EMPIRICAL MANUSCRIPT

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

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Abstract

Deaf and hard-of-hearing (DHH) students have delayed morphographic knowledge that negatively affects their morphographic analysis and decoding abilities. Morphographic analysis instruction may improve DHH students’ morphographic knowledge delay. The purpose of this study was to determine the effects of morphographic instruction on the morphographic analysis skills of reading-delayed, late-elementary DHH students. The research question was: What effect does morphographic instruction have on the morphographic analysis skills of DHH students who are reading below grade level? The study included 3 student participants and 1 teacher participant from a local school district. The researchers used a multiprobe multiple baseline across participants design. The intervention was implemented for 20 min a day, 5 days a week for 2–3 weeks. Visual analysis of the data revealed the requisite number of demonstrations of effect and replications. The intervention improved DHH students’ ability to dissect words and determine affix meanings, which may in turn positively affect their decoding abilities. Implications of this study and future research are discussed.

Deaf and hard-of-hearing (DHH) readers often do not attain grade-equivalent reading levels (Easterbrooks & Beal-Alvarez, 2012). Perhaps one reason is that they do not bring the same morphographic knowledge to the reading task as their hearing counterparts (Gaustad, Kelly, Payne, & Lylak, 2002). 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). Morphographic knowledge includes understanding the meanings of affixes, roots, and base words, deconstructing words into their component morphographs, and combining morphographs in a rule-based manner to create a new word or to change the grammatical class of a word (Gaustad, 2000). Morphographs include base words, roots, and affixes (Maggs et al., 1981); 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.

Deacon and Kirby (2004) discovered that morphographic skills and phonological skills were comparable as predictors of reading comprehension in typically hearing students in fourth through ninth grades. For third through fifth graders, morphographic skills made a unique contribution to word reading beyond that of phonological skills (Deacon & Kirby, 2004). Similarly, Nagy, Berninger, and Abbott (2006) found that morphographic knowledge makes a unique contribution to decoding accuracy for hearing fourth and fifth graders. These findings indicate a shift from a phonological focus to morphological focus on decoding (Deacon & Kirby, 2004; Nagy et al., 2006) in the upper elementary grades: phonological skills plateau and morphological skills continue to develop (Berninger, Abbott, Nagy, & Carlisle, 2010). Although the importance of phonological instruction for DHH students has been documented (Beal-Alvarez, Lederberg,
The lexical quality hypothesis (Perfetti & Hart, 2001) proposes that word knowledge supports literacy skills; that is, the quality of one’s bank of known words and known meanings directly influences the development of literacy skills. Emergent readers have a limited lexicon, or word bank, and they often decode words using individual letters (Verhoeven & Perfetti, 2003). As emergent readers develop, they begin to decode words in orthographic chunks (i.e., morphographs; van Hoogmoed, Knoors, Schreuder, & Verhoeven, 2013) employing higher quality lexical retrieval. A morphographic knowledge delay can interfere with the decoding process and impede higher lexical quality retrieval.

Morphographic Knowledge and Instruction

Morphographic knowledge delay affects DHH students regardless of communication modality (e.g., listening and spoken language [LSL], Signed Exact English, and 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) and struggle to understand morphemes when they see them in print (Dixon, Zhao, & Joshi, 2012). Further, many DHH children are delayed language learners (Lederberg & Spencer, 2009) who process morphologically complex words inefficiently because they depend on the lexical language level. For example, rethink is a morphologically complex word because its meaning is clear from its constituent morphographs. However, delayed language learners will not deconstruct the word into its constituent parts to determine its meaning; they will look at it as a whole word and attempt to determine meaning (Jiang, 2004). Perhaps, this processing deficit could be remedied through morphographic analysis instruction.

Morphographic analysis instruction includes several components: (a) recognizing constituent morphographs within multimorphographic words, (b) learning the morphographs’ meanings, and (c) studying the rules to create new words from derivational morphographs (Harris, Schumaker, & Deshler, 2011). Morphographic analysis interventions that focused on derivational morphographs have been implemented at varying grade levels with positive effects on hearing students’ morphographic analysis skills (Apel, Brimo, Diehm, & Apel, 2013; Harris et al., 2011; Wysocki & Jenkins, 1987). Apel et al. (2013) implemented a morphological/morphographic intervention with kindergarteners and first and second graders with large effect sizes for morphological knowledge. Wysocki and Jenkins (1987) found similar gains in fourth, sixth, and eighth grade students. Harris et al. (2011) discovered that the student participants who received morphographic instruction decoded novel words for meaning with higher accuracy than student participants who received instruction on a vocabulary retention strategy or business-as-usual instruction (Harris et al., 2011). Although the use of derivational morphographic instructional strategies with DHH students has yet to be empirically tested (xxxxBlindedxxx, 2014), the findings of Harris et al. (2011) indicate that students who are at risk for morphographic knowledge delay benefit from explicit instruction in this area.

The link between morphographic knowledge and reading comprehension can be explained in two ways. First, English has more morphographically transparent words than phonologically transparent words. For instance, let us consider the words “magic” and “speak.” When readers see the words (i.e., magic /mædʒɪk/) and speak /spiːk/), they may notice the orthographic similarity of “magic” that retains its spelling in both words but when one says “speak,” they may notice that “speak” is not a spelling in both words. However, it is rarely included in DHH students’ daily reading lessons (Gaustad, 2000). This gap in instruction is troubling because these students often have a morphographic knowledge delay that begins at an early age (Gaustad, 1986) and persists through college (Gaustad et al., 2002).

Second, morphographic knowledge makes a significant contribution to reading comprehension through vocabulary (Kieffer & Lesaux, 2012) also utilizing a morphographic decoding strategy that improves one’s vocabulary (Baumann, Edwards, Boland, Olejnik, & Kame’enui, 2003). When readers’ morphographically decode, they should be breaking multimorphographic words into their constituent morphographs, determining the morphographs meanings, and reconstructing the word to assess its meaning within the sentence. For example, a student may know the meanings of the morphograph re- and the root word write. When the reader decodes the novel word rewrite, she can deconstruct the word, recall the meanings, and assess if the meaning “to compose again” fits the sentence. Now, the reader has encountered a new word and used her morphographic knowledge to determine the word’s meaning and in turn improve her vocabulary (Arnbak & Elbro, 2000). Those readers who have a larger vocabularies are better readers than those with smaller vocabularies (Kyle & Harris, 2010) and 60% of unfamiliar vocabulary that children attempt to read at the fifth grade level can be morphographically decoded (Nagy & Anderson, 1984).
Based on the principles of Direct Instruction (DI; Marchand-Martell et al., 2004), Spelling through Morphographs (Dixon & Engelmann, 2007) is a DI curriculum that explicitly teaches affix meaning and morphographic analysis through scripted lessons, planned practice, and cumulative review. The curriculum includes affix meaning instruction, word building, word dissecting, and spelling rule activities (Dixon & Engelmann, 2007). Corrective Spelling through Morphographs (Dixon & Engelmann, 1979), the precursor to Spelling through Morphographs, was implemented with typically hearing fourth, fifth (Maggs et al., 1981), and seventh graders (Robinson & Hesse, 1981) with positive effects on spelling (Maggs et al., 1981) and morphographic analysis (Robinson & Hesse, 1981). Kraemer, Kramer, Koch, Madigan, and Steely (2001) implemented Corrective Spelling through Morphographs as well as other DI curriculums with 6th–12th grade DHH students. Although effects of Corrective Spelling through Morphographs alone cannot be determined because it was part of an intervention package, the researchers (Kraemer et al., 2001) found positive effects on spelling, reading comprehension, and language. To date, this curriculum has not been investigated with DHH students measuring morphographic analysis.

The purpose of this study was to determine the effects of morphographic instruction on the morphographic analysis skills of fourth and fifth grade DHH students with a reading level between second and fourth grade. Elements from the Spelling through Morphographs curriculum were chosen to develop lesson plans for the present study because DI curriculums have been effective for teaching discreet literacy skills to DHH students (Trezek & Malmgren, 2005; Trezek, Wang, Woods, Gampp, & Paul, 2007) in the past. Hence, the present study did not intend to investigate the implementation of the Spelling through Morphographs curriculum itself but to use elements of the curriculum to develop scripted lesson plans. The primary research question was: What effect does morphographic instruction have on the morphographic analysis skills of DHH students who are reading below grade 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 students’ affix knowledge?

**Method**

**Participants**

Initially, four student participants and one teacher participant were included in this study. However, the fourth participant left the study as his family relocated to another school during baseline data collection. As indicated in Table 1, all student participants had a diagnosed hearing loss, literacy instruction from a teacher of the deaf and hard of hearing (TODHH), a literacy goal on their current Individualized Education Program, placement in the fourth through eighth grade, a second to fourth grade reading ability determined by Woodcock Johnson III Tests of Achievement (WJ-III: Woodcock, McGrew, Mather, & Schrank, 2001), letter-word identification (LWI), and passage comprehension (PC) subtests, instruction in a self-contained DHH classroom for reading, and no severe visual, cognitive, or physical disabilities that inhibited their ability to utilize the instructional materials.

Although the study was open to fourth through eighth grade students, the student participants that agreed to participate were in the fourth (Brian) and fifth grades (Megan and Sienna). This age group was targeted because of the model curriculum’s
guidelines. To further describe the student participants, the primary author requested the students’ age, expressive and receptive language modality preference, and home language information. All the students used sign and speech in the classroom for receptive and expressive communication and used English at home with the exception of Brian. English and Cambodian were used in his home.

The teacher participant was the TODHH for the student participants. She held a current certification for teaching DHH students, verified that she was the teacher of record for the student participants’ reading, attended professional development related to the curriculum, and provided a minimum of 45 min daily literacy instruction to the student participants. The classroom was managed by two TODHHs; however, after consenting and completing training for the study, one teacher was not able to participate for health reasons. The remaining TODHH did not feel that she could complete all the parts of the study due to time constraints and the needs of other students not included in the study so the primary author, a state-certified, experienced TODHH, taught one of the student participants. The TODHH taught Megan and Brian (pseudonyms). The primary author taught Sienna (pseudonym).

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 small group setting using simultaneous communication (i.e., signing and speaking at the same time). Therefore, simultaneous communication was used during assessments, probes, and intervention instruction that were conducted in the DHH classroom. The classroom had two circle tables and one kidney table with three to four chairs surrounding them.

Research Design

We implemented a multiprobe multiple baseline across participants design (Kazdin, 2011) across 4 weeks of intervention. Multiple baseline single case designs are utilized when the behavior being measured cannot be reversed or unlearned (Kazdin). Further, this research design allows the researchers to analyze the data at an individual level. Analyzing the data at this level is important to address the variability often found among DHH students (Harris & Beech, 1998) and to address the individualized nature of special education (Horner et al., 2005).

Materials

Study eligibility measures
Two subtests of the WJ-III were given to verify the student participants’ reading ability level and determine if the student was eligible (second and fourth grade level on the LWI and PC subtests) for the study. The first subtest administered was the LWI subtest. During this assessment, the student participant was asked to recognize different English letters or read words that were presented on a flipbook. The second subtest that was administered was 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.

Preintervention material
First, the Morphemic Awareness Test (Luetke, Stryker, & McLean, 2013) was used to measure the students’ awareness of the associations of base and derived or inflectional morphographs. The task included the presentation of a sentence with four possible answers. 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 researchers of the student participant’s current morphographic knowledge. Reliability and validity data for this measure are not available at this time, but the assessment was created specifically for DHH students and is readily available. The original assessment had three test items for each morphograph tested; however, the primary author chose to present one test item for each morphograph due to time restrictions. The student participants completed the assessment in a permanent product format.

The second measure was a researchers-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 reading and telling the meaning of the base words that would be potentially taught in the lessons. For example, the student would attempt to read the printed word annual and tell the primary author what the word meant. This pretest was given to determine the word sets for the study to ensure that the student participants had not previously acquired the skills targeted by the intervention and to discern the students’ base-word knowledge. Weak base-word knowledge may negatively affect students’ 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.

Intervention materials
Several materials were required in order to implement this study. First, the TODHH and primary author delivered 10 daily scripted lessons during intervention instruction time. In addition, the primary author created 40 visual organizer pages (20 for the teacher and 20 for the primary author) that could be reused and were part of the daily instruction. The TODHH 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 were modeled after the curriculum’s workbook exercises. The probe consisted of morphographically analyzing the 10 target words (Table 2) with two morphographic units (e.g., ___+___ = dental). These probes were given during the following phases: baseline, generalization, and maintenance. There were several versions of each measure. The items themselves remained unchanged, but the numerical order of the items was varied. Generalization and maintenance probes were not collected for affix meaning because that skill was not the primary focus of this study.

Intervention repeated measures
The intervention repeated measures were similar to the baseline/generalization/maintenance probes in every way but one. The intervention repeated measures consisted of analyzing only the five target words that were being taught in that intervention phase. Similar to the baseline/generalization/maintenance
probes, there were several versions of each measure where the items did not change, but the numerical order was varied.

Validity and fidelity measures
Two researcher-created social validity measures were completed by the TODHH and student participants to determine the validity of this intervention within the school context. The measures asked different questions in a similar format. Regarding the fidelity measure, the primary author adapted an instruction implementation fidelity measure that is used widely with DI programs. The original measure included a zero to three rating for each area. It was adapted to include percentages of occurrence that corresponded with the zero, one, two, or three rating. For example, if the teacher followed the script 80% of the time, the TODHH would be given a score of 3 for that requirement. Also, the primary author created the assessment and probe implementation fidelity measure. 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 Variables
The independent variable for this study was morphographic instruction modeled after the Spelling through Morphographs curriculum (Figure 1) and implemented for 20 min a day, 5 days a week for 2–3 weeks. The lessons included fast-paced instruction and interactive communication between the TODHH or primary author and the student. The TODHH or primary author used simultaneous communication to present the lessons. The primary author, TODHH, and students used ASL signs in an English word order with emphasis on using signs that were conceptually accurate.

The TODHH and primary author went over the scripted lessons and discussed sign usage in order to deliver instruction similarly using conceptually accurate signs. In addition, the TODHH and primary author agreed to fingerspell the word morphograph during instruction and assessment sessions. To address how to sign the target affixes, the TODHH and primary author determined what the goal of the lesson was. If the lesson objective was to teach the morphograph, the TODHH or primary author fingerspelled the morphograph smoothly without stopping between letters. If the lesson objective was to teach the spelling of the morphograph, the TODHH or primary author fingerspelled the morphograph with a slight delay between the letters. The students were expected to respond similarly depending on the goal of the lesson. Although not discouraged to use their voices, the student participants accommodated the TODHH and primary author and used simultaneous communication during the intervention and assessment sessions. At times, the activity required a written response (i.e., What is the first morphograph? (signal), MYTH, Write that in the first blank.) or pointing (i.e., Where do I write the first morphograph, MYTH? ).

Several modifications were made to the original curriculum when developing the lessons for this study. First, each target morphograph was taught and reviewed in the same manner. No one morphograph received more instruction or emphasis across days than another morphograph. Second, the intervention lesson plans included root word instruction (assist means to help), affix instruction (-ant means a person or things that does something), word dissection (The first morphograph in the word assistant is assist. Show me where you would write the first morphograph assist. assist + ____ = assistant), and morphographic rules (all words have morphographs). The original curriculum includes further instruction such as oral spelling and word discrimination that were not included in this intervention instruction. These activities were not included because we were measuring discrete skills (word analysis and affix meaning) as a result of instruction. Including spelling instruction and word discrimination instruction would have lengthened instruction time without providing data to answer the research question. Third, the meaning of the root word was taught along with the affix because based on pretesting, the student participants did not know the root word meanings. Lastly, a visual organizer (Figure 2) was included to provide visual support during

### Table 2. Target words lists

<table>
<thead>
<tr>
<th>Intervention Week 1</th>
<th>Intervention Week 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant</td>
<td>Biannual</td>
</tr>
<tr>
<td>Mythology</td>
<td>Adduct</td>
</tr>
<tr>
<td>Amoral</td>
<td>Actually</td>
</tr>
<tr>
<td>Section</td>
<td>Difference</td>
</tr>
<tr>
<td>Dental</td>
<td>Gullible</td>
</tr>
</tbody>
</table>

Figure 1. Lesson example from Spelling through Morphographs. Reprinted with permission from Dixon and Engelmann (2007).
instruction (Easterbrooks & Stoner, 2006). After developing the lessons including these modifications, the primary author had the lessons approved by a senior researcher experienced with implementing DI curriculums.

In addition, the primary author created workbook pages or planned practice that were consistent from lesson to lesson and modeled after Spelling through Morphographs. Planned practice included word dissection (_____ + _____ = assistant), affix definition matching (-ant = a person or thing that does something), word meaning (_____ helps me with everything), and sentence completion (My _______ helps me with everything). In the word dissection portion of the workbook page, there were novel words that included a taught morphograph (taught word: bia-
nual and novel word: bicycle) for further practice. The TODHH or primary author gave the student participant feedback on the workbook pages and corrected the student participant’s mistakes with them. Make-up sessions were provided if students were absent.

Lastly, the TODHH or primary author employed correction procedures prescribed in the model curriculum. If the student participant 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 participant corrected the practice. If the student participant made mistakes during the affix instruction, the TODHH or researcher utilized a model, test, and delayed test correction procedure. The TODHH or researcher modeled the answer (e.g., The morphograph re- means again), asked the student to tell her the answer that was just given (e.g., What does the morphograph re- mean?), and delayed for a few seconds and tests again (e.g., What is the morphograph? What does the morphograph re-mean? Please correct your paper).

The dependent variable for this study was correct responses to morphographic analysis items (e.g., _____ + _____ = gullible; Harris et al., 2011). A correct response was defined as having the entire word dissected correctly. There were two sets of five target multimorphographic words created from the pretest results (Table 2). One word set was taught in intervention ses-
sion one and the second word set was taught in intervention session two. Each word set met the following criteria: all the words had two morphographs, two words had eight to nine letter words, and three words had 10–12 letters (Harris et al., 2011).

Procedures

Once approval was attained, the primary author recruited teacher participants and consents were obtained. Next, a letter was sent home to the families whose children met the criteria and parental permission was obtained. Lastly, the primary author 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 needed.

Prior to baseline, two events occurred. First, teacher participants received a 2-hr training in implementing the intervention. The primary author explained the nature of DI and taught several practice lessons (Stephenson, Dostal, & Wolbers, 2013). During the training, the teacher participants taught an example lesson to each other. The teachers were required to obtain a 90% fidelity score in training before they were allowed to teach the intervention. The TODHH received a 91% implementation fidelity score. Second, the primary author conducted four preintervention observations (2 announced and 2 unannounced) to ensure that morphographic instruction (i.e., word dissecting, word building, affix instruction, or morphographic spelling rules) was not part of the teacher participants’ daily literacy instruction. Although the primary author did not witness any direct morphographic instruction, there was a small poster on the classroom wall that included the word “prefix” and its definition.

At this point, pretesting began. The primary author admin-
istered the WI-III subtests, Morphemic Awareness Test, and the researcher-created target word pretest to the student participants prior to collecting baseline data. The student received no feedback during the test. The primary author scored all assessments and determined the 10 target words from the results of the target word pretest. These 10 target words were separated into two sets of 5 words for the two intervention phases. The TODHH agreed not to instruct on morphographs or 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. The baseline probe included dissecting all 10 words included in the intervention. When administering baseline probes, the TODHH obtained consent, distributed the assessment or probe, requested that the student wait for further instructions, and provided scripted instructions. For example, the TODHH said, “Fill in the blanks to show the morphographs in each word.” The following is how the task appeared to the student participants: _______ + _______ = bia-
nual or _______ + _______ = mythology. The student participant worked on the probe for no more than 10 min. The TODHH collected the assessment and provided no feedback. The primary author scored all measures and graphed the students’ percentage of correct responses.

Baseline was established for participant one (Megan) when she demonstrated a minimum of five consecutive data points with a mean score of 20% or less correct responses out of 10 possible responses on the baseline probe or until stability was established (Kazdin, 2011). Once baseline was established for Megan, she began intervention instruction and the remaining two stud-
ent participants (Sienna and Brian) received business-as-usual literacy instruction from the TODHH or the primary author. Sienna and Brian established baseline through a minimum of five probes with three of those probes occurring consecutively prior to intervention or until baseline was stable (Kazdin, 2011).

Affix meaning scores were also obtained from the student worksheets. Five affixes were taught in each phase of the intervention for a total of 10 affixes. A correct response was defined as matching the appropriate affix to its meaning. Although, data pertaining to affix meaning did not determine phase changes, the primary author was interested in the student participants’ ability to determine, through matching, the meanings of the taught affixes. One affix meaning accuracy data point was collected in baseline before the intervention began.

Intervention phases

There were two intervention phases. Five target multimorpho-
graphic words were taught during each phase. At the beginning of
the intervention session each day, the TODHH or primary author assessed the student participant using the procedure described previously. The intervention phases taught five target multimorphographic words each; therefore, intervention repeated measures only included the five target words being taught during that phase of the intervention. For both intervention phases, mastery criteria were a minimum of five data points with a score of 80% or better correct responses out of five possible responses on for three out of four consecutive data points. When a student participant met these criteria, another student participant began intervention and the current student participant moved on to the generalization phase. If a student participant did not make progress on the intervention assessments during the intervention phases, the TODHH or primary author would continue the intervention for a minimum of 10 sessions. After 10 sessions, that student participant would be excused from the study and the next participant would be entered into intervention when baseline criterion was met.

During the intervention phases, the TODHH or primary author followed the lesson script and conducted the lesson as described. The student participant responded to questions through sign language and voice. Affix meaning accuracy data were obtained from the student worksheet daily prior to correction. Generalization or maintenance data were not collected for affix meaning. When intervention phase one mastery criteria were met, the generalization phase began. Simultaneously, another student began intervention. When intervention phase two phase-change criteria were met, the maintenance phase began.

**Generalization phase**
Procedures, during the generalization phase, were the same as for baseline. At this point in the study, the student participant had received instruction on 5 out of the 10 words on the baseline probe. The generalization probe included all 10 words (5 instructed and 5 not instructed). If the student scored between 0% and 80%, then TODHH or primary author started the second intervention phase. If the student scored above 80%, then the student did generalize the skill and would begin the maintenance phase.

**Maintenance phase**
Once mastery criteria for second intervention phase were met, the student participant did not interact with any of the intervention materials for 10 sessions. During the 10 sessions, the student received business-as-usual literacy instruction from the TODHH. The same assessment procedures described previously were used. The students completed the maintenance probe that included all 10 targeted words. The primary author scored the probes and graphed the scores.

**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 TODHH and student participants. Ratings are addressed in 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 randomly selected assessment sessions, intervention sessions, and permanent products. Interrater reliability was collected on 30% of the 50% sessions or permanent products mentioned previously. Fidelity and reliability were collected on the assessment sessions through a researcher-created checklist. For the intervention sessions, fidelity and reliability were collected through a rating form. Lastly, permanent products were scored independently and compared to determine fidelity and reliability. Second and third raters were trained and completed practice sessions not included in the final calculations. These raters scored or rated sessions or products independently. Reliability was calculated through point-by-point agreement (agreements/agreements + disagreements × 100; Kazdin, 2011) with an expectation of 88% or better. Fidelity and reliability percentages are listed in Table 3.

**Results**

**Preassessment Results**
Before initiating baseline data collection, the primary author administered several assessments. The reasons for administering the assessments were twofold: (a) to ensure that the student participants met the study’s inclusion criteria and (b) to understand their skills better. Overall scores are presented in Table 1.

**Reading ability**
The primary author administered the WJ-III LWI and PC subtests. As indicated in Table 1, Megan, Sienna, and Brian had a reading delay. They all performed better on the letter/word identification subtest than on the PC subtest. Also, they all met the criteria to be included in the study because they all were reading at or between the second to fourth grade levels.

**Morphemic awareness**
On the Morphemic Awareness Test, Megan did not know the derivational morphographs un-, mis-, ful, and pre-. Sienna did not know the morphographs -ness, mis-, and im-. Lastly, Brian did not know several morphographs: -ly, dis-, mis-, less, re-, ment, -ness, pre-, ent, -able, and -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, 7 out of 11 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

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**Table 3. Fidelity and reliability calculations**

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<th>Fidelity</th>
<th>Reliability</th>
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<td></td>
<td>Percentage</td>
<td>Range</td>
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<td>Assessment sessions</td>
<td>97</td>
<td>78–100%</td>
</tr>
<tr>
<td>Intervention sessions</td>
<td>93</td>
<td>90–98%</td>
</tr>
<tr>
<td>Permanent Product</td>
<td>100</td>
<td>100–100%</td>
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intervention. Finally, the primary author 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.

**Intervention Results**

After scoring the repeated measures, the student participants’ morphographic analysis scores were graphed using the multiple baselines across student design (Kazdin, 2011). Visual analysis of the morphographic analysis data paths was used to analyze the results at the student level. The primary author evaluated the morphographic analysis data for the following features: stability, level, trend, immediacy of effect, percentage of overlapping data, and consistency similar to Guardino and Antia (2012) and suggested in Kratochwill et al. (2010).

**Megan**

**Morphographic analysis**

Figure 3 presents Megan’s data. Her morphographic analysis data path is indicated with circles. 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 (6.7–100% 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 60% 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 (i.e., the percentage of data from one phase that is the same as the data from a previous phase; Kratochwill et al., 2010).

**Affix meaning**

The triangle data path denotes the affix meaning accuracy scores. 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 3 presents Sienna’s data. During baseline, Sienna’s scores were stable with a mean of 15% accuracy. Sienna’s phase one intervention data presented an increasing trend with a change in level ($M = 15\%$ to $M = 92\%$) and an immediacy of effect from 13% to 93% accuracy, she entered the generalization phase. Sienna obtained a score of 70% accuracy on the affix meaning probe and began the second phase of intervention. Consistent with intervention phase one, there was a change in level from 15% to 92% accuracy and an immediacy of effect from 70% to 87% accuracy. After 10 sessions, the TODHH administered the maintenance probe and 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 3 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. Brian entered the generalization phase. He obtained a score of 60% accuracy on the generalization probe 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 2-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 no immediacy of effect from 60% 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 were no overlapping data between phases.

**Social validity**

Social validity ratings were collected separately for the student participants and TODHH. The students rated the intervention on different aspects from one to five. A score of 1 indicated that they strongly disagreed, 3 indicated indifference, and 5 indicated strongly agreed. The numbers were accompanied by an icon to assist them in understanding the rating system. The results are displayed in Table 4. Overall, the students rated the intervention as a three or higher on average in all areas. The TODHH also completed a social validity questionnaire.

The TODHH responded to a questionnaire that rated the intervention on a scale of 1–5: a score of 1 indicated that she strongly disagreed and 5 indicated strongly agreed. The TODHH strongly agreed that the intervention would be easy to implement and was appropriate for classroom instruction. She agreed that she would like to implement the intervention after the study was completed. Lastly, the TODHH 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 TODHH also answered three open-ended questions. The first question asked the TODHH how she would change the intervention. The TODHH indicated that she would like to implement the intervention with small groups instead of one on one. The second question asked about the challenges and benefits of implementing a scripted curriculum. The TODHH responded that the benefits were that the script helped maintain the integrity of the instruction and made it easy to stay on task. The challenge was that one student found the repetition frustrating. The last question on the questionnaire asked how the students reacted to the intervention. The TODHH responded that most of the students reacted positively. One student “was frustrated toward the end” because the student did not like the repetitive nature of the script “just wanted to move on.” Overall, the TODHH’s responses indicated that she liked the intervention but would prefer to implement it in small groups and that this type of instruction may not be suitable to address all students’ learning needs or styles.

### Table 4. Student participants’ social validity ratings

<table>
<thead>
<tr>
<th>Statement</th>
<th>Mean rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>I liked learning about morphographs</td>
<td>4.3</td>
</tr>
<tr>
<td>Learning about morphographs was fun</td>
<td>3.7</td>
</tr>
<tr>
<td>I can break apart words now</td>
<td>4.7</td>
</tr>
<tr>
<td>I would recommend learning about morphographs to a friend</td>
<td>3.0</td>
</tr>
<tr>
<td>I learned a lot about morphographs</td>
<td>4.7</td>
</tr>
<tr>
<td>I can use what I learned about morphographs in other classes at school</td>
<td>3.7</td>
</tr>
</tbody>
</table>

**Discussion**

The purpose of this study was to determine the effects of morphographic instruction on the morphographic analysis skills of DHH students. Our primary research question was: What effect does morphographic instruction have on the morphographic analysis skills of DHH students who are reading below grade level? We answered this question through repeated assessment of morphographic analysis skill. We found that morphographic instruction does positively change the student participants’ morphographic analysis skills. There were three demonstrations of effect (Kratochwill et al., 2010) confirmed by the change from baseline to intervention for all three student participants. Further, Sienna and Brian’s data replicated the data paths (Kratochwill et al., 2010) 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. A functional relation between the morphographic...
intervention and the students’ morphographic analysis skills was established. These findings support previous findings that DHH students can improve literacy skills through DI programs (Trezek & Hancock, 2013; Trezek & Malmgren, 2005; Trezek & Wang, 2006) paired with a visual organizer (Easterbrooks & Stoner, 2006).

Second, we asked if students would be able to generalize what they had learned to untaught words. All of the students were able to analyze one or two untaught words during the generalization phase. However, they were not able to apply the word analysis knowledge at a mastery level. This finding suggests that DHH students require more than a short intervention: they may need ongoing teacher-led, explicit instruction in the area of morphographs as a part of their daily literacy curriculum if the intention is for them to generalize from taught to untaught morphographs. During the student participants’ workbook planned practice, 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). Indicating that a generalization measure that included taught morphographs with novel root words may have also been an appropriate measure.

Third, we asked the following question: If gains are made in morphographic knowledge, will that knowledge maintain over time? 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 did Megan. Megan maintained her morphographic analysis knowledge over time but not 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. 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 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.

Lastly, we wanted to know if morphographic instruction could influence students’ affix knowledge. We found that 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 although 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 correction procedures. The students required 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 need 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 et al., 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. With instruction, their skills improved. This finding supports the work of others who have suggested that DHH students benefit from instruction from professionals who have experience working with DHH students and who provide high-quality instruction (Marschark, Sapere, Convertino, & Pelz, 2008).

During pretesting, the researchers discovered that Megan and Sienna could decode the root words but could define only one of those root words. Brian could neither decode nor define the root words prior to intervention. This gap in background knowledge did not seem to influence their ability to learn the target affixes and root words. Modifying curriculum and planning lessons, with the understanding that DHH students often bring deficient background knowledge to tasks, is common (Hoffman & Wang, 2010; Schirmer, 2000; Wang & Paul, 2011). Reading in meaningful chunks is a developmentally appropriate task for students this age (Carlisle & Fleming, 2003) and the Individuals with Disabilities Education act requires educators to provide access to the general education curriculum. For these students, that meant providing instruction on morphographs with modifications to bridge the gap between grade-level demands and the student’s present level of performance.

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, often attempting syllable breaks, at each opportunity. The primary author 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. This finding suggests that DHH students may require morphographic analysis instruction to deconstruct words using morphographic rules.

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) and to add to the knowledge base surrounding morphographic analysis in the field of deaf education (Tucci, Trussell, & Easterbrooks, 2014). Improving a DHH students’ morphographic analysis and affix meaning knowledge could not only influence their decoding skills (Carlisle, 2000) and vocabulary but also, more distally, their reading comprehension (Carlson, Jenkins, Li, & Brownell, 2013; Dyer, MacSweeney, Szczerski, Green, & Campbell, 2003).

Limitations and Directions for Future Research

This study has several limitations that lead to recommendations for future research. As with all single case design studies, replication from an independent lab is needed to meet standards of research rigor (Kratochwill et al., 2010). Future researchers may consider replicating this study in various geographic locations or employing group design. The scripted lessons may be a second limitation of this study. The social validity results suggest that 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...
A third limitation was the age of the students. Fourth through eighth grade may be late to begin morphographic instruction, especially considering that it appears in the Common Core Standards (Common Core State 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).

A fourth limitation to this study was choosing the words that were not semantically salient to teach a new skill. The target word gullible can be broken into “gull” meaning “to trick” and “ible” meaning “can or able to.” Historically, the word gullible meant “able to trick,” but the current meaning of gullible is “quick to believe something that is not true” (Gullible [Def. 1], n.d.). There is a debate surrounding teaching root word meanings because the meanings have changed throughout the years; however, students can still glean some information from the meanings if they know the root meanings (Goodwin, 2014). During initial morphographic analysis instruction, future researchers may choose words that the root word meanings have remained the same.

Further, we chose our target words from the district approved spelling list. Future researchers may decide to teach word groups that are aligned with curriculum content. For example, the morphograph –ology can be combined with many root words (i.e., biology, sociology, and psychology). Teaching word families aligned with content area texts may provide the DHH reader with more word familiarity to aid in understanding the morphograph in different contexts (Carlisle & Katz, 2006).

A fifth limitation is the focus of this intervention on a single literacy skill. In the future, researchers may decide to investigate the affix and root word meaning instruction more in-depth and as part of a comprehensive literacy curriculum. The results of this study indicate that learning and using affix meanings will be more difficult than rote word analysis. Future researchers could integrate context clue instruction (Ram, Marinellie, Benigno, & McCarthy, 2013) or phonological instruction with morphological or morphographic instruction (Nunes, Bryant, & Olsson, 2009) to see if the skills support each other. Lastly, this intervention did not teach morphographic analysis dissection rules for derived words that change their spelling. 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 reading comprehension (Deacon & Kirby, 2004; Nagy et al., 2006; Nunes, Burman, Evans, & Bell, 2010). DHH students often have a morphographic knowledge delay that may negatively affect their reading ability (Gaustad & Kelly, 2004). 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. Although 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 (Mayberry, del Giudice, & Lieberman, 2011), the results also suggest the importance of explicit instruction that addresses affix meanings and word deconstruction. Although additional research is needed to validate morphographic instruction for this population, the study contributes positively to the morphographic instruction evidence base for instructing DHH students.

Conflicts of Interest

No conflicts of interest were reported.

References


