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Effects of Morphographic Instruction on Deaf and Hard-of-Hearing Students' Morphographic Analysis Skills

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ACCEPTANCE

This dissertation, EFFECTS OF MORPHOGRAPHIC INSTRUCTION ON DEAF AND HARD-OF-HEARING STUDENTS' MORPHOGRAPHIC ANALYSIS SKILLS, by JESSICA W. TRUSSELL, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy, in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

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ABSTRACT

EFFECTS OF MORPHOGRAPHIC INSTRUCTION ON
DEAF AND HARD-OF-HEARING STUDENTS'
MORPHOGRAPHIC ANALYSIS SKILLS
by
Jessica W. Trussell

Deaf or hard-of-hearing (DHH) students struggle with literacy (Easterbrooks & Beal-Alvarez, 2012; Traxler, 2000) and literacy sub-skills (phonology, Leybaert, 2000; vocabulary, Lederberg & Beal-Alvarez, 2011; morphographic knowledge, Gaustad, Kelly, Payne, & Lylak, 2002). Morphographic knowledge includes separating words into their components to determine the meaning. This skill allows the reader to decode words in orthographic chunks (Carlson, Jenkins, Li, & Brownell, 2013). According to the automatic information processing reading theory (LaBerge & Samuels, 1974), proficient readers must decode in orthographic chunks, or morphographs, to allow for higher quality lexical retrieval (Perfetti, 2002) and develop automaticity. However, many DHH readers have delayed morphographic knowledge (Gaustad et al., 2002; Gaustad, 1986) that affects their morphographic analysis skills (Gaustad & Kelly, 2004). Morphographic analysis instruction may improve this delay (Gaustad, 2000; Nunes, Burman, Evans, & Bell, 2010). *Spelling through Morphographs* (Dixon & Engelmann, 2007) is a Direct Instruction curriculum that teaches morphographs through scripted lessons and planned practice. The purpose of this study was to determine the effects of morphographic instruction modeled after the Direct Instruction curriculum, *Spelling through Morphographs* (Dixon & Engelmann, 2007), on the morphographic analysis skills of reading-delayed DHH students attending fourth through eighth grade. The study included three student participants and one teacher participant from a local school

district. The researcher used a multi-probe multiple baseline across participants design (Kazdin, 2011) followed by visual analysis of the data. A functional relation was established between the intervention and the participants' morphographic analysis skills. This intervention improved DHH students' ability to dissect words, which may in turn positively affect their decoding abilities. Implications and future research are discussed.

EFFECTS OF MORPHOGRAPHIC INSTRUCTION ON DEAF AND HARD-OF-HEARING STUDENTS' MORPHOGRAPHIC ANALYSIS SKILLS

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A Dissertation

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ABBREVIATIONS

ASL	American Sign Language
DHH	Deaf and Hard of Hearing
DI	Direct Instruction
IRR	Inter-rater Reliability
LQ	Lexical Quality
LSL	Listening and Spoken Language
LWI	Letter-word Identification
PC	Passage Comprehension
VP	Visual Phonics
TODHH	Teacher of the d/Deaf/hard of hearing

CHAPTER 1

MORPHOGRAPHIC INSTRUCTION WITH DEAF AND HARD-OF-HEARING STUDENTS: A REVIEW OF THE LITERATURE

Deaf and hard-of-hearing (DHH) students struggle to achieve grade-equivalent literacy abilities (Easterbrooks & Beal-Alvarez, 2012; Traxler, 2000). More specifically, these students struggle with text-based skills, such as decoding (Strassman, 1997), which may partially explain their overarching literacy difficulties. Decoding is the ability to use a printed word to access the correct entry in the mental lexicon and retrieve semantic information (Haptonstall-Nykaza & Schick, 2007). Morphographic knowledge influences decoding (Carlisle, 2000) which is related to later reading comprehension (Carlson, Jenkins, Li, & Brownell, 2013; Dyer, MacSweeney, Szczerbinski, Green, & Campbell, 2003; McCardle, Scarborough, & Catts, 2001). Morphographic knowledge in second and third grades is a predictor of reading comprehension in fourth through ninth grades after controlling for phonological awareness (Deacon & Kirby, 2004; Nagy, Berninger, & Abbott, 2006). Kieffer and Lesaux (2012) found that morphographic knowledge made a significant contribution to reading comprehension indirectly via vocabulary. Those who have a larger vocabulary are better readers (Lee, 2011) and decoding using morphographic information (i.e., deconstructing an unknown word into know morphographs to determine the word's meaning) improves vocabulary (Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003). Nunes, Burman, Evans, and Bell (2010) determined that the use of morphographic decoding strategies is a predictor of reading comprehension in DHH students. These researchers' findings suggest that

morphographic knowledge is essential to literacy achievement. However, DHH students have delayed morphographic knowledge (Gaustad, Kelly, Payne, & Lylak, 2002; Gaustad, 1986) and morphographic instruction is rarely integrated into their daily literacy instruction (Gaustad, 2000). Intervening on this delay might offer DHH students a meaning-oriented decoding strategy (Arnbak & Ebro, 2000) that has the potential to improve their literacy outcomes.

Morphographs are orthographic representations (Maggs, McMillan, Patching, & Hawke, 1981) of a language's smallest units that retain meaning (Reed, 2008). For example, the word *biology* originates from the Greek *bio* meaning life and *ology* meaning the study of, therefore, *biology* means *the study of life*. Morphographs include base words, roots, and affixes (Maggs et al., 1981). All words contain one or more morphographs (Dixon, 1991). Morphographic knowledge aids the decoding process in two ways (Carlisle, 2003). First, morphographic knowledge provides the reader with information about the word's meaning. Second, it provides information regarding how the word being decoded relates to the words surrounding it (Nielsen, Luetke, & Stryker, 2011). There are two different types of morphographs: derivational and inflectional. Derivational morphographs can be combined to create new words and inflectional morphemes, such as *–ed* and *–s*, provide surface structure grammar (Reichle & Perfetti, 2003; Verhoeven & Perfetti, 2003). When students analyze derivational and inflectional morphographs during reading, they are utilizing a meaning-oriented decoding strategy that provides clues about the sentence's surface-structure grammar (Arnbak & Elbro, 2000; Reichle & Perfetti, 2003). The first step in decoding using morphographs is morphographic analysis.

Morphographic analysis is splitting the multi-morphographic word being decoded into its component morphographs (Carlisle, 2000). For instance, if the unfamiliar word to be decoded is *tricycle*, then one could decompose *tricycle* into its component morphographs *tri-* and *cycle* to try to determine the word's meaning. This skill is the basis for morphographic awareness and is positively correlated to word reading (Carlisle, 2000). Further, morphographic analysis skills can be independent of phonological skills serving as a compensatory strategy for readers who struggle with phonological encoding (Casalis, Colé, & Sopo, 2004). Some DHH readers struggle to decode using phonological encoding and require other strategies to aid in word reading (e.g., morphographic analysis) (for a recent review, see Mayberry, del Guidice & Lieberman, 2011). Morphographic word analysis is potentially beneficial for the DHH population because it focuses on meaningfully analyzing common orthographic patterns that occur within words (Hayes, Treiman, & Kessler, 2006; Pacton, Fayol, & Perruchet, 2005; Share, 2008) and is accessible entirely through the visual pathway (Gaustad, 2000). The guiding questions for this literature review are: What is the existing research base for morphographic instruction with DHH students? Is morphographic instruction an evidence-based practice for this population? To answer these questions, the theoretical framework for this type of instruction will be identified; characteristics of DHH students and of an evidence-based practice will be discussed, and the extant literature in the area of decoding and morphographic instruction will be reviewed herein.

Theoretical framework

Morphographic text analysis strategies align with the lexical quality (LQ) hypothesis (Perfetti & Hart, 2001). An extension of LaBerge and Samuel's (1974)

automatic information processing in reading theory, the LQ hypothesis proposes that literacy skills are supported by word knowledge. Word knowledge is the ability to retrieve a detailed orthographic, phonologic, or morphographic and semantic representation of a word during reading (i.e. high lexical quality retrieval). Proficient readers have the ability to engage in high lexical quality retrieval or to decode at a level of automaticity (LaBerge & Samuels, 1974; Verhoeven & Perfetti, 2008) that frees cognitive resources to focus on comprehension (LaBerge & Samuels, 1974). For example, emergent readers decode words initially as individual letters (Verheoven & Perfetti, 2008). As their reading skills develop, readers (typical readers: Casalis et al., 2004; Frost, Kugler, Deutsch, & Forster, 2005; DHH readers: van Hoogmoed, Knoors, Schreuder, & Verhoeven, 2013) decode words in orthographic chunks (e.g., morphographs). These readers obtain higher quality lexical retrieval skills that lead to decoding automaticity during the reading process. Delayed morphographic knowledge may impede the ability to decode words in orthographic chunks and affect retrieval as well as automaticity. This delay is a characteristic of many DHH readers (Gaustad et al., 2002).

Characteristics of DHH students

DHH students are considered to be a more heterogeneous population than their hearing counterparts (Harris & Beech, 1998). This heterogeneity may be due to several factors. First, DHH students have varying degrees of hearing loss, giving them access to spoken English that differs (Blackorby & Knokey, 2006). Second, DHH students are educated in diverse settings using a range of communication methodologies (e.g., listening and spoken language [LSL], total communication, and bilingual/ bicultural) and

accessing various types of services (e.g., auditory training, interpreting services, early intervention) whose availability may be determined by factors beyond the control of the student (e.g., location) (States Accountability Office, 2011). Lastly, DHH students use a wide array of technologies (e.g., cochlear implants, hearing aids) to interact with their educational environment (Gallaudet Research Institute, 2010). These differences culminate in a diversity of experiences, strengths and needs within the DHH population. Further, this heterogeneity of the population requires professionals to develop a multitude of instructional options to meet their educational needs.

Pervasive language and literacy difficulties are another characteristic of the DHH student population. These students often have a deficient English vocabulary base (Kyle & Harris, 2010; Meadow, 2005) and struggle with grammar (Lederberg, Schick, & Spencer, 2012). These two issues often translate into literacy difficulties because of the relationship between linguistic and literacy competence (Storch & Whitehurst, 2002). As previously stated, the morphographic knowledge delay that is common amongst DHH students is a part of language and literacy. DHH students who use LSL struggle with the acquisition of morphographs because they experience a degraded auditory signal causing them not to hear some English morphemes (Guo, Spencer, & Tomblin, 2013) during spoken conversation. Similarly, those who use signed languages may not see the English morphemes (Gaustad et al., 2002) in through-the-air conversations. Children who do not experience morphemes receptively often are delayed or do not use morphemes in their expressive language (Guo et al., 2013). Children who do not use English morphemes in their expressive language have difficulty understanding morphographs in print (Dixon, Zhao, & Joshi, 2012). Further, DHH children are often delayed English language

learners (Lederberg & Spencer, 2009). Children who acquire a language later in life do not process morphographical components with the same automaticity as those who acquired the same language during the normal developmental period. These late learners depend on the lexical level of language, which is less efficient than using orthographic chunks, when processing morphographically complex words. For example, the word *unhappiness* is a morphographically complex word because the word's meaning is clear from the morphographic components. Late-language learners may not structurally analyze *unhappiness* and decompose the word into its morphographic components to determine a definition. Delayed language learners may attack the word as single lexical item slowing the decoding process (Jiang, 2004). These findings suggest that DHH students may struggle developing and using morphographic knowledge because they often lack receptive experience with morphemes and are often late-language learners. Gaustad (2000) proposed that morphographic instruction could improve this literacy sub skill.

Evidence-based practices for DHH students

Literacy intervention research to determine evidence-based practices for DHH students is scarce (Easterbrooks & Stephenson, 2006; Luckner, Sebald, Cooney, Young, & Muir, 2005/2006). An evidence-based practice is an instructional program, intervention or strategy that has consistently produced positive results during experimental testing (Odom et al., 2005). To help determine whether evidence-based literacy practices for DHH students existed, Luckner and colleagues (2005/2006) examined 964 studies that were linked to reading and deafness. Of these 964 studies, only 22 studies satisfied the requirements, outlined by What Works Clearinghouse

(2011), to establish an evidence-based practice. Of the 22 studies, no studies were systematically replicated, the few group design studies were poorly planned, and all of the studies examined different dimensions of literacy (Luckner et al., 2005/2006). More recent reviews of the component areas of literacy (vocabulary; Luckner & Cooke, 2010; reading comprehension; Luckner & Handley, 2008; fluency; Luckner & Urbach, 2011; decoding; Tucci, Trussell, & Easterbrooks, 2014) have been conducted; the authors of each review concluded that further research into literacy instruction strategies to improve outcomes for DHH students in these component areas is necessary. Upon closer look at the decoding interventions research, Tucci and colleagues (2014) identified 12 studies that experimentally-tested decoding strategies with DHH students. The authors suggested further research was required to determine what decoding strategies were evidence-based for this population.

Decoding and DHH students

As regards decoding, Visual Phonics (VP; International Communication Learning Institute, 1996) and fingerspelling have been paired with various curriculums and strategies to improve DHH students' word reading skills. Researchers have engaged in explicit phonological skills instruction with DHH students (Beal-Alvarez, Lederberg, & Easterbrooks, 2011; Bergeron, Lederberg, Easterbrooks, Miller, & Connor, 2009; Guardino, Syverud, Joyner, Nicols, & King, 2011; Trezek & Malmgren, 2005; Trezek & Wang, 2006, Tucci & Easterbrooks, 2013) in particular using VP in conjunction with various reading curriculums. VP is a system of discrete hand shapes for each phoneme in the English language developed to clarify the sound and symbol relationship between spoken and print English (Waddy-Smith & Wilson, 2003). VP paired with explicit

instruction reading curriculums has had positive effects on the decoding abilities of younger (Beal-Alvarez et al., 2011; Bergeron et al., 2009; Guardino, Syverud, Joyner, Nichols, et al., 2011; Trezek & Wang, 2006) and older DHH students (Trezek & Malmgren, 2005). With young DHH students, Bergeron and colleagues (2009) implemented an emergent reading curriculum, *Foundations for Literacy* (Lederberg, Miller, Easterbrooks, & Connor, 2011), and VP with three to seven year old DHH students ($N = 10$; 3 signing and 7 listening and spoken language (LSL) students). The author reported that the participants could decode 60% of taught words and 30% of novel words after a year of instruction. Similarly, Beal-Alverez and colleagues (2011) found that four year old signing DHH children ($N = 3$) who participated in similar instruction (i.e. *Foundations* and VP) could decode 15-23% of taught words and 0% of novel words.

Researchers have also paired VP with Direct Instruction (DI) programs to determine if decoding skills could be improved (Trezek & Malmgren, 2005; Trezek & Wang, 2006). Trezek and Wang (2006) utilized a pre/posttest group design to investigate the influence of VP paired with *Reading Mastery I* (Englemann & Bruner, 1995) on the decoding skills of 13 kindergarten and first grade DHH readers. The researchers discovered that this DI curriculum paired with VP increased the participants decoding skills. Further, a large effect size for decoding ($d = -1.6$) was found (Trezek & Wang). With late-elementary students, Guardino and colleagues (2011) utilized a multiple case study design with 6 DHH participants who all used LSL (ages 7-12 years). The researchers investigated the effectiveness of the curriculum *Teach Your Child to Read in 100 Easy Less*ons (Engelmann, Haddox & Bruner, 1983) with VP. Upon completion of instruction, all of the participants increased their ability to read non-sense words. With

middle school age students, researchers (Trezek & Malmgren, 2005) paired VP, *Corrective Reading-Decoding A* (Engelmann, Carnine, & Johnson, 1999) and the Baldi (Massaro, 2006) the "talking head" technology in a quasi-experimental pre/posttest group design. Twenty-three sixth through eighth grade signing DHH middle school participants were assigned to a treatment and comparison group. Both groups participated in 45 minutes of reading instruction daily for eight weeks. The treatment group received the intervention package (i.e., DI instruction, VP and Baldi) and the comparison group received instruction from the district approved curriculum. Upon completion of the intervention, researchers found that the treatment group performed significantly better on pseudo word reading than the comparison group (Trezek & Malmgren). In contrast, Narr (2008) investigated the relationship between the number of years in VP instruction and various literacy components, including decoding. The participants were in kindergarten through third grade ($N = 10$) and used sign supported English as well as American Sign Language (ASL). The author discovered that the number of years VP had been part of instruction did not correlate with the decoding abilities of these readers. Thus, the long-term relationship between phonics instruction that includes VP and decoding is unclear.

Another tool that has been explored to improve decoding with this population is fingerspelling. Fingerspelling may provide a pronunciation or expressive function for DHH students when they are decoding an unknown word (Chamberlain & Mayberry, 2008). Haptonstall-Nykaza and Schick (2007) implemented a repeated-measures design with 21 DHH students (ages 4 to 14 years) to compare two conditions, a sign condition and a fingerspelling condition. The researchers investigated which condition better enabled the deaf students' to learn the fingerspelled and print version of the word. In the

sign condition, the printed English word and ASL sign were matched. In the fingerspelling condition, the lexicalized fingerspelling, the ASL sign and the printed English word were matched. The students were more likely to recognize the printed English word taught during the fingerspelling condition than the words taught in the sign condition. Although the two conditions were highly correlated (r = .94), the participants were able to create a more reliable link between the printed word and sign through the fingerspelling strategy (Haptonstall-Nykaza & Schick).

The aforementioned studies are a promising start to improving DHH students' decoding skills, however, more strategies need to be explored (e.g., speech reading, morphographic instruction). While English is an alphabetic language and teaching grapheme-phoneme relationships are important, proficient readers process English words morphographically (Frost et al., 2005). Because of this, morphographic interventions should be considered when planning literacy instruction for DHH students.

Morphographic instruction

Morphographic instruction comprises the study of word structure, the rules for combining morphographs to create words, the instruction of morphographs and their meanings within the context of print (Harris, Schumaker, & Deshler, 2011; Wood, Mustian, & Cooke, 2010). This type of instruction is consistent with the final stage of visual analysis of decoding or the orthographic stage. Decoding entails three stages of visual analysis: logographic, alphabetic, and orthographic (Frith, 1985). During the logographic stage, the reader uses visual analysis skills, previous exposure to print and word knowledge to gather contextual knowledge to decode. During the alphabetic stage, the reader visually analyzes the letters and uses phonological awareness to sound out the

words. During the orthographic stage, the reader processes the word in orthographic chunks or morphographs (Firth) which is more efficient and more indicative of a proficient reader (van Hoogmoed et al., 2013). There is a possibility that a reader does not have to pass through each stage while learning to read. Students who have not mastered the alphabetic principle have benefitted from morphographic instruction (Arnbak & Elbro, 2000) and are better able to interpret unfamiliar written words (Nagy et al., 2006).

Morphographic instruction is essential for several reasons. First, context clues and direct instruction of novel words is limited (Wysocki & Jenkins, 1987). Morphographic analysis provides the reader with an additional tool to decode new words. Second, Nagy and Anderson (1984) estimated that 60% of the novel vocabulary children encounter while reading could be morphographically decoded for meaning. Third, many morphographs are spelled the same across words even when their pronunciation changes (e.g., heal and health; McCutchen, Logan, & Biangardi-Orpe, 2012) and are combined in a rule-based manner (Chomsky, 2005). This regularity allows readers to look for orthographic patterns (Griva & Anastasiou, 2009) in order to process text in orthographic chunks (Van Hoogmoed et al., 2013). Lastly, word families based on morphographs (e.g., unicycle, bicycle, and tricycle) assist in recognition of new words. This effect is larger for big morphographic word families (Carlisle, 2000). Teaching morphographs explicitly would allow DHH students to improve their morphographic knowledge, morphographic analysis skills and process text in orthographic chunks that may positively influence decoding.

Morphographic instruction and typical readers

Morphographic instruction has been implemented with elementary students with positive results (for a review see Reed, 2008). With elementary-age learners, Apel, Brimo, Diehm, and Apel (2013) utilized a pre/posttest group design with 61 kindergarteners through second graders. The intervention focused on sorting, finding and listening to words with the target morpheme or morphograph in small groups for 25 minutes a day, 4 days a week for 9 weeks. At posttest, all of the study participants had improved their word identification skills with medium to large effect sizes (kindergarten, $d = 0.85$; first grade, $d = .58$; second grade, $d = .50$). Researchers found that morphographic instruction coupled with context clue instruction improved fifth graders' ability to decode morphographically decipherable words (Baumann et al., 2003) with an immediate improvement in students' ability to decode words that contained a taught morpheme (Baumann et al., 2002). Henry (1989) compared morphographic instruction to phonological instruction with third, fourth, and fifth ($N = 443$) grade students randomly assigned at the classroom level to one of two conditions (i.e., morphographic or phonological instruction). Students in the classrooms that received the morphographic instruction made significant gains in decoding when compared to outcomes for students who received the phonological instruction. Vadasy, Sanders, and Peyton (2006) explored morphographic word analysis in two studies using a quasi-experimental non-equivalent groups design with second and third grade ($N = 46$) students who were struggling with decoding. A paraprofessional implemented the intervention individually for 30 minutes a day, 4 days a week for 20 weeks. The intervention included instruction in word-level skills, morphographic word analysis and oral reading. As a result of intervention,

participants in both studies increased their decoding scores (Vadasy et al.). Morphographic instruction has also been investigated with older readers.

Morphographic instruction has been implemented with hearing middle students with only one study measuring decoding. Wysocki and Jenkins (1987) employed a group design randomized at the classroom level with fourth, sixth, and eight grade students (N = 217). The authors chose two word sets that included 12 word pairs each. The word pairs were selected because they were morphographically-related (e.g., friendly, unfriendly, friendship) and low-frequency words. The participants were taught only one word set but were tested on both. The researchers taught the words through explicit, fast-paced instruction that included choral responding. After intervention, the participants read a novel word containing a taught morpheme within context. When decoding the novel word, some participants gave a morphologically similar word that was not the appropriate part of speech to complete the sentence (e.g., sapient for sapience). The researchers concluded that while these answers were not correct, they may not have been completely wrong. Although the decoded word was not in perfect form, it still provided the reader with some information to support comprehension of the text surrounding the novel word (Wysocki & Jenkins, 1987). These results suggest that middle school readers can use morphological information to decode words for meaning but that they may not always apply morphographic rules accurately. Another population that has benefitted from morphographic instruction is students with disabilities.

Morphographic instruction and readers with disabilities

Morphographic instruction has been implemented with readers who have high incidence disabilities (Harris et al., 2011; Wood et al., 2010). Harris and colleagues

(2011) employed a comparison group design ($N = 230$) and randomly assigned high school classrooms to one of three conditions: word mapping, vocabulary LINCing (Ellis, 1992), and a test-only condition. Intervention occurred over 10 days at 45 minutes per session. Each group received pre- and post-intervention testing on word knowledge. The word mapping condition included instruction in a word analysis strategy that students could use to infer meanings of unfamiliar words. First, the student used a graphic organizer to deconstruct the word into its word parts or morphographs. Second, the students used a reference guide to find the meaning of the morphographs. Third, the students predicted the meaning of the new word. Last, they checked the meaning by looking up the unfamiliar word up in the dictionary. The second condition, vocabulary LINCing (Ellis, 1992), required the students to learn a mnemonic strategy to aid them in recalling the vocabulary words' meanings. First, the students wrote the word and its definition. Second, the student identified words that would help remind them of the unfamiliar word. Third, the students generated a story that connected the reminder word to the unfamiliar word and drew a picture of the important parts of the story. Lastly, the students tested themselves by recalling the reminder word, story, and picture that led to the unfamiliar word's meaning. The test-only condition received business-as-usual instruction from the district-approved curriculum with no special emphasis on vocabulary. Under the three conditions, students in the word mapping group decoded novel words for meaning (Harris et al., 2011) more accurately than students in the other two conditions. Importantly, this intervention was carried out using instruction through print English (Harris et al.) which would make this type of instruction suitable for DHH readers (Gaustad, 2000).

Morphographic instruction and DHH readers

At present, there are no morphographic intervention studies with DHH participants that measured decoding. However, Researchers in the United Kingdom implemented a researcher-created morphographic intervention and measured spelling, reading comprehension, and written expression outcomes (Nunes et al., 2010). Nunes and colleagues (2010) used a pre/posttest group design that included a morphographic intervention ($N = 85$) and control condition ($N = 88$) (Nunes et al.). The study included DHH participants from age 6 to age 12 (M = 10 years, 4 months) who were randomly assigned to one of the two conditions at the classroom level. The researchers developed a 10 week intervention complete with teacher-led explicit instruction, board and computer games, books, and sentence completion activities (e.g., The dog walked home). The intervention included morphographic instruction (e.g., past, present and future morphology or affix meanings) and sentence completion (e.g., The apple tree grows) tasks among other activities. The teachers implemented the 10 week intervention for 4-7 months because instruction was presented at the student participants' learning pace. None of the intervention classrooms finished the entire intervention. Although no one completed the instruction, the intervention group performed better on the posttest in all three assessed areas: spelling, reading comprehension and written expression (Nunes et al., 2010). This intervention study did not measure the discrete skill of decoding even though decoding skill is a predictor of reading comprehension (McCardle et al., 2001). The researchers demonstrated that explicit morphographic instruction could improve DHH students' reading comprehension; however, it cannot currently be considered an evidence-based practice for this population according to the guidelines set forth by Odom

and colleagues (2005). The researchers further demonstrated that teaching morphographic skills through explicit teacher-led instruction using visual print-oriented approach (e.g., PowerPoint® slides, sentence completion, and books) was effective for this population. Visual strategies to teach morphographs may utilize DHH students' existing enhanced visual processing skills (Musselman, 2000).

Visual strategies for DHH students

Evidence exists to support the importance of visual strategies for DHH learners (Easterbrooks & Stoner, 2006; Easterbrooks & Stephenson, 2006; Luckner, Slike, & Johnson, 2012; Perfetti & Sandak, 2000). DHH individuals may have enhanced visual memory (Cattani, Clibbens, & Perfect, 2007) and may use or manipulate the visual code differently (Odom, Blanton, & McIntire, 1970) when compared to their hearing counterparts. DHH students may learn print-based skills (e.g., morphographic strategies) more readily (Evans, 2004) than other skills. For example, weak DHH readers use visual analysis skills while reading English more effectively than weak hearing readers (Hirsh-Pasek & Freyd, 1983a). In addition, Clark, Gilbert and Anderson (2011) found visual analysis skills used while decoding were more effective for college-age DHH readers. Gaustad (2000) suggested that DHH readers have a natural tendency to use regularities in English orthography to assist in decoding. Hirsh-Pasek & Freyd (1983b) found that DHH readers could identify word pairs with 90% accuracy. Arnbak and Elbro (2000) noted that the association between morphemes and their orthographic representations is more reliable than the phoneme-grapheme associations. Perhaps, this natural inclination and reliable association should be capitalized on by providing this population with explicit

instruction on these orthographic regularities or morphographs. One explicit instructional method that has been investigated with DHH students is DI.

Direct Instruction and DHH students

DI was developed by Siegfried Engelmann and Wesley C. Becker in the 1960's and is based on Engelmann's theory of instruction. This theory suggests that a student's learning can be enhanced by clear, carefully sequenced instructional presentations and generalization strategy instruction (Marchand-Martell, Slocum, & Martell, 2004). Teachers should convey information in a clear, succinct and effective manner. The teacher scripts associated with DI provide lesson and teacher consistency (Trezek & Wang, 2006). Further, DI programs use particular teaching strategies. These strategies include: (a) achievement-based groupings, (b) small group instruction, (c) fast-paced lessons, (d) frequent choral responding, (e) and vigilant monitoring of each student's progress (Carnine, Silbert, Kame'enui, & Tarver, 2004; Marchand-Martell et al., 2004). There is evidence that DHH students benefit from DI programs paired with visual strategies (e.g., VP).

DI programs have been implemented with DHH populations to improve varying dimensions of literacy (Guardino et al., 2011; Trezek & Malmgren, 2005; Trezek & Wang, 2006). *Corrective Reading Decoding A* (Engelmann, et. al, 1999) was implemented with DHH middle school students ($N = 22$). The researchers supplemented the curriculum with VP and Baldi. Baldi was software that showed facials movements related to different sounds and words. The treatment group made significant gains in grapheme-phoneme correspondence and pseudoword decoding. Trezek and Wang (2006) implemented *Reading Mastery I* with 13 DHH kindergarteners and first graders ($N = 13$).

The intervention was in place for a year and was also supplemented with VP. Employing a pretest/posttest group design, the researchers discovered that the students improved their decoding, psuedoword decoding, and reading comprehension skills. Lastly, Guardino and colleagues (2011) employed a multiple case study design to determine the effects of a DI curriculum called *Teach Your Child to Read in 100 Easy Lessons* (Engelmann et al., 1983). There were six DHH participants from seven to twelve years of age included in the study. The curriculum was again supplemented with VP. Upon completion of the study, all the participants demonstrated gains in phonological decoding. These findings suggest that DHH students may benefit from modified DI literacy curriculums that are supplemented with visual strategies that address the population's unique learning needs. A DI curriculum that teaches morphographs is *Spelling through Morphographs* (Dixon & Engelmann, 2007).

Spelling through Morphographs (Dixon & Engelmann, 2007) is a DI curriculum that teaches derivational and inflectional morphographs through scripted lessons and planned practice. The curriculum includes affix meaning instruction, word building, word dissecting, and spelling rule activities (Dixon & Engelmann). *Spelling through Morphographs* has been implemented with typically hearing fourth, fifth (Maggs et al., 1981), and seventh graders (Robinson & Hesse, 1981) with positive effects on spelling. Berninger and colleagues implemented *Spelling through Morphographs* with fourth through ninth grade students with dyslexia (Berninger et. al, 2007) with positive effects on word decoding accuracy. To date, this curriculum has not been investigated with DHH students. Researchers have suggested that explicit morphographic instruction

similar to the instruction found in *Spelling through Morphographs* should be investigated with DHH readers (Gaustad, 2000).

Future Directions

Some skilled DHH readers rarely use phonological coding while reading (Clark et.al, 2011). These individuals may be effectively using a morphographic decoding approach (Allen et. al, 2009; Clark et. al, 2011; Freel et al., 2011; Gaustad, 2000). Although DHH readers use morphographic strategies while they read to provide access to word meanings (Clark et. al, 2011), there is debate regarding how these strategies develop without explicit instruction. Nunes, Bryan, and Bindman (2006) discovered a two-way causal relationship between literacy and morphographic knowledge that suggests readers develop morphographic strategies over time through this relationship. Since DHH readers have delayed morphographic knowledge at a young age (Gaustad, 1986), they may experience the "Matthew effect," or the gap between proficient readers and struggling readers that widens over time. If DHH readers experience the "Mathew effect," then the two-way causal relationship between literacy and morphographic knowledge (Nunes et al., 2006) would not be as beneficial to DHH readers as it is to typical readers. DHH readers would require more explicit instruction in morphographs than other readers to close the gap. Future research investigating the effects of morphographic instruction on DHH students' morphographic knowledge is required to determine if this type of instruction would influence DHH students' decoding skills positively (Gaustad, 2000).

Morphographic instruction could provide DHH readers with an alternate and additional word attack strategy that could improve their literacy skills. Easterbrooks and

Beal-Alvarez (2013) recognized the lack of evidence-based practices in the field of deaf education. These two researchers suggested that, when there is not an evidence-based practice to teach a skill, teachers should choose strategies that include several of the following qualities: higher order thinking skills, communication between the teacher and student, visual strategies, explicit instruction and scaffolding. Morphographic analysis instruction incorporates several of these qualities such as visual strategies, explicit instruction, and scaffolding. Future researchers should test this strategy empirically to determine if morphographic analysis should be included in a DHH student's daily literacy instruction. There are several morphographic instructional strategies that employ the qualities suggested by Easterbrooks and Beal-Alvarez.

First, Harris et al.'s (2011) morphographic word mapping strategy employs explicit instruction and visual strategies. Future researchers may consider teaching DHH students to dissect words into their morphographic units using the word-map visual organizer. The strategy includes dissecting words morphographically, explaining the component morphographs and putting the morphographs back together to define the novel word (Harris et al.). Determining if DHH students can do this would inform the knowledge base surround morphographic and literacy instruction for this population. DHH students have had success with visual organizers in the past (Easterbrooks & Stoner, 2006; Lang & Steely, 2003) and could benefit from the visual nature of this strategy.

Second, DI curriculums employ several of the qualities outlined by Easterbrooks and Beal-Alvarez (2013). Specifically, *Spelling through Morphographs* is a DI curriculum employs visual strategies and explicit instruction to teach word dissecting,

word building, affix instruction and morphographic spelling rules. The curriculum also requires clear communication between the teacher and the student. Future researchers may consider implementing this curriculum with modifications (e.g., deliver the instruction using sign language, adding visual prompts) for DHH students and measure the curriculums' effects on morphographic analysis.

Conclusion

Recent literature reviews have determined that there is a need for high–quality literacy intervention research with DHH students (Easterbrooks & Stephenson, 2006; Luckner & Cooke, 2010; Luckner et al., 2006; Luckner & Urbach, 2011; Tucci, Trussell & Easterbrooks, in press). Since the turn of the 21st century, when the National Reading Panel (National Institute of Child Health and Human Development, 2000) identified phonology as one of the six key factors in literacy success, there has been a surge of research on the effectiveness of phonological methods to teach grapheme-phoneme correspondence to deaf children (Beal-Alvarez et al., 2011; Bergeron et al., 2009; Guardino et al., 2011; Syverud, Guardino, & Selznick, 2009; Tucci & Easterbrooks, 2013) with mixed results (see review, Allen et al., 2009). Some skilled DHH readers do not employ phonological coding while reading (Clark et al., 2011) and may be using morphographic knowledge to facilitate word reading (Allen et. al, 2009; Clark et. al, 2011; Freel et al., 2011; Gaustad, 2000). However, DHH students exhibit a morphographic knowledge delay. This delay has an effect on decoding and in turn reading comprehension (Clark et al., 2011; McCardle et al., 2001). Future researchers should investigate morphographic instruction with DHH readers to determine if this strategy could improve their morphographic knowledge and later decoding skills.

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CHAPTER 2

EFFECTS OF MORPHOGRAPHIC INSTRUCTION ON THE MORPHOGRAPHIC ANALSYS SKILLS OF DEAFAND HARD-OF-HEARING STUDENTS

Deaf and hard-of-hearing (DHH) readers often do not attain grade-equivalent reading levels (Easterbrooks & Beal-Alvarez, 2012; Traxler, 2000) partially because they have weak literacy sub-skills (e.g., decoding, vocabulary; Leybaert, 2000; Gaustad, Kelly, Payne, & Lylak, 2002; Strassman, 1997). Decoding entails using the orthographic representation of a word to accomplish two cognitive tasks: (1) accessing the correct internal lexicon entry and (2) determining the printed word's meaning (Haptonstall-Nykaza & Schick, 2007). One basis for decoding is morphographic knowledge. The smallest units of a language that retain meaning are called morphemes (Reed, 2008). When morphemes are represented through orthography, they are called morphographs (Maggs, McMillan, Patching, & Hawke, 1981). Morphographs include base words, roots, and affixes (Maggs et al.); every word contains one or more morphographs (Dixon, 1991). For example, the word *review* can be analyzed morphographically (i.e. separated into its component morphographs) as *re-* and *view*. *Re-* means *again* and *view* means *to look at*; therefore, *review* means *to look at again*. Morphographic knowledge includes understanding the meanings of morphographs, deconstructing words into their component morphographs, and combining morphographs in a rule-base manner to create a new word or to change the grammatical class of a word. This type of knowledge is positively correlated to later reading comprehension (Carlson, Jenkins, Li, & Brownell, 2013; McCardle, Scarborough, & Catts, 2001) and is critical to grade-level equivalent literacy attainment (Hurry et al., 2005). For typical readers, morphographic knowledge in second

and third grades predicts reading comprehension in fourth through ninth grade after phonological skills are held constant (Deacon & Kirby, 2004; Nagy, Berninger, & Abbott, 2006). Morphographic knowledge also makes a significant contribution to reading comprehension through vocabulary (Kieffer & Lesaux, 2012) because utilizing a morphographic decoding strategy improves one's vocabulary (Baumann et al., 2002; Baumann, Edwards, Boland, Olejnik, & Kame'enui, 2003). Additionally, students who have a larger vocabulary are better readers (Kyle & Harris, 2010). Further, use of morphographic decoding strategies predicts reading comprehension more accurately than decoding strategies based on the grapheme-phoneme relationship (Nunes, Bryant, & Barros, 2012). These findings demonstrate the importance of morphographic knowledge to reading achievement (Deacon & Kirby, 2004; Nagy et al., 2006; Nunes et al., 2012). DHH students often have a morphographic knowledge delay that begins at an early age (Gaustad, 1986) and persists through college (Gaustad & Kelly, 2004). This delay affects their ability to decode text (Kruk & Bergman, 2013), yet, morphographic instruction is rarely included in their daily reading lessons (Gaustad, 2000). Integrating morphographic instruction into literacy education for DHH students may provide this population with a meaning-oriented decoding strategy that could improve their reading comprehension.

Morphographic knowledge aids the decoding process in two ways: (1) by providing the reader with a definition of the word, and (2) by providing information about how the decoded word relates to surrounding words (Carlisle, 2003; Nielsen, Luetke, & Stryker, 2011). Morphographs are separated into two categories: derivational and inflectional. Derivational morphographs are combined to create words. Inflectional morphographs, such as *–ed* and *–s*, provide surface structure grammar (Reichle &

Perfetti, 2003; Verhoeven & Perfetti, 2003). If students analyze words during reading using the two morphograph types (i.e., derivational and inflectional), then they are applying a decoding strategy that gives them clues to the word's meaning and surface-structure grammar (Arnbak & Elbro, 2000; Reichle & Perfetti, 2003). More importantly for DHH students, this strategy is accessible entirely through the visual pathway. English literacy instruction that is focused on the visual part of the language, or morphographemes, may benefit those DHH students who do not access the auditory portions of the language or the graphophonemic relationship (Gaustad, 2000). This visually-oriented instruction (i.e., morphographic instruction) is grounded in the lexical quality hypothesis (Perfetti & Hart, 2001).

Theoretical framework

An extension of LaBerge and Samuel's (1974) automatic information processing reading theory, the lexical quality hypothesis (Perfetti & Hart, 2001) proposes that word knowledge supports literacy skills. Word knowledge is defined as a comprehensive phonologic, morphographic, or orthographic representation accompanied by a semantic representation (Reichle & Perfetti, 2003). Skilled readers process their word knowledge or decode with automaticity (LaBerge & Samuels, 1974; Verhoeven & Perfetti, 2008). Automaticity means processing underlying reading tasks, such as decoding, with minimal cognitive resources (Kelly, 2003). When readers decode with automaticity, the reader frees cognitive resources to comprehend what is being read instead of focusing on text analysis (LaBerge & Samuels, 1974). Early readers have low lexical quality because they often decode words using the individual letters (Verheoven & Perfetti, 2008). As early readers develop, they begin to decode words in orthographic chunks (i.e.,

morphographs; van Hoogmoed, Knoors, Schreuder, & Verhoeven, 2013) employing higher quality lexical retrieval and in turn achieving automaticity of the decoding process. Several issues (e.g., morphographic knowledge delay) can interfere with the decoding process and impede higher lexical quality retrieval. DHH students often have a morphographic knowledge delay that may hinder their ability to decode in orthographic chunks and with automaticity.

DHH students and morphographic knowledge

DHH students often struggle with language and literacy. They tend to have a weak English vocabulary base (Kyle & Harris, 2010; Meadow, 2005) and grammatical knowledge (Lederberg, Schick, & Spencer, 2012). Because of the reciprocal relationship between language and literacy (Storch & Whitehurst, 2002), their language issues translate into later literacy issues. One piece of this language and literacy deficiency is deficient morphographic knowledge. This delay affects DHH students regardless of communication modality (e.g., listening and spoken language [LSL], Signed Exact English, American Sign Language [ASL]; Gaustad et al., 2002; Guo, Spencer, & Tomblin, 2013).

DHH students who use LSL may not hear some morphemes (Guo et al., 2013) and those who use sign language may not see English morphemes (Gaustad et al., 2002) during conversation or instruction. Children who do not gain morphological knowledge through incidental means are deficient in their use of morphemes expressively (Guo et al., 2013). Dixon, Zhao, and Joshi (2012) discovered that children who lack morphemes in their expressive language struggle to understand morphemes when they see them in print (i.e. morphographs). Further, many DHH children are delayed language learners

(Lederberg & Spencer, 2009). Delayed language learners process morphographically complex words inefficiently because they depend on the lexical language level. For example, *rethink* is a morphographically complex word because its meaning is clear from its constituent morphographs. However, delayed language learners will not break the work apart into its constituent parts to determine its meaning. They will look at it as a whole word and attempt to determine meaning (Jiang, 2004). Understanding what delayed language learners do while decoding helps in understanding why DHH children have morphographic knowledge delays. In light of these findings (Jiang), explicit morphographic instruction should be considered to improve DHH students' morphographic decoding abilities.

Decoding and DHH students

Determining evidence-based decoding intervention strategies for DHH students is difficult due to the lack of literacy intervention research conducted in the field (Easterbrooks & Stephenson, 2006; Luckner, Sebald, Cooney, Young, & Muir, 2005/2006). When looking specifically at decoding, Tucci, Trussell, and Easterbrooks (2014) identified twelve empirical studies that met a predetermined standard of rigor; however, none investigated morphographic instructional strategies (Guardino, Syverud, Joyner, Nichols, & Mauer, 2011; Trezek & Malmgren, 2005; Trezek & Wang, 2006). The majority of the studies focused on phonological skills intervention with DHH students and one study investigated fingerspelling (Haptonstall-Nykaza & Schick, 2007).

Researchers have implemented explicit phonological skills interventions with DHH students at various ages (Beal-Alvarez. Lederberg, & Easterbrooks, 2011; Bergeron, Lederberg, Easterbrooks, Miller, & Connor, 2009; Miller, Lederberg, &

Easterbrooks, 2013; Trezek & Malmgren, 2005; Trezek & Wang, 2006; Tucci & Easterbrooks, 2013). The majority of the studies employed Visual Phonics (VP; International Communication Learning Institute, 1996) paired with a Direct Instruction (DI) reading curriculum. VP is a system of handshapes and movements that represent and clarify the English phonemes. Researchers have found that DI reading curriculums (e.g., *Reading Mastery I*, Englemann & Bruner, 2002; *Corrective Reading Decoding A,* Engelmann, Carnine, & Johnson, 1999) supplemented with VP have a positive effect on the phonological decoding abilities of elementary (Guardino et al., 2011; Trezek & Wang, 2006) and middle school DHH students (Trezek & Malmgren, 2005). Conversely, Narr's (2008) study demonstrated that the number of VP instructional years did not correlate to performance on a decoding measure for elementary DHH readers. These findings leave the relationship between instruction that includes VP and decoding unclear (for a review, see Mayberry, del Giudice, & Lieberman, 2011).

Haptonstall-Nykaza and Schick (2007) investigated fingerspelling as a decoding tool. Fingerspelling may be a DHH student's pronunciation method for novel words (Chamberlain & Mayberry, 2008). Haptonstall-Nykaza and Schick (2007) paired the printed English word with its lexicalized fingerspelling during instruction, which increased their DHH participants' ability to recognize the printed word. Although these studies utilizing VP and fingerspelling are encouraging efforts towards developing a decoding strategies evidence base, more investigations into these and other strategies (e.g., speech reading, morphographic instruction) are warranted (Tucci et al., 2014).

Morphographic instruction

Morphographic instruction includes several components: (1) recognizing constituent morphographs within multi-morphographic words (i.e., morphographic analysis), (2) learning the morphographs' meanings, (3) studying the rules to create new words from derivational morphographs, (4) and studying the rules of adding inflectional morphographs to words to indicate surface structure grammar (Harris, Schumaker, & Deshler, 2011; Wood, Mustian, & Cooke, 2010). Those with intact morphographic knowledge are better able to decode novel vocabulary (Nagy et al., 2006). For example, 60% of unfamiliar vocabulary that children attempt to read at the fifth grade level could be morphographically decoded (Nagy & Anderson, 1984). Further, English has more morphologically transparent words than phonologically transparent words (e.g., heal and health; McCutchen, Logan, & Biangardi-Orpe, 2012) allowing readers to look for orthographic patterns (Griva & Anastasiou, 2009). These orthographic patterns or chunks are essential for reading with automaticity (van Hoogmoed et al., 2013). For these reasons, morphographic instruction has been investigated with typical readers, readers with disabilities and DHH readers with encouraging results (Harris et al., 2011; Nunes, Burman, Evans, & Bell, 2010; Wysocki & Jenkins, 1987).

Morphographic instruction and typical readers

Morphographic interventions have been implemented at all elementary grade levels will positive effects on decoding (Apel, Brimo, Diehm, & Apel, 2013; Henry, 1989; Vadasy, Sanders, & Peyton, 2006). Apel and colleagues (2013) utilized a pre/posttest group design with 61 kindergarteners, first and second graders. The intervention focused on sorting, finding and listening to words with the target morpheme

or morphograph in small groups for 25 minutes a day, 4 days a week for 9 weeks. At posttest, all of the study participants had improved their word identification skills with medium to large effect sizes (Kindergarten, $d = 0.85$; 1st grade, $d = .58$; 2nd grade, $d = .50$). Similarly, Vadasy et al. (2006) conducted two pre/posttest group design studies with second and third graders (study 1, $N = 31$; study 2, $N = 35$). Both studies' intervention groups focused on morphographic analysis and the control groups focused on oral reading. The researchers found a large effect size for word identification or decoding (study 1, $d = 0.71$; study 2, $d = 1.06$). Further, Henry (1989) found that adding morphographic instruction to third, fourth and fifth graders' ($N = 443$) daily literacy instruction resulted in increased word recognition ability when compared to typical reading instruction. These findings suggest that morphographic instruction has a positive influence on the decoding abilities of elementary-age readers. Similar results have been documented with older readers as well.

Morphographic interventions have been implemented with older readers; one study measured decoding (Wysocki & Jenkins, 1987). Researchers employed a 3 (4th, 6th or 8th grade) x 2 (taught or untaught words) x 2 (strong or weak sentence context) factorial design using 12 word pairs that were morphographically-related (e.g., unfriendly, friendly) and low-frequency. The researchers randomly assigned the participants to be instructed on one of the two word sets. The intervention was explicit, fast-paced instruction with choral responding. Post intervention, the participants were asked to read a new word with a known morphograph in a sentence that provided contextual information. Although some participants gave morphographically similar words that violated the sentence's grammatical rules (e.g., *different* for *difference*), the

responses were not entirely wrong. The participants decoded the word imperfectly but demonstrated the use of morphographic information to support their text comprehension. These researchers suggested that middle school-aged readers can utilize morphographic information to support word reading for meaning (Wysocki & Jenkins). Other populations that have benefited from strategic morphographic interventions are high school students with and without disabilities.

Morphographic intervention and readers with disabilities

Harris and colleagues (2011) implemented strategic morphographic instruction with high schoolers ($N = 230$) with and without disabilities. The researchers utilized a comparison-group design and randomly assigned nine classrooms to one of the following conditions: word mapping, vocabulary LINCing (Ellis, 1992), and a test-only condition. The word mapping strategy group received instruction on morphographic analysis or word dissection. The vocabulary LINCing (Ellis, 1992) group received instruction on a mnemonic strategy that aided vocabulary recall. The test-only group received business-as-usual instruction from the district approved curriculum. All of the student participants completed word knowledge assessments before and after the intervention. The instruction occurred for 45 minutes a day for 10 days. At post-test, the researchers discovered that the student participants in the word mapping condition decoded novel words for meaning with higher accuracy than student participants in the other two conditions (Harris et al., 2011). Most pertinent to this review, the word mapping strategy intervention was implemented entirely through print English. Instruction that is focused on print English may benefit DHH readers (Gaustad, 2000), who need enhanced visual support for learning.

Morphographic intervention and DHH readers

Although Nunes et al. (2010) did not measure decoding, they are the only researchers that have empirically-tested a morphographic intervention with DHH participants. This team implemented a researcher-designed morphographic intervention and measured spelling, reading comprehension, and written expression outcomes. The researchers utilized a pre/posttest group design with 173 six to twelve year old (M = 10 years, 4 months) DHH participants randomly assigned at the classroom level to two conditions: morphographic intervention condition (N = 85) and a control condition (N = 88). The 10 week morphographic intervention included: explicit instruction, board and computer games, books, and sentence completion activities (e.g., The boy walked home). The control condition included business-as-usual instruction. The 10 week intervention was implemented at student participants' learning pace (four to seven months) and no intervention groups finished the intervention. At posttest, the researchers found that the morphographic intervention group outperformed the control group on spelling, reading comprehension and written expression assessments (Nunes et al., 2010). Although this study did not measure decoding specifically, the results demonstrated that morphographic instruction can improve DHH students' reading comprehension, which suggests an improvement in their reading component skills (e.g., decoding, vocabulary). Further, the intervention instruction was explicit and teacher-led much like Direction Instruction (DI) curriculums that have been successful at teaching DHH students phonology-based decoding skills (Trezek & Malmgren, 2005; Trezek &Wang, 2006).

Direct Instruction and DHH students

DI is based on the theory that student learning can be boosted by explicit, intentionally sequence strategy instruction and generalization strategy instruction (Marchand-Martell, Slocum, & Martell, 2004). DI programs include teacher scripts that provide lesson and teacher consistency (Trezek & Wang, 2006). Moreover, DI programs use particular teaching strategies: (a) skill-level groupings, (b) small group instruction, (c) fast-paced lessons, (d) frequent choral responding, (e) and attentive monitoring of student's progress (Carnine, Silbert, Kame'enui, & Tarver, 2004; Marchand-Martell et al., 2004). There is an emerging evidence-base for using DI programs paired with visual strategies (e.g., VP) to improve the decoding skills of DHH students.

DI programs paired with visual strategies have improved DHH students' decoding skills (Trezek & Malmgren, 2005; Trezek & Wang, 2006). *Corrective Reading Decoding A* (Engelmann et al., 1999) in conjunction with Baldi (software that demonstrated the facial movements of sounds and words; Massaro, 1998) and VP increased the pseudoword decoding of DHH middle school students (Trezek & Malmgren, 2005). Similarly, *Reading Mastery I* (Englemann & Bruner, 2002) paired with VP increased the decoding skills of DHH kindergarteners and first graders (Trezek & Wang, 2006). These researchers' findings indicate that DHH students benefit from DI literacy curriculums supplemented with visual strategies. *Spelling through Morphographs* (Dixon & Engelmann, 2007) is a DI curriculum that teaches affix meaning and morphographic analysis (Dixon & Engelmann). Morphographic analysis instruction is of interest because this skill is positively correlated to decoding abilities (Carlisle, 2000; Kruk & Bergman, 2013). To date, this curriculum has not been investigated with DHH students.

The purpose of this study was to determine the effects of morphographic instruction modeled after the DI curriculum, *Spelling through Morphographs,* on the morphographic analysis skills of fourth to eighth grade DHH students with a reading level between second and fourth grade. The primary research question was: What effect does morphographic instruction have on the morphographic analysis skills of DHH students with a second to fourth grade reading level? The secondary research questions were: If gains are made in morphographic knowledge, will that knowledge generalize to untaught words? If gains are made in morphographic knowledge, will that knowledge maintain over time? What effect does this instruction have on their affix knowledge?

Method

Participants

Four student participants and one teacher participant were included in this study. The study participants met the following inclusion criteria: (1) diagnosed hearing loss, (2) received literacy instruction from a teacher of the d/Deaf/hard of hearing (TODHH), (3) had a literacy goal on current Individualized Education Program, (4) placed in the fourth through eighth grade, (5) had a second to fourth grade reading ability determine by *Woodcock Johnson III Tests of Achievement letter-word identification* (LWI) and *passage comprehension* (PC) subtests (WJ III: Woodcock, McGrew, Mather, & Shrank, 2001), (6) participated in a self-contained DHH classroom for literacy instruction, (7) and had no severe visual, cognitive or physical disabilities that inhibited their ability to utilize the instructional materials. The researcher focused on students who met these criteria because they satisfied the age and reading level requirements of the model curriculum, *Spelling through Morphographs*, as well as could access the curriculum without

extensive modifications. The researcher requested the students' age, degree of hearing ability, expressive and receptive language modality preference, and home language information (Appendix A). This additional information was included to describe the student participants further (see Table 1). One participant was lost due to attrition; he relocated to another school during baseline data collection.

Table 1

Student participants' background information

Student	Grade	Age[a]	Unaided at 1000HZ (L/R) (dB)	Preferred Communication Mode	Amplification	Language in home
Megan	5th	10;2	65/65	Sign/ Speech	HA	English
Sienna	5th	10;0	90/CI	Sign/ Speech	HA &CI	English
Brian	4th	9;3	70/50	Sign/ Speech	HA	English & Cambodian

Note. [a] =Age expressed in years;months; L= Left; R = Right; dB = Decibel; CI=Cochlear implant; HA=Hearing aid.

The teacher participant was the TODHH for the student participants. The inclusion criteria for the teacher participant were as follows: (1) held current certification for teaching DHH students (2) was the teacher of record for the student participants' reading, (3) was willing to attend professional development related to the curriculum, and (4) provided a minimum of 45 minutes daily literacy instruction to the student participants. Teacher participants who satisfied the requirements were recruited to ensure that they had background knowledge about the educational needs of the DHH population and the reading process. Due to unforeseen circumstances, the researcher, a state-certified and experienced TODHH, taught one student participant during the study at the teacher participant's request. The classroom was run by two TODHHs; however, one teacher was not able to participate for health reasons after consenting and completing training for the study. The remaining teacher participant did not feel that she could complete all of the parts of the study independently due to time constraints and the needs of other students not included in the study. The researcher decided to teach one phase of the study to address the teacher participants concerns. The remaining TODHH taught Megan and Brian (pseudonyms). The researcher taught Sienna (pseudonym). This arrangement prevented the TODHH from presenting the intervention material twice in one day to two students separately, which would have been a time commitment of more than a thirty minutes. The researcher obtained approval for this research from her university's institutional review board and the public school district's research review board. Consent, assent and participation approval were obtained prior to participation.

Setting

The study was conducted in a public school setting in the northwestern United States. The classroom included DHH students from kindergarten to sixth grade and two TODHHs. The student participants received instruction in a DHH classroom in a small group setting. The classroom language modality was simultaneous communication; therefore, simultaneous communication (i.e. signing while speaking) was used during assessments, probes and intervention instruction. The assessments, probes, and intervention instruction were conducted in the DHH classroom. The classroom had two circle tables and one kidney table with three to four chairs surrounding them. A tower FM system was used during full group instruction. This technology was not utilized during the study because the intervention was delivered in a one to one setting.

Research design

This study followed a multi-probe multiple baseline across participants design (Kazdin, 2011). The design included several phases (Phase A, B, C, D, and E) and three tiers (student participants). Prior to baseline, the student participants completed a pre-test that contained possible multi-morphographic words for the intervention. The words were taken from the school district's grade-level spelling lists. The pre-test test items were assessed in the following manner: _____ +_____= adduct with ad + duct = adduct scored as the correct answer. The researcher chose 10 target words from the pretest that all of the student participants were unable to dissect. These 10 target words were separated into two sets of 5 words for the two intervention phases (Phase B and D). Each set met these criteria: all the words had two morphographs, two words had eight to nine letter words and three words had ten to twelve letters (Harris et al., 2011).

In phase A, baseline was established for all student participants. The baseline probe (Appendix B) included a word dissection task for the ten target words. A correct answer would be ad + duct= adduct or gull + ible = gullible. The researcher scored these measures and graphed the students' percentage of correct responses. Baseline was established for participant one when she demonstrated a minimum of five consecutive data points with a mean score of 20% or less correct responses out of ten possible responses on the baseline probe. All other student participants established baseline through a minimum of five probes with three of those probes occurring consecutively prior to intervention. Each baseline tier was required to have a mean score of 20% or fewer correct responses out of ten possible responses on the baseline probe before the researcher initiated the intervention (Phase B).

Phase B was the first intervention phase. Prior to each intervention session, the student participant completed the repeated measure that included morphographic analysis (i.e. ___ + ___ = dental) of the intervention phase's five target words. The researcher scored these measures and graphed the students' percentage of correct responses. Phase-change criteria for the intervention phase (Phases B) included a minimum of five data points with a score of 80% or better correct responses out of five possible responses on the repeated measure for three out of four consecutive data points. When the student met these mastery criteria, the next student participant began intervention and the current student participant moved on to the generalization phase, Phase C. If a student participant scored a 20% or less on the repeated measure for a maximum of ten sessions, that student participant would be excused from the study and the next participant would be entered into intervention when baseline criterion was met. Data collection for all

intervention phases concluded when the student met mastery criteria. Once data collection had ceased for the intervention phase B, phase C began.

During the generalization phase, or phase C, the baseline probe was administered the session after the data collection for phase B concluded. At this point in the study, the student participant had received instruction on 5 out of the 10 words on the baseline probe. The phase-change criteria for phase C were two pronged: (1) a score between 0% and 80% on the probe, the student entered intervention for the second set of words or (2) a score above 80% the data collection ceased and maintenance was collected after 10 sessions. Scoring above 80% on the baseline probe meant that the student had generalized the morphographic analysis skill and did not require further intervention. Otherwise, the student entered the second intervention phase, Phase D.

Similar to phase B, the student completed the researcher-created repeated measure that included the second set of five target words before intervention each day. The phase change rule for phase D was a minimum of five sessions with a score of 80% or better on the repeated measure for three out of four consecutive phases or a maximum of ten sessions with 20% or fewer on the repeated measure. Once the student reached mastery criteria in phase D all data collection ceased, and phase E began. Phase E was a maintenance phase.

Phase E included administering the baseline probe ten sessions after data collection ceased for phase D. The students completed the baseline probe with all ten words that were instructed. The researcher scored the probes and graphed the scores.

Materials

Pretest materials. The first measure was a researcher-created pretest that included 30 words from the district curriculum that were potential target words. The students attempted to analyze each word morphographically (e.g., ___+____=biannual). Also, the pretest included a word reading and word comprehension assessment of the base words that were taught in the curriculum. For example, the test had the word *annual* in print. The researcher asked the student to read the word aloud (through sign or speech) and to tell the researcher what that word meant. This pre-test was given for several reasons. First, it was given to determine the word sets for the study and to ensure the student participants had not previously acquired the skills targeted by the intervention. Also, the student's base-word knowledge may affect their ability to analyze the derived form (Carlisle & Katz, 2006). For example, if one did not know the base form *pack* then one may struggle to analyze the derived form *repack*. Three more pretests were administered that were not researcher-created.

Two subtests of the WJ-III were administered to verify the student participants' reading ability level. The first subtest administered was the LWI subtest. During this assessment, the student participant is asked to recognize different English letters or read words that were presented on a flipbook. The second subtest that was administered is the PC subtest. During this assessment, the student participant read sentences or passages with missing words that were presented on a flipbook. The student participant tried to determine what the missing words should be to make the passage complete. Second, the *Morphemic Awareness Test* (Luetke, Stryker, & McLean, 2013) is a measure of students' awareness of the associations of base and derived or inflectional morphographs. This

measure was created specifically for use with DHH students. The task included the presentation of a sentence with four answers choices. The students must read or have the sentence read to them and then choose the correct derived or inflected form that completes the sentence. This assessment informed the researcher of the student participant's current morphological knowledge. Reliability and validity data for this measure are not available at this time, but the assessment was chosen because it was created specifically for DHH students and readily available. The original assessment had three test items for each morphograph tested; however, the researcher chose to present one test item for each morphograph due to time restrictions. The student participants completed the assessment in a permanent product format. These three assessments were given prior to baseline.

Intervention materials. Several materials were required in order to implement this study. First, the teacher participant and researcher delivered 10 daily lessons modeled after the *Spelling through Morphographs* presentation book during intervention instruction time. In addition, the researcher created 40 visual organizer pages (20 for the teacher, 20 for the researcher; Appendix H) that could be reused and were part of the daily instruction. The teacher received a *Spelling through Morphographs* teacher guide book to review prior to intervention. This book provided an overview of the curriculum and some strategies to improve student learning. Each student had 10 workbook pages modeled after the *Spelling through Morphographs* workbook.

Baseline/generalization/maintenance probes. The baseline/generalization/maintenance probes and repeated measures were modeled after the curriculum's workbook exercises. The probe consisted of morphographically

analyzing 10 target words (see Table 2) with two morphographic units (e.g., ___+___= dental). The two repeated measures were similar to the probe but contained five words each. These words were taken from the 10 words on the probe. The measure was created to mirror activities in the *Spelling through Morphographs* student workbook.

Table 2

Target words lists

Intervention Week 1	Intervention Week 2
assistant	biannual
mythology	adduct
amoral	actually
section	difference
dental	gullible

Validity and fidelity measures. Two researcher-created social validity measures were completed to determine the validity of this intervention within the school context. The teacher participant (Appendix C) and student participants (Appendix D) completed a social validity measure. The measures asked different questions in a similar format. The final materials were fidelity measures. The researcher adapted an instruction implementation fidelity measure (Appendix E) that is used widely with Direct Instruction programs. The original measure included a zero to three rating for each area. It was adapted to include percentages of occurrence to correspond to the zero, one, two or three rating. For example, if the teacher followed the script 80% of the time, the teacher would be given a score of 3. The researcher created the assessment and probe implementation fidelity measure (Appendix F). This measure was a checklist created to ensure that the probes and repeated measures were administered in the same manner each time.

Independent and dependent variable

The independent variable for this study was morphographic instruction modeled after *Spelling through Morphographs* curriculum for 20 minutes a day, five days a week for two to three weeks. The researcher chose to use the curriculum *Spelling through Morphographs* as a model because this instruction has had positive effects on morphographic analysis skills for students with and without disabilities (Berninger et al., 2007; Hesse, Robinson, & Rankin, 1983). However, the curriculum's instructional and practice activities were not consistent, which made implementing the curriculum using single case design research methods difficult. Further, it was not developed for students with hearing loss and required an additional visual organizer (Appendix H) to meet the unique learning needs of the DHH population (Easterbrooks & Stoner, 2006). To solve

these issues, the researcher modeled lessons after those found in the curriculum and had the lessons approved by a senior researcher familiar with DI curriculums. Also, the researcher created workbook pages that were consistent from lesson to lesson and modeled after *Spelling through Morphographs.*

The dependent variable for this study was correct responses to five morphographic analysis items (e.g., _____ + _____= gullible; Harris et al., 2011). There were two sets of five target multi-morphographic words created from the pretest results. There were several versions of each repeated measure. The items themselves remained unchanged but the numerical order of the items was varied to ensure that the students were not able to memorize the order of the answers over time.

Procedures

Once approval was attained, the researcher contacted the building principals of the approved site. The researcher explained the study and the principal gave the researcher the two TODHHs' contact information. The researcher held a meeting at the school, and both teachers agreed to be a part of the study.

After the teacher participant consents were signed, a letter was sent home to the families whose children met the criteria. The researcher answered all parent inquiries and parental permission was obtained. Lastly, the researcher discussed the study with each potential student participant. The student participants assented by signing a letter explaining the research study. The letter was read to them if the child did not have sufficient literacy skills to read the letter independently. Next, the teacher participants received training in implementing the activities.

The researcher held a one day, two hour training in the teacher participants' classroom. The teacher explained the nature of Direct Instruction and taught several practice lessons (Stephenson, Dostal, & Wolbers, 2013). During the training, the teacher participants taught an example lesson. Teacher participant 1 received a 91% implementation fidelity score and Teacher participant 2 received a 95% fidelity score. A proposed study schedule was discussed. Prior to intervention, the researcher conducted four pre-intervention observations to ensure that morphographic instruction was not part of the teacher participants' daily literacy instruction.

The researcher observed the teacher participants teaching reading to the student participants on four separate occasions. Two observations were announced, and two were unannounced. The researcher was looking for the following types of instruction: word dissecting, word building, affix instruction, or morphographic spelling rules. Although the researcher did not witness any direct morphographic instruction, there was a small poster on the classroom wall that included the word 'prefix' and it's definition. Also, the teacher participants' self-reported that morphology was part of their instruction, but this was not verified through the observations. At the point, pretesting began.

The researcher administered the *WJ-III*, *Morphemic Awareness Test* and the researcher-created target word pre-test to the student participants prior to collecting baseline data. The student received no feedback during the test. The researcher scored all assessments and determined the 10 target words from the results of the target word pretest. The teacher participant agreed not to instruct on morphographs, including the 10 target words for the duration of the research study.

Baseline/probe phase. During the first session, baseline probes were administered to all student participants individually. When administering baseline probes, the teacher participant obtained assent, distributed the assessment or probe, requested that the student wait for further instructions and provided scripted instructions. The script mirrored the script of the curriculum during planned practice. For example, the teacher said, "Fill in the blanks to show the morphographs in each word." The following is how the task appeared to the student participants: _____ +_____= biannual or _____ + _____ = mythology. The correct answers were bi + annual = biannual or myth + ology = mythology. The student participant worked on the probe for no more than ten minutes. The TODHH collected the assessment and provided no feedback. The researcher scored the assessments and recorded the percentage correct. This procedure was repeated for a minimum of five sessions or until stability was established (Kazdin, 2011). Once baseline was established for participant one (Megan), intervention began for that participant. This procedure occurred for a minimum of five sessions before the second (Sienna) and third (Brian) students entered intervention, with three of those sessions occurring consecutively prior to intervention or until baseline was stable (Kazdin, 2011). Affix meaning scores were also obtained from the student worksheets. Although, these data did not determine phase changes, the researcher was interested in the student participants' ability to determine, through matching, the taught affixes' meanings. One affix meaning accuracy data point was collected in baseline before the intervention began.

Intervention phases. At the beginning of the intervention session each day, the teacher participant or researcher assessed the student participant using the procedure

described previously. The TODHH instructed Megan and Brian. The researcher instructed Sienna. The teacher participant or researcher obtained the student participants' assent prior to initiation of the session by asking if the student was "ready to work on word parts." Next, the TODHH or researcher followed the lesson script and conducted the lesson as described. The lessons included affix instruction, word building and word dissection instruction daily. In addition, the lessons included fast-paced instruction, and interactive communication between the teacher or researcher and the student. The teacher participant or researcher used sign language and fingerspelling to present the lessons. The TODHH and researcher agreed to fingerspell the word morphograph during instruction and assessment sessions. The student participant responded to questions through sign language or voice.

Further, the TODHH or researcher employed correction procedures prescribed in the model curriculum, *Spelling through Morphographs*. The first correction procedure was applied to the morphographic analysis practice. The researcher provided laminated cards that have the following printed on them: _____ + _____=_____. If the student made a mistake on the morphographic analysis during planned practice, then TODHH or researcher analyzed the word correctly using the graphic organizer and the student corrected the workbook page. The second correction procedure was used during affix instruction and practice. If the student made mistakes during the affix instruction, the TODHH or researcher utilized a model, test and delayed test correction procedure from *Spelling through Morphographs*. This correction procedure had three steps: (1) the TODHH or researcher modeled the answer, (e.g., "The morphograph re- means again.") (2) the TODHH or researcher asked the student to tell her the answer that was just given

(e.g., “What does the morphograph re- mean?”), and (3) the TODHH or researcher delayed for a few seconds and tested again (e.g., “What is the morphograph? What does the morphograph re- mean? Please correct your paper.”) Planned practice included word dissection (_____ + _____ = assistant), affix definition matching (ant=a person or thing that does something), word meaning (_____ a person or thing that helps) and sentence completion (My _____ helps me with everything.). The TODHH or researcher gave the student feedback on the workbook pages. Make-up sessions were provided if students were absent. When Phase B phase-change criteria were met, the generalization phase, or phase C, began. Simultaneously, another student began intervention. Affix meaning accuracy data were obtained from the student worksheet daily prior to correction. Generalization or maintenance data were not collected for affix meaning.

Generalization phase. Procedures, during the generalization phase, were the same as for baseline. The teacher gave the ten-word baseline/generalization/maintenance probe during one session after the participant met mastery criteria for phase B. The student received no feedback from the teacher. The researcher scored the probe and graphed the score. If the student scored between 0 and 80%, then TODHH or researcher started the second intervention phase or phase D. If the student scored above 80%, then the student generalized the skill and did not need the additional intervention phase. If this occurred, data collection would cease, and the student would begin the maintenance phase.

Maintenance phase. Once Phase D data collection ceased, the student participant did not interact with any of the intervention materials. After ten sessions, the

researcher or teacher followed the same procedures established during baseline. The student participant completed a maintenance probe. The researcher scored the probe and graphed the percentage correct that the participant achieved.

Social validity

Participants also provided information on a social validity assessment that evaluated the effectiveness of the intervention in terms of ease of implementation, appropriateness to setting, cost effectiveness and perceived benefit to the teacher and student participants. Ratings are addressed in the results section.

Fidelity

Fidelity was collected on the baseline/intervention/generalization/maintenance sessions, intervention implementation, and permanent product scoring. All assessment and intervention sessions were digitally recorded to aid in collecting fidelity and reliability scores. Fidelity was collected on 50% of the assessment sections. The research used a fidelity checklist (see Appendix F) to collect fidelity on the sessions run by the TODHH and a second rater collected fidelity on the sessions run by the researcher. 97% average assessment fidelity was obtained (range = 78 % to 100%). A third rater was trained to collect reliability data for the purpose of establishing interrater reliability (IRR) through watching the video recorded assessment sessions. During training, 90% average IRR was achieved on practice sessions before the rater began rating IRR sessions independently. Reliability was calculated through point by point agreement (Kazdin, 2011) with an expectation of 88% or better. If an 88% or better IRR was not obtained, retraining was considered. The third rater collected IRR on 30% of the 50% assessment

videos used for fidelity data collection. 97% average IRR was calculated (range= 86% to 100%).

During the intervention, the researcher and a second rater collected implementation fidelity (Appendix E) on a fidelity rating form. Implementation fidelity of 88.9% or better was expected or teacher retraining was required. The second rater was trained to recognize the parts of the intervention and to complete the fidelity rating form for the sessions that were taught by the researcher. 93% average implementation fidelity was calculated (range = 90% to 98%). The third rater was also trained to complete the implementation fidelity form for the purpose of collecting IRR data. During training, 90% or better IRR on practice sessions was obtained before the third-rater viewed IRR sessions. Treatment fidelity IRR was calculated through point by point agreement (Kazdin, 2011). Once 90% or better reliability was obtained in training, the third rater completed an identical rating form on 30% of the 50% intervention sessions used for implementation fidelity data collection. 90% average IRR was calculated for the intervention sessions (range = 87% to 93%).

The second rater was also trained to obtain reliability on scoring the repeated measures. The training target of 100% reliability was set for the practice papers, and this condition was met before the rater was permitted to score papers independently. The second rater scored 50% of the permanent products, which were calculated through point by point agreement (Kazdin, 2011). Reliability was calculated and reached the established criterion of 100%. The third rater collected IRR on 30% of the 50% permanent products throughout the study. Reliability for the third rater was calculated

through point by point agreement and also reached the established criterion of 100% on the permanent products.

Results

Pre-intervention results. Before initiating baseline data collection, the researcher administered several assessments to ensure that the student participants met the inclusion criteria and to understand their skills better. The first assessments were the WJ-III LWI and PC subtest. All of the student participants scored above the third grade level on word recognition (see Table 3). Further, the student participants' had passage comprehension abilities at or above the second grade level. The second assessment administered before baseline was the *Morphemic Awareness Test* (Luetke, Stryker, & McLean, 2013). Overall scores are presented in Table 3. Megan struggled with the derivational morphographs *un-, -th, mis-, -ful*, and *pre-*. Sienna struggled with the morphographs *–ness, mis-,* and *im-*. Lastly, Brian struggled with several morphographs: *–ly, dis-, mis-, -less, re-, -ment, -ness, pre-, -ent, -able, -ous*. According to the district curriculum, all of the morphographs that Megan and Sienna struggled with should have been mastered by the end of fourth grade. For Brian, seven out of eleven of the morphographs he struggled with should have been mastered by third grade. These findings indicated that these students were not meeting minimum district grade-level requirements in the area of morphology, warranting the present intervention. Finally, the researcher asked each student to read and give a definition of the base words that would be part of the intervention. Megan and Sienna could read all of the base words but could only define one word, *assist*. Brian could decode the word *dent* but could not define any of the target base words.

Table 3

Students' pre-intervention assessment scores

Student	Grade	WJ-III Letter/Word ID [a]	WJ-III Passage Comprehension [a]	Morphemic Awareness Score [b]
Megan	5th	3.8	3.4	70%
Sienna	5th	4.4	3.1	91%
Brian	4th	3.0	2.1	45%

Note. [a] = grade equivalency expressed in grade level.months; [b] = percentage correct out of 33 test items, WJ-III = *Woodcock Johnson III Tests of Achievement*, ID = identification

Intervention results. After scoring the repeated measures, the student participants' morphographic analysis scores were graphed using the multiple baselines across student design (Kazdin, 2011). The affix meaning scores were collected from the daily student worksheet. Visual analysis of the morphographic analysis data paths was used to analyze the results at the student level. The researcher evaluated the morphographic analysis data for the following features: stability, level, trend, immediacy of effect, percentage of overlapping data, and consistency as suggested by Kratochwill et al. (2010).

Megan

Morphographic analysis. Figure 1 below presents Megan's data. The path indicated with a circle denotes her morphographic analysis data. During baseline, Megan demonstrated a mean accuracy of 14%, and she met the criterion to enter intervention. During the first intervention phase, there was a change in level (M = 14 % to M = 100%) and an immediacy of effect from 6.7% to 100% accuracy. Megan's intervention data scores presented a stable trend at 100% accuracy which met the criteria to enter the generalization phase. Megan obtained 60% accuracy on the generalization measure, which met the criteria for her to enter the second intervention phase. The second intervention phase data were consistent with the first intervention phase data. There was a change in level (M = 14 % to M =100%) and an immediacy of effect from 6.67% to 100% accuracy. The second intervention phase data were stable at 100% accuracy. Because Megan's scores met mastery criteria, data collection ceased. At this point, Megan did not interact with any intervention materials for 10 sessions. After 10 sessions,

a maintenance data point was collected. She obtained a 60% accuracy score on the maintenance probe. There was 0% of overlapping data between phases.

Affix meaning. The affix meaning accuracy scores are denoted by the triangle data path. During baseline, Megan obtained 0% accuracy on the affix meaning probe. Intervention data presented an increasing trend that was consistent across both intervention phases. The mean across both intervention phases was greater than 90%. There were no overlapping data between phases.

Sienna

Morphographic analysis. Figure 1 presents Sienna's data. During baseline, Sienna's scores were stable with a mean of 15% accuracy; thus, she met the criterion to enter intervention. Sienna's phase one intervention data presented an increasing trend with a change in level (M = 15% to M = 96%) and an immediacy of effect from 13% to 93% accuracy, which were sufficient to permit the TODHH to administer the generalization probe. Sienna obtained a score of 70% accuracy on the generalization probe and, as a result, was entered into the second phase of intervention. Data in intervention phase two were consistent with intervention phase one as there was a change in level from 15% to 92% accuracy and an immediacy of effect from 13% to 87% accuracy. Sienna's scores met criteria and she was entered into the maintenance phase. After 10 sessions, the teacher administered the maintenance probe on which Sienna obtained a score of 100% accuracy. There was 0% overlapping data between phases.

Affix meaning. Sienna obtained 0% accuracy on the affix meaning probe during baseline. Intervention data presented an increasing trend and were consistent for both

intervention phases. The mean for phases one and two intervention data reached 60% accuracy. There were no overlapping data between phases.

Brian

Morphographic analysis. Figure 1 presents Brian's data. Brian's baseline data were stable at a mean of 9% accuracy and he was entered into the intervention phase. Data from intervention phase one were plotted and demonstrated an increasing trend with a change in level (M = 9% to M = 92%) and an immediacy of effect from 10% to 87% accuracy. Thus, criteria were met to enter Brian into the generalization phase. Brian obtained a score of 60% accuracy on the generalization measure and the second phase of intervention began. Unlike the other two students, Brian's phase two's intervention data were not consistent with his data from phase one. Perhaps this may be attributed to the two-day school break that occurred during phase two intervention data collection (see missing data points). However, there was a change in level (M = 9% to M = 76%) and an immediacy of effect from 10% to 60% accuracy. With criteria met, Brian was moved into the maintenance phase. Brian obtained a 90% accuracy score on the maintenance data probe with 0% of overlapping data between phases.

Affix meaning. Brian obtained 0% accuracy on the affix meaning probe during baseline: he demonstrated an increasing trend during intervention. His means during intervention phase one mean was 56% and for intervention phase two was 60%. The intervention phases were consistent, and there was no overlapping data between phases.

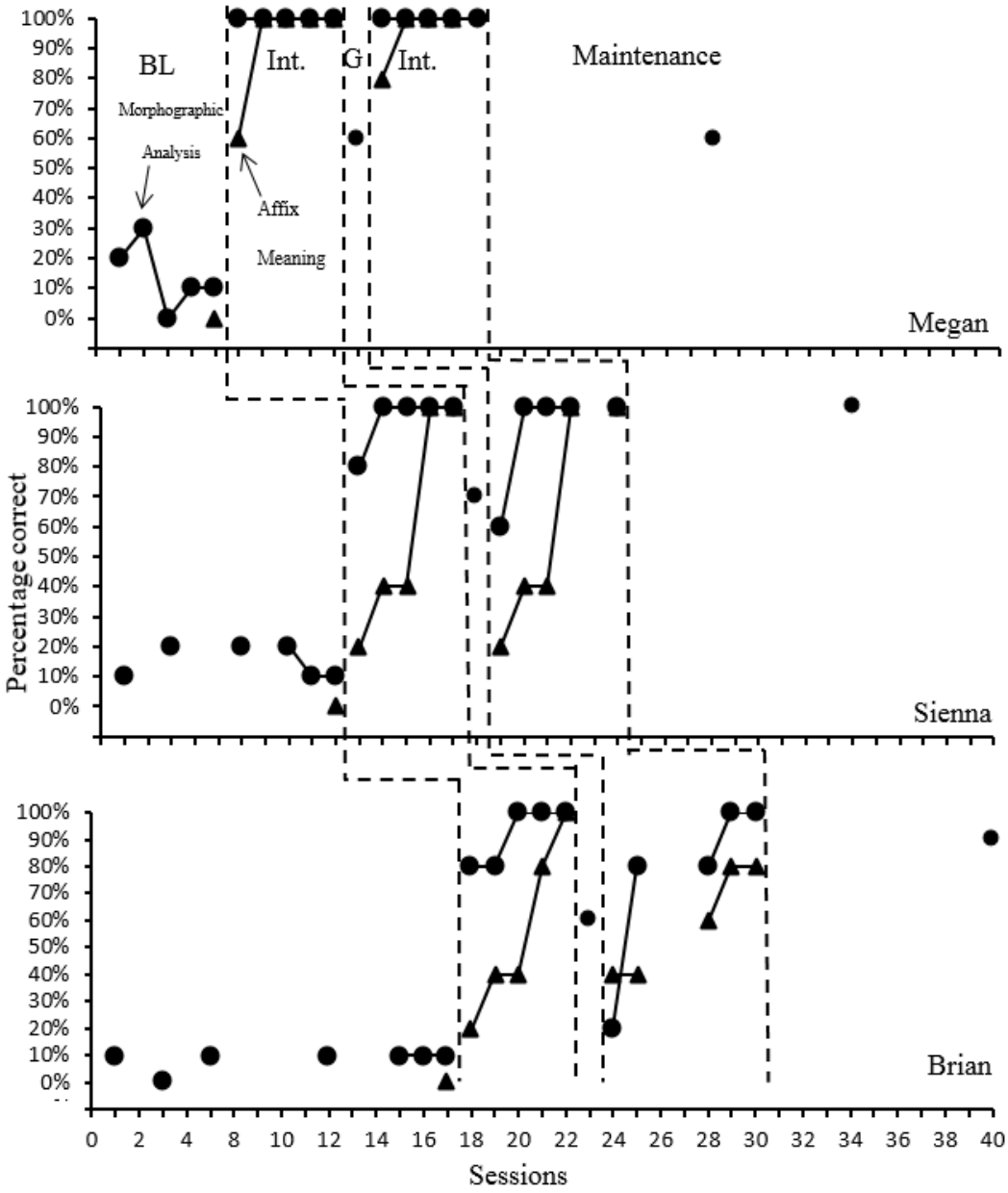

Figure 1. Student participants' graphs. BL = Baseline, Int. = Intervention, G = Generalization.

Social validity

Social validity ratings were collected separately for the student participants and teacher participant. The students rated the intervention on different aspects from one to five. A score of one indicated that they strongly disagreed, three indicated indifference and five indicated strongly agreed. The numbers were accompanied by an icon to assist them in understanding the rating system. The students agreed that they liked using morphographs, they learned a lot and could break apart words (see Table 4). They indicated indifference to the following statements: learning about morphographs was fun, I would recommend learning about morphographs to a friend, and I can use what I had learned in other classes at school. Overall, the students rated the intervention as a three or higher on average in all areas. The teacher participant also completed a social validity questionnaire.

Table 4

Student participants' social validity ratings

Statement	Mean rating
I liked learning about morphographs.	4.3
Learning about morphographs was fun.	3.7
I can break apart words now.	4.7
I would recommend learning about morphographs to a friend.	3.0
I learned a lot about morphographs.	4.7
I can use what I learned about morphographs in other classes at school.	3.7

The teacher participant responded to a questionnaire (Appendix C) that rated the intervention on a scale of one to five: a score of one indicated that she strongly disagreed, and five indicating strongly agreed. The teacher strongly agreed that the intervention would be easy to implement and was appropriate for the classroom. The teacher agreed that she would like to implement the intervention after the study was completed. Lastly, the teacher felt indifferent about the intervention aligning with her literacy goals for the students and whether or not the intervention was beneficial for the students. The teacher also answered three open-ended questions. The first question asked the teacher how she would change the intervention. The teacher indicated that she would like to implement the intervention with small groups instead of one on one. She said she "would like for it (intervention) to be a part of a daily routine with a larger group." The second question asked what are the challenges and benefits of implementing a scripted curriculum. The teacher responded that the benefits were that the script helped maintain the integrity of the instruction and made it easy to stay on task. The challenges with the scripted curriculum were that one student found the repetition frustrating. The last question on the questionnaire asked how the students reacted to the intervention. The teacher responded that most of the students reacted positively. One student "was frustrated towards the end" because the student did not like the repetitive nature of the script and "became frustrated with the concept of mastery." The student "just wanted to move on." Overall, the teacher's responses indicated that she liked the intervention but would like to implement it in small groups instead of one to one and that this type instruction may not be suitable to address all students' learning needs or styles

Discussion

The purpose of this study was to determine the effects of morphographic instruction on the morphographic analysis skills (Arnbak & Elbro, 2000) of DHH students with a reading delay in fourth through eighth grade. A functional relation between the morphographic intervention and the students' morphographic analysis skills was established. There were three demonstrations of effect demonstrated by the change from baseline to intervention for all three student participants. Further, Sienna and Brian's data replicated the data paths of the first participant, Megan. When looking across the graphs, all baselines were consistent, and Sienna and Brian's intervention data were consistent with one another. These findings support Nunes and colleagues' (2010) results that DHH students can improve their morphographic skills through teacher-led intervention as well as Easterbrooks and Stoner's (2006) work because the students benefitted from a visual organizer. Also, this study builds on the findings of Trezek and Malmgren (2005) and Trezek and Wang (2006) because the participants in this study improved a literacy skill through DI.

The participants increased their ability to match an affix to its meaning on the student workbook pages. The slope for the affix knowledge data paths for Brain and Sienna were not as steep as the slope for their morphographic analysis, suggesting that while they might readily have learned the task of breaking the words apart in rote fashion, they did not have an equal facility with the underlying meaning of the affixes. During the affix tasks, Brian and Sienna would often confuse two or three of the affixes and were required to go through the correction procedure. The students took more instructional sessions to master the affix meanings than they took to master the morphographic

analysis. These findings suggest that DHH students require explicit instruction that is focused on meaning as well as morphographic analysis. Further, DHH students may require more repetitions (Ensor & Koller, 1997) as well as scaffolding than other populations (Plessow-Wolfson & Epstein, 2005) during meaning based instruction. This is important because morphographic skills continue to grow beyond fourth grade (Berninger, Abbott, Nagy, & Carlisle, 2010; Deacon & Kirby, 2004). These students were in fourth and fifth grades and had a morphographic knowledge delay during the same period of time when hearing children's morphographic knowledge is growing. However, the morphographic knowledge delay that these participants were demonstrating could be improved by instruction implemented by a TODHH with a certain level of expertise (e.g. TODHH state-certification, ability to match student's communication modality). This finding supports others who have suggested that DHH students benefit from instruction from professionals who have experience working with DHH students and implementing strategies developed for their unique learning needs (Marschark, Sapere, Convertino, & Pelz, 2008)

Megan's baseline performance warrants further examination. During baseline, all of the student participants were incorrectly deconstructing the target words by dissecting them into syllables. Megan was the only participant who would try different combinations of word parts at each opportunity. The researcher tracked her correctly scored responses, and they changed each time she completed the probe, indicating that she was attempting a new strategy. Also, her accuracy scores declined throughout the baseline phase. This inconsistency in accuracy indicated that although Megan could guess the correct morphographic deconstruction of a word at times, she was not

employing consistent morphographic rules to answer the probe. While the students did try to dissect the words into syllables, this finding suggests that DHH students require explicit, teacher-led instruction to deconstruct words meaningfully (i.e. morphographic analysis).

The students were unable to generalize what they had been taught to novel multi-morphographic words. This measure included all of the target words and was the same measure from baseline. Consequently, the probe did not measure the generalization of taught morphographs only untaught morphographs. On the other hand, there were novel words with taught morphographs on the student worksheets and the students were able to dissect the word appropriately (e.g., taught word= section, novel word= action). This finding suggests that DHH students require more than just a short intervention: they may need ongoing direct instruction in the area of morphographs as a part of their daily literacy curriculum if our intention is for them to generalize from taught to untaught morphographs.

Sienna and Brian maintained the majority of the morphographic analysis skills that they learned during the intervention. Interestingly, they both scored the intervention more favorably on the social validity questionnaire than Megan scored the intervention. Megan did not maintain her morphographic analysis knowledge as well as the other two participants. Also, she did not like the format of the intervention. She was often asking the TODHH to "do it (the intervention) quickly." In contrast, her data showed the largest immediacy of effect and change in level when compared to Sienna's and Brian's data paths indicating that she might have benefitted from a faster-paced intervention with a greater number of morphographs. In contrast, perhaps she did not respond well to paper

and pencil tasks but would have enjoyed a more active intervention. Some students may find the repetition of DI instruction frustrating as described by the TODHH participant on the social validity questionnaire. This suggests that the intervention should incorporate differentiated instruction in future trials as consistent with current best practices in education.

The importance of this study's findings is rooted in the need to address the continued literacy struggles for DHH students (Easterbrooks & Beal-Alvarez, 2012; Traxler, 2000) and to add to the knowledge base surrounding decoding in the field of deaf education (Tucci et al., in press). Improving a DHH students' morphographic analysis and affix meaning knowledge could influence their meaning-oriented decoding skills. Kieffer and Lesaux (2012) found that morphological awareness increases reading comprehension because it increases a child's vocabulary knowledge. Further, vocabulary depth and breadth are strong indicators of reading success (Lee, 2011). DHH children who have better vocabulary skills have better literacy skills (Kyle & Harris, 2010). Hence, morphographic instruction has the potential not only to affect a DHH students' decoding skills and vocabulary but more distally, their reading comprehension. Further research is needed to determine the nature of the relationship between daily, ongoing morphographic instruction and reading comprehension.

This study has several limitations that lead to recommendations for future research. The first limitation is the small sample size. Due to the small sample size, the results cannot be easily generalized to the heterogeneous DHH student population. Future researchers may consider replicating this study in various geographic locations (Kratchowill et al., 2010) or employing group design. Another limitation of this study

was experimental control. The researcher requested that the TODHH not teach morphographs for the duration of the study but was not present the entire school day to ensure that instruction was not occurring. Although this is an issue that arises from conducting research in an applied setting, the data gathered in this particular study indicated that the teacher did follow the request of the researcher. Future researchers may employ different methods to exact experimental control and reduce threats to internal validity. The scripted lessons may be another limitation of this study. The social validity results suggest that while not all students enjoy this kind of paper and pencil-based instruction; instructional designers might consider more active ways of teaching this skill such as using Smartboards and iPads. Also, future researchers may choose to modify the script (e.g. shorten the script, less repetitions) to see if they find similar results. A third limitation was the age of the students. Fourth through eighth grade may be late to begin morphographic instruction, especially when considering that it appears in the common core standards (Common Core Standards Initiative, 2011) in second grade. This age group was targeted because of the model curriculum's guidelines; however, future researchers may want to implement morphographic interventions with younger students (Apel et al., 2013). Lastly, a very specific morphographic skill was taught during this study that is a limitation. This intervention did not teach morphographic analysis dissection rules for derived words that change their spelling. Because very little is known about morphographic instruction and DHH students, the researcher felt that an intervention including complex word dissection strategies was beyond the scope of this research. Consequently, future researchers may choose to build

on this study's findings by teaching more complex word dissection strategies that address derived forms that change spelling.

Conclusion

Word dissection skills are a part of morphographic knowledge and are positively correlated with word identification (Carlisle, 2000). DHH students often have a morphographic knowledge delay that negatively affects their reading ability (Gaustad et al., 2004). Past researchers have found that morphographic instruction improves DHH students' reading comprehension, spelling and writing abilities (Nunes et al., 2010). Based on the results of the present study, morphographic instruction can also improve students' morphographic analysis skills that may in turn improve their decoding abilities. While this type of instruction could provide this population with a meaning-oriented word identification strategy (Arnbak & Elbro, 2000) that is less dependent upon phonemic decoding (Casalis et al., 2004; Mayberry et. al, 2011), the results also suggest the importance of direct instruction that addresses the meaning side of the intervention as well as the deconstructing side of the intervention. Although additional research is needed to validate morphographic instruction for this population and to investigate other decoding strategies, the study contributes positively to the decoding-strategies evidence base for instructing DHH students.

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APPENDIXES

APPENDIX A

Background Information Form

Today's Date: _____

Child's Name:_____ Child's Date of Birth:_____

Person completing form:

Name:_____ Relation to Child: _____

Does the child wear hearing aid(s) now? _____ Yes _____ No

If yes, how many? one or two

How much does s/he use it at school? Never Occasionally Almost Always

Student's hearing loss unaided (only for those without cochlear implants):
Unaided Thresholds in:
Right Ear _____ dB at 500Hz_____ dB at 1000Hz_____ dB at 2000Hz_____ dB at 4000Hz
Left Ear _____dB at 500Hz_____ dB at 1000Hz_____ dB at 2000Hz_____ dB at 4000Hz
☐ Degree of loss unknown or no audiological data available.

Does the child use a cochlear implant(s) now? _____ Yes _____ No

If yes, how many? one or two

How much does s/he use it at school? Never Occasionally Almost Always

Type of hearing loss: ("Progressive" can be checked in combination with any other descriptor)
☐Conductive ☐Sensorineural ☐Mixed ☐Auditory Neuropathy ☐Progressive

Is the child's mother deaf? ____ yes ____ no
Is the child's father deaf? ____ yes ____ no

Does the child have a reading goal on his/her IEP? ____ yes ____ no

What language is used in the home? (English, Spanish, American Sign Language, etc…) _____

What form of communication is used in the home? (speech only, sign only, speech & sign) _____

Does the child have an additional diagnosed disability? (cognitive/intellectual, motor/physical, other)

___ yes ___ no

If yes, please describe below any information you have on the specific kind and severity of the disability.
Thank you!

APPENDIX B

Baseline/Generalization/Maintenance Probe

Name: _____ Date: _____

Phase: _____ Session: _____

1) _____ + _____= assistant
2) _____ + _____= addict
3) _____ + _____= biannual
4) _____ + _____= amoral
5) _____ + _____= mythology
6) _____ + _____= difference
7) _____ + _____= gullible
8) _____ + _____= dental
9) _____ + _____= section
10)_____ + _____= actually

APPENDIX C

Teacher Participant: Social Validity Measure

Completed by: _____ Date: _____

Directions: Please circle the number that describes how you feel about the morphographic instruction intervention.

This intervention would be easy to implement in my classroom.
Strongly Disagree---1---2---3---4---5--- Strong Agree
The curriculum aligns with some of the literacy goals I have for my students.
Strongly Disagree---1---2---3---4---5--- Strong Agree
This intervention was beneficial to the students.
Strongly Agree---5---4---3---2---1--- Strongly Disagree
The intervention was appropriate for my classroom.
Strongly Disagree---1---2---3---4---5--- Strong Agree
I will implement this intervention after the conclusion of this research study.
Strongly Agree---5---4---3---2---1--- Strongly Disagree

Please answer as briefly or in as detailed a manner as you wish. Feel free to write on the back.

1. If you were going to change this intervention in any way, how would you change it to implement in your classroom?

2. What were the challenges and benefits to implementing a scripted curriculum with your students?

3. How did the students react to the intervention? (Circle one and explain)

   Positively Negatively Neutral

APPENDIX D

Student Participant: Social Validity Measure

Name:_____ Date:_____

Directions: Please read or pay attention carefully. Circle the number that best fits what you think.

1. I liked learning about morphographs.

2. Learning about morphographs was fun.

3. I can break apart words now.

4. I would recommend learning about morphographs to a friend.

5. I learned a lot about morphographs.

6. I can use what I learned about morphographs in other classes at school.

APPENDIX E

Fidelity Observation Form-Spelling through Morphographs

Teacher:	**Observer:**	**IOA:**
Date:	**Time:**	
Lesson #:	**# students in group:**	**Grade(s):**

SCALE

0- Not Implemented	**1-**Improperly Implemented	**2-** Somewhat Implemented	**3-**Appropriately implemented
20% of the time or less	40% of the time	60% of the time	80% of the time

Please circle the number which best describes your observation of the use of each instructional skill. The observation should last through the **entire** reading lesson. Space is provided on the back for written comments.

SET UP/MANAGEMENT				
1. Materials are organized and readily available.	0	1	2	3
2. Lesson begins within 2-3 minutes of designated time.	0	1	2	3
3. Teacher provides positive reinforcement/specific praise.	0	1	2	3
4. All students are on-task; off-task behavior is addressed.	0	1	2	3
INSTRUCTION				
5. Teacher delivers instruction according to script.	0	1	2	3
6. Teacher provides clear signals.	0	1	2	3
7. Student responses are confident.	0	1	2	3
8. Teacher looks at students when they respond.	0	1	2	3
9. Teacher delivers instruction at a brisk pace. (at least 5-7 responses from students per minute)	0	1	2	3
10. Teacher affirms final responses.	0	1	2	3
11. Teacher corrects each student mistake properly.	0	1	2	3
WORKBOOK				
12. Teacher instructs when indicated during exercises.	0	1	2	3
13. Teacher monitors independent work during exercises.	0	1	2	3
14. Student work is graded and corrected.	0	1	2	3

Total number of points: _____

Total number of possible points: 42

Fidelity Score (Agreements/Agreements-Disagreements * 100):_____

* Adapted from

http://www.nclack.k12.or.us/cms/lib6/OR01000992/Centricity/Domain/249/Corrective%20Reading%20Fidelity%20Observation%20Form.pdf

APPENDIX F

Assessment Procedure Fidelity: Morphographic Instruction

Date: _____ Time:_____

Completed by: _____

Study Participant: _____

IOA:_____

Directions: Please provide a 1 beside the procedures completed or a 0 if a procedure was not completed.

Assessment Baseline:_____ Intervention Assessment:_____ Maintenance: _____

____1. At the start of the session, ask the participants for assent. If assent is not obtained, excuse the participant(s).
____2. Tell the participants to write their name and the date on the paper.
____3. Ask the student participants finger on the first section.
____4. Checks to see if all students are in the right place.
____5. Follows the assessment script
____6. Does not give positive or negative performance feedback to the student participants.
(Can prompt the student to go on to the next section if the student is stuck)
____7. Allows the student participants to work for 10 minutes
____8. Collects the papers.
____9. Expresses gratitude for their efforts.

Total points obtained:_____

Total points possible: 9

Fidelity Score (Agreements/Agreements-Disagreements * 100):_____

APPENDIX G

Pre-intervention Classroom Observation Checklist: Morphographic Instruction

Teacher:_____

Date:_____

Observer:_____ Observation # _____

Please indicate if any of the following types of instruction were seen during literacy instruction. If yes, please describe in space provided.

Instruction type	Yes	No
Affix meaning instruction		
Word dissection: breaking a word down into component parts		
Word building: composing a word from component parts		
Morphographic spelling rules		

APPENDIX H

Visual Organizer Example