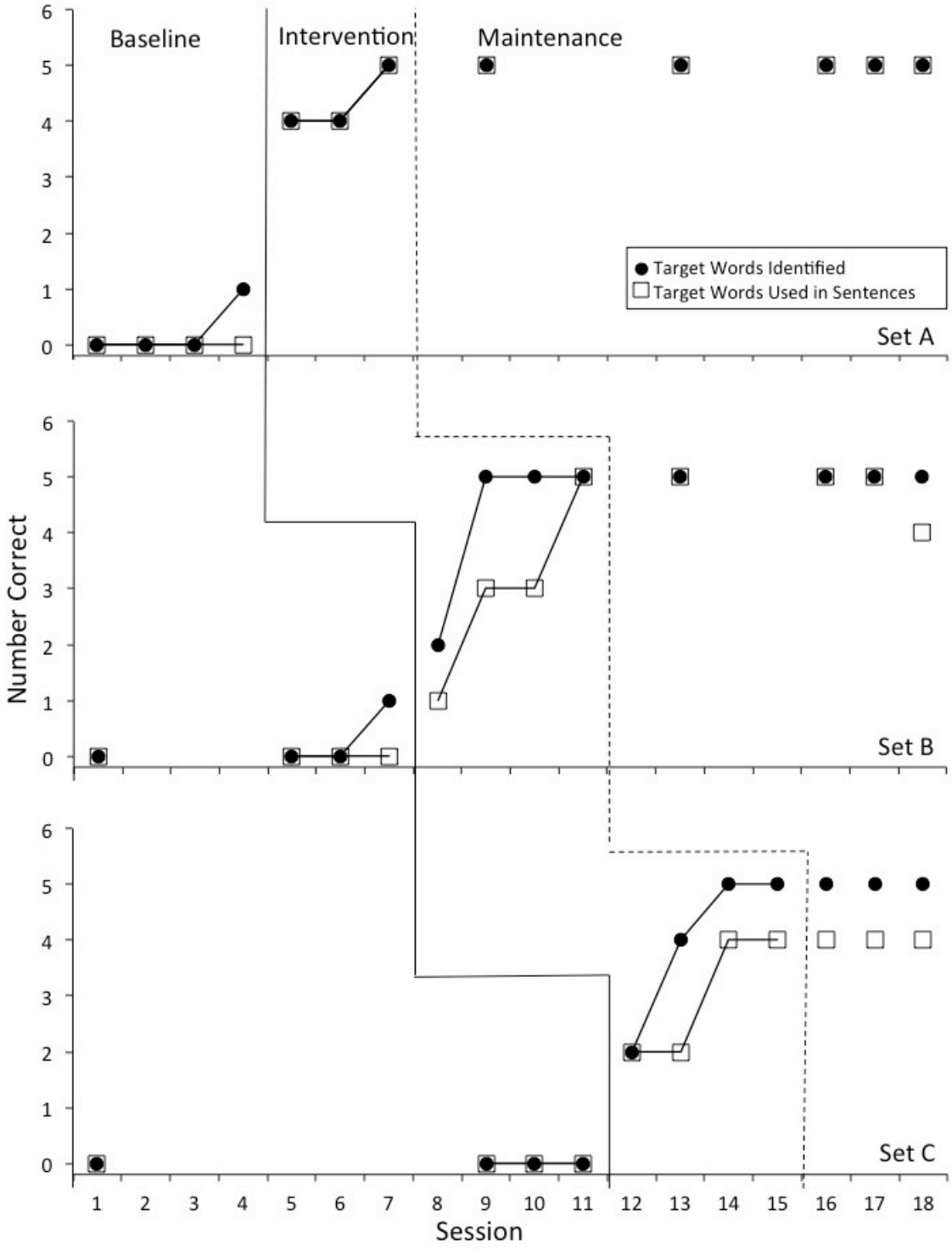

Figure 5. Graph of words identified and words used correctly in sentences across three word sets for Olivia.

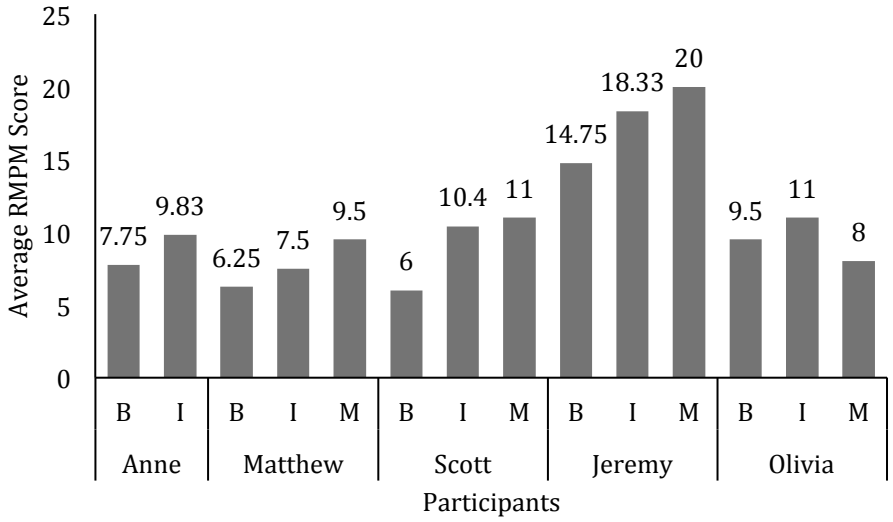

Figure 6. Average Reading Milestones Progress Monitoring scores for baseline, intervention, and maintenance phases across participants (n = 5). B = baseline; I = intervention; M = maintenance.

Table 3

Display of participant data for N = 5 participants.

Participant	Anne	Matthew	Scott	Jeremy	Olivia
Words Identified Set A					
Baseline	M = 0.0	M = 1.0	M = 0.8	M = 0.5	M = 0.3
Intervention	M = 3.2	M = 4.7	M = 3.7	M = 4.7	M = 4.3
Maintenance	M = 4.0	M = 4.2	M = 4.8	M = 5.0	M = 5.0
Baseline Trend	none	+	+	none	+
Intervention Trend	+	+	+	+	+
Baseline Range	0	3	1	1	1
Intervention Range	4	1	3	1	0
Sessions to meet criterion	6	3	7	3	3
Relative Level Change	positive	positive	positive	positive	positive
Words Used in Sentences Set A					
Baseline	M = 0.0	M = 0.3	M = 0.0	M = 0.5	M = 0.0
Intervention	M = 2.8	M = 3.3	M = 2.7	M = 4.7	M = 4.3
Maintenance	M = 3.8	M = 1.6	M = 4.3	M = 5.0	M = 5.0
Baseline Trend	none	+	none	none	none
Intervention Trend	+	none	+	+	+
Baseline Range	0	1	0	1	0
Intervention Range	4	1	4	1	1
Relative Level Change	positive	positive	positive	positive	positive

Words Identified Set B					
Baseline	*M* = 0.0	*M* = 0.0	*M* = 0.8	*M* = 0.0	*M* = 0.3
Intervention	*M* = 3.0	*M* = 3.6	*M* = 3.5	*M* = 4.3	*M* = 4.3
Maintenance	*M* = 5.0	*M* = 4.8	*M* = 4.5	*M* = 5.0	*M* = 5.0
Baseline Trend	none	none	+	none	+
Intervention Trend	+	+	+	+	+
Baseline Range	0	0	1	0	1
Intervention Range	5	4	3	2	3
Sessions to meet criterion	8	5	6	6	3
Relative Level Change	positive	positive	positive	positive	positive
Words Used in Sentences Set B					
Baseline	*M* = 0.0	*M* = 0.0	*M* = 0.2	*M* = 0.0	*M* = 0.0
Intervention	*M* = 2.8	*M* = 3.6	*M* = 2.2	*M* = 4.3	*M* = 3.0
Maintenance	*M* = 4.0	*M* = 4.0	*M* = 3.0	*M* = 5.0	*M* = 4.8
Baseline Trend	none	none	+	none	none
Intervention Trend	+	+	+	+	+
Baseline Range	0	0	1	0	0
Intervention Range	5	4	2	2	4
Relative Level Change	positive	positive	positive	positive	positive
Words Identified Set C					
Baseline	*M* = 1.0	*M* = 1.3	*M* = 0.8	*M* = 1.6	*M* = 0.0
Intervention	*M* = 3.3	*M* = 4.0	*M* = 4.3	*M* = 4.3	*M* = 4.0
Maintenance	NA	*M* = 3.5	*M* = 5.0	*M* = 5.0	*M* = 5.0
Baseline Trend	+	+	+	+	none
Intervention Trend	+	+	+	+	+
Baseline Range	2	4	1	3	0
Intervention Range	2	3	1	1	4
Sessions to meet criterion	NA	4	3	3	4
Relative Level Change	positive	positive	positive	positive	positive
Words Used in Sentences Set C					
Baseline	*M* = 0.0	*M* = 0.8	*M* = 0.8	*M* = 1.4	*M* = 0.8
Intervention	*M* = 2.5	*M* = 1.3	*M* = 3.0	*M* = 4.3	*M* = 3.0
Maintenance	NA	*M* = 0.5	*M* = 4.0	*M* = 5.0	*M* = 4.0
Baseline Trend	none	+	+	+	none
Intervention Trend	+	+	+	+	+
Baseline Range	0	3	1	2	0
Intervention Range	3	2	2	1	2
Relative Level Change	positive	positive	positive	positive	positive
Tau-U Words Identified					
Word Set A	1.00*	.58^	.89*^	1.00*	.75^
Word Set B	.88*	1.00*	.87*^	1.00*	.81^
Word Set C	.94*	.50^	.75^	1.00*	1.00*
Weighted Average	.94***	.70**^	.84**^	1.00***	.86***^
Tau-U Words Used in Sentences					
Word Set A	.83*	.75^	1.00**	1.00*	1.00*
Word Set B	.88*	1.00*	.80*^	1.00*	1.00*
Word Set C	1.00*	.13^	.75^	1.00*	1.00*

Weighted Average	.90***	.63*^	.86**^	1.00***	1.00***
Average RMPM Score					
Baseline	*M* = 7.7	*M* = 6.3	*M* = 6.0	*M* = 14.8	*M* = 9.5
Intervention	*M* = 9.8	*M* = 7.5	*M* = 10.4	*M* = 18.3	*M* = 11.0
Maintenance	NA	*M* = 9.5	*M* = 11.0	*M* = 20.0	*M* = 8.0
Average Intervention Session Length in min	*M* = 9	NA	*M* = 12	*M* = 8.5	*M* = 8.6

Note: NA = not available; + = increasing; - = decreasing.
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.
^Data set controlled for baseline trend

Social Validity

Social validity ratings were collected from each participant. When asked if they liked doing the flashcards, three participants indicated that they did, one participant indicated she 'kind of liked' the flashcards, and another participant indicated she did not like the flashcards. All five participants reported that they liked doing the RMPM passages. Four out of five participants reported that they thought they learned to read new words during the intervention. One participant did not think that she learned to read new words. Four of five participants reported that they learned to use new words in sentences and one participant reported that she did not learn to use new words in sentences.

Summary

The purpose of this study was to determine if IR increases target word identification, use of target words in sentences, and silent reading performance in elementary aged children with varying degrees of hearing loss. After each screening session, the number of words participants correctly identified and the number of words participants were able to use appropriately in sentences were graphed using a multiple baseline across word sets design (Gast & Ledford, 2010). Results were visually analyzed

for changes in level, trend, and variability. Tau-U estimates were calculated (Vannest, Parker, & Gonen, 2011) to examine treatment effect size.

Kratochwill et al. (2010) recommended that strong evidence of a causal relation in a single case design (SCD) study requires minimally three demonstrations of the effect of the intervention. These include: (1) documentation of variability, trend, and level within each phase; (2) documentation of immediacy of the effect, overlap, consistency, and observed versus projected outcomes; and (3) examination of external factors (Kratochwill et al., 2010, p. 16). This study is considered a "proof of concept" based on the criteria proposed by Kratochwill et al. (2010).

Visual analysis of level, trend, and variability for Anne, Scott, Jeremy, and Olivia demonstrated the effect of IR for words identified and target words used in sentences. Tau-U estimates for Anne and Jeremy further support the effect of IR for increasing identification of target words and their use in sentences. For Scott, Tau-U estimates confirms the visual analysis for increased target words identified and use of target words in sentences in two word sets when controlling for baseline trend. Tau-U estimates are further evidence to support an increase in Olivia's ability to use target words in sentences for all word sets. Olivia increased her ability to identify one target word prior to starting intervention for two word sets. The Tau-U estimates were non-significant despite a large change in her ability to identify target words from baseline to intervention.

Chapter 5

DISCUSSION

The purpose of this study was to determine if incremental rehearsal (IR) increases word identification in elementary aged children who are deaf or hard of hearing (D/HH). The study included five participants ranging in age from 6 to 11 years and kindergarten through fifth grade with varying degrees of hearing loss. A single-subject multiple probe, multiple baseline design across three word sets was used to examine if IR increased: (1) word identification of target words, (2) use of target words in sentences, and (3) silent reading performance. The study was conducted during the school year for a period of 7 weeks. IR is a drill-rehearsal flashcard strategy that incorporates frequent repetition (Burns, Dean, & Foley, 2004). Unknown words were introduced as a single item at a time and rehearsed nine times before introducing a second unknown word. The flashcards are displayed incrementally so that the time between unknown and known words items becomes increasingly longer. Participants were asked to identify and use target words in sentences and assessed on overall reading performance with the Reading Milestones Progress Monitoring (RMPM) passages (McAnally & Rose, 2012).

The idea for this study was generated by a comparison study examining the retention and generalization of IR and IR with an added vocabulary component was added (Petersen-Brown & Burns, 2011). The vocabulary component included introducing a target word, providing a definition, and using it in a sentence. Participants were then told to repeat the word, provide a definition, and use it in a sentence. Results suggested that participants who received training using IR with a vocabulary component retained

and generalized more words than through the use of IR alone (Petersen-Brown & Burns, 2011). This study used similar IR procedures where participants were told to use the target words in sentences. Unlike the Petersen-Brown and Burns study (2011), definitions of target words were not included in the intervention since not all targeted Fry words are defined without context (i.e., the, an, or, etc.).

This study furthers research conducted by Dimling (2010), Geoffrion (1981), van Staden (2013), and Wang and Paul (2011) all of whom included a vocabulary strategy integrated into word identification practices. An additional modification was the use of 9 known words as part of the IR paradigm in lieu of 7 known words used by Petersen-Brown and Burns (2011). This modification was made to increase opportunities for practice. Frequent opportunities to practice were components of studies conducted by Dimling (2010), Ensor and Koller (1997), Geoffrion (1981), van Staden (2013), and Wang and Paul (2011) that also led to increased word identification for participants.

All five participants increased the number of target words that they were able to use in sentences during the seven-week intervention period. This increase ranged from 14 to 15 across all participants. During the intervention phase, Anne identified 15 new target words in 18 sessions, Matthew identified 14 words in 12 sessions, Scott identified 15 words in 16 sessions, Jeremy identified 15 target words in 12 sessions, and Olivia was able to read 15 target words in 11 sessions.

Visual analysis of level, trend, and variability for Anne, Scott, Jeremy, and Olivia demonstrated the effect of IR for words identified and target words used in sentences. Tau-U estimates for Anne and Jeremy further support the effect of IR for increasing

identification of target words and their use in sentences for all word sets. For Scott, Tau-U estimates support the visual analysis for two word sets when controlling for baseline trend. Tau-U estimates are further evidence to support an increase in Olivia's ability to use target words in sentences for all word sets. Matthew had one demonstration of effect for target words identified and use of those words in sentences.

The RMPM passages were used to monitor participants' general reading progress during the intervention. All participants increased their mean scores from baseline to intervention over the course of 7 weeks (11-18 intervention sessions). Three participants increased their mean score during maintenance. Anne did not meet performance criterion for the third word set and did not have maintenance information. Olivia's average score on the RMPM decreased during maintenance, but her ability to identify words and use the target words in sentences was maintained.

Limitations

This study has several limitations. The first limitation is that all participants used spoken language. Due to the communication methodology, the results may not generalize to students who use manual or other alternative forms of communication. Future research should explore the use of IR with children who use American Sign Language (ASL), Sign English (SIGLISH), Cued Speech, or alternative communication systems.

An additional limitation is that one person, the primary researcher, conducted the study. It is not known if the process could be easily generalized across teachers. The researcher found the IR process easy to follow and implement. It was time consuming to create sets of flashcards for each participant at the onset of the study. Once the initial set

of flashcards was created, the process was less time consuming as the researcher only needed to change the unknown flashcards in each deck.

This study did not include experimental controls. While the researcher asked that the assigned special education teacher not to teach the target words during the intervention phase, there was no guarantee that instruction of the words did not occur either by the general education teacher, at home with parents, or within the special education resource room.

Another limitation of this study is that data was not collected for each word set when a phase change occurred. This was an oversight by the researcher. Anne, Scott, and Jeremy demonstrated stable baselines for three data points prior to implementing the intervention. There is also no known longitudinal effect of IR training beyond the intervention period. An additional limitation of this study is that session length was not available for Matthew due to technological difficulties.

It is important to note the increasing trend line present during baseline for Matthew in word sets A and C, baseline data was not stabilized prior to introducing the intervention. This was also the case for identifying target words in word sets A and B for Olivia. Since the results were not stabilized prior to implementing the intervention it is unknown if Matthew and Olivia would have increased their word identification and use of target words in sentences for those two word sets. Due to time constraints the researcher implemented the intervention prior to stabilization to provide participants with the intervention for all three word sets.

Future Research

If a causal relation is warranted between IR and its effects on word identification, use of words in a sentence, and overall reading comprehension for children with hearing loss, additional studies will need to be conducted to establish the use of IR as an evidence-based practice for children with hearing loss. Horner et al. (2005) proposed the following criteria for identifying evidence-based practices with the use of SCD studies:

> (a) the practice is operationally defined; (b) the context in which the practice is to be used is defined; (c) the practice is implemented with fidelity; (d) results from single-subject research document the practice to be functionally related to change in dependent measures; and (e) the experimental effects are replicated across a sufficient number of studies, researchers, and participants to allow confidence in the findings (pp. 175-176).

Replication of the studies should occur over at least five separate studies, by three different researchers, with a minimum of 20 participants (Horner et al., 2005; Kratochwill et al., 2010). This study will need to be replicated an additional four times. Two different researchers will need to replicate the study and at least 15 additional participants will be needed.

If IR is effective in increasing word identification, use of words in sentences and reading comprehension, future studies should also be conducted to determine if increasing word identification improves reading fluency for children with hearing loss. Research to determine the optimal set size and dosage for children with varying degrees of hearing loss and alternative language and communication systems is needed. Future

studies could also be conducted to determine if IR is effective using a different presentation method (computer or iPad instead of flashcards).

Conclusion

This study represents only a "tip of the iceberg" with respect to possible interventions that may prove beneficial to increasing word identification and subsequently reading proficiency among children who are D/HH. Word identification is a part of the reading process. Children with varying degrees of hearing loss often struggle to achieve grade level reading outcomes (Allen, 1986; Dew, 1999; Holt, Traxler, & Allen, 1997; Karchmer & Mitchell, 2003; Traxler, 2000). Researchers have found IR to increase word identification among struggling readers (Burns, 2007a; Burns, 2007b; Burns & Boice, 2009; Burns & Kimosh, 2005; Joseph, 2006; Joseph, et al., 2012; Nist & Joseph, 2008; Szadokierski & Burns, 2008). The results of this study suggest that an established evidence-based practice with a variety of populations, IR, may improve word identification for children with varying degrees of hearing loss. While additional research is needed regarding the effects of IR with children who are D/HH, this study contributes positively to the relatively scant literature based regarding word identification intervention strategies for children who are deaf or hard of hearing.

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Appendix A
Principal Letter of Support

Brooke Peterson, Doctoral Candidate
University of Minnesota
250 Education Sciences Building
56 East River Rd.
Minneapolis, MN

March 10, 2015

Dear Brooke,

I am writing this letter in support of your proposed dissertation study, "Word Identification and Children who are Deaf/Hard of Hearing." You have my approval to recruit participants for your study from this Midwest Elementary School. You also have my approval to conduct your study at this Midwest Elementary School. At this Midwest Elementary School, we strive to have all students reach their highest potential. As a teacher of the Deaf/Hard of Hearing at this Midwest Elementary School and doctoral candidate at the University of Minnesota, you work with a unique population of students. I appreciate your efforts to implement research-based strategies and interventions with our students who are Deaf/Hard of Hearing at this Midwest Elementary School.
I am hopeful that your study will be approved and look forward to continued success in our Deaf/Hard of Hearing program at this Midwest Elementary School.

Sincerely,

Principal
Midwest Elementary School Principal

Appendix B
Teacher Letter of Support

Brooke Peterson, Doctoral Candidate
University of Minnesota
250 Education Sciences Building
56 East River Rd.
Minneapolis, MN

March 10, 2015

Dear Brooke,

I am writing this letter in support of your proposed dissertation study, "Word Identification and Children who are Deaf/Hard of Hearing." I am supportive of you recruiting participants and conducting your study at this Midwest Elementary School. As we currently share the caseload of students with hearing loss at this Midwest Elementary School, I understand that my role in your study will be to collect parental consent forms from participants if they turn them in to me.

I appreciate your efforts to implement research-based strategies and interventions with our students at this Midwest Elementary School. I am hopeful that your study will be approved and look forward to continued success in our Deaf/Hard of Hearing program at this Midwest Elementary School.

Sincerely,

XXXXXXXXX
Teacher of the Deaf/Hard of Hearing
Midwest Elementary School

Appendix C
Parent/Guardian Letter

Dear Parents,

As some of you may know, I am a doctoral candidate at the University of Minnesota. My primary interest is in identifying teaching strategies that will improve students' reading skills. I am conducting a study to examine the use of a teaching strategy called Incremental Rehearsal (IR) with children who are Deaf or Hard of Hearing. IR has been used successfully to develop word identification and reading comprehension with diverse groups of children.

Children in the study will be assessed for words that they do and do not know. Once the assessment is complete, the children will receive instruction and systematic word recognition practice on the unknown words. Instruction will occur over 24 sessions in an eight week time period. Sessions will be part of the regular school day and last no longer than 20 minutes.

To participate in the study, children need to have a documented hearing loss, attend this Midwest Elementary School, have a sight word vocabulary of 9 commonly used words (Fry Words), and have 15 commonly used words that they are not able to read.

Attached is a parental consent form, which provides additional information regarding the study. If you have any questions or would like to have your child participate in my study, please contact me at mens0055@umn.edu or XXX-XXX-XXXX.

Sincerely,

Brooke Peterson
Doctoral Candidate, University of Minnesota
Department of Educational Psychology- Special Education

Appendix D
PARENTAL CONSENT FORM

Word Identification and Children who are Deaf/Hard of Hearing

Dear Parent/Guardian of _____,

Your child is invited to be in a study to examine the effects of using Incremental Rehearsal on word identification. Your child was selected as a possible participant because he or she has a hearing loss and is in elementary school. We ask that you read this form and ask any questions you may have before agreeing to your child's participation in the study.

This study is being conducted by Brooke Peterson, a doctoral candidate in Educational Psychology at the University of Minnesota. Brooke is a licensed elementary education teacher, reading specialist, and teacher of the Deaf/Hard of Hearing.

Background Information

The purpose of this study is to examine the effect of Incremental Rehearsal on word identification. This intervention will examine if the use of Incremental Rehearsal increases your child's ability to read target words that they do not know. The study will also examine if increased word identification results in the your child's ability to use the target word in a sentence and increased reading comprehension.

Incremental rehearsal is a flashcard strategy used to target words that your child does not know. It incorporates frequent practice and repetition of words that are targeted with words your child can already read.

Procedures

To be eligible for this study, your child needs to be in kindergarten through sixth grade and have a documented hearing loss.

If you allow your child to be in this study, he or she will do the following things:

- Complete a pre-assessment task that requires participants to read Fry words printed on flashcards. Students will be shown the words until there are 9 cards the child is able to read and 15 that they are not able to identify.
- Receive reading instruction using the intervention during 24 sessions over a period of eight weeks. The intervention sessions will last no longer than 20 minutes. During the intervention the children will be introduced to five words that they were not able to identify in the pre-assessment task. These words will be practiced and reviewed using Incremental Rehearsal.
- Participate in screening before the reading instruction. During screening, the children will be asked to identify the 15 words that they were not able to identify during the pre-assessment. If a child is able to identify one of the previously unknown words, he or she will be asked to use it in a sentence. Students will also be asked to complete a one-minute *Reading Milestones Placement and Monitoring* passages as a measure of reading comprehension.
- At the end of each session your child will receive a PBIS slip. The sessions will be video recorded focusing on the researcher and the materials. Your child's voice will be on the recordings. At the completion of the study, the recordings will be destroyed.

Risks and Benefits of being in the Study
There are no known risks to your child due to participating in this study. Direct benefits of participating in this study may include increased word identification and reading comprehension.

Compensation
Your child will receive PBIS slips for participating.

Confidentiality
The records for this study will be kept private with no name identification on the scoring or recording forms. In any report, no information will be included that would make it possible to identify your child. Research records will be stored securely and only the researcher will have access to the records. Study data will be encrypted according to current University policy for protection of confidentiality. Video recordings will be accessible to only the researcher and another doctoral student for the purpose of scoring. The video recordings will be erased at the completion of the study.

Voluntary Nature of the Study
Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect your current or future relations with the University of Minnesota or your school program. If you decide to allow your child to participate, you are free to withdraw at any time without affecting those relationships.

Contacts and Questions
The researcher conducting this study is Brooke Peterson. If you have any questions now, or after you have given your consent, **you are encouraged** to contact Brooke via email at mens0055@umn.edu or via telephone at XXX-XXX-XXXX. You may also contact Susan Rose, the researchers advisor, at (612)624-6387 or srose@umn.edu.
If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

You will be given a copy of this information to keep for your records.
Statement of Consent
I have read the above information. I have asked questions and have received answers. I consent to my child's participation in the study.

Child's Name (please print):_____

Signature of parent or guardian:_____Date:_____

Signature of Investigator:_____Date: _____

Appendix E
Demographic Information Form

Participant Number:

Gender: _____Female _____Male

Birthdate: _____/_____/_____

Age: _____

Age at identification: _____

Type of Hearing Loss:
_____ bilateral _____unilateral

Right ear: _____sensorineural _____conductive _____mixed
Left ear: _____sensorineural _____conductive _____mixed

Average Degree of Hearing Loss **without** Amplification (500, 1000, and 2000):
Right ear: _____
Left ear: _____

Type of amplification (check all that apply):
Right ear: _____ none _____ hearing aid _____ cochlear implant
_____ personal FM system _____ soundfield system

Left ear: _____none _____ hearing aid _____ cochlear implant
_____ personal FM system _____ soundfield system

How often is amplification used during the day:
Right ear: _____ all day _____ 4 hours per day or less _____ never
Left ear: _____ all day _____ 4 hours per day or less _____ never

Does the child have a documented additional disability?
_____ yes
Disability label: _____
_____no

Language(s) used at home: _____

Language(s) used at school: _____

Primary Language of Child: _____

Primary Mode of Communication:
_____ speech
_____ sign language
_____ combination of speech and sign language

Receptive Language Test Administered in the Last 9 Months:
_____
Standard Score: _____

Expressive Language Test Administered in the Last 9 Months:
_____
Standard Score: _____

Race: _____

Hearing status of parents:

Mother: _____ hearing _____ hearing loss
Father: _____ hearing _____ hearing loss

Appendix F
Intervention Fidelity Checklist

Incremental Rehearsal Fidelity Checklist

Session Length: _____ Observer: _____

Identification Letter: _____ Session #: _____

Step	Yes	No	N/A	Comments
Each item is presented on an index card				
There are a total of 10 items in the set at all times				
Modeling first word using the following steps:				
1. Interventionist: "This is .."				
Interventionist says word correctly				
2. Interventionist: "What word is this?"				
Student responds with correct word				
3. "Good." Interventionist uses the word in a sentence.				
4. Interventionist uses the word semantically and syntactically correct in a sentence.				
5. Interventionist: "What word is this?"				
6. *Interventionist: "Good. Use the word in a sentence."*				
Error correction: "This is _____. What word is this?"				
Unable/incorrect sentence use: Researcher provides sentence again and asks student to repeat it.				
First rehearsal sequence using the following steps:				
1. Interventionist: "Tell me the word" or "What word is this?" (PROMPT ON FIRST CARD AND AS NEEDED ON SUBSEQUENT CARDS)				
2. "Use it in a sentence"				
3. Present 1st unknown word, student uses in sentence and 1st known word				
4. Present 1st unknown, student use in sentence, 1st known, 2nd known				
5. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd knowns				
6. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd , 4th knowns				
7. Present 1st unknown, student uses in				

sentence, then 1st , 2nd , 3rd , 4th, 5th knowns				
8. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th knowns				
9. Present 1st unknown, student uses in a sentence then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th knowns				
10. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th knowns				
11. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th , 9th knowns				
Error Correction Procedure:				
Student given 5 seconds to respond before using error correction procedure				
"This word is _____. (sample sentence). What word is this?" (student responds appropriately) *"Use it in a sentence"*				
Modeling second word using the following steps:				
6. Interventionist: "This is ____."				
Interventionist says word correctly				
7. Interventionist: "What word is this?"				
Student responds with correct word				
8. "Good." Interventionist uses the word in a sentence.				
9. Interventionist uses the word semantically and syntactically correct in a sentence.				
10. Interventionist: "What word is this?"				
6. *Interventionist: "Good. Use the word in a sentence."*				
Error correction: "This is _____. What word is this?"				
Unable/incorrect sentence use: Researcher provides sentence again and asks student to repeat it.				
Second rehearsal sequence using the following steps:				
12. Interventionist: "Tell me the word" or "What word is this?" (PROMPT ON FIRST CARD AND AS NEEDED ON SUBSEQUENT CARDS)				
13. "Use it in a sentence"				
14. Present 1st unknown word, student uses in				

sentence and 1st known word				
15. Present 1st unknown, student use in sentence, 1st known, 2nd known				
16. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd knowns				
17. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd , 4th knowns				
18. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd , 4th, 5th knowns				
19. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th knowns				
20. Present 1st unknown, student uses in a sentence then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th knowns				
21. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th knowns				
22. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th , 9th knowns				
Error Correction Procedure:				
Student given 5 seconds to respond before using error correction procedure				
"This word is _____. (sample sentence). What word is this?" (student responds appropriately) *"Use it in a sentence"*				
Modeling Third word using the following steps:				
11. Interventionist: "This is ____."				
Interventionist says word correctly				
12. Interventionist: "What word is this?"				
Student responds with correct word				
13. "Good." Interventionist uses the word in a sentence.				
14. Interventionist uses the word semantically and syntactically correct in a sentence.				
15. Interventionist: "What word is this?"				
6. *Interventionist: "Good. Use the word in a sentence."*				
Error correction: "This is _____. What word is this?"				
Unable/incorrect sentence use: Researcher provides sentence again and asks student to				

repeat it.				
Third rehearsal sequence using the following steps:				
23. Interventionist: "Tell me the word" or "What word is this?" (PROMPT ON FIRST CARD AND AS NEEDED ON SUBSEQUENT CARDS)				
24. "Use it in a sentence"				
25. Present 1st unknown word, student uses in sentence and 1st known word				
26. Present 1st unknown, student use in sentence, 1st known, 2nd known				
27. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd knowns				
28. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd , 4th knowns				
29. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd , 4th, 5th knowns				
30. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th knowns				
31. Present 1st unknown, student uses in a sentence then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th knowns				
32. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th knowns				
33. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th , 9th knowns				
Error Correction Procedure:				
Student given 5 seconds to respond before using error correction procedure				
"This word is _____. (sample sentence). What word is this?" (student responds appropriately) *"Use it in a sentence"*				
Modeling fourth word using the following steps:				
16. Interventionist: "This is ____."				
Interventionist says word correctly				
17. Interventionist: "What word is this?"				
Student responds with correct word				
18. "Good." Interventionist uses the word in a sentence.				
19. Interventionist uses the word semantically				

and syntactically correct in a sentence.				
20. Interventionist: "What word is this?"				
6. *Interventionist: "Good. Use the word in a sentence."*				
Error correction: "This is _____. What word is this?"				
Unable/incorrect sentence use: Researcher provides sentence again and asks student to repeat it.				
Fourth rehearsal sequence using the following steps:				
34. Interventionist: "Tell me the word" or "What word is this?" (PROMPT ON FIRST CARD AND AS NEEDED ON SUBSEQUENT CARDS)				
35. "Use it in a sentence"				
36. Present 1st unknown word, student uses in sentence and 1st known word				
37. Present 1st unknown, student use in sentence, 1st known, 2nd known				
38. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd knowns				
39. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd , 4th knowns				
40. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd , 4th, 5th knowns				
41. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th knowns				
42. Present 1st unknown, student uses in a sentence then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th knowns				
43. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th knowns				
44. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th , 9th knowns				
Error Correction Procedure:				
Student given 5 seconds to respond before using error correction procedure				
"This word is _____. (sample sentence). What word is this?" (student responds appropriately) *"Use it in a sentence"*				

Modeling fifth word using the following steps:				
21. Interventionist: "This is ____."				
Interventionist says word correctly				
22. Interventionist: "What word is this?"				
Student responds with correct word				
23. "Good." Interventionist uses the word in a sentence.				
24. Interventionist uses the word semantically and syntactically correct in a sentence.				
25. Interventionist: "What word is this?"				
6. *Interventionist: "Good. Use the word in a sentence."*				
Error correction: "This is _____. What word is this?"				
Unable/incorrect sentence use: Researcher provides sentence again and asks student to repeat it.				
Fifth rehearsal sequence using the following steps:				
45. Interventionist: "Tell me the word" or "What word is this?" (PROMPT ON FIRST CARD AND AS NEEDED ON SUBSEQUENT CARDS)				
46. "Use it in a sentence"				
47. Present 1st unknown word, student uses in sentence and 1st known word				
48. Present 1st unknown, student use in sentence, 1st known, 2nd known				
49. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd knowns				
50. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd , 4th knowns				
51. Present 1st unknown, student uses in sentence, then 1st , 2nd , 3rd , 4th, 5th knowns				
52. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th knowns				
53. Present 1st unknown, student uses in a sentence then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th knowns				
54. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th knowns				
55. Present 1st unknown, student uses in a sentence, then 1st, 2nd, 3rd, 4th, 5th, 6th , 7th , 8th , 9th knowns				

Error Correction Procedure:				
Student given 5 seconds to respond before using error correction procedure				
"This word is _____. (sample sentence). What word is this?" (student responds appropriately) *"Use it in a sentence"*				

Intervention Termination:				
Unable to identify unknown word on 3 consecutive displays				

_____ of _____ steps completed = _____ %

Notes:

- N/As occur when student has reached 3 errors and the session has been terminated
- N/As also occur when students proceed through the process without needing a prompt
- Do not count N/As in the total number of steps above

Overall Comments by Observer:

Note: This checklist was modified with permission from Peterson et al. (2014).