Effective Literacy Interventions for Students Who Are Deaf or Hard of Hearing

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy
in the Graduate School of The Ohio State University

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Graduate Program in Educational Studies

The Ohio State University
2017

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Abstract

This dissertation will serve four purposes. First, findings will be presented from a systematic review of the literature related to literacy interventions for students who are deaf/hard of hearing from prekindergarten through high school. Second, findings will be presented from an experimental study that will investigate the effects of a reading racetrack intervention on sight word acquisition in elementary students who are deaf or hard of hearing. Third, a practitioner-focused manuscript related to specific literacy interventions will be presented. The final purpose of this dissertation is to describe my line of inquiry, including a statement of my past, current, and future research.

Keywords: literacy, interventions, deaf, hard of hearing
This dissertation is dedicated to my family, friends, and all of those in the “village.”
Acknowledgments

I would like to express my gratitude to the many individuals who made this dissertation possible. First, I am grateful for the administrators, teachers, staff, and students Ohio School for the Deaf. It was a pleasure to work in Jen Behary’s classroom and get to know her students. OSD is fortunate to have such a talented and dedicated teacher who sees the limitless potential in her students.

I am grateful for my advisors, Sheila Alber-Morgan and Moira Konrad. I appreciate your guidance, feedback, and mentoring throughout my time in the special education program. Thank you for demonstrating excellence in conducting high-quality research and effective teaching. I hope to pass what I have learned from you on to my students as I go forward in my career. I also must express my gratitude to Ralph Gardner. It has been wonderful having you to talk to about issues related to educating students who are deaf/hard of hearing. I have enjoyed having this connection within the special education program.

Finally, my career would not be possible without two important groups of people. First, to the Deaf Community: thank you for welcoming me into the community, for your patience in my learning your language and Culture, and allowing me to become an ally. Second, I have to express my appreciation for the families of children who are deaf/hard of hearing whom I have met and become friends with over the years. The friendships and
relationships I have built with families have provided inspiration and kept me grounded.

Thank you!
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Davenport, C.A. & Alber-Morgan, S.R. (2016). I have a child with a cochlear implant in
my classroom, now what? TEACHING Exceptional Children. 49(1), 41-48.
Fields of Study

Major Field: Educational Studies

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Chapter 1: Introduction

For students who are deaf or hard of hearing (DHH), learning to read and write can be an arduous task. Although becoming a skilled reader is not out of reach for these students, they face barriers that oftentimes require substantial effort to overcome. The advent of universal newborn hearing screening and early identification of hearing loss has led to higher expectations for achievement across all areas, including literacy. In the United States, the national “1-3-6” guidelines provide states the goals of screening infants’ hearing by 1 month, diagnosis by 3 months, and early intervention by the time the child is 6 months of age (National Center for Hearing Assessment and Management, 2011). Earlier identification leads to earlier intervention; the premise is that if the critical needs of infants who are DHH are met promptly, the likelihood of developmental delays occurring is reduced. In theory, meeting those needs, particularly related to language and communication, should yield increased positive outcomes on literacy skills as these children enter school. However, literacy outcomes for students who are DHH have remained significantly below those of hearing children for decades (Lederberg, Schick, & Spencer, 2013).

The oft-cited statistic of the average high school student who is DHH in the U.S. graduating reading at a fourth grade reading level, with 10% graduating reading on grade
level, creates a grim picture (Traxler, 2000). The majority of students who are DHH, regardless of type of program in which they are enrolled, are still not achieving grade level literacy (Spencer & Marschark, 2010). Moreover, regardless of language used, the literacy gap between hearing children and those who are DHH tends to widen with age (Harris & Moreno, 2004). Despite the controversies related to modality and language, one cannot ignore these issues when discussing literacy development.

The interplay between language and literacy is well established in the literature on hearing children, and may well be easier to grasp. When teasing out the connection among communication mode, language, and literacy in students who are DHH, the story is a bit more complicated. The title of Musselman’s (2000) article, “How Children Who Can’t Hear Learn to Read an Alphabetic Script? [A Review of the Literature on Reading and Deafness]” is one version of a common question asked by those curious about how individuals who are DHH learn to read. For typically hearing children, their language experience map onto print; the language they use face-to-face is intimately connected to the language they encounter in text. For children who are DHH, developing spoken language, although not impossible, is likely to be inhibited, thus negatively impacting the saliency of print. Without an intact face-to-face spoken or signed language, children who are DHH do not have the requisite foundation for developing age-appropriate literacy skills (Mayer, 2007). This is not to say that young children who are DHH should not be exposed to print in the absence of a fully formed spoken or signed language, but that there must be a recognition that learning to read and write is substantially more difficult without age-appropriate language.
Of course, discussion of print literacy (and most other issues related to deafness) in students who are DHH must include cochlear implants. Cochlear implants are widely available to young children who are deaf, with the vast majority receiving them as infants or young toddlers. Cochlear implants provide children who are deaf access to sound, improving speech perception. Along with developing spoken language, proponents of early implantation often point to literacy as being a major goal. With auditory access these children can develop literacy skills in the language they use (e.g., English).

Archbold et al. (2008) report better literacy outcomes for children receiving cochlear implants at a young age. They explored the literacy achievement of children with average intelligence who received cochlear implants before 42 months of age and that literacy achievement is maintained at 5 and 7 years post-implant. The mean reading lag was less than 7 months for the children 7 years post-implant. Earlier implantation appears to have a positive effect on reading outcomes, but may not fully close the achievement gap between students who are DHH and their hearing peers. Moreover, more research is necessary to investigate how long gains that are made in the early years are maintained over time. For example, a study by Harris and Terlektsi (2011) found that children with cochlear implants (or hearing aids) demonstrated reading delays of 3 years on average. There are still unanswered questions related to reading achievement in children with cochlear implants, including, what are the long-term reading outcomes for children who receive cochlear implants early? Do the advantage some implanted children experience maintain over time, and if so, for how long? Furthermore, questions remain about the interactions of the components of reading instruction, specifically phonological awareness and reading ability.
Phonemic awareness is one of the components identified by the National Reading Panel (2000) as necessary for reading instruction. The development of phonemic awareness in children who are DHH has received much attention from the research community, but with some variance on causal effects. Research studies conducted with children who are DHH with functional hearing (e.g., via cochlear implants) have shown that phonemic awareness and language correlates and predicts reading outcomes (Lederberg et al., 2013). Geers and Hayes (2011) write that although phonological development in children with cochlear implants is generally delayed compared to hearing peers, some research suggests that the development of phonological awareness occurs in a similar sequence as hearing children. Although these processes may be similar to those of hearing children, auditory-only phonological awareness skills, such as rhyming, segmenting words, and blending sounds, in children who are DHH with cochlear implants are still depressed compared to hearing children (Webb & Lederberg, 2014).

Although there has been increased recognition of the reciprocal relationship between phonological awareness and reading for students who are DHH, there may be nuances that have yet to be identified. For example, the role of visual and kinesthetic cues, such as speech reading and articulation may support auditory phonological knowledge (Lederberg et al., 2013). Beal-Alverez, Lederberg, and Easterbrooks (2012) conducted a study with preschoolers with and without speech perception using Visual Phonics as a supplement to teach grapheme-phoneme correspondence. Results indicated that the multimodality support was effective for all study participants.

The development of some spoken phonological representation may be possible for students without speech perception and use sign, however does not result in age-
appropriate literacy skills (Lederberg et al., 2013). Children who use American Sign Language (ASL) are communicating in a language that has no written representation. They are essentially learning two separate languages in two different modes. Research demonstrates that the acquisition of sign language does not prevent spoken language from developing (Spencer & Marschark, 2010). A child who is deaf can develop both signed and spoken language. Proponents of a bilingual approach typically advocate for the use of visually based strategies, such as using a child’s sign language skills to bridge the gap between ASL and English in print. One strategy is to connect words in print to the meaning of the word using ASL. Another strategy is using fluent fingerspelling, a manual representation of the alphabet, where production is smooth (as opposed to letter-by-letter articulation) which can be used to articulate syllables and consonant clusters. This strategy has shown promise for some readers who are DHH. Research by Padden and Ramsey (2000) demonstrated a strong correlation between children’s fingerspelling skills and reading skills.

Researchers dedicated to understanding how children who are DHH become literate, and the barriers that prevent literacy, have relied mostly on descriptive and correlational studies. Given the available literature on literacy outcomes of students who are DHH, there are few studies that investigate effectiveness of specific interventions targeting reading and writing. For this reason, this dissertation will focus on evaluating literacy interventions for this population. Specifically, this dissertation will serve four purposes:
1. To present findings from a systematic review of the literature related to literacy interventions for students who are deaf and hard of hearing from prekindergarten through high school (Chapter 2).

2. To present findings from an experimental study that investigated the effects of a reading racetrack intervention on sight word reading of elementary students who are deaf and hard of hearing (Chapter 3).

3. To present a practitioner-focused manuscript related to literacy instruction for preschool and elementary students who are deaf and hard of hearing (Chapter 4).

4. To describe my line of inquiry – a statement of my past, current, and future research (Chapter 5).
Chapter 2: Literature Review

This chapter presents a review of the literacy intervention literature for students who are deaf or hard of hearing in grades prekindergarten through twelfth grade. A description of the search methods and coding procedures is provided, followed by a discussion of the results, discussion, directions for future research, and implications for practice.

Abstract

The purpose of this review was to explore the effectiveness of literacy interventions for students who are deaf or hard of hearing in prekindergarten through high school. Single-subject studies that were published in peer-reviewed journals between 2004 and 2016 were selected and reviewed based on specific inclusion criteria. Search results indicated 10 studies met criteria. A variety of interventions were implemented with students who are deaf or hard of hearing to determine effectiveness in teaching reading and writing skills. Four studies were related to Foundations for Literacy, a curriculum developed for preschoolers who are DHH. Limitations and directions for future research are described as well as implications for practice.
An Examination of Literacy Interventions for Students Who Are Deaf and Hard of Hearing

A major challenge for students who are deaf and hard of hearing (DHH) is the acquisition of language and literacy skills (Dyer, MacSweeney, Szczerbinski, Green, & Campbell, 2003). Students who are DHH are diverse in their language-learning environments, presence of additional disabilities, or lack thereof, response to amplification, family involvement, and need for educational accommodations. Despite earlier identification and diagnosis of deafness, and access to amplification (i.e., cochlear implants, hearing aids), the majority of DHH children lag behind their hearing peers in literacy skills (Lederberg, Schick, & Spencer, 2013).

The extent to which literacy delays occur in students who are DHH is vast. Only ten percent of students who are DHH achieve age-appropriate literacy skills (Traxler, 2000). Despite the ongoing controversies regarding modes of communication and use of amplification, this statistic holds true across the spectrum of children who are DHH (e.g., children who are DHH with and without auditory access). Two areas that affect literacy acquisition are the general underlying language abilities and the ability to use spoken phonological knowledge for decoding words (Lederberg, Schick, & Spencer, 2013).

Many children who are DHH struggle to acquire a first language, either signed or spoken. Because the majority of DHH children (95%) are born to hearing parents who are typically not fluent in sign language, access to a visual language is often nonexistent (Karchmer & Mitchell, 2004). Although the language trajectories of children who are DHH are often different than those of hearing children, it is important to note that children who are DHH are capable to attaining age-appropriate language levels. Children
who are DHH who are immersed in a sign-rich environment (e.g., have signing Deaf parents or regularly interact with the Deaf community) often develop language at rates typical of hearing children (Beal-Alverez & Huston, 2014; Lederberg, Schick, & Spencer, 2013). Yet the lags in language development for the majority of DHH children, including those with additional disabilities, have a significantly negative impact on literacy outcomes (Bruce & Borders, 2015).

Technological improvements with cochlear implants and hearing aids have provided more DHH children with the potential to access auditory information and develop spoken phonological knowledge for decoding words. Yet the use of cochlear implants and hearing aids has not fully mitigated the challenges in developing age-appropriate language (Spencer & Marschark, 2010). Archbold et al. (2008) found that children implanted before 42 months of age demonstrated age-appropriate reading levels five and seven years post-implant. Research has also shown that children with cochlear implants or hearing ages 12 to 16 years (i.e., the number of years after implantation) are on average three years behind in reading, regardless of being implanted at or before 42 months of age, or after 42 months (Harris & Terlekski, 2001). Therefore, amplification alone does not solve the literacy challenges faced by students who are DHH. Factors found to positively influence literacy outcomes, as well as overall academic achievement for students who are DHH in general education settings include high expectations from parents and school personnel and collaboration among professionals (Reed, Antia, & Kreimeyer, 2008). Children who are DHH, regardless of auditory access to speech require intensive intervention to acquire language on par with hearing peers.
Given the need for effective literacy interventions and the dearth of evidence-based practices, the issues educators who teach students who are DHH are myriad. Moreover, the combination of deafness being a low-incidence population, the widespread nature of the population geographically, and a history of controversy around communication modality, has resulted in few evidence-based practices (Luckner, 2006). Evidence-based practices are traditionally defined as practices supported by multiple experimental studies of high quality (Cook, Tankersley, Cook, & Landrum, 2008). How do educators teaching students to read and write proceed when faced with interventions with little to no evidence? Spencer and Marschark (2010) recommend taking into account the various studies available across multiple study designs to identify convergent ideas. One way to identify convergent themes and patterns in interventions is through systematic review of existing literature. The following section describes previous literature reviews related to literacy interventions for students who are DHH.

**Previous Literature Reviews**

Luckner, Sebald, Cooney, Young, and Muir (2005/2006) conducted a meta-analysis of literacy research with students who are DHH ages 3 to 21 years. They reviewed 22 peer-reviewed studies published from 1963 to 2003. All studies were experimental and had to include a control group of students who are DHH. Upon locating studies with sufficient statistical information (e.g., means, standard deviations, group sizes, $F$ values, $t$ values, $r$ values), the researchers estimated effect size for outcomes. Effect size was also estimated for all dependent variables. Although not yet established as evidence-based practices, findings from this review suggest some evidence for the following: rehearsal of reading words and stories, explicit vocabulary instruction and
practice with short passages, high-interest literature, instruction in the grammatical principles of ASL and how to translate ASL into English, instruction in reading comprehension strategies, interactive instruction, reading to young students, use of captions, use of word processing, use of simple stories and word recognition practice with young readers, use of the general education curriculum, and direct teaching of sight words, and teaching of morphological rules. The present review provides an updated review of literacy studies conducted with students who are DHH.

Luckner and Handley (2008) examined research studies published from 1963 to 2005 specifically related to reading comprehension with students who are DHH ages 3 to 21 years. The researchers reviewed studies that employed a range of methodologies, including descriptive, quasi-experimental, experimental, correlation, pre- and post-test, and single-subject. Out of the 52 studies reviewed, 27 included an intervention. None of the interventions qualified as a “strong” or “possible” evidence-based practice for reading comprehension, according to criteria set by U.S. Department of Education Institute of Education Science (2003). However, five interventions met the criteria for a “tentative evidence-based practice,” interventions that have undergone correlational study, but not yet experimental investigation (Thompson, Diamond, McWilliam, Snyder, & Snyder, 2005). The category of “tentative evidence-based practice” stands in contrast to “evidence-based practice” as defined by Title IX of No Child Left Behind (CITE). Evidence-based practices are established through multiple high-quality studies that demonstrate experimental control (i.e., group experimental, quasi-experimental, and single-subject studies) (Cook et al., 2008). Interventions qualifying as “tentatively evidence-based” include explicit comprehension strategy instruction; teaching students
story grammar; modified directed-reading thinking activities (i.e., concept development, sight vocabulary, guided reading, discussion, skill development, and enrichment); activating background knowledge; and use of well-written, high-interest text. The current review includes studies targeting reading comprehension, yet narrows the scope of Luckner and Handley (2008) by including only single-subject studies targeting literacy skills in students who are DHH.

More recently, Luckner and Urbach (2012) reviewed reading fluency studies with students who are DHH range from age 5 to 21 years. All studies were published between 1970 and 2009. Six studies in total met inclusion criteria including those using correlation and quasi-experimental designs, and single participant pre- and post-test. Four of the six studies were intervention studies. A common component among these four studies was the use of repeated reading (e.g., word lists and passages). None of the studies met the criteria for a “possible” evidence-based practice as set by What Works Clearinghouse (Valentine & Cooper, 2004) or the design requirements by the U.S. Department of Education Institute on Education Sciences, National Center for Education Evaluation and Regional Assistance (2003). In addition to including more recent studies and only those using single-subject designs, the current review evaluated studies that met inclusion criteria using an updated version of What Works Clearing House standards for single-subject research (e.g., Kratochwill et al., 2013).

Although rigorous standards were applied in each of the previous literature reviews (e.g., What Works Clearinghouse standards, statistical information), there are several limitations in each of the reviews. In Luckner et al. (2005/2006), relatively few studies met the inclusion criteria suggesting a dearth in literacy studies. Although three
researchers reviewed studies, it is possible that relevant studies were overlooked. In addition, a limitation of many of the studies reviewed provided some information about participant characteristics (e.g., age and gender), whereas other important characteristics such as ethnicity, hearing level, age of identification, or amplification use were omitted. In Luckner and Handley’s review (2008), limitations included the possibility of insufficient search terms used and the fact that reading, summarizing, and identifying implications for each study was an interpretive process. The primary limitation of Luckner and Urbach’s (2012) review of reading comprehension studies was that none of the studies included qualified as experimental. Furthermore, a limitation of the studies reviewed was that they used quasi-experimental and causal comparative methods, as well as pre- and post-tests and case studies. The present review will expand on Luckner et al. (2005/2006) and Luckner and Urbach (2008) in several ways. First, the present review includes studies from recent years (i.e., beyond 2005 and 2009, respectively). Second, studies included in this review must have employed single-subject design (SSD) methods (also referred to as single-case design). Last, all studies in the present review were evaluated according to the What Works Clearinghouse (WWC) Single-Case Design Technical Documentation (Kratochwill et al., 2013).

**Group Versus Single-Subject Designs**

The Individuals with Disabilities Education Improvement Act of 2004 requires educators to use evidence-based practices (IDEA, 2004). Educators can no longer rely what they “believe to be true”; educational practices must be research-based. In order for researchers to establish the intended effects of an educational practice, they must establish a functional relationship between variables (Tankersley, Harjusola-Webb,
Landrum, 2008). Identification of educational interventions has traditionally been done through group experimental or quasi-experimental research designs. These studies are regarded as the “gold standard” or providing the most dependable evidence, for determining evidence-based practices (Cook et al., 2014). Group designs compare the effectiveness of a program or practice between two groups, a treatment group and control group (i.e., providing the intervention to only one group). Other key features of group design research studies include large samples, random assignment to treatment and control groups, and statistical analyses of outcomes (Cook, Cook, Landrum, & Tankersly, 2008).

Though group-oriented research is important in establishing evidence-based practices in the field of education, conducting these types of studies proves challenging with special populations, such as individuals with disabilities (Horner et al., 2005). Single-subject research is a methodological approach using experimental means, yet differs from group experimental designs in several ways. First, as in group designs, researchers are able to draw conclusions about the effectiveness of an intervention, but in single-subject research, participants serve as their own controls (Horner et al., 2005). This is an important consideration when studying special populations, which tend to be small and diverse, making it difficult to have enough subjects to participate in research studies. Second, group designs rely on statistical analysis of data (e.g., the mean outcomes across participants), whereas SSD uses analysis of within-subject data to draw conclusions about a treatment, or intervention (although there are statistical methods available for analyzing single-subject research). Therefore, individual responsiveness, or non-responsiveness, can be obscured with group designs. Researchers may conclude that a particular
treatment is effective for most participants, but are unable to analyze data at the individual level. Studies using a single-subject design can demonstrate the effects of an intervention on an individual’s behavior. Third, the goal of some group-oriented research studies is to determine the effectiveness of a socially significant phenomenon (e.g., improving rates of smoking cessation), the primary goal of all single-subject research is improving socially significant behaviors (Tankersley, Harjusola-Webb, & Landrum, 2008). Although conceptually similar, SSD targets behavioral or learning outcomes with the goal of increasing or decreasing the target behavior, depending on the nature of that behavior (i.e., appropriate or inappropriate) at the individual level.

Features of Single-Subject Research

The purpose of SSD research is to demonstrate a functional relationship between independent variables and dependent variables. A functional relationship can be determined through the manipulation of an independent variable and the change in the dependent variable (Horner et al., 2005). SSD studies document the extent of experimental control, rather than correlational or descriptive by comparing performance pre- and post-intervention. A combination of the following features define SSD research: (a) the participant is the unit of analysis, (b) operational definitions of participants and setting, (c) one or more dependent variables (i.e., target behavior that is observed and carefully measured), (d) independent variable (i.e., treatment or intervention), (e) baseline conditions, (f) repeated measurement, (g) visual analysis of data, (h) internal and external validity, and (i) social validity (Horner et al, 2005).

The evaluative process in SSD is referred to as baseline logic. Baseline logic is employed across all SSD experimental designs (Gast, 2010). SSD experimental designs
include A-B-A withdrawal (sometimes referred to as a reversal design), alternating treatments, multiple-baseline, and changing criterion. In an A-B-A design, the A condition is the non-treatment (i.e., control) phase, and the B condition is the treatment phase of the experiment. The A condition is maintained until the target behavior demonstrates stability. Once the target behavior is stable, treatment is implemented. Behavior in both conditions is observed and measured and compared across conditions. In an A-B-A design, the experiment ends with a return to baseline. In all instances, an additional treatment phase is preferable because it produces replication and strengthens experimental control. For example, in an experiment where there is a positive effect of an intervention on a word-learning task, ending the experiment in the control condition does not allow the experimenter to replicate results, thus not creating experimental control. By re-introducing the intervention condition (i.e., ABAB design), the experimenter can conclude that the dependent variable is functionally related to the independent variable.

An in-depth explanation of all single-subject experimental designs is beyond the scope of this article.

Before introducing an independent variable, steady state responding is necessary. Steady state responding is a pattern of responding that demonstrates little variation over time as measured by a defined dimension (i.e., duration, latency, frequency; Johnston & Pennypacker, 1993). Any changes in the dependent variable when the independent variable is introduced are compared against the dependent variable during baseline conditions. This provides the analyst a way to objectively measure changes in behavior rather than using subjective means (i.e., observation). Baseline data also provides guidance in setting initial criteria for reinforcement. Without baseline data, it is difficult
to set appropriate criteria. Baseline logic entails three elements – prediction, verification, and replication. Steady state responding during baseline conditions allows the analyst to predict that if baseline conditions remain intact, the target behavior will continue without an upward or downward trend and with relative stability. Verification occurs by demonstrating that baseline levels would have remained unchanged had the independent variable not been introduced, reducing the probability of confounding variables being responsible for the change in behavior. Replication allows for the determination of reliable effects and increased internal validity of a study by replicating experimental conditions.

In order to determine the effectiveness of an intervention, the researcher uses visual inspection of individual data paths. Once data are plotted for baseline and intervention conditions, visual analysis can be conducted. Visual analysis is a systematic process for evaluating the graphic representation of continuous data, involving four elements: level, trend, variability, and immediacy (Horner et al., 2005). Level refers to the magnitude of an individual’s behavior from the end of one phase to the beginning of the next phase. For example, across five baseline sessions, a student could read zero out of 10 words correctly. In intervention sessions, the student could read five words in the first two sessions, 6 words and 5 words in the next two sessions, and 10 words in the final three sessions. The mean performance for that student increased from 0 to 6.2 words read correctly. Inspecting the data trend, the upward or downward pattern of data, provides a method to understand the direction of a behavior change in the past, and to predict future behavior changes. Visually inspecting trend lines is particularly helpful for teacher and other practitioners; it is a relatively straightforward method to determine how an
individual has, and will, respond to an intervention. With an ascending trend line, one can see that the behavior improved, or increased, and vice versa for descending trend line. 

*Variability* is the degree to which performance fluctuates within a condition. Using the same example above, the student’s data indicates very little fluctuation; her performance is relatively stable. Finally, *immediacy* refers to the change in level between the last three data points in one phase and the first three data points in the next phase. The more immediate the effect, the stronger demonstration there is an intervention effect.

**Use of Single-Subject Research with DHH Students**

Students who are DHH are in desperate need of improved outcomes. However, those who work in the field of deaf education have long lamented the lack of evidence-based practices via randomized, controlled studies (Luckner, 2006). First, deafness is a low-incidence disability. The U.S. Department of Education, National Center for Education Statistics (2016) reports that 0.2-1.0% of students with disabilities receive DHH services. Wendel, Cawthon, Ge, and Beretvas (2016) cite population heterogeneity as a major challenge in conducting group experiments with students who are DHH. Students who are DHH vary widely in critical areas such as age of onset of deafness, parental hearing status, communication mode, and use of amplification. Single-subject designs are applicable to addressing the individual needs of students who are DHH by offering an alternative to group designs in order to evaluate the effectiveness of educational interventions and programs (Bullis & Anderson, 1986).

Wendall et al. (2016) identifies four advantages of using SSD with students who are DHH. First, single-subject research is typically conducted with small numbers of participants making it appropriate for low incidence populations such as the DHH student
population. This stands in contrast to group designs, which typically require large numbers of subjects randomly selected from the population. Second, all participants in SSD receive treatment, or access to the intervention. Group experiments involve participants assigned to the treatment group receiving treatment while those assigned to the control group are not afforded that opportunity. For students who are DHH and all students who have individualized education programs, it is unethical to withhold a potentially effective intervention. Third, teachers can initiate action-oriented research using single-subject designs. Upon identifying a problem and possible intervention, a teacher can collect and analyze data, and make instructional decisions based on that data. Last, single-subject research offers opportunities for teachers to evaluate the effectiveness of interventions they believe are socially valid. If teachers are resistant to an intervention, the intervention is unlikely to be effective, or implemented with fidelity. Single-subject research offers researchers interested in improving outcomes for students who are DHH a methodology that is practical, straightforward, and relatively efficient in determining if an educational intervention is effective (Bullis & Anderson, 1986). Yet it is imperative that these types of research studies are conducted with rigor in order to ensure validity.

One set of guidelines for evaluating SSD research is from What Works Clearinghouse.

**What Works Clearinghouse Standards**

The Institute for Education Sciences established What Works Clearinghouse (WWC) in 2002. The goal of WWC is to independently evaluate the internal validity of studies that evaluate educational and psychological interventions. The initial focus was on evaluating group-oriented methodologies, such as randomized controlled trials. With an increased awareness of the role single-subject research plays in evaluating the
effectiveness of educational interventions, the WWC released complementary standards for evaluating this methodology (Kratochwill et al., 2013). *The Procedures and Standards Handbook*, version 3.0 (Kratochwill et al., 2010/2014) proposes guidelines for designing and evaluating single-subject designs. The SSD evaluation guidelines include protocol for ensuring internal validity by determining the strength of the research design, in addition of evidence through visual analysis.

SSD studies in this review were evaluated using a three-step process based on WWC standards. First, all studies were evaluated according to four areas, as directed by the Standards guidelines. Studies were categorized as (a) Meets Standards without Reservations, (b) Meet Standards with Reservations, and (c) Does Not Meet Standards. Studies were identified as Meets Standards without Reservations, by using a dichotomous scale to code each study, according to the following qualities:

1. Systematic manipulation of the independent variable. Studies had to have descriptions of baseline and intervention conditions.

2. Inter-observer agreement (IOA). Studies had to report IOA for at least 20% of sessions. The mean IOA reported must have been at least 80%.

3. Data points per phase. Each study had to include at least three opportunities to demonstrate an experimental effect.

4. Baseline. Each study had to include at least three data points in baseline phases.

Second, to evaluate the rigor of the methods used for each study, and to determine how trustworthy the results were, the number of data points was counted across all conditions (i.e., baseline and intervention) for each participant. If the study included five data points in each phase (i.e., every baseline and intervention phases for each
participant), the study was categorized as Meets Standards without Reservations. If the study had at least three data points, but fewer than five, for each phase for each participant, the study was categorized as Meets Standards with Reservations.

Third, the strength of the studies that met standards was evaluated by creating a success estimate. This is important in guiding researchers and consumers in judging how meaningful the results are, and whether or not a particular intervention should be endorsed. Success estimates were calculated by dividing the number of opportunities to demonstrate an experimental effect by the number of times the change in condition meaningfully changed the behavior. If there were two or fewer effects (e.g., 2/3, 2/5), the study was ranked as having no effect. If the effects were at least 3 and that number is less than the number (e.g., 3/4, 4/6) of opportunities, the study was ranked as “moderate evidence.” If the number of effects and the number of opportunities was equal (e.g., 3/3, 5/5), the study was ranked as “strong evidence.”

The purpose of this literature review was to identify intervention studies addressing literacy skills in students who are DHH in preschool through 12th grade via single-subject design research. All studies were examined using the What Works Clearinghouse standards. Limitations and recommendations for future research will be discussed.

Method

Inclusion Criteria

The author included articles that met the following criteria: participants had to be in pre-kindergarten through 12th grade, participants had to have a diagnosed hearing loss, and the study had to examine a literacy intervention with a single-subject research design
(excluding AB designs). Studies with adult participants and those with participants’ whose deafness was not the primary disability were excluded. Additionally, dependent variables had to be a skill directly related to reading or writing behaviors. Research studies using group comparison methods were not included for the following reasons: primary interest was in the effects of an intervention on individual student literacy skills, not an overall average across study participants, group designs tend to not describe individual participant’s characteristics, and single-subject designs allow rigorous data analysis for non-responders and responders, whereas group designs can obscure this information (Horner, et al., 2005). Quasi-experimental research studies were not included due to the inability to examine effects of an intervention on individual participant behavior. Additionally, descriptive studies, case studies and single-subject AB designs were not included. These methods do not allow for identification of functional relations because of the lack of baseline conditions.

All studies included in the search had to be published in English and in peer-reviewed journals between 2004 and 2016.

*Literature Search*

A comprehensive search of articles was conducted by searching the following electronic databases: Academic Search Complete, EBSCO-HOST, ERIC, Education Research Complete, Education Full Text (HW Wilson), PsychINFO, and Education Abstracts. The search string was (deaf* OR hearing impair* OR hard of hearing OR hearing loss) AND (single subject OR single case) AND (literacy OR read* OR writ* OR vocabulary OR comprehend* OR phon* OR fluency OR alphabet*). Second, a hand search of the following journals was conducted: *Journal of Deaf Education and Deaf*
Studies, American Annals of the Deaf, and The Volta Review. Websites for these journals were also searched for “online first” articles. Articles published between 2004 and 2016 were reviewed. Third, the reference lists of articles collected were reviewed for additional articles to be included in the current review. Fourth, an ancestral search of the articles retrieved in the initial search was conducted after the initial search. Any relevant articles included in those reference lists were included reviewed and retrieved.

After articles were identified and retrieved, they were screened for the inclusion criteria. Included studies were coded and analyzed.

Coding and Analysis of the Literature

All studies included were coded in order to facilitate identification of patterns and trends, as well as differences among variables. Coding variables included participant characteristics and settings, dependent variables, independent variables, and outcomes.

All studies were also coded using WWC standards for SSD. Some studies did not explicitly state or include some variables; those articles were coded using the information provided.

Intercoder Agreement

To ensure accuracy of coding, a graduate student independently examined and coded 33.3% of the included studies. The first author trained the graduate student to code articles using a coding form. After meeting a criterion of at least 95% with the first author on two consecutively coded articles, the graduate student coded randomly selected articles. For each experiment, the first author used a point-by-point method to calculate intercoder agreement. She divided the number of agreements for each item by the total
number of items for each experiment and multiplied that number by 100 to yield a percentage of agreement. Intercoder agreement was 100% across experiments.

Results

A total of 10 studies from 8 articles met the inclusion criteria for this review, summarized in Table 1. The majority of studies were published in the *Journal of Deaf Studies and Deaf Education* (50%), followed by *Communication Disorders Quarterly* (20%). One study (10%) was found in *The Volta Review* and one in *American Annals of the Deaf* (10%).
<table>
<thead>
<tr>
<th>Study authors</th>
<th>Age range (years)</th>
<th>Dependent variable</th>
<th>Independent variable</th>
<th>Summary findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beal-Alverez et al. (2012) Study One</td>
<td>4-9</td>
<td>Grapheme-phoneme correspondences correctly spoken</td>
<td>Specific instruction in grapheme-phoneme correspondence using Foundations curriculum and Visual Phonics (participant with no speech perception ability); one-on-one setting</td>
<td>Range of 1-7 correct across participants; average latency of 4.5 sessions</td>
</tr>
<tr>
<td>Beal-Alverez et al. (2012) Study Two</td>
<td>4-4-7</td>
<td>Grapheme-phoneme correspondences correctly produced</td>
<td>Specific instruction in grapheme-phoneme correspondence using Foundations curriculum and Visual Phonics (participants had various levels of speech perception); small group setting</td>
<td>Range of 1.11-1.43 correct across participants; average latency of 1.28 sessions</td>
</tr>
<tr>
<td>Benedick et al. (2015)</td>
<td>9-2–10-9</td>
<td>Strategic and non-strategic behaviors observed during read-aloud and retelling procedures, reading comprehension</td>
<td>Comprehension, Check, &amp; Repair (CC&amp;R) strategy</td>
<td>General increase in strategic reading behavior ($M=1.0-11.66$); General decrease in nonstrategic reading behavior ($M=2.16-1.1$)</td>
</tr>
<tr>
<td>Bennett et al. (2014)</td>
<td>11-5–11-10</td>
<td>Ability to respond to a picture prompt by stating a sentence (spoken or English-based sign system) that accurately describe the picture or answered questions about the picture</td>
<td>Language for Learning (scripted lessons using English-based sign while simultaneously speaking)</td>
<td>Range of sessions until criterion of 80% response rate reached = 3-10</td>
</tr>
</tbody>
</table>

Table 1. Summary of Characteristics of Reviewed Studies
Note: *Two participants presented unstable baselines. Researchers choose to implement intervention after 10 baseline points across both participants. **One participant demonstrated mastery (96% correct) on rhyme recognition at baseline. *** First graders in Year 1 progress ranged from a half to 1 year; half to 2 years of progress in Year 2 as second graders. Of the two students in grade 2 during the first year of intervention, one made almost 1 year of progress and the other half a year, but the following year both made almost 2 years of progress. Third graders (N=5) 3 the first progress ranged from a quarter to 2 years. The following year three of those students made no progress, two of the students made almost 2 years progress. Scores dropped between end of school year and the beginning of the next school year, particularly for earlier grades.
Participants

The studies included a total of 37 participants. The majority of intervention studies in this review targeted skills at the pre-kindergarten and kindergarten level \((n = 5)\) or grades 1–5 students \((n = 4)\). None of the studies in the review focused on students in sixth to eighth grade. One study focused on 9th-12th grade students. Participants ranged in age from 3 to 18 years. All 10 studies reported participants’ gender; 16 were female and 21 were male. Two studies reported participants’ race or ethnicity; among those, none of the participants were African American, five were White, one was Hispanic/Latino, one was Asian, and one was multiracial. The majority of participants had no additional disabilities \((n = 34)\). The remaining participants \((n = 3)\) had diagnoses of cerebral palsy, auditory processing disorder, and emotional-behavioral disorder. See Table 2 for demographic information about participants.

Thirty-six participants had a bilateral hearing loss, and one had unilateral hearing loss. Of the four studies that reported types of deafness (i.e., sensorineural, conductive, or mixed), 14 participants had sensorineural hearing loss, none had a conductive hearing loss or a mixed hearing loss. All but one study (i.e., Trussl & Easterbrooks, 2010) reported amplification use by participants. All studies reported amplification for each participant. Of the 37 participants total, 19 had cochlear implants (i.e., unilateral or bilateral), 17 used hearing aids, and one participant used a cochlear implant and a hearing aid.

All studies reported mode of communication for each participant. Twenty participants used some form of sign language, including American Sign Language, an English-based sign system, or Pidgin (e.g., contact) sign language. Ten participants used
spoken language. Four participants used a combination of sign and spoken language. Three studies (i.e., Beal-Alverez, Lederberg, & Easterbrooks, 2012; Miller, Lederberg, & Easterbrooks, 2013; Bennett, Gardner, Leighner, Clancy & Garner, 2014) explicitly stated parental hearing status. Eight participants had two hearing parents; two participants had one hearing parent and one deaf parent; two participants had two deaf parents. One study (i.e., Wolbers, Dostal, Graham, Cihak, Kilpatrick, & Saulsburry, 2015) implied the parents were Deaf by stating that ASL was the language used in the home. English was the primary language of the home for 14 participants. Six households used some form of spoken and sign language. Four households used some form of sign language (e.g., ASL, sign-supported-speech). Spanish was spoken in three of the households, and a spoken language other than English or Spanish (i.e., Cambodian) was spoken in one household.
<table>
<thead>
<tr>
<th>Variables</th>
<th>Percent</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant's Grade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PreK-Kindergarten</td>
<td>51.3</td>
<td>19</td>
</tr>
<tr>
<td>1st-5th</td>
<td>40.5</td>
<td>15</td>
</tr>
<tr>
<td>6th-8th</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>9th-12th</td>
<td>0.08</td>
<td>3</td>
</tr>
<tr>
<td>Participant's Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Girl</td>
<td>41.1</td>
<td>16</td>
</tr>
<tr>
<td>Boy</td>
<td>58.9</td>
<td>21</td>
</tr>
<tr>
<td>Participant's Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>12.5</td>
<td>1</td>
</tr>
<tr>
<td>Black</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Hispanic/Latino</td>
<td>12.5</td>
<td>1</td>
</tr>
<tr>
<td>White</td>
<td>62.5</td>
<td>5</td>
</tr>
<tr>
<td>Multiracial</td>
<td>12.5</td>
<td>1</td>
</tr>
<tr>
<td>Additional Disabilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>94.6</td>
<td>34</td>
</tr>
<tr>
<td>Yes</td>
<td>53.6</td>
<td>3</td>
</tr>
<tr>
<td>Type of Hearing Loss</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensorineural</td>
<td>100</td>
<td>14</td>
</tr>
<tr>
<td>Conductive</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Mixed</td>
<td>0.0</td>
<td>0</td>
</tr>
<tr>
<td>Amplification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CI (unilateral or bilateral)</td>
<td>51.3</td>
<td>19</td>
</tr>
<tr>
<td>HA</td>
<td>45.9</td>
<td>17</td>
</tr>
<tr>
<td>CI + HA</td>
<td>2.7</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 2. Participant Demographics

CI = cochlear implant; HA = hearing aid

Settings

The setting was reported in all 10 studies. All of these studies took place in a school setting. Of those studies, eight (80%) were conducted in DHH classrooms, one study (10%) was conducted in a special education classroom, and one (10%) in a school library. None of the studies reviewed took place in a general education classroom or home environment. See Table 3 for setting information.
<table>
<thead>
<tr>
<th>Variables</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention Setting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DHH classroom</td>
<td>8</td>
<td>80.0</td>
</tr>
<tr>
<td>Special education classroom</td>
<td>1</td>
<td>10.0</td>
</tr>
<tr>
<td>General education classroom</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>School library</td>
<td>1</td>
<td>10.0</td>
</tr>
<tr>
<td>Home</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Mode of Instruction*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASL/sign</td>
<td>7</td>
<td>63.6</td>
</tr>
<tr>
<td>Spoken language</td>
<td>3</td>
<td>27.3</td>
</tr>
<tr>
<td>Sign and speech</td>
<td>1</td>
<td>90.1</td>
</tr>
</tbody>
</table>

Table 3. Intervention Setting Information

*Bergeron, et al. included participants in two separate placements; one placement used ASL/sign, the second placement used spoken language

Desigs

Of the ten studies, nine used multiple-baseline designs (e.g., across participants, across content). One study used changing criterion (i.e., Easterbooks & Stoner, 2006).

Dependent Variables

One study had multiple dependent variables measuring literacy behaviors. Benedict, Rivera, and Antia (2015) measured the number of strategic and non-strategic behaviors observed during read-aloud and retelling procedures, and number of details retold in one minute. Two articles presented two studies each, all of which measured phoneme-grapheme correspondence (i.e., Beal-Alverez et al., 2012; Bergeron, et al., 2009). Two studies focused on writing measures. Wolbers et al. (2015) scored writing samples, including information reports, and persuasive writing using a writing rubric for writing from the National Assessment Governing Board, U.S. Department of Education. Easterbrooks and Stoner (2006) measured the number of adjectives included in a written product. One study measured the number of correct responses to morphographic analysis items (e.g., ____ + ____ = gullible) (i.e., Trussel & Easterbrooks, 2015). Benedict et al. (2015) measured the ability of students to respond to a picture prompt by stating a
sentence (e.g., spoken or English-based sign system) that accurately describes the picture or answered questions about the picture. Bennett et al. (2014) targeted English syntax in fifth grade students. The dependent variable was students’ ability to respond to a picture by stating a sentence that accurately described the picture or to answer questions about the picture using English syntax either through spoken English or English-based sign system.

**Independent Variables**

Literacy interventions varied across studies. The following provides descriptions of each intervention, method, or strategy that was examined in this review.

*Children’s Early Intervention.* Bergeron et al. (2009) included two studies embedding a semantic association strategy into two different literacy curricula for the purpose of explicitly teaching phoneme-grapheme correspondence. Study One was conducted with pre-kindergarten and kindergarten students during the first year of the four-year project developing *Foundations for Literacy* (second study described below.) Using a weekly framework, the study assessed the effectiveness of embedding a semantic association strategy using stories and pictures from the *Children’s Early Intervention (CEI)*, a 35-minute-a-day intervention program. Each week the teacher read a CEI story focusing on a phoneme-grapheme correspondence. The weekly framework involved repeated readings, enacting the story, reviewing the targeted phoneme-grapheme correspondence and engaging in a key word activity (used to teach that correspondence).

*Foundations for Literacy.* In developing Foundations for Literacy, Bergeron et al. (2009) replicated the study described above (e.g., semantic association strategy to assess effectiveness of teaching phoneme-grapheme correspondence) but embedded it in the
Foundations for Literacy curriculum. Both studies are the first on teaching phoneme-grapheme correspondences for DHH pre-kindergarteners. Foundations for Literacy, an emergent literacy curriculum developed for young DHH children, was created specifically for prekindergarten students by providing multimodality support in a 60-minute-a-day instruction period. The curriculum provides instruction that is code-based (e.g., alphabetic knowledge and phonological awareness skills) and meaning-based (e.g., vocabulary and comprehension) (Bergeron et al., 2009).

Beal-Alvarez et al. (2012) extended the 2009 Bergeron et al. studies on phoneme-grapheme correspondence by conducting two studies targeting the same skill. This work was also part of the four-year project developing Foundations for Literacy. In this study, used the semantic association strategy paired with Visual Phonics with participants requiring additional multimodal support because of limited speech perception. Developed by Waddy-Smith and Wilson (2003), Visual Phonics is a tool to improve speech articulation and reading. It uses 45 different handshapes and movements that resemble the articulation of each sound in the English language, each with a corresponding written symbol (Waddy-Smith & Wilson, 2003).

Study One was conducted with the first author of the study who was fluent in ASL and proficient in Visual Phonics and a five-year old student. Following the weekly framework used in Bergeron et al. (2009) using repeated readings of an activity-based story, which was accompanied by a large concept card, enacting the story, language experience activities, and recall of the activity. The difference was that the interventionist used Visual Phonics during the initial week of instruction of each grapheme-phoneme for all phonemes. The use of Visual Phonics was faded after the participant acquired a
phoneme and used only when the participant needed additional visual support. Instruction included emphasis on the participant’s speech production and phoneme production. Study Two extended Bergeron et al.'s (2009) study using a semantic association strategy in a small group of DHH preschoolers with speech perception by using the same strategy with a small group of DHH preschoolers with various levels of speech perception ability. Study Two followed the same intervention procedures as Study One but included fluency charting, which the interventionist modeled for the participants.

*Phonological awareness instruction.* Miller et al. (2013) took place during third year of the development of *Foundations for Literacy*. This study examined the effectiveness of the phonological awareness instruction component of the curriculum. In the first month of intervention, teachers taught the vocabulary the participants would need to know to understand phonological awareness instruction, such as *sound*, *beginning*, and *word*. After introducing each phonological awareness skill, participants engaged in practice activities related to that skill. Frequency and type of activity varied based on participants’ performance.

*Morphographic instruction.* Trussel and Easterbrooks (2015) used morphographic instruction to teach morphographic analysis and affix meaning to fourth and fifth grade students who are DHH. The scripted lessons were modeled after the *Spelling for Morphographs* curriculum and adapted for using via sign language (i.e., first author and teacher of the deaf agreeing on sign usage). The lessons were designed to be fast-paced and to be interactive between instructors and student. Intervention lesson plans included root word and affix instruction, word dissection, and morphographic rules. The meaning
of the root words were taught alongside the affix, based on pre-assessments of student knowledge of root words. Students used visual organizers for visual support.

*Comprehension, Check, & Repair.* Using teacher-student dyads, Benedict et al. (2015) measured reading comprehension and reading behavior using Comprehension, Check, and Repair (CC&R). CC&R is a metacognitive strategy with the purpose of teaching students how to self-monitor their reading comprehension through self-questioning. CC&R includes components identified by the National Reading Panel (National Reading Panel [NRP], 2000) as effective in teaching reading comprehension. These components include comprehension monitoring, question generation, and question answering. Before intervention sessions began, the researcher trained the teachers one-on-one in the CC&R strategy using discussion, role-play, video, and Power Point presentations.

*Strategic and Interactive Writing Instruction.* Wolbers et al. (2015) examined the effects of Strategic and Interactive Writing Instruction (SIWI) on the written expression of DHH elementary students across three genres: recount/personal narratives, information report, and persuasive writing. Three guiding principles drive SIWI. First, instruction is *strategic* – students are explicitly taught strategies for writing processes. Second, instruction is *interactive* – writing pieces are discussed and co-constructed collaboratively among teachers and students. Third, *writing instruction* aims at explicitly developing metalinguistic competency, and implicitly developing linguistic competency in ASL and English (with students who sign). Teachers were trained in the SIWI method prior to the study beginning. They met with researchers online on a weekly or biweekly basis throughout the school year to discuss student responses to instruction. Teachers also
video recorded daily writing lessons and reviewed them during a three-day SIWI workshop mid-year to review and reflect on their practice.

*Visual tool.* The only study targeting literacy skills in DHH in grades 7 through 12 was Easterbrooks and Stoner (2006). The researchers investigated the use of a visual tool to increase the use of adjectives in writing a response to age-appropriate action pictures with students in grades 9 through 12. The visual tool was a sheet of paper with five sets of two lines down the left side and five circles in a row after each set. Twice the teacher modeled looking at an action-oriented picture (e.g., several men rowing a kayak frantically on a river) and creating a list of five major nouns from the pictures and writing them on the left hand side of the visual tool. She then used a group of questions (e.g., How many? How does it feel? How old? What size?) to develop a list of adjectives in response to the questions and filled in the circles on the right hand side. Student instruction consisted of a week of modeling, three days of shared writing, and one day of guided writing with the scaffold of the visual tool and a list of questions, as described above.

*Language for Learning.* Bennett et al. (2014) taught fifth graders to respond to picture prompts using Language for Learning, a scripted reading curriculum that incorporated key components from Direct Instruction. These components include explicit instruction, progress monitoring, and lessons taught in one-on-one or small group settings. Lessons were implemented one-on-one unless students responded more than 80% of the time during lessons. Otherwise, students were placed into small groups for instruction. Several modifications were made to the scripted lessons. First, the experimenter used spoken and English-based signing for all directions and stimuli items.
Second, minor modifications were made in accordance to the needs of students who are DHH in terms of language used. For example, instead of saying, “Say the whole thing”, the experimenter said, “Say the whole sentence.” Last, the experimenter was unable to strictly follow scripts intended for group instruction during one-on-one instruction, such as “We are going to talk about a boy [in the room].”

*Application of What Works Clearinghouse Standards*

The rigor of each study design and the strength of outcomes were evaluated using guidelines in *The Procedures and Standards Handbook*, version 3.0 (Kratochwill et al. 2010/2014) for designing and evaluating single-subject designs. Each study in this review has been categorized as Meets Standards or Does Not Meet Standards. Those categorized as Meets Standards have been identified as “Meeting Standards With Reservations” or “Meets Standards Without Reservations.” Further, the strength of outcomes for each study has been calculated. Studies have been ranked as “no evidence,” “moderate evidence,” or “strong evidence.”

*Standards of evidence.* To qualify as “Meets Standards of Evidence,” studies had to demonstrate the following: (1) systematic manipulation of the independent variable, (2) reported IOA for at least 20% of sessions with a mean IOA of at least 80%, (3) at least three opportunities to demonstrate an experimental effect, and (4) at least three data points in baseline phases.

The majority of studies (n = 6 out of 10) met all four criteria for “Meets Standards” (i.e., Beal-Alverez et al., 2013; Miller et al., 2013; Bennett et al., 2014; Easterbrooks & Stoner, 2006; Trussel and Easterbrooks, 2015; and Wolbers et al., 2015). Studies qualifying as “Meets Standards without Reservations” include Study Two by
Beal-Alverez et al. (2012) and Wolbers et al. (2015). Each of these studies had 5 data points across all phases for each participant. Four studies had at least 3 but less than 5 data points across all phases for each participant, qualifying them as “Meets Standards With Reservations” (e.g., Bennett et al., 2014; Easterbrooks & Stoner, 2006; Trussel & Easterbrooks, 2015).

Two studies qualified as “Does Not Meet Standards.” Study One in Beal-Alverez et al. (2012) reported IOA for less than 20% of sessions (i.e., 17%). Miller et al. (2013) did not report IOA. In addition, they collected 2 data points for baseline phases citing this as a limitation of the study. Studies One and Two in Bergeron et al. (2009) did not include graphs for all participants, preventing visual analysis. In this case, it is impossible to determine whether or not studies the met standards of evidence.

Success estimates. Success estimates were calculated dividing the number of opportunities to demonstrate an experimental effect by the number of times the change in condition meaningfully changed the target behavior. Studies in this review were ranked as the following: (a) no effect (i.e., 2 or fewer demonstrations of effect, (b) moderate effects (i.e., if an effect was observed on three occasions and that number was less than the number of opportunities, (Kratochwill et al., 2013) or (c) strong effect (i.e., there were an equal the number of effects and opportunities). Success estimates were calculated only for studies that met the WWC standards of evidence.

In the present review, the majority of studies \((n = 6)\) ranked as having a “strong effect.” Through visual analysis, each of these studies (Easterbrooks and Stoner, 2006; Study Two in Beal-Alverez et al., 2012; Miller et al., 2013; Bennett et al., 2014; Trussel & Easterbrooks, 2015; Wolbers et al., 2015) it was determined that there were equal
demonstrations of effect and opportunities for demonstration of effect. Because Study One of Beal-Alverez et al. (2012), Miller et al. (2013) did not meet standards of evidence, success estimates were not calculated. Success estimates were also not calculated for Study One and Study Two in Bergeron et al. (2009) because graphs for all participants were not included in the published article. See Table 4 for results of WWC application for each study.

<table>
<thead>
<tr>
<th>Study</th>
<th>Manipulation of IV</th>
<th>Three attempts to demonstrate an effect</th>
<th>Three data points in each phase</th>
<th>IOA</th>
<th>Design rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>S1</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>Does not meet standards</td>
</tr>
<tr>
<td>S2</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Meets w/o reservations</td>
</tr>
<tr>
<td>S3</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Meets w/ reservations</td>
</tr>
<tr>
<td>S4</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Meets w/ reservations</td>
</tr>
<tr>
<td>S5</td>
<td>Yes</td>
<td>Yes</td>
<td>No*</td>
<td>No</td>
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</tr>
<tr>
<td>S6</td>
<td>Yes</td>
<td>Yes</td>
<td>No*</td>
<td>No</td>
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</tr>
<tr>
<td>S7</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
<td>Meets w/ reservations</td>
</tr>
<tr>
<td>S8</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>NP</td>
<td>Does not meet standards</td>
</tr>
<tr>
<td>S9</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>NP</td>
<td>Does not meet standards</td>
</tr>
<tr>
<td>S10</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Meets w/ reservations</td>
</tr>
</tbody>
</table>

Table 4: Results of What Works Clearinghouse Application

*Graphs were not included in published article.
Discussion

The ability to read and write is critical to academic success. However, literacy is a major challenge for most DHH children, and research on interventions is relatively limited. Findings from this review suggest that over a period of 12 years, a total of 10 literacy single-subject design studies have been conducted with students who are DHH from prekindergarten to high school.

Studies included in this review were evaluated for methodological rigor using WWC standards for single-subject design (Kratochwill et al., 2010). The evaluative steps outlined by WWC allow consumers to judge the meaningfulness of results, and ultimately, the level of evidence provided for endorsing use of the intervention in practice. Studies that meet standards without reservations must report IOA for at least 20% of sessions with at least a mean of 80%. High levels of IOA increase the internal validity of single-subject studies. Success estimates are created by dividing the number of times an intervention was implemented (or withdrawn) by the number of times the change in condition meaningfully changed the behavior. Six studies in this review demonstrated strong effects (i.e., the number of effects were equal to the number of opportunities for an effect to occur) indicating valid results. The remainder of this article will provide information on the interventions with the strongest effects, limitations and directions for future research, and implications for practice.

Overall findings indicate that explicit instruction is integral to teaching literacy skills to students who are DHH. Common among the interventions implemented were systematic, direct, and outcome-oriented, all of which have been identified as elements of explicit instruction (Archer & Hughes, 2011). The visual tool used with high school
students effectively increased use of adjectives in writing responses to picture prompts. Intervention procedures involved systematic fading of modeling and guidance before students generated writing samples independently (Easterbrooks & Stoner, 2006).

Wolbers et al. (2015) also used an intervention that incorporated explicit instruction with third through fifth graders to improve writing and language outcomes. Students were explicitly taught strategies for writing processes and collaborated with teachers to co-construct a written report. Explicit writing lessons improved all five students’ written expression across multiple genres (e.g., recount/personal narratives, information report, and persuasive reports) with the most robust findings with information reports and persuasive writing (i.e., most immediate change in behavior and highest percentage of nonoverlapping data).

Studies with elementary students that demonstrated strong effects were explicit morphographic instruction on morphographic analysis (Trussel & Easterbrooks, 2015) and scripted lessons using English-based signing while speaking on student English-based responses (i.e., spoken or signed) to picture prompts (Bennett et al., 2014). Both studies used modified versions of widely available programs (i.e., Spelling Through Morphographs and Language for Literacy, respectively). In each study, the participants (e.g., fourth and fifth graders with varying levels of auditory access and a presence of additional disability) responded positively to scripted lessons delivered by the experimenter (interventionist) who used simultaneous communication. Lessons were explicit, systematic, fast-paced, and highly interactive.

Two of the studies that were conducted with preschoolers and had strong effects were related to ongoing research connected to developing an early literacy curriculum
designed for preschoolers who are DHH with functional hearing (Lederberg, Miller, Easterbrooks, & Connor, 2014). *Foundations for Literacy* was developed as a systematic and explicit emergent curriculum that is code-based (phonological awareness and alphabetic knowledge) and meaning-based (vocabulary), both of which are areas of difficulty for students who are DHH (Lederberg, Schick, & Spencer, 2013). The curriculum was designed for students who are DHH with functional hearing because of the prevalence of these students in schools (Lederberg et al., 2014). However, Beal-Alverez et al. (2012) provides some evidence that children without functional hearing may benefit from similar strategies for teaching grapheme-phoneme correspondence.

Using *Foundations* along with Visual Phonics Beal-Alverez et al. (2012) targeted phoneme-grapheme correspondence in preschoolers with varying levels of speech perception who relied either solely on sign language or a combination of sign and speech. Students in this study were able to produce the correct phoneme for a presented grapheme in one to two sessions.

Miller et al. (2013) also used *Foundations for Literacy*, embedding explicit instruction (i.e., modeling, rehearsal, and feedback), to teach preschoolers to segment syllable, isolate initial phonemes, and to recognize rhymes. This study also included students with varying levels of speech perception. One group was in a listening and spoken language program, and the other in program that used sign language. All participants, regardless of ability to perceive speech, were able to attain important skills associated with phonological awareness by the end of the study. Although one participant without functional hearing had some difficulty segmenting syllables, likely due to his difficulty in producing multisyllabic words.
**Limitations and Directions for Future Research**

Several limitations of this review should be noted. First and foremost, there are relatively few studies investigating the effects of literacy interventions for students who are DHH, restricting the generalization of these findings. A limited range of literacy skills was targeted across the 10 studies with few targeting reading comprehension or writing skills. Further research is needed to substantiate findings from this review and to evaluate interventions on these underrepresented literacy skills. In addition, most studies involved students who are DHH in pre-kindergarten to sixth grades with only one study focusing on students who are DHH at the high school level. Second, every effort was made to identify all pertinent studies, but it is possible that studies meeting inclusion criteria were inadvertently overlooked. The author also excluded dissertations and theses targeting literacy interventions for students who are DHH. Future studies may use a different search string, or use combinations of search terms instead of Boolean terms.

A third limitation relates to participant descriptions. Only two out of the 11 studies described racial backgrounds of participants. The overall homogeneity of participants (i.e., White) represents a discrepancy between racial backgrounds of study participants and the reality of students who are DHH from diverse racial backgrounds in classrooms. A slight majority of the studies reported language used in the home. Most students lived in homes where English was the primary language; second most represented was ASL/sign-system. With an increase in students from diverse language backgrounds, it may be beneficial to deliberately recruit students from diverse ethnic and language backgrounds for intervention studies. Also, most studies reported degree of hearing loss for participants, yet this characteristic was not reported in a standard fashion.
Some studies explicitly stated hearing levels as aided or unaided; others did not, leaving the reader to assume one way or another. The author recommends standardization of how participant characteristics are reported. Collecting student information related to type of deafness, degree of hearing loss, and whether or not the degree reported is aided or unaided would be useful in determining effectiveness of interventions across students who are DHH with different profiles.

Implications for Practice

The majority of studies included in this review involve students who are DHH in prekindergarten, kindergarten, and the elementary grades (i.e., first through sixth). The reason for the focus on students in lower grades may reflect a stronger sense of urgency in establishing evidence-based literacy practices for younger students. There is certainly a need for continued research efforts at the preschool and elementary grades to determine which programs or interventions are effective, as well as to substantiate findings from previous studies. Yet there is a critical gap in the literature with older students who are DHH. Easterbrooks and Stoner (2006) conducted the only intervention study published in the last 11 years focusing on high school students. There were no studies meeting inclusion criteria for this review that focused on students in seventh and eighth grades. This continues to create a conundrum for educators teaching in the middle school and high school grades in selecting interventions supported by research.

All studies in this review were conducted in DHH classrooms. One reason for this may be due to the challenge in locating the single students who are DHH mainstreamed in general education classrooms. Oftentimes state departments of education report numbers of students with low-incidence disabilities within school districts if there are
more than a certain number of those students creating a barrier to identifying, locating, and recruiting individual students who are DHH placed in pubic schools. State schools for the deaf or school districts with DHH programs provide researchers with groups of students who are DHH (and teachers) to recruit for research studies. The majority of students who are DHH are placed in general education classrooms. This incongruence in intervention settings (i.e., schools for the deaf) and student placement in self-contained DHH classrooms points to a gap in the research. A 2008 study (Reed, Antia, & Kreimeyer) revealed that approximately 85% of students who are DHH are placed in public school programs with 45% of their time spent in general education classrooms. These statistics suggest that educators teaching students who are DHH in general education settings should use caution when interpreting outcomes in terms of generalization to general education settings. However, common instructional strategies found effective with hearing children were also found in the interventions reviewed in this paper. When teaching various literacy skills, it would behoove educators to employ strategies such as explicit instruction, repeated readings, visual organizers, and modeling.
Chapter 3: Research Paper

This chapter functions as a stand-alone research paper. It includes a brief literature review, description of method, results, discussion of findings, directions for future research, and implications for practice.

Abstract

This study examined the effects of a reading racetrack game on acquisition, maintenance, and generalization of sight words for four kindergarten students who are deaf. The game consisted of placing sight words around a racetrack board and prompting the participant to read the words. A multiple probe design across picture sets demonstrated that playing the reading racetrack game was functionally related to acquisition of vocabulary to 100% mastery on at least three consecutive sessions for each participant. Three out of four participants maintained most of the sight words acquired for two or four weeks after intervention and generalized reading the words to another presentation format.
Effects of Reading Racetrack Instruction on Reading Fluency of Elementary Students Who Are Deaf

The majority of students who are deaf or hard of hearing (DHH) in the United States graduate high school reading far below grade level. Early identification of hearing loss, early intervention services, and technological advances (e.g., cochlear implants) have improved reading outcomes, but there is still a long way to go toward all students who are DHH becoming fully literate (Moeller, 2000; Strong, Clark, & Walden, 1994; Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). Despite decades of research on language and literacy approaches with students who are DHH, Traxler (2000) reports only ten percent of students who are DHH achieve age-appropriate literacy levels.

The field of deaf education continues to be replete with controversy over how children who are DHH should be taught (i.e., listening/spoken language only, Total Communication, American Sign Language/English) and where they should be taught (i.e., regular classrooms, separate classrooms, special schools for the deaf). And while the controversy carries on, teachers of students who are DHH struggle to meet the needs of this diverse population. Educators and specialists are faced with students from diverse backgrounds and language experiences, use of technology (e.g., cochlear implants, hearing aids), and quality of early intervention services. Teachers of the deaf, other intervention specialists, and general education teachers need effective strategies for reading instruction.

The dearth of research studies on reading interventions for students who are DHH is exemplified by relatively recent literature reviews. A meta-analysis of all literacy research conducted with students who are DHH ages 3 to 21 years between 1963 and
2003 identified 22 peer-reviewed articles (Luckner, Sebald, Cooney, Young, & Muir, 2005/2006). Another review of the literature focusing only on reading comprehension with students ages 3 to 21 years published between 1963 and 2005 included 52 studies, 27 of which examined an intervention, the rest descriptive studies (Luckner & Handley, 2008). A third literature review on reading fluency studies with the same population identified six studies (Luckner & Urbach, 2012).

Aside from the obvious need for reading intervention studies with students who are DHH, these three literature reviews reveal other overall findings. First, not only is the field in need of intervention studies, but those that are methodologically sound. For example, of the six reading fluency studies in Luckner and Urbach (2008), four were intervention studies, none of which met standards established U.S. Department of Education, Institute of Educational Sciences, National Center for Education Evaluation and Regional assistance (2003) or “possible evidence” by What Works Clearinghouse (Valentine & Cooper, 2003). One important finding was the general lack of specific demographic information collected for study participants. Given the great diversity of this population, particularly related to length of enrollment in early intervention services, language and communication, and amplification use, this information is critical to contextualizing intervention outcomes. Another finding is the growing consensus around using explicit instruction (i.e., direct explanation, modeling, guided practice, and independent application) to teach various reading skills (e.g., strategies for checking comprehension).

One way of addressing the limited amount of intervention research with students who are DHH is to look at the available literature on hearing students to identify
interventions that may be adapted for students who are DHH. Given the findings of previous literature on students who are DHH, an effective literacy intervention might include elements of explicit instruction, a visual component, and a format that is engaging and motivating. Once such intervention that has been researched with hearing children both with and without disabilities is reading racetracks (Alexander, McLaughlin, and Derby 2008; Anthony, Rinaldi, Hern & McLaughlin, 1997; Crowley, McLaughlin, & Kahn, 2012; Falk, Band, & McLaughlin, 2003; Rinaldi & McLaughlin, 1996).

Studies on using reading racetracks targeting sight word fluency have been conducted mostly with students with and without disabilities in the elementary grades (e.g., Anthony, Rinaldi, Hern & McLaughlin, 1997; Crowley, McLaughlin, & Kahn, 2012; Falk, Band, & McLaughlin, 2003; Rinaldi & McLaughlin, 1996). Several studies have extended original reading racetrack research conducted in the 1990’s, including Falk et al. (2003) who combined flashcard instruction with playing the reading racetrack game with third graders. This study demonstrated increased Dolch sight word fluency and decreased errors for all three participants. Alexander, McLaughlin, and Derby (2008) extended reading racetrack research findings to four 8 and 9-year-olds with intellectual disability, health impairments, autism, and severe learning disabilities. All four students increased correct sight word identification, decreased errors, and increased fluency. However, most participants did not demonstrate generalization to new words.

Crowley et al. (2013) extended the reading racetracks research to a different population, two elementary students with autism one of whom used augmentative and alternative communication (ACC) device. Using a multiple baseline across word sets design, this study demonstrated that reading racetracks combined with flash cards
improved sight word identification for both participants. Both participants increased words learned from 0 at baseline to 100% during intervention for each of the six word sets. Maintenance data were limited to one word set for one participant and generalization data were not reported.

The current study seeks to extend previous racetrack research by employing the reading racetrack intervention with elementary students who are DHH. An additional extension of previous research is the inclusion of maintenance and generalization measures for all participants. This study has been designed to answer the following research questions:

1. What are the effects of the reading racetrack game on sight word acquisition for elementary students who are deaf or hard of hearing?
2. What are the effects of the reading racetrack game on maintenance of new sight words?
3. What are the effects of the reading racetrack game on generalization of new sight words?
4. What are the opinions of students and teachers about the intervention?

**Method**

**Participants**

Participants were recruited from a kindergarten class at a state school for the deaf. Although the school uses a dual language approach (ASL and English), students were eligible to participate regardless of preferred language, communication mode, or amplification use. Consent forms were sent to all families of children in the kindergarten class, four of which were signed and returned.
Amaya, a day student at the school, was a 5-year 7-month old white girl with a profound rising to severe hearing loss who did not use amplification. Jaden, a day student, was a 6-year 8-month old white boy with a severe to profound hearing loss who used no amplification. He was the only participant with an additional diagnosis. Diagnosed as legally blind, his visual acuity without corrective lenses was 20/250. Although he had glasses, he wore them during only a few sessions. The glasses were broken throughout the majority of the study. Print materials were modified to a 40-point font for Jaden. Samira, a residential student, was a 6-year 4-month old white female with a moderately-severe to severe hearing loss. She had bilateral hearing aids, however her teacher reported that she rarely used them. She did not wear hearing aids at any point during the present study. Joy was a 6-year 3-month old white girl with a severe to profound hearing loss. She wore a cochlear implant in her right ear. Joy was a residential student at the school. See Table 3 for participant demographic information.
<table>
<thead>
<tr>
<th>Participants</th>
<th>Amaya</th>
<th>Jaden</th>
<th>Samira</th>
<th>Joy</th>
</tr>
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<tbody>
<tr>
<td>Age (years-months)</td>
<td>5-7</td>
<td>6-8</td>
<td>6-4</td>
<td>6-3</td>
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<td>Gender</td>
<td>F</td>
<td>M</td>
<td>F</td>
<td>F</td>
</tr>
<tr>
<td>Hearing level</td>
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<td>Severe to profound</td>
<td>Moderately-severe to severe</td>
<td>Severe to profound</td>
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<tr>
<td>Amplification (left/right)</td>
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<td>None</td>
<td>HA/HA (rarely uses)</td>
<td>-/CI</td>
</tr>
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<td>Additional diagnosis</td>
<td>None</td>
<td>Legally blind*</td>
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<td>None</td>
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<td>D/D</td>
<td>H/H</td>
</tr>
<tr>
<td>Related services</td>
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<td>O&amp;M 400 minutes/year; OT 90 minutes/month</td>
<td>SLP 120 minutes per month</td>
<td>SLP 80 minutes monthly; auditory training 20 minutes twice weekly</td>
</tr>
</tbody>
</table>

Table 5. Individual student profiles

Note. HA = hearing aid; CI = cochlear implant; D = Deaf; H = hearing; O&M = orientation and mobility; OT = occupational therapy; SLP = speech language pathology

Setting

The intervention took place at a state school for the deaf serving students who are DHH preschool through 12th grade. The school uses a dual language approach focusing on the development of American Sign Language (ASL) and English, through print and/or spoken language.

All baseline and experimental sessions were conducted in a one-on-one format in a corner of the kindergarten classroom where students who were not participating in the study engaged in small group or individuals activities.
The researcher, who served as the interventionist, was a doctoral student in special education program. She was a trained teacher of the deaf with over 10 years experience working with young children who are deaf and hard of hearing.

**Definition and Measurement of Dependent Variable**

The dependent variable was the number of sight words read correctly. To determine the number of sight words read correctly, the experimenter showed the student flashcards one at a time and waited three seconds for the child to read the word. All four participants signed their responses. A response was counted as correct if the participant independently read the word, or self-corrected, within 3 seconds. A response was scored as incorrect if the child did not respond within 3 seconds, responded with another word, or said, “I don’t know.” Word sets included 10 words for Amaya, Jaden, and Samira. Joy’s word sets initially included 10 words; however, due to lack of progress, the number of words was reduced to 3 in each word set. For Amaya, Jaden, and Samira, mastery criterion were reading all 10 words correctly, and all three words correctly for Joy.

**Experimental Design and Procedures**

This study used a multiple probe design across word sets. The experimental conditions were baseline, intervention, maintenance, and generalization. Prior to the beginning of baseline data collection, pre-assessment was conducted to determine unknown sight words. For a participant to move to the next word set, he or she had to participate in at least four sessions, correctly read at least eight words in the second to last session, and all ten words in the final session.
**Pre-assessment.** In order to provide assurance of words known and unknown by each participant, two pre-assessment probes were conducted. In these sessions, the experimenter presented each participant with 40 flashcards with sight words on them to determine words to be used in this study. The purpose of this pre-assessment was to create a bank of sight words for each student. Sight words were from the Journeys, an English Language Arts program for students K-6. The kindergarten list for Journeys has 88 words, divided into six lists. Lists 5 and 6 were used for this study. Words that are typically fingerspelled in ASL (i.e., by) were removed. For words from the Dolch lists that have multiple signs, the researcher and teacher decided which sign would be used for the purposes of this experiment. The experimenter recorded sight words read correctly and incorrectly. The sight words were divided into two stacks, one for words read correctly, one for words read incorrectly. This procedure was done during each of the two pre-assessment sessions. The words read incorrectly were used in the study.

**Baseline.** During baseline sessions, the experimenter administered sight word identification probes using a set of 10 sight words for Amaya, Jaden, and Samira, and three sight words for Joy. All words were derived from the pre-assessment. The experimenter provided the following instructions to the participants (using ASL), “I will show you some flashcards and you tell me the word. If you don’t know the word, you can say, ‘I don’t know.’ If you can read the word, great!” The experimenter showed the first word to the participant and nodded (“go”). If the participant was not ready, the experimenter signed, “Ready?” and nodded a second time. As each card was shown, the experimenter placed the flash cards read correctly in one stack, and cards read incorrectly
in a second stack. Sight words read correctly and incorrectly were recorded on a data sheet (see Appendix A).

A secondary baseline probe was conducted using the same sight words used in the primary baseline probe. These words were presented in a paragraph (sight words were highlighted) in order to evaluate a generalization measure for each participant. The researcher read the paragraph to the students and stopped at the target words. Students were prompted to read the highlighted word. At the conclusion of each baseline probe, the experimenter thanked the participant and gave him or her a high five.

Typical sight word instruction by the classroom teacher during baseline conditions included introducing new words by spelling the word, teaching the sign for the word, and using it in context. Large group, small group, and individual activities were conducted throughout the week, all of which reinforced the target words. Examples of activities were read-alouds with the target words highlighted in the book, as well as repeated readings where the students had to find the words in the text (i.e., words are not highlighted). Other activities included a memory game and worksheets where students read the target word, traced it, wrote it, colored it, and then cut and glued the letters in the correct order.

**Reading racetrack instruction.** Intervention materials included a reading racetrack game template with 30 blank cells, three sets of 10 sight word flashcards, and a timer. Each participant played the game using individualized sets of sight words. On the game board for Amaya, Jaden, and Samira, each of the 10 words was presented randomly three times (e.g., 30 words total). For Joy, each of the three target words was presented 10 times. One-on-one intervention sessions lasted approximately 10 minutes.
The following procedures were implemented for Amaya, Jaden, and Samira. The experimenter placed the intervention racetrack on the table in front of the participant with the ten words from one set presented three different times in random order on the racetrack (e.g., 30 pictures total). The intervention began with the experimenter modeling pointing to the first 10 words on the racetrack, modeling reading the word aloud, and having the participant practice reading the word. The experimenter then directed the student to point to the first 10 words and read them as best she can. If the student read a word correctly, the experimenter will provide praise (i.e., “good reading”).

If the student paused for longer than 3 seconds, misread the word, or mispronounced the word, an error correction procedure was carried out. The error correction procedure began with the researcher pointing to the word and saying, “I’ll read the word to you first” and then reading the word aloud. Next, the experimenter said, “Let’s read the word together.” Then the experimenter pointed to the word and directed the student to read the word aloud three times. Once the student read through each of the first 10 words, the experimenter said, “Now we are going to play the game again and I want you to read the words as quickly as you can. If you do not know a word, you can say “I don’t know” and I will tell you the word. The rest of the words on the track are the same ones we just read. Ready, go!” The experimenter set the timer for one minute; when the timer went off, the experimenter told the student to stop reading. The experimenter provided the student with performance feedback by sharing how many words he/she read correctly and how many he/she read the previous time playing the game. The experimenter gave the student praise and thanked him/her for playing.
After completing several sessions with Joy using 10 words per set, it became apparent that she would need some modifications to the intervention. She was not acquiring the words at a rate comparable to the other three participants, and she appeared less engaged. The researcher decided to reduce the number of words to teach, increase the number of practice opportunities, and include a visual motivational component. As such, the researcher modified the intervention as follows for her. The experimenter placed the intervention racetrack on the table in front of her with the three words from one set presented 10 different times in random order on the racetrack (e.g., 30 pictures total). In addition, the experimenter placed a “pond,” made from blue paper, and 30 “rocks,” large clear beads, on the table. With all of the “rocks” in the “pond,” the intervention began with the experimenter modeling pointing to the first three words on the racetrack, modeling the word aloud, and having the participant practice reading the word. After the participant read each word, she was instructed to move one “rock” onto the word on the game board. The experimenter then directed the student to point to the first word and read it, moving the “rock” to the side of the word. Then she was prompted to read the second word, move the “rock” to the side, and then go back and reread the first word, moving the rock back onto the word. This process continued for the third word. If the student read a word correctly, the experimenter will provide praise (i.e., “good reading”). If the student paused for longer than 3 seconds, misread the word, or mispronounced the word, an error correction procedure was carried out. The error correction procedure began with the experimenter pointing to the word and saying, “I’ll read the word to you first” and then reading the word aloud. Next, the experimenter said, “let’s read the word together.” Then the experimenter pointed to the word and directed the student to read the word aloud
three times. Once the student read through each of the first three words, the experimenter said, “Now we are going to play the game again and I want you to read the words as quickly as you can. If you do not know a word, you can say “I don’t know” and I will tell you the word. The rest of the words on the track are the same ones we just read. Ready, go!” The experimenter set the timer for one minute; when the timer went off, the experimenter told the student to stop reading. The experimenter provided the student with performance feedback by sharing how many words she read correctly and how many she read the previous time playing the game. The experimenter gave the student praise and thanked her for playing.

The experimenter conducted a post-intervention probe for the set of sight words used in that intervention session immediately following the racetrack game with each participant. The experimenter showed the student flashcards one at a time, giving the student 3 seconds to respond. The experimenter recorded correct and incorrect words read on a data collection sheet (see Appendix B). Praise was provided after the probe and the experimenter gave the student a high five.

**Maintenance.** The experimenter began administering maintenance probes two weeks after the end of each intervention phase. If time permitted, an additional maintenance probe was administered 4 weeks after the first maintenance probe. Maintenance probes consisted of the same three sets of sight words that were directly taught and assessed during the reading racetrack intervention, and were administered using the same procedures used in baseline and intervention.

**Generalization.** Generalization probes were administered during the maintenance phase. The generalization probes consisted of each set of sight words used intervention
phase, but presented (and highlighted) in a paragraph. The generalization probe was administered using the same procedures used in baseline.

**Interobserver Agreement**

For the dependent variables, all baseline, intervention, maintenance, and generalization sessions were video recorded. A graduate student assessed Interobserver agreement (IOA) on 33% of the baseline, intervention, maintenance, and generalization sessions. The student was a former teacher of the deaf and fluent signer. Prior to data collection, the experimenter provided the graduate student with training via videoconference. Training consisted of the experimenter providing her with a written description of the dependent and independent variables and allowing her time to read it, following by a verbal description. The experimenter and graduate student discussed the sign for each sight word, as well as what constitutes a correct/incorrectly verbal response (e.g., related to possible articulation errors).

The graduate student collected IOA data by viewing video of sessions and recording each response as correct or incorrect. The observer independently scored each word expressed as correct or incorrect by comparing the participants’ signs to an answer key. The experimenter compared agreements and disagreements on an item-by-item basis. IOA was calculated by dividing the number of agreements by the total number of agreements plus disagreements and multiplying by 100. Mean IOA across conditions was 100%.

**Procedural Integrity**

Procedural integrity was assessed on 33% of all sessions. The same observer was provided with a checklist (see Appendix C) to score the experimenter’s procedural steps
as either observed or not observed. Procedural integrity was calculated by dividing the number of observed steps by the total number of steps and multiplying by 100%. Mean procedural integrity was 92.6 (range: 78–100%).

Social Validity

To assess social validity, the participants and their teacher completed a questionnaire (see Appendix D). For the participants, the experimenter read two statements aloud to the students, “I like playing the reading racetrack game” and “I want to play the game again sometime.” Students responded by marking a smiley face, indicating they agree with the statement, a neutral face, or a sad face, indicating that they disagree with the statement.

For the teacher, social validity was assessed by asking her to respond via email to the following statements using a 5-point scale: (a) How effective do you feel the intervention was in increasing vocabulary, (b) How pleased are you with your students’ progress in acquiring vocabulary, (c) This intervention is relatively simple to implement in my classroom, (d) This intervention could easily be constructed without consuming many resources. The questionnaire will also include the following questions, “Would you use this intervention to increase vocabulary in other students? Why or why not? (See Appendix E for questionnaire.)

Results

Response to Reading Racetracks

Figures 1 through 4 shows baseline, intervention, maintenance, and generalization data for Amaya, Jaden, Samira, and Joy respectively. Data for Amaya, Jaden, and Samira
demonstrate the reading racetrack was functionally related to their increase in words reads correctly. A complete experimental study could not be conducted for Joy.

**Amaya.** Figure 1 shows that baseline responding was somewhat variable across word sets. She did not read any of words correctly in set one, but read a mean of 2.3 (range of 0–4) correctly in set two, and a mean of 1.2 (range of 0–2) correctly in set three. After intervention, her data demonstrate an immediate and high level of responding. Correct responding in set one was somewhat variable (e.g., \( M = 6.2 \)), whereas it was less variable for set two (e.g., \( M = 9 \)) and set three (e.g., \( M = 8.7 \)). For each set, she achieved 100% accuracy within 2 to 5 sessions.

Maintenance probes were collected 2 weeks and 4 weeks post-intervention for each word set. Data for Amaya indicate she maintained the majority of words in each set. She maintained a mean of 7.0 of the words in the first set, a mean of 9.5 words in the second set, and a mean of 9.0 words in the third set. Amaya’s data indicate she maintained all 10 words in each word set. Generalization data were collected during baseline for the second and third word sets and again 2 weeks post-intervention. The number of words she was able to generalize in word sets two and three increased from zero to 100% for both word sets.
Figure 1. Amaya's reading racetrack graphs
Jaden. Figure 2 indicates somewhat variable responding in baseline. In set one, he read a mean of 0.6 (range of 0–2) correctly, a mean of 1.3 (range of 0–4) correctly in set two, and a mean of 0.6 (range of 0–1) in set three. After intervention, his data show immediate positive responding to the intervention. He read a mean of 9 words correctly (range of 6–0) in set one, a mean of 9 words (range of 7–10) in word set two, and a mean of 7.6 words (range of 4–0) in word set three.

Maintenance data were collected two weeks and four weeks post-intervention for each word set. At two weeks post-intervention he had maintained 8 words in word set one. When probed four weeks post-intervention, he read 3 words correctly. When probed the next session (i.e., the next day) he read 7 correctly. In word set two, he maintained a mean of 7.5 words, and a mean of 6.5 in word set three. Generalization data were collected one week post-intervention for each word set. Jaden generalized a mean of 7.6 words in word set three.
Figure 2. Jaden's reading racetrack graphs
**Samira.** Figure 3 indicates low and stable responding in word set one ($M = 0.8$; range: 0–1). Responding in baseline for word sets two and three was low and stable, with a mean of 0.8 words read correctly and 0 read correctly, respectively, across sessions 1 through 5. However, baseline probes conducted immediately (e.g., sessions 14–17) before starting word set two indicated a substantially higher level of responding ($M = 6$ for both word sets). Daily baseline probes were conducted to evaluate level of responding across multiple sessions. Samira demonstrated steady state responding over three consecutive sessions before intervention for word set two was implemented. The baseline probe prior to entering word set three intervention indicated she had maintained those 6 words read correctly prior to starting word set two. Intervention data for word sets two and three indicate an immediate and robust response to the game. She met mastery criteria of 10 words read correctly in the first session for each word set and continued at that level for two subsequent sessions. It should be noted that Samira’s attendance improved significantly during word set two and three intervention as compared to during word set one.

One maintenance probe was conducted two weeks post-intervention for the first and second word sets. Four-week probes were not conducted for any of the word sets and two-week probe was not conducted for word set three and due to time constraints. Samira maintained 8 words in word set one and 10 in word set two. Generalization data were collected one week post-intervention for word sets one and two. The number of words she could generalize increased from zero to 10 words in word sets one and two. Maintenance data were not collected for word set three due to time constraints, however
one generalization probe was administered immediately after the last session in word set three. Samira generalized all 10 words.

Figure 3. Samira's reading racetrack graphs

Joy. Figure 4 indicates low and stable responding in word sets one and two with 0 words read correctly. After intervention, her data show an immediate and marked increase. She read 100% of the words in word sets one and two. Word set three was not conducted due to time constraints.
One maintenance probe and one generalization probe were conducted for the first word set one week post-intervention. Joy failed to maintain or generalize any words in word set one.
Figure 4. Joy's reading racetrack graphs
Social Validity

Student Social Validity Reports

When the experimenter presented each participant with the statement, “I like playing the racetrack game” with a picture of a smiley face, neutral face, and frowny face, all participants circled the smiley face. Additionally, all participants indicated that they would like to play the game again sometime by circling the smiley face.

Anecdotally, Amaya appeared to enjoy the timing component and liked to go as fast as she could reading around the racetrack. She greeted the researcher most sessions by asking, “Is it my turn to play the game?” Counting how many words Jaden read correctly after playing the game appeared highly motivating. He liked to count the words himself (signed “count myself”) and frowned and crossed his arms when he did not read all 10 words correctly. He often asked if he could try again. Joy also appeared motivated to play the game and often asked “Is it my turn?” when the researcher arrived in the classroom.

The change in level of motivation was particularly interesting. Once the “pond” and “rocks” were introduced with Joy, she became much more motivated to play the game. When she struggled with 10-word sets, she resisted playing and would say she didn’t like the game. She said that the “pond” and “rocks” were her favorite part and enjoyed setting up those materials. She also responded positively when fewer words were targeted. She was able to read all three words correctly the first intervention session and insisted on telling her teacher. Before one session, she got her teacher’s attention and said, “Watch! I want to show you.” Afterwards, she told her teacher, “I got them all right!” After another session, she went over to her teacher and said, “I didn’t get any
right.” Her teacher responded, “Really?” Joy smiled and said, “Just kidding, I fooled you!”

Teacher Social Validity Report

The participants’ classroom teacher strongly agreed that the reading racetrack was an effective intervention for her students, and was very pleased with their progress in acquiring new sight words. She strongly agreed that the intervention would be relatively simple to implement in her classroom, and that it could be easily constructed without consuming many resources. She is interested in implementing the intervention with her students because, “The result indicate that it is effective.” She also stated, “While differentiation is always needed (i.e. the number of words given), students benefit from the repeated practice and 1:1 attention this strategy provides.”

Discussion

The purpose of the present study was to examine the effects of a reading racetrack on the acquisition, maintenance, and generalization of sight words for four kindergarten students attending a state school for the deaf. All participants increased the number of sight words they could read after the intervention was implemented. The results demonstrate a functional relation between the reading racetrack and the acquisition of sight words for Participants Amaya, Jaden, and Samira. A full experiment could not be completed with Joy due to implementing a new experiment close to the end of the school year using fewer words in each word set. There were not enough days left to complete a full experiment.

Amaya, Jaden, and Samira all had the same mastery criteria in which they needed to read 10 words correctly. Amaya reached mastery criteria in a mean of 3.3 sessions
(range of 2–5 sessions), Jaden in a mean of 3 sessions (range of 24 sessions), and Samira in a mean of 2.6 sessions (range of 1–6 sessions). Samira required substantially more sessions (i.e., 6) to reach mastery for word set one. During this time period she had numerous absences. During intervention for the first word set, she was absent an average of 2 to 3 days per week. Her attendance improved towards the end of the semester. The immediacy of her responses to the intervention increased during word sets two and three, which aligned with when her attendance improved. Samira reached mastery criteria of reading 3 words correctly in the first session for each word set. Results from this study are commensurate with those of previous reading racetrack studies (Crowley et al., 2013; Rowley et al., 1997) in which students shows marked improvements in number of words read correctly after one to two intervention sessions.

For Joy, a combination of extensive absences and initially starting the intervention with too many words contributed to an extensive number of sessions in word set one intervention. She averaged 2 to 3 days absent per week throughout the semester in which this study was conducted. After four consecutive sessions of reading three words correctly, supplemental instruction was introduced. Three subsequent consecutive sessions of reading three or four words correctly, then a second type of instructional instruction was implemented. She read three, four, and seven words correctly in the final three sessions. At that point, the experimenter reassessed the situation and discussed Joy’s lack of progress. At that point, the experimenter started the process over by conducting a pre-assessment, sight words, implemented baseline, and word set one intervention.
The majority of previous reading racetrack studies have not collected maintenance data. Rinaldi et al. (1997) conducted one posttest on the “final day of the experiment” (p. 225); however, it is unclear how many days after the last intervention session the posttest occurred. In light of this, with the exception of Joy, maintenance outcomes were similar to the results in Rinaldi et al. (1997) in which participants maintained most words post-intervention. The current study extended those studies by collecting maintenance data one or two week post-intervention for all participants. Amaya maintained a mean of 8.6 words at two weeks, and a mean of 9 words at four weeks. Jaden maintained a mean of 7.3 words at two weeks, and 7 at four weeks (discounting the initial data point for four weeks, which the researchers considered a “blip”). Samira maintained a mean of 9 words across word sets two and three.

Joy was the outlier among the group of participants in regards to maintenance performance. It is important to note that out of the four participants in the present study, Joy had the least foundation in terms of language. Compared to the other participants, she had a more limited vocabulary (e.g., ASL and English) at the time of the study. This likely impacted the slow acquisition of target words during the initial experiment and the lack of retention of words acquired in the first word set in the present study. She did not maintain any of the three words in word set one when probed one week post-intervention. Although concerning, this is consistent with anecdotal information shared by the teacher. According to teacher, if the class is working on a specific grammar concept for instance, she needs more repetitions to learn it initially. Once Joy picks up the concept, she maintains it as long as they are working on that skill. If it is not a skill that “builds” on a previous skill and is not revisited for a while, she often needs a good bit of review to
remember. Much like with sight words, the teacher reports it takes her longer to learn them (e.g., she might only master 2–3 of the 6 during the week). Once Joy learns those words, she maintains them as long as they continue to appear in our reading frequently (for example, she remembers words like: the, a, I, like—which were learned in the beginning of the year), but will forget words she learned for the weekly unit if they are something that does not appear as often to be reinforced. The teacher provided the following example: at the end of unit 4, she read 11 of the 24 words from that unit. She was able to recall 4 of those words when retested for two weeks later. The words she knew were: is, of, so, will—two frequently occurring words and two fingerspelled words).

It is important for students of all abilities to be able to generalize skills to different contexts. This study extended previous reading racetrack studies by collecting generalization data. Participants Amaya, Jaden, and Samira generalized the majority, if not all, words when presented and highlighted in a paragraph. Generalization data were not collected for Joy because of time constraints due to changes in procedures.

Social validity is critical in to bridging the research-to-practice gap. Teacher and student opinion are important in an intervention being accepted and ultimately, implemented. The social validity results in the current study further support the use of reading racetracks. Amaya, Jaden, and Samira displayed eagerness and excitement about playing the game. They consistently responded favorably to playing the game.

Joy initially enjoyed the game, but over time, her struggle to acquire the words resulted in her displaying frustration. She would say that she did not want to play the game and resist joining the experimenter at the table. Her low level of correct responding
resulted in her being in intervention for word set one for an extended number of sessions (i.e., 10 sessions). Although two different types of supplemental instruction were implemented, she continued to read three to four words correctly. After reducing the number of words to three in a set, she correctly responded, which was motivating for her.

The social validity of this intervention was further supported by positive teacher opinion. The classroom teacher viewed the reading racetrack as an effective intervention for her students. She appreciated that it was adaptable, and commented on that aspect of the game, particularly in regards to Joy. This student’s rising frustration before changes were made prompted discussion between the teacher and experimenter and resulted in coming up with solutions that reduced frustration and increased the student’s success rate.

Findings from the present study support previous research on reading racetracks to teach sight words to elementary students (Chandler et al., 2012; Ehlers et al., 2012; Higgins et al., 2012) and extend the findings in the following ways. First, this study was conducted with students who are deaf, a different population than prior studies. Past studies implemented the intervention with students with autism (Chandler et al., 2012), learning disabilities (Falk et al., 2003), and students without disabilities (Anthony et al., 1997; Rinaldi & McLaughlin, 1996). Second, this study evaluated maintenance of newly acquired sight words at two weeks and four weeks post-intervention, which has not been done in previous studies. Finally, this study assessed participants’ ability generalize sight words to a different content, an outcome that not included in reading racetrack studies to date.

Limitations/Directions for Future Research
Study results demonstrate that reading racetracks were functionally related to an increase in sight words for four kindergarteners who are deaf. However, several limitations should be considered. First, the experimenter could not fully control for participants’ exposure to the sight words used for the intervention. Sight words were selected from lists intended to be taught at the end of the school year, yet some participants required an extended number of sessions resulting in the teacher “catching up” to the target words in the intervention. Due to rising baselines, it appears that participants were exposed to sight words incidentally. Waiting for baseline data to stabilize controlled for this issue. For example, Samira’s baseline data increased for word sets two and three. Subsequent baseline points were taken to control for the apparent exposure to many of the words in those word sets. Future studies may attempt to restrict exposure to sight words by starting sessions earlier in the school year, or selecting words from lists scheduled to be taught significantly later in the school year.

Second, there were limitations related to maintenance and generalization measures. Although Amaya and Jaden maintained the majority of words across word sets, long-term maintenance of newly acquired words cannot be determined. Two possibilities for future research are extending the maintenance period beyond two and four weeks, and conducting maintenance probes after summer recess. A functional relationship between the reading racetrack and generalization of sight words could be established for Jaden and Samira, but not for Amaya because baseline generalization data were not collected. Future studies should ensure baseline generalization probes are conducted for all participants.
Finally, there are two limitations related to social validity. First, the experimenter implemented all aspects of the current study, including data collection and analysis. The inclusion of IOA and procedural integrity measures mitigated that limitation; however, training the classroom teacher to implement the intervention would enhance the social validity of future studies. Training the classroom teacher to implement the intervention may improve the chances the teacher would continue using the intervention with her students. Second, the manner in which student and teacher opinions were collected possibly resulted in biased responses. Social contingencies (i.e., desire to please) can play a role in how individuals respond to questionnaires. Future studies may attempt to limit or remove this type of bias by providing the classroom teacher, as well as students, a choice between the target intervention and other interventions. Systematic observations of teacher and student behavior would provide more objective information about the social validity of this treatment.

**Implications for Practice**

Reading racetracks provide a convenient framework for incorporating elements of explicit instruction, including modeling, feedback, and rehearsal. Integral to implementing the game is the teacher modeling reading the words aloud, leading the student through error correction procedures (i.e., I do-we do-you do), and multiple exposures to each word. Research with hearing students demonstrates that effective reading instruction is systematic, direct, engaging, and outcome-oriented (Archer & Hughes, 2011). There is a growing body of studies with students who are DHH using single-subject design that evaluate the effectiveness of interventions targeting other literacy skills that incorporate these elements (e.g., Bennett, Gardner, Leighner, Clancy,

Bergeron et al. (2009) incorporated elements of explicit instruction into weekly lessons to teach preschoolers and early elementary students phoneme-grapheme correspondence. All students had some level of speech perception. Teachers introduced a set of phoneme-grapheme correspondences in a systematic manner, starting with those that are easier to produce for hearing children. By teaching this skill systematically and directly, participants successfully acquired the target phoneme-grapheme correspondences. More recently, Miller et al. (2013) effectively taught five preschoolers (three in an auditory/oral program, two in a sign language program) phonological awareness skill (i.e., syllable segmentation, initial phoneme isolation, and rhyming) using explicit instruction. First, they explicitly taught vocabulary related to phonological awareness (e.g., beginning, word, sound), then directly taught each phonological awareness skill. The students engaged in practice activities for each skill. Frequency and type of skill were determined based on participants’ performance.

The current study adds to the knowledge base related to literacy instruction for kindergarten students who are DHH by demonstrating that reading racetracks were effective in teaching novel sight words. As demonstrated in this study, reading racetracks can be customized based on student need. Teachers can differentiate the game while maintaining the evidence-based elements integral to the game. Students who are DHH are diverse in the language and communication modes they use. The racetrack game can be played using the language and mode of the students’ preference.
An additional strategy that may have been helpful for Joy, and possibly for other students who are DHH, is to provide distributed and cumulative practice. An element of explicit instruction, distributed and cumulative review allows students to practice newly acquired skills periodically along with known material (Archer & Hughes, 2011). For students like Joy, who struggle with retaining new information, including sight words, distributive practice periodically may be an effective method to address maintenance issues.

Teachers of students who are DHH often lament the lack of evidence-based practices, particularly related to literacy. This study lays the foundation for future replications that may develop into an evidence-based practice for teaching sight words for this group of students.
Chapter 4: Practitioner Paper

This chapter is a practitioner paper intended to translate and disseminate the results of Chapters 2 and 3 for educators and other professionals working with students who are deaf/hard of hearing.

Abstract

Teachers of students who are deaf and hard of hearing often lament the lack of evidence-based practices for their students, particularly in the areas of language and literacy. For hearing students, the evidence strongly supports explicit instruction. However, there is emerging evidence indicating that explicit instruction is also effective for students who are deaf and hard of hearing. In addition to providing information to support practitioners’ understanding of how deafness impacts language and literacy development, this paper will outline the primary elements of explicit instruction. Reading racetracks, a specific intervention that incorporates these elements, will be described. Finally, instructions and tips for using reading racetracks in the classroom will be shared.
Racing to Better Language and Literacy Outcomes for Preschool and Elementary Students Who Are Deaf and Hard of Hearing

Ruben taps Maria, an itinerant teacher of the deaf, on the shoulder excitedly to get her attention. He points to “how” on the classroom word wall and signs the word. She signs back, “Wow, that’s awesome!” Ruben is deaf and mainstreamed in a kindergarten classroom. The two are still getting to know each other since the school year just started. In addition to receiving educational interpreting services, Ruben receives direct services from Maria three times a week. Maria also provides consultative services to his IEP team.

Including Ruben, Maria works with five elementary students in a large suburban school district. Like the students of most teachers of the deaf, Maria’s represent a range of diversity. All have hearing parents, but some are from low-income families, others from families with more resources. One of her students is from a family who primarily speaks Spanish at home. Two of her students are profoundly deaf, use American Sign Language (ASL), and have interpreters. The other three students’ hearing levels range from mild to moderate, and they use either spoken language or a combination of spoken and sign language. All use cochlear implants or hearing aids. One of her students also has a mild intellectual disability. In addition to Maria’s students using different language and communication modes, they are also diverse in terms of their language abilities and literacy levels.

Maria is always on the lookout for effective literacy interventions for her students. Knowing that evidence-based practices are few and far between in the field of deaf education, Maria often looks outside the field for something that may work. While she
would like to use an intervention intended for students like hers, she is used to getting creative. Recently, she was looking on the Internet for ideas and came across an intervention she was unfamiliar with, reading racetracks. It looked like something that incorporated elements of explicit instruction, could be individualized, and might motivate her students.

Great strides have been made in improving language and literacy outcomes for students who are deaf and hard of hearing. Newborn hearing screening and early intervention, and advances in technology, have increased the potential for children who are deaf and hard of hearing (DHH) to develop age appropriate language and literacy skills (Lederberg, Spencer, & Schick, 2003). However, too many of these students continue to demonstrate delays in these critical areas. Trained teachers of the deaf, general education teachers, and cross-categorical special educators face the same conundrum when educating students who are deaf and hard of hearing, the lack of evidence-based practices for this population (Luckner, Sebald, Cooney, Young, & Muir, 2005/2006). While researchers are hard at work investigating language and literacy interventions for students who are DHH, practitioners can look to the emerging evidence for students who are DHH, as well as the evidence available in other areas of education.

This article describes reading racetracks, an intervention that is effective for students with disabilities (e.g., ADHD, autism), and how racetrack-style games can be used to address language and literacy skills for students who are DHH. It also includes information on how deafness impacts language and literacy development, the elements of explicit instruction, and how explicit instruction can guide teachers toward effective
practices. Finally, the author will provide tips for making racetrack games work in your classroom.

**How Deafness Impacts Language and Literacy Development**

Students who are DHH have the capacity to develop age appropriate language and literacy skills. Children who are born to deaf parents who use sign language are at an advantage; they are exposed to a fully formed and accessible language from birth (Lederberg, Schick, & Spencer, 2013). However, the vast majority of children who are DHH are born to hearing parents (Moeller, 2000). History has demonstrated this mismatch of hearing status creates numerous challenges for hearing parents. Deafness is a low-incidence occurrence; for many hearing parents their child is the first person who is DHH they have met. Hearing parents must learn ways to support their child’s language development, some of which may or may not be intuitive (e.g., getting the child’s attention before talking/signing) (Yoshinaga-Itano, 2003). High-quality family-centered early intervention services provide families with information on deafness, how to support their child’s communication and language development, and resources in order to do so successfully (Meinzen-Derr, Wiley, & Choo, 2011; Moeller, 2000; Yoshinaga-Itano, 2003). See *Why Early Intervention Matters*.

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**Why Early Intervention Matters**

When it comes to early hearing detection and intervention for children who are deaf and hard of hearing, early is better. Children of families enrolled in early intervention services have significantly better speech, language, and social-emotional outcomes (Meinzen-Derr, Wiley, & Choo, 2011; Yoshinaga-Itano, 2003). A diagnosis
soon after birth allows families to enroll in early intervention services and begin receiving support and resources about how to support their child’s development. Early intervention specialists provide families with information related to communication and language development, amplification, and work with other professionals (i.e., occupational therapists, physical therapists, etc.) as needed. Specialists also provide families with emotional support and counseling, in addition to connecting them with other families and individuals who are deaf and hard of hearing.

Most families with children who have been diagnosed with a hearing loss receive early intervention services. However, there are families who, for a variety of reasons, may start services much later or not at all. Families who move frequently or who are difficult to contact can be lost in the system. Unfortunately, the children of families who do not receive early intervention services often arrive at school with significant language delays (and possibly delays in other areas). For educators who work with children who are deaf and hard of hearing, it is important to find out whether or not they received early intervention services, and for what length of time. That information can provide relevant information related to students’ language and literacy abilities.

The challenges children with more severe hearing levels face may be more obvious than those for children with mild or moderate hearing levels or unilateral hearing loss. Without auditory access to speech, or access to fluent signers, children with severe to profound hearing levels struggle to develop language at the same rate as hearing children. Moreover, although this group of children presents a complex picture of language and literacy development, there is a greater understanding of this population
because the majority of research in deaf educations is being conducted with students with severe to profound hearing levels (Moeller, Tomblin, Yoshinaga-Itano, Connor, & Jerger, 2007). However, researchers are turning their attention to children with functional hearing, including those with mild to moderate hearing levels, unilateral hearing loss, and children with cochlear implants. Children in both groups, those with and without functional hearing, often struggle to develop age appropriate language skills impacting literacy development (Moeller et al., 2007).

For educators unfamiliar with this population of students, having a general understanding of how deafness impacts language and literacy outcomes can be helpful. However, it is important for teachers to remember is that students who are DHH are diverse. They are diverse in etiology, cultural and linguistic background, amplification, and the presence, or absence, of additional disabilities (Guardino & Cannon, 2016). This is in addition to the demographic attributes that exist or all students, including level of family involvement, cultural and linguistic background, and socio-economic status. This heterogeneity has impacted the development of evidence-based practices in deaf education. It is a challenge to conducting research with low-incidence populations that are also highly diverse. The good news is that the extant research provides some guidance for educators. The evidence that explicit instruction is effective with hearing students is clear, and overall, the same can be said for students who are DHH.

**Explicit Instruction**

Literacy instruction is effective when it is explicit and systematic (Archer & Hughes, 2011). This is true for the five major components of the reading process: phonemic awareness, phonics, fluency, vocabulary, and comprehension (NRP, 2000).
Directly teaching skills and strategies in these areas may be an obvious method, but over the years, direct instruction has received some criticism from the education community. Yet the research is clear; instruction that is systematic, engaging, direct, and outcome-oriented yields successful outcomes (Archer & Hughes, 2011). When planning instruction in any content area, particularly reading and writing, consider the following:

• **Systematic.** The key to systematic instruction is planning, and careful planning at that. Prior to instruction, teachers need a game plan. Effective and efficient learning requires logical sequencing of instruction. New knowledge and skills should build on prior knowledge and skills. Consider how lessons and activities are sequenced; students must acquire basic skills before learning more complex skills, or combining more than one basic skill (Archer & Hughes, 2011).

• **Engaging.** It is not uncommon for teachers to plan a great lesson that falls flat. It happens to most teachers! Engaging students is critical to the delivery of instruction. Active student responding is key. Active student responses are detectable and measurable responses to an instructional antecedent (Barbetta, Heron, & Heward, 1993). Research demonstrates that allowing students to engage regularly and frequently throughout lessons has a positive impact on learning (Sterling, Barbetta, Heward, & Heron, 1997; Utley, Reddy, Delquadri, & Greenwood, 2001).

• **Direct.** Effective instruction is direct. It is clear and unambiguous. Learning objectives are explicitly stated and shared with students, target behaviors are operationally defined, and data is used to guide instructional direction. The main
components of direct instruction are modeling, guided practice, corrective feedback, and cumulative review (Archer & Hughes, 2011).

- **Outcome-oriented.** Knowing where you are going is critical to know how you will get there. A hallmark of explicit instruction is that goals are explicit, and student progress towards meeting those goals is regularly monitored. Progress monitoring goes hand in hand with performance feedback. Be specific, constructive, and positive when giving feedback. Making mistakes is part of the learning process; just do not allow students to practice those mistakes! Correct mistakes before they become a pattern.

Students with and without disabilities who receive literacy instruction that is carefully planned and delivered, as well as direct and engaging have a greater likelihood of literacy achievement. One example of a reading intervention that meets these criteria, when implemented with fidelity, is a reading racetrack. The next section describes the research on reading racetracks, the components of the game, and how it is played.

**What The Research Says**

To date most research studies on racetrack games have been conducted with hearing children with and without disabilities. Studies with children who have disabilities included those with autism spectrum disorder, learning disabilities, intellectual disabilities, and severe disabilities (e.g., Anthony, Rinaldi, Hern & McLaughlin, 1997; Crowley, Mclaughlin, & Kahn, 2012; Falk, Band, & McLaughlin, 2003; Rinaldi & McLaughlin, 1996). Most studies were done with elementary students, although some were with preschoolers. Reading skills, including sight word acquisition and fluency, were targeted most frequently with elementary students. Of the studies conducted with
preschoolers with disabilities, one taught them sight word identification (Higgins, McLaughlin, Derby, & Long, 2012). The others focused on building math skills, such as numeral identification and shape recognition (Chandler, McLaughlin, Neyman, & Rinaldi, 2012; Ehlers, McLaughlin, Derby, & Rinaldi, 2012; Herberg, McLaughlin, Derby, & Gilbert, 2011). Two recent studies were conducted with students who are deaf/hard of hearing (i.e., Davenport, Alber-Morgan, Clancy, & Kranak, in press; Davenport, Konrad, Alber-Morgan, & Clancy, 2017).

Davenport et al. (2017) investigated the effects of a picture racetrack on the acquisition, maintenance, and generalization of expressive sign vocabulary with two preschool students who were deaf. Using individualized sets of photographs (selected based on student need) representing curriculum-based (e.g., apple, pumpkin) and functional vocabulary (e.g., school, house), both students increased their vocabulary. Both preschoolers maintained most of the vocabulary and were able to generalize the majority to a different format (e.g., the pictures were presented in a photo album). Additionally, the preschoolers reported enjoying the game and their classroom teacher appreciated it being effective, easy to implement, and resource-friendly. Establishing an evidence-based practice requires more than one study with two participants, but this study points teachers to a vocabulary intervention that may be useful with their preschoolers who are deaf.

The second racetrack study conducted with students who are deaf targeted sight words (Davenport et al., 2017). Four kindergarten students, all of whom were deaf and used American Sign Language as their primary language, participated in the study. Study results demonstrated that the reading racetrack game improved sight word acquisition,
maintenance, and generalization for three out of four participants. The researchers pulled
the sight words from the Journeys, the classroom curriculum. Like previous racetrack
studies, each set of sight words were customized based on student need. The game proved
to be effective for all three participants, however one participant required supplemental
instruction (described in detail later in this article).

Reading Racetracks

Reading racetracks provide a convenient framework for incorporating elements of
effective instruction, including modeling, multiple exposures to sight words, repeated
practice with active student responding, and frequent feedback. As noted above,
racetrack-like games have been researched with various types of students targeting
different skills (e.g., number and color identification), however most have focused on
sight word acquisition. The game board is designed to look like a racetrack with blank
cells. The number of cells is predetermined, based on the number of target words. Sight
words selected should be based on the individual needs of students.

Components of a Reading Racetrack

Major components of a reading racetrack are model, lead, and test, which are
common elements of explicit instruction. Specifically, these procedures are found in
Direct Instruction (Carnine, 2010). These components were developed for teachers to use
in implementing error correction with students. The idea is that students rehearse correct
responses, and do not rehear incorrect responses. Research has shown that model, lead,
test is effective in teaching reading skills to students with various disabilities and at
different grade levels (Bechtolt, McLaughlin, Derby, & Blecher, 2014; Browder,
Ahlgrim-Delzell, Courtade, Gibbs, & Flowers, 2008; Rinaldi, Sells, & McLaughlin,
Another way of conceptualizing model, lead, test is “I do-we do-you do” (Sayeski & Paulsen, 2003). Here is how the approach works:

Model. First, the teacher demonstrates the target skill (i.e., “I do”). Instead of students listening to verbal information about how to perform a skills or task, the teacher explicitly demonstrates the skill. During this phase the teacher may even talk through her thought process as she demonstrates the skill. Simply modeling the skill may be sufficient for some students, while other students may require more detailed information during the modeling phase.

Lead. Next, the teacher walks students through the target skill. Teacher and students perform the skill together (i.e., “we do”). Students are required to perform the skill and the teacher provides praise for steps of the skill, or the skill itself, performed correctly. Specific feedback is given on any errors made. The student repeats the skill until performed accurately.

Test. In the final step, the teacher asks the student to perform the skill independently. Some students will need support monitoring their performance, others will be able to self-monitor.

How to Play

To begin playing the game, the teacher sets a timer for 1 minutes and says, “Ready, set, go!” As the student reads the words around the track, the teacher records words read correctly and incorrectly. An error correction procedure is used for any words read incorrectly. An example of an error correction procedure is, “I do – we do – you do.” In this procedure the teacher reads the word aloud, the teacher and student reads the word together, and then the teacher prompts the student to read the word independently. An
optional way to end the game is for the teacher to help the student chart his or her performance. To implement a reading racetrack, following the steps below:

1. Teacher models pointing to the first 10 words on the racetrack and saying each word aloud.
2. Teacher directs the student to point to the words and read as many on the racetrack as best he/she can.
3. If student reads correctly the first 10 words, provide praise after each word. If the student pauses for longer than 3 seconds, misreads the word, or mispronounces the word, the teacher points to the word and reads it aloud. If the student makes no errors the teacher says, “Now we are going to play the game again and I want you to read the words as quickly as you can. On your mark, get set, go!”
4. Teacher points to the word and says, “I’ll read the word to you.” Teacher reads the word.
5. Teacher says, “Let’s read the word together.” Student and teacher read word together.
6. Teacher says, “Point to the word and read it 3 times”.
7. Teacher gives student praise and thanks him/her for playing.
8. Teacher says, “Now we are going to play the game again and I want you to read the words as quickly as you can. On your mark, get set, go!”
9. Teacher starts timer.
10. When timer sounds, the teacher says, “Stop reading.”
11. Teacher counts total words read and number of words read incorrectly and records on reading racetrack data sheet. Teacher tells student how many words were read correctly.

12. Teacher gives student praise and thanks him/her for playing.

The procedures just described are relatively straightforward. However, some students may require modifications and/or supplemental instruction to acquire sight words. Davenport et al. (2017) modified the number of target words and game procedures with one participant. In this study, each student played the game with 10 words (represented three times on the track for multiple exposures). However, one participant struggled to acquire that many words, even with frequent sessions. In consultation with the classroom teacher, the researchers reduced the number of target words to three. The number of cells on the track remained the same (30 cells) so each word was represented 10 times. The number of words was reduced while the number of exposures was increased. At the same time, supplemental instruction was introduced to improve this student’s motivation and ability to acquire novel sight words.

Racetrack Materials

Materials needed to implement a reading racetrack are customizable, readily available to teachers, and low-cost. See the following list of items needed, as well as optional items.

- Racetrack game template: The racetrack template includes blank cells to fill in with target words. See Figure 5 for an example. Teachers can use this template or make their own. Regardless of the template used, each target word should be represented multiple times. The number of target words should be based on
student data. Be sure to randomize the order of the words so students do not memorize a pattern.
Figure 5. Reading racetrack game template
- List of words: Words from a variety of curricula, such as Dolch and Journeys, can be used with a reading racetrack. Target words should be words that are unknown to the student.

- Timer: If a reading racetrack is used to target a student’s reading fluency, a timer will be needed. A stopwatch or timer application on a phone works well.

- Data collection sheet: It is important to track student progress when using a reading racetrack. See Figure 6 for an example of a data collection sheet. It is straightforward, and easy to use. Simply place a + for correct responses and a – for incorrect responses.
## Reading Racetrack Data Collection

<table>
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<th>Sight words</th>
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Correct/Incorrect

*Figure 6. Example of data collection form*
○ Flash cards (optional): Accompanying flash cards with sight words printed on them may be used for post-intervention assessment. After the student has played the racetrack game, show the student the flashcards one at a time to see which words from the racetrack they have acquired.

○ Graph paper (optional): Graph paper may be used for plotting data. Either the student or the teacher and the student together can plot the number of words read correctly and incorrectly.

○ Token: Some type of token (e.g., toy car, figurine) to move around the racetrack can be incorporated. The student can move the piece, touching each word, as he/she reads around the track.

Using the materials listed above, teachers can use reading racetrack with students who are struggling readers. The components of the game relate to the elements of explicit instruction. The next section describes those components in more detail.

_How to Make Racetrack Games Work In Your Classroom_

_Maria often uses various pre-teaching strategies with her students who are deaf and hard of hearing and has recently incorporated reading racetracks into her “bag of tricks.” She likes that she can use it with all of her students, regardless of the language communication mode they use. She matches the mode of her students, including Ruben who uses ASL. Maria has found that the interactive nature of the game helps keep her students engaged. Ruben likes the racing part, as well as counting how many words he read correctly each time he plays._

As a teacher, particularly if you are working with students who are deaf or hard of hearing, you may be thinking of all the challenges of implementing a racetrack game in
your classroom with your students. When considering using racetrack games with your students, keep in mind the flexible nature of these types of games. See the following potential challenges and responses.

Challenge #1: *I have more than one student who is deaf or hard of hearing in my classroom, and they use diverse communication modes.*

Solution: Reading racetracks can be customized based on the communication needs of individual students. For students who are deaf or hard of hearing, this means that the person implementing the game can match the language (e.g., English, ASL) and communication mode (e.g., spoken language or sign) the child uses. For example, a student who uses primarily ASL, the teacher can play the game following all steps using ASL. The teacher can implement the same game using simultaneous communication or spoken language only.

Challenge #2: *I want to use reading racetracks with my students, but they are reading at different levels.*

Solution: Reading racetracks can be individualized based on student level. If students are working from different Dolch sight word lists, the racetracks for those students can be filled with sight words from their respective lists. Sight words for one student may be pulled from kindergarten list and another may be working on the first grade list.

Challenge #3: *I don’t have time to work one-on-one with each of my students.*

Solution: Studies on racetrack games have been conducted either with researchers or classroom teachers implementing the game with students. However, this does not mean instructional assistants, other staff (e.g., speech-language pathologists), or trained
volunteers could not implement the game. Racetrack games could be played with a student during center time or while other students are engaged in a group activity.

**Challenge #4: I have a student who is not motivated to play the racetrack game.**

Solution: Racetrack games can be customized in a variety of ways, including the use of reinforcers and different types of reinforcers. Playing the game itself may not motivate some students. Ensuring the use of specific praise is important, but if the game and praise are not sufficient, stickers or other tangible motivators may be necessary to reinforce student engagement. One adaptation to the reading racetrack game that may appeal to students is creating a “pond” on a separate piece of paper (apart from the game template) and beads as “rocks.” Each time the student reads a sight word correctly she moves a “rock” into the “pond.”

**Challenge 5: Some of my students struggle to acquire and maintain sight words.**

Solution: Instead of presenting, for example, a complete set of novel words, consider presenting new words along with some known words. This strategy of sequencing target words with known words is referred to as interspersal (Knight, Ross, & Taylor, 2003). Research conducted with students with disabilities indicates that a ratio of 30% unknown to 70% known words is effective (Cooke & Guzaukas, 1993). This strategy may work for your students, too!

**Challenge #6: I'm worried my students will not generalize skills acquired by playing the game.**

Solution: Students acquiring new skills is fine and well, but teachers know the importance of students being able to generalize those skills to different contexts, environments, and with different people. Especially for students with disabilities,
generalization cannot be assumed. Educators must program for generalization of newly learned skills. If reading sight words is the target skill with the racetrack game, a different staff member could present those same sight words to the student. Another option would be to present those sight words highlighted in a paragraph.

Although not an exhaustive list of challenges teachers may face when implementing racetrack games, the solutions that accompany the challenges emphasize the fact that racetrack games can be custom-made based on student language and communication mode, academic level, and motivation. If it is appropriate to target five sight words at a time with one student, the racetrack can be made with cells for five words. If a student is ready to learn a list of 10 words, the racetrack can be made accordingly.

Conclusion

By winter break the classroom word wall has expanded, including sight words from the kindergarten word list. Each day Maria visits Ruben’s school, he is eager to show her the newest words that have been added. She still uses the reading racetrack game to pre-teach vocabulary and has discovered that it is effective in supporting Ruben’s maintenance of words learned. Although Ruben enjoys the game, Maria takes note when he becomes less motivated and will add an extra element to keep it fun. She has used a toy car, which he really enjoyed. She has also added a graphing component, something she had not done before with her students. However, she has found a simple child-friendly bar graph has been highly motivating for Ruben. After playing the game, he takes out a colored pencil and with Maria’s help colors in the bar on the graph.
Acquiring grade-level language literacy skills is often a steep climb for students who are DHH, yet the research on interventions with these students is limited. Research indicates that reading instruction for typically hearing students is effective when it is systematic, direct, engaging, and outcome-oriented (Archer & Hughes, 2011). However, current research on literacy instruction for students who are DHH also points to explicit strategies as effective and efficient (i.e., Beal-Alverez, Lederberg, & Easterbrooks, 2012; Bennett, Gardner, Leighner, Clancy, & Gardner, 2014; Trussel & Easterbrooks, 2015).

Reading racetrack games provide a framework for providing instruction that meets these criteria. The game can individualized based on student ability, and procedures can be carried out in the language or communication mode of the student who is DHH. Teachers who have a background in deaf education are well aware that one size does not fit all when it comes to meeting the needs of students who are DHH. A reading racetrack is an intervention that is rooted in evidence-based literacy instruction, and can be customized.
Chapter 5: Research Statement

The purpose of this dissertation was to examine literacy interventions for students who are deaf and hard of hearing. Chapter 2 was a review of literacy studies conducted with students who are deaf or hard of hearing prekindergarten to 12th grade. All studies published used single-subject research methods. Chapter 3 extended the literature by examining the effects of a reading racetrack game on sight word acquisition, maintenance, and generalization in kindergarten students who are deaf. The aim of Chapter 4 is to disseminate these findings by translating research to practice. Chapter 4 provides practitioners with specific strategies for implementing literacy interventions with their students who are deaf and hard of hearing. In this final chapter, I present my research interests and aims.

As a student during my undergraduate studies, I spent time in several classrooms for students who are DHH for field experience and student teaching. Most of the students were from hearing families, and most of those families struggled to communicate with their children and to deal with their deafness in general. I began asking my mentor teachers about what services there are for families, particularly when their children were infants and toddlers. I learned about early intervention services and began researching what those services looked like and what types of related jobs were available. This led me
to pursue Master’s degree at Gallaudet University, the world’s only liberal arts institution designed specifically for Deaf undergraduate and graduate students. My experience as a graduate student there sparked my desire to dig deeper into learning how children who are deaf and hard of hearing can be successful. Seeing the success of my professors, mentors, and peers at Gallaudet showed me firsthand what is possible for children who are deaf and hard of hearing—with the right educational and familial supports, so much is possible! But what are those educational and familial supports? This is the question I have worked to answer since my time at Gallaudet.

My experience as a statewide early childhood consultant providing services to local education agencies serving preschoolers and early elementary students who are deaf or hard of hearing highlighted the need for evidence-based practices for this population. Nearly all of the students who I observed in the classroom over a nine-year period had deficits in language and literacy. Teachers, administrators, and related services providers all wanted to know what types of interventions and strategies they should be using with their students. “Are there strategies that work well with students who are deaf or hard-of-hearing?” “Can you share some evidence-based practices with us?” I often sought out evidence-based practices for deaf and hard of hearing students, but found very few. This led to my wondering if there were interventions and strategies that work with hearing students, which could be studied with students with hearing loss. With strong mentorship from my doctoral co-advisors, Dr. Sheila Morgan and Dr. Moira Konrad, I was able to parlay my interest in these critical areas as a practitioner and consultant into a line of related research as a scholar.
To begin a line of research related to language interventions, Dr. Morgan and I investigated the effectiveness of a picture racetrack game on sign vocabulary acquisition with preschoolers who are deaf (Davenport, Alber-Morgan, Clancy, & Kranak, 2017). Extending the research on reading racetracks, an intervention shown to be effective with elementary students with autism spectrum disorder, ADHD, and other disabilities, we were able to contribute to the literature on literacy interventions with young children who are deaf.

This project led us to ask about whether or not studies had been conducted with teachers on training them to implement a reading racetrack. My background as a practitioner has kept me grounded in wanting to know not only what works for students, but also for teachers. Most young children who are deaf or hard of hearing are served in general education classrooms with teachers who have little to no experience meeting a deaf child’s unique language and literacy needs. Applying my training in applied behavior analysis as a student in the special education program to my practitioner experience, I explored the use of Behavioral Skills Training (BST) with teachers. In collaboration with Drs. Morgan and Konrad, we were able to meld the two areas by conducting a study using BST to train elementary teachers to implement reading racetracks with students who were struggling readers (Davenport, Konrad, & Alber-Morgan, under review). This study was conducted with hearing teachers (and hearing students) and will function as a pilot for future research using BST with teachers working with students who are deaf or hard of hearing.

These two research studies led me to conduct a literature review (see Chapter 2) examining the research on literacy intervention with students who are deaf and hard of
hearing. This review indicated that 10 single-subject studies were conducted in this area between 2004 and 2016. Studies focused on various literacy behaviors (i.e., grapheme-phoneme correspondence, alphabetic principle, writing more descriptively), yet none focused on sight word acquisition. The results of this literature review clearly demonstrated the need for quality literacy intervention studies with this population.

As a follow up to this review, I evaluated the effectiveness of a reading racetrack game on the acquisition of sight words with four kindergarten students who are deaf (see Chapter 3). Results indicated that this intervention was effective for most of the participants in acquiring novel sight words. Three out of four of the participants acquired three sets of 10 words and maintained the majority of those words two- and/or four-weeks post-intervention. Additionally, the same three participants demonstrated they could generalize those words to a different content. One participant initially struggled to acquire 10 words, even with supplemental instruction, resulting in the number of words in a set being reduced to three.

In the future, I aim to further my study of language and literacy interventions, as well as methods of training teachers to implement related interventions with fidelity. I want to continue these lines of research in order to refine the usefulness and feasibility of interventions. I am particularly interested in the newly published *Foundations for Literacy* curriculum developed for prekindergarten children who are deaf and hard of hearing. *Foundations*, a 25-week/1 hour daily intervention has a solid evidence base, I would like to investigate methods of teacher training on lesson implementation with fidelity.
Another one of my main goals in pursuing a doctorate was to address the needs of families with children who are deaf and hard of hearing. As co-founder and current board member of Ohio Hands & Voices, a family-driven organization supporting families of children who are deaf and hard of hearing without bias towards communication choices, I am acutely aware of the benefits families and children reap from strong early intervention services and from supporting one another through their parenting journey. While my current focus is on exploring language and literacy interventions with young children who are deaf and hard of hearing, I plan to pursue a line of research regarding specific parenting factors that positively impact language and literacy outcomes of children with hearing loss.

Deaf education is a fascinating field, full of challenges and controversy related to language and culture and how children learn best, but it is also a field in need of research. Children who are deaf or hard of hearing have an amazing amount of potential for learning and growth in all areas, yet academic outcomes for far too many continue to be dismal, and practices are oftentimes informed by myths and gut instinct rather than evidence. My primary goal in pursuing a doctorate was to participate in moving the field forward in determining how best to support children who are deaf and hard of hearing and their families. Transitioning my career as a practitioner into an academic position at the university level, I aspire to conduct research, engage with pre-service professionals, initiate and carry out collaborative projects, and generally be part of the greater discussion around how young children who are deaf and hard of hearing and their families are supported.
References

Note: References denoted with asterisks (*) were included in the literature review.


Appendix A: Baseline probe data collection
Baseline Probe Data Collection

Participant ID: ________________________  Date: _______________
Set Number: __________________________
Session Number: _______________________  IOA: _______________________

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Appendix B: Intervention data collection form
# Intervention Data Collection Form

Participant ID: ________________________  Date: ______________

Set Number: ____________________________  IOA:

Session Number: _______________________

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<th>Sight word</th>
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Appendix C: Procedural integrity checklist
Procedural Integrity Checklist

<table>
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<tr>
<th>Steps</th>
<th>Observed</th>
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<tbody>
<tr>
<td>1. Experimenter models pointing to the first 10 words on the racetrack and saying the word aloud. Student is asked to repeat each word after the experimenter reads.</td>
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<tr>
<td>2. Experimenter directs the student to point to the words and read as many on the racetrack as best he/she can.</td>
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<tr>
<td>3. If student reads correctly the first 10 words, provide praise after each word. If the student pauses for longer than 3 seconds, misreads the word, or mispronounces the word, the experimenter points to the word and reads it aloud. (if no errors, skip to step #8)</td>
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<td>4. Experimenter points to the word and says, “I’ll read the word to you.” Teacher reads the word.</td>
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<td>5. Experimenter says, “let’s read the word together.” Student and teacher read word together.</td>
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<td>6. Experimenter says, “point to the word and read it 3 times”.</td>
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<tr>
<td>7. Experimenter gives student praise and thanks him/her for playing.</td>
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<tr>
<td>8. Experimenter says, “now we are going to play the game again and I want you to read the words as quickly as you can.” “On your mark, get set, go!”</td>
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<td>10. When timer sounds, the experimenter</td>
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</table>
11. Experimenter counts total words read and number of words read incorrectly and records on Reading Racetrack data sheet. Experimenter tells student how many words they read correctly.

12. Experimenter gives student praise and thanks him/her for playing.

*Checklist for Participant 3 was adapted to reflect her intervention targeting three words instead of 10.
Appendix D: Student social validity questionnaire
Student Questionnaire

1. Did you like playing the racetrack game?

2. Would you like to play the game with your teacher?

3. What did you like to play the game again?
Appendix E: Teacher social validity questionnaire
Teacher Questionnaire

Please answer the following questions about the intervention used for this study and the results. (1 = not at all, 2 = unsatisfied/ineffective/disagree, 3 = neutral, 4 = agree, 5 = extremely effective/satisfied/strongly agree)

1. How effective do you feel the intervention was in increasing reading fluency?
   
   1 2 3 4 5

2. This intervention is relatively simple to implement in my classroom (e.g., not too time consuming).
   
   1 2 3 4 5

3. This intervention could easily be constructed without consuming many resources.
   
   1 2 3 4 5

4. Would you use this intervention to increase vocabulary in other students? Why or why not?