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Morpheme Use of Preschool Children Who Are Deaf or Hard-of-Hearing

by

Catherine Olaso

A thesis

submitted in partial fulfillment

of the requirements for the degree of

Master of Science in Speech Language Pathology

Idaho State University

Summer 2018

Committee Approval

To the Graduate Faculty:

The members of the committee appointed to examine the thesis of CATHERINE OLASO find it satisfactory and recommend that it be accepted.

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Notice of Exemption

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Dear Ms. Olaso,

After review, I've determined that your study: Morpheme Use of Preschool Children who are Deaf or Hard-of-Hearing does not fall under the definition of research as defined in Title Code of Federal Regulations, Part 46[45CFR 46].

Research is defined as:

> Federal research regulations and the Health Insurance Portability and Accountability Act of 1996 (HIPPA) define research as "a systematic investigation, including research development, testing, and evaluation, designed to develop or contribute to generalizable knowledge." The first of these two elements—the use of a systematic investigation—may be a characteristic of both research and non-research projects. Public health practice, quality assessment (QA) and quality improvement (QI) programs, resource utilization reviews, and outcome analyses are examples of non-research activities that frequently use statistical and other scientific methods to collect and analyze data in a manner that is identical to research studies... The primary goal of the activity must be to develop or contribute to generalizable knowledge to be called research.

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Your proposed study is not subject to review by the Human Subjects Committee. You are free to proceed with your study as described.

Sincerely,

Ralph Baergen PhD, MPH, CIP
Chair, Human Subjects Committee

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Dedication

This thesis is dedicated to my children: Mason, Reed, Connor, Liam, Nolan and Lauren.

The world is yours. Believe in yourself and never hesitate to follow your dreams.

I love you.

ACKNOWLEDGEMENTS

I would like to extend my sincerest gratitude to the faculty who helped me complete this thesis. First and foremost, I express my appreciation to my thesis advisor, Dr. Kristina Blaiser, whose continual enthusiasm, guidance and encouragement buoyed me up and kept me excited throughout this endeavor. Her expertise and dedication to the field of Communication Sciences and Disorders has inspired me to strive to embrace my clinical future with the same passion and confidence she exudes. Truly, I could not have asked for a better mentor.

I also express deepest thanks to my thesis committee, Dr. Diane Ogiela, Amy Hardy, and Dr. Ryan Lindsay. Their insight and suggestions did much to shape the direction and success of my project. I am honored to have learned from them during the course of my graduate studies experience.

Finally, I wish to convey my love to all of the many friends and family members who offered a listening ear, encouraging words, technical help, and prayers. I could not have endured the long days and rigorous course work of my graduate journey without you. Thank you for endlessly cheering me on and helping me believe in myself.

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Morpheme Use of Preschool Children Who Are Deaf or Hard-of-Hearing
Thesis Abstract – Idaho State University (2018)

The preschool years are a critical time frame for the emergence and acquisition of grammatical morphemes. The rate of a child's morphological growth between three and five years of age directly impacts language proficiency. Due to reduced and/or delayed auditory access, many preschool children who are deaf or hard-of-hearing (DHH) exhibit a deficiency in morpheme production during oral communication and often lag behind their same-age hearing peers in morphological development. Understanding of the morphological abilities of preschool children who are DHH can guide speech-language pathologists' clinical decision making, shape optimal developmental outcomes, and possibly prevent long term comprehensive services for this population in the future. The purpose of this study is to examine grammatical morphemes used in obligatory contexts for accuracy by preschool children who are DHH and the influence of intervention on accuracy over time.

Key Words: Deaf, Grammatical morphemes, Hard-of-hearing, Language sample, Preschool language development.

Background

Approximately one to three out of every 1,000 live births in the United States results in a diagnosis of hearing loss (Cunningham & Cox, 2003). Hearing loss can impact a child's developing vocabulary and expressive language (Hulsing, Luetke-Stahlman, Loeb, Nelson, & Wegner, 1995; Lederberg, Schick, & Spencer, 2012). The implementation of Individuals with Disabilities Education Act (IDEA) 2004, gave rise to a growing number of children who are deaf or hard-of-hearing (DHH) transitioning to mainstream classrooms with less time in special education settings (Schildroth, 1988; Stinson & Antia, 1999). With increased numbers of students who are DHH integrated into the least restrictive environment, it is imperative that speech-language pathologists (SLPs), specifically school-based SLPs, are prepared to address this population's language needs in a comprehensive manner. Unfortunately, a clear understanding regarding spoken language development of this population is limited, as data addressing the evaluation of the language and oral skills of children who are DHH is relatively scarce (Moeller et al., 2010).

The preschool years (ages 3 – 5) have shown to be a critical time frame for the emergence and acquisition of grammatical morphemes (Goffman & Leonard, 2000; Rice, Wexler, & Hershberger, 1998; Rispoli, Hadley, & Holt, 2009). Grammatical morphemes are small units of language that can be attached to words to add to or change their meaning. A young child's starting point in the development of morphology, defined as, "A system of rules for combining the smallest units of language into words" (Hoff, 2001,p. 402), begins as early as nineteen to twenty-one months of age (Brown, 1973; Rispoli et al., 2009). The rate of a child's morphological growth between three and five years of age, directly impacts language proficiency. Many morphological makers in the English language can be correlated with

approximately 4000 Hz. This level is considered a key frequency for /s/ and /z/. Auditory access to 4000 Hz provides not only consonant quality, but additional cues relevant to learning and understanding parts of speech such as: plurals, possessives, auxiliaries, third person, copulas, idioms, singular verb forms, past perfect and questions (Ling, 2002). Due to reduced and/or delayed auditory access, especially at 4000 Hz, many preschool children who are DHH exhibit a deficiency in morpheme productions during oral communication, and often lag behind their same-age hearing peers in morphological development. The purpose of this paper is to examine the morphemes used in obligatory contexts by preschool children who are DHH. Grammatical morphemes will be evaluated for accuracy across time as well as to determine whether or not a correlation to external variables such as age first identified with hearing loss, degree of hearing loss, age of implant or fitted with technology and length of early intervention services may exist. Increased understanding of the morphological abilities of preschool children who are DHH will guide SLPs clinical decision making, shape optimal developmental outcomes, and possibly prevent long term comprehensive services for the child in the future.

Morphological Skills of Children who are Deaf or Hard-of-Hearing

To better understand the extent of the language deficits that often result as a consequence of reduced auditory input, examining the language development of hearing children proves insightful. Paul and Norbury (2012) list the morphemes expected to emerge in typically developing children between the ages of three to five years of age. At 36 months, a child should generally be able to demonstrate the following morphemes in an obligatory context: (1) *Present tense auxiliaries,* (2) *Be verbs,* (3) *Auxiliary verbs,* (4) *Articles,* (5) *Irregular past tense,* (6) *Plural – s* and (7) *Possessive –'s*. By 60 months of age, the child should be able to productively use: (1) *Regular past tense – ed* and (2) *Third person singular – s* in obligatory contexts. Brown

(1973) developed a timeline of ages at which specific morphemes typically emerge in language development (See Appendix A). Although these projected timelines can be a beneficial guide when assessing the morphological development of toddlers and preschool children, it should also be noted that they are not without variability.

Advances in hearing technology and newborn hearing screenings have facilitated the development of spoken language skills in children who are DHH. However, many children in this population are prone to lag behind in developing morphological skills at the same rate as their hearing peers (Moeller et al., 2010), leading to challenges with both language and literacy development (Moeller, Tomblin, Yoshinaga-Itano, Connor, & Jerger, 2007). Two aspects most directly related to hearing loss and spoken language involve deficits in articulation and the use of bound morphemes (Elfenbein, Hardin-Jones, & Davis, 1994). Children who are DHH often lack the ability to perceive differences in sounds. Stelmachowicz, Pittman, Hoover, and Lewis (2002) conducted an aided perception study of /s/ and /z/. Test items included singular and plural nouns spoken by both a male and female talker. Forty children who are DHH between the ages of 5 to 13 years were compared to a control group of 36 hearing children, ages three to five years. Results showed that the hearing children displayed no significant effects with the talker or the singular/plural noun forms. However, children who are DHH varied in performance across ages, with plural noun forms spoken by a female talker producing the greatest number of errors. Moeller et al. (2010) found that upon comparison of four children who are DHH, ages 4 – 60 months, and ten of their age-matched hearing peers, the children who are DHH omitted postvocalic /s/ and /z/ as late as five years of age; while the hearing children made few errors with postvocalic /s/ and /z/. The difficulty that children who are DHH experience with high frequency morphemes such as /s/ and /z/, as well as other assorted voiceless morphemes may not

always be apparent on a standardized test. Standardized assessments are not normed on children who are DHH, and therefore not sensitive to the specific language errors of this population. For this reason, SLPs need an evidence-based protocol geared toward detecting the specific language errors made by children who are DHH. An accurate and comprehensive understanding of the language capabilities of a child who is DHH involves highlighting and dissecting the child's individual language profile to determine which key aspects of language are lacking. Early intervention is critical in targeting each missing foundational piece of language. Morphemes are considered to be included as part of the foundational development of language. Morphemes that share the grammatical property of tense such as (1) *Copula Be* (My dog is big), (2) *Auxiliary Be* (The boy is swimming), (3) *Auxiliary Do* (Does she want to go?), (4) *Third person singular present tense – s* (She goes), and (5) *Past tense regular – ed* (She jumped), begin to appear in typical development between two and two and a half years of age (Rispoli et al., 2009) and are generally mastered by age four (Rice et al., 1998). However, Moeller et al. (2010) found that the children who are DHH in their study began initial productivity, not mastery, with tense morphemes at around four-years of age while the hearing children comprising the control group demonstrated productivity closer to three years.

Current literature continues to support a developmental gap between children who are DHH and their hearing peers, especially with regard to morphological development. For example, while some children who are DHH have been reported to perform similarly in lexical and syntactic diversity as their hearing peers (Elfenbein et al., 1994) many children continue to fall behind age expected norms in the development of grammar (Lederberg et al., 2012). Elfenbein et al. (1994) conducted a speech and language study involving 40 children who are DHH between 5 and 18 years of age. Each child participated in two standardized tests – the

Fisher-Logemann Test of Articulation Competence (Fisher & Logemann, 1971) to measure articulation skills, and the Grammatic Completion subtest of the *Test of Language Development* (TOLD; Newcomer & Hammill, 1977) to measure grammar competency. A language sample was collected by asking the children questions about school and hearing loss during an interview. A speech sample was obtained by asking the children to produce a story retell. Compared to the control group, children who are DHH exhibited morphological difficulty with the following articulation test items: (1) *Irregular plural nouns,* (2) *Possessives,* (3) *Past perfect tense,* (4) *Comparatives,* and (5) *Simple present tense*. Substitution errors comprised the most common phonological error for the children who are DHH, especially with regard to affricates and fricatives. Additionally, language sample errors occurred in the following decreasing order: (1) *Uncontractible copula,* (2) *Uncontractible auxiliary,* (3) *Plural – s,* (4) *Possessive –'s,* and (5) *Articles.* This difficulty with production of high frequency morphemes has been replicated in other literature such as Koehlinger, Van Horne, and Moeller (2013), McGuckian and Henry (2007) and, Moeller et al. (2010).

Koehlinger et al. (2013) compared the oral language skills of children who are DHH with hearing peers. Testing groups were composed of 60 three-year-olds and 40 six-year-olds with hearing loss, as well as control groups of 23 hearing three-year-olds and 17 hearing six-year-olds. The syntax subtest of the *Comprehensive Assessment of Spoken Language* (CASL; Carrow-Woolfolk, 1999) was administered to all children along with probes for /s/, /t/, /z/, and /d/, among the three-year old groups. Language samples were collected from all children utilizing Play-Doh and play-based conversational contexts. However, differences in sampling elicitations also occurred between groups during the last few minutes of the sample. The three-year-olds participated in a 5-minute picture description with a parent and the 6-year-olds

received a modeled narrative or personal experience from the clinician and were then asked if something similar had happened to them. The children who are DHH produced language samples that had lower mean length of utterance (MLU) in words than their hearing peers in both groups. Additionally, children who are DHH produced fewer obligatory morphemes than their hearing peers as noted in the following decreasing order from most to least: (1) *Past tense – ed,* (2) *Third person singular – s,* (3) *Contractible auxiliary,* (4) *Contractible copula* (5) *Uncontractible auxiliary,* and (6) *Uncontractible copula*. This weakness in grammatical tense exhibited by children who are DHH mimics some of the same language characteristics of children with specific language impairment (SLI). Children with SLI are often known to omit verb morphemes marking tense in speech output (Rice & Wexler, 1996). In fact, Rice et al. (1998) noted that deficits with grammatical verb tense markers at the preschool level has shown to be a clinical marker characteristic of children with specific language impairment (SLI). This view is also consistent with Goffman and Leonard (2000) who observed that the strengths or weaknesses of a young child's verb morphology can often serve as a predictor of their language proficiency.

McGuckian and Henry (2007) examined the accuracy of grammatical morpheme production in 10 children (mean age 7;4) who are DHH and compared them to 10 hearing children (mean age 3;2) with equivalent MLUs. Elicited and spontaneous language samples demonstrated that the children who are DHH used both *possessive –'s* and *plural – s* with less frequency than their hearing peers. However, they produced (1) *Progressive – ing,* (2) *Articles,* and (3) *Irregular past tense* in the samples more often than their normal hearing peers. The morphemes that proved the most challenging for children who are DHH included the following in decreasing order: (1) *Possessive –'s,* (2) *Past tense – ed,* and (3) *Third person singular – s,* (4)

Contractible auxiliary, (5) *Irregular past tense,* (6) *Contractible copula,* (7) *Plural – s.* The order of accuracy in the production and use of grammatical morphemes by the children who are DHH reflected patterns similar to children who are acquiring English as a Second Language.

Moeller et al. (2010) conducted a longitudinal study of four children, ages 38 to 41 months, with late identified, mild-moderate hearing loss. The children who are DHH were compared to a control group of 10 hearing children. The authors examined the plausibility of the children who are DHH overcoming the effects of early delays in order to be on task with their hearing peers. Susceptible delays in phonology and morphosyntax were investigated through a battery of standardized tests and language sampling procedures. Results indicated that reduced access to auditory experiences contributed to pronounced delays in receptive and expressive language development. With appropriate amplification and intervention, three of the four children who are DHH were able to demonstrate systematic improvement and catch up to age-matched peers on standardized speech and language measures by 60 months of age. However, problems with morphological markers and phonology at the conversational level were predicted likely to persist. For example, three of the four children in the study continued to exhibit tense errors after 54 months of age with the verb markers: (1) *Third person singular – s,* (2) *Contractible copula,* (3) *Contractible auxiliary* and (4) *Past tense – ed*; an age that hearing children rarely demonstrate verb tense inaccuracy. In addition, morphological delays are not isolated to conversation. For many children with a hearing loss, personal and/or fictional narratives, often lack complex syntactic structure, especially related to verb tense/agreement and morphological markers (McGuckian & Henry, 2007; Moeller et al., 2010) and often resemble the narratives of children with a language disorder (Young et al., 1997).

The Impact of Early Identification, Amplification and Intervention

Growing evidence suggests that the combination of early identification of a hearing loss (prior to six months of age), amplification, and early intervention services significantly impacts a child's prognosis for acquiring language on par with developmental milestones (Carney & Moeller, 1998; Moeller, 2000; Prendergast, Lartz, & Fiedler, 2002; Yoshinaga-Itano, Sedey, Coulter, & Mehl, 1998). For children who are DHH, access to auditory stimuli as early as possible is crucial in forming a foundation for successful language production. In their 2007 annual position statement, the Joint Committee on Infant Hearing (JCIH;2007) advocates a 1-3-6 policy; which recommends children are screened for hearing loss by one month of age, identified with hearing loss and fitted with hearing aids by 3 months of age, and enrolled in early intervention by six months of age.

Hadley, Rispoli, Fitzgerald, and Bahnsen (2011) found that the evolution of morphemes from exposure to production is a step-by-step process that is influenced by auditory input. Before children initiate morpheme use in conversation, they benefit from parents who provide high levels of information input around tense and agreement markers. Children who received high levels of verb tense modeling from their parents demonstrated faster initial growth and increased levels of verb tense/agreement productivity by 30 months.

Yoshinaga-Itano et al. (1998) examined the receptive and expressive language skills of 150 children who are DHH between the ages 1;1 – 3;0. The children were divided into two groups (1) those identified with a hearing loss by six months of age, and (2) those identified with a hearing loss after six months of age. Each primary caregiver completed the *Minnesota Child Development Inventory* (MCDI; Ireton & Thwing, 1974), a standardized questionnaire designed to evaluate different areas of development. Significant differences existed between the groups in

the area of language, with the early identified group performing at almost one standard deviation above the later identified group.

Children who are DHH experience challenges obtaining clear and consistent acoustic information from the environment. Muñoz and Blaiser, (2011) noted that hearing aids and/or cochlear implants serve as an important mechanism in providing children who are DHH consistent access to speech sounds. This early, consistent access to sounds helps make critical connections within the auditory centers of the child's brain necessary for language development. Reduced access to environmental cues through auditory information often contributes to poorer foundational skills necessary for a developing child to adequately define the rules of language formulation and vocabulary. Hearing technology aids the perception of various auditory aspects of the speech signal. The American Speech Hearing Association (ASHA) notes that the early identification of hearing loss along with the early use of hearing technology are critical components in the development of speech and language skills of children who are DHH. Overall, early amplification leads to more positive outcomes for children who are DHH (Fitzpatrick, Crawford, Ni, & Durieux-Smith, 2011).

In conjunction with early identification and amplification, early intervention services have been supported by both medical and special education professionals as a means of providing children who are DHH with increased support for language development and academic achievement. In the study cited above by Yoshinaga-Itano et al. (1998) it's important to note that the children categorized as either having early or late hearing loss identification all started early intervention services soon after their hearing loss was diagnosed, suggesting that early identification alone does not ensure improved outcomes, but often requires follow up with early intervention.

Moeller (2000) examined the vocabulary skills of 112 five-year olds with congenital, bilateral sensorineural hearing loss who were enrolled at various ages into an early intervention program. Additionally, a subgroup of 80 of the listed 112 participants, were also tested for verbal reasoning skills. Assessment tools included the *Peabody Picture Vocabulary Test* (PPVT; Dunn & Dunn, 1997) and the *Preschool Language Assessment Instrument* (PLAI; Blank, Rose & Berlin, 1978). All children were compared to same-age hearing peers. Overall results indicated that the children who are DHH, who were enrolled early into an intervention program (generally by 11 months) performed higher than the later-enrolled children in both vocabulary and verbal reasoning skills. In fact, early enrolled children demonstrated vocabulary and verbal reasoning skills that approximated those of the control group. In their review of treatment efficacy for children who are DHH, Carney and Moeller (1998) concluded that early intervention programs have been found to lessen the extent of speech and language delays and other consequences of hearing loss experienced by children who are DHH.

Current Language Assessment Procedures

SLPs must make clinical decisions based on thorough assessments that accurately target the speech and language strengths and weaknesses of children, including those who are DHH. Evidence-based practice suggests that standardized instruments alone are not adequate in providing all clinical information necessary to ascertain the extent of a language impairment, and should therefore be supplemented with non-standardized assessments (Kover, Davidson, Sindberg, & Weismer, 2014; Southwood & Russell, 2004). Standardized measures lack specific information about the skills an individual child possesses, the skills that are emerging and the skills the child has yet to acquire. Additionally, a standardized measure alone cannot provide functional data that evaluates a child's natural language in real-life contexts. A language sample

is an optimal non-standardized assessment to use in conjunction with a standardized measure, because a language sample creates an opportunity for the SLP to appraise a child's language profile within the naturalistic context required for a concrete assessment. For more than 90 years, researchers and clinicians have relied on language sample analysis as the "gold standard" in documenting linguistic development via an informal measure (Evans & Craig, 1992; Heilmann, Nockerts, & Miller, 2010; Johnston, 2006; Longhurst & File, 1977; Longhurst & Grubb, 1974; Miller, Andriacchi, & Nockerts, 2016; Nippold et al., 2014). ASHA recognizes the collection of a language sample as a valid and useful skill for all clinicians in the field of speech-language pathology (ASHA, n.d.).

In a survey of 253 SLPs within the United States, Kemp and Klee (1997) found that 85% of clinicians use language samples in their assessment of children with language impairments. A survey by Hux, Morris-Friehi, & Sanger (1993) examining the language sampling practices of 239 SLPs in nine states, noted that most respondents utilized the input from language samples for multiple purposes. The most common use of a language sample was to supplement standardized measures and assist in treatment planning. In regard to examining grammatical morpheme use in children, Rispoli et al. (2009) reported, "…accuracy in spontaneous language samples remains the most commonly used metric for studies of morphosyntactic development" (p. 933). Likewise, Stelmachowicz et al. (2002) noted that a language sample, spontaneous or elicited, is the typical standard for assessing morphological development.

Given the benefits of early identification, amplification and intervention, a larger portion of children who are DHH have been able to acquire spoken language skills almost comparable to that of typically developing hearing children. However, many children who are DHH still demonstrated delays in spoken language despite the use of hearing technology (Lederberg, et al.,

2012). This study offers a unique perspective on the role of intervention and its impact on the oral language gaps often seen between children who are DHH and their same-age hearing peers. Access to multiple language samples that track the participants' longitudinal changes in morpheme production accuracy over time provides valuable clinical information on the efficacy of intervention practices.

Research Questions

Given development and the current literature, this project assessed the following target morphemes: (1) *progressive – ing,* (2) *preposition – on,* (3) *preposition – in,* (4) *plural – s,* (5) *irregular past tense,* (6) *possessive – 's,* (7) *uncontractible copula,* (8) *auxiliary – Do,* (9) *articles,* (10) *past tense – ed,* (11) *third person singular – s,* (12) *third person irregular,* (13) *uncontractible auxiliary,* (14) *contractible copula,* (15) *contractible auxiliary.* For a sample of preschool children who are DHH that receive weekly individual therapy and classroom intervention for 3 hours a day / 4 days a week:

1. Is there a difference in the number of obligatory contexts of the target morphemes by time?
2. Is there a difference in accurate production of the target morphemes by time?
3. What, if any, demographic or hearing variables relate to a child's proportion correct morpheme use across time?

It is hypothesized that preschool children who are DHH will demonstrate increased accuracy of morphemes in obligatory contexts over time.

It is also hypothesized that preschool children who are DHH will demonstrate persistent errors with the morphemes: (1) *Copula Be,* (2) *Auxiliary Be,* (3) *Auxiliary – Do,* (4) *Third person singular – s* (5) *Past tense – ed.*

Operational Definitions

Language sampling contexts included four categories from which the participants could choose a preferred activity (see Appendix B). At least two different activities were encouraged per language sample. Target morphemes were chosen for coding based on current literature and developmental appropriateness for three to five-year-old preschool children (See Appendix C). Morphemes were coded as accurate or errored. Errors constituted omissions, additions, substitutions or over-regularizations of the target morphemes (see Appendix D).

Method

This thesis is a retrospective study that makes use of data obtained from a larger, ongoing research project evaluating language sampling practices with children who are DHH. Institutional review board (IRB) approval along with participant demographics were obtained prior to data analysis.

Participants

Seventeen preschoolers consisting of 11 boys and 6 girls ranging in ages 3:0 – 5:4 (mean age 3:7) comprised the study participants. Most of the children spoke English as the primary language at home, with the exception of two, bilingual second language learners with Spanish as the primary language spoken at home. All of the children had either a unilateral hearing loss (n = 6) or a bilateral hearing loss (n = 11) diagnosed as mild to profound. Age of identified hearing loss ranged from birth – 35 months. The technology used by the participants included hearing

aids (n = 14), hearing aid and cochlear implant (n = 1), or bone anchored hearing aid – BAHA (n = 1). One participant diagnosed with a severe unilateral loss had no aid.

All of the children were enrolled in the Listening and Spoken Language Preschool of the Idaho Educational Services for the Deaf and the Blind (IESDB). Each participant averaged 20 minutes a week of individual pull-out services by the school-based speech-language pathologist, with the remainder of the listening and spoken language intervention occurring in the classroom setting, which was provided four days a week for 3 hours each day. Demographic variables are displayed in Table 1.

Language Elicitation Methods

A monthly 50 utterance language sample was collected from 17 preschool children who are DHH and attended a local preschool program focused on enhancing oral speech and language skills. Samples were collected by undergraduate research assistants who received training on Miller and Iglesias' (2012) Systematic Analysis of Language Transcripts (SALT), and had a manual outlining elicitation and collection guidelines. The samples were elicited in a small, quiet room using a variety of toys throughout the session which included all or some of the following: (1) Play-Doh in isolation, (2) toys, (3) Play-Doh with toys, (4) a children's book that was introduced in class, and a fifth contextual category - conversation without any stimuli that occurred during activity transitions.

Data Transcription

Language samples were collected throughout the participants' school year starting in November (Time 1) and ending in May (Time 2). These two time points and the difference between them were analyzed to examine the accuracy of morphemes used in obligatory contexts

over time. The average length of intervention between Time 1 and Time 2 language samples was 6.05 months (range of 3 to 7). Target morphemes were selected based on current literature identifying specific morphemes that are challenging for children who are DHH, but developmentally appropriate for children ages three to five years. As mentioned earlier, target morphemes consisted of (1) *progressive – ing*, (2) *preposition – on*, (3) *preposition – in*, (4) *plural – s*, (5) *irregular past tense*, (6) *possessive – 's,* (7) *uncontractible copula*, (8) *auxiliary – Do*, (9) *articles*, (10) *past tense – ed*, (11) *third person singular – s*, (12) *third person irregular*, (13) *uncontractible auxiliary*, (14) *contractible copula*, (15) *contractible auxiliary* (See Appendix C). All samples were video and audio recorded, and transcribed by the same student clinician who obtained the language sample.

Reliability

Each undergraduate student transcribed, analyzed and input the data from their assigned participants' samples into SALT. All 50 utterances from each of the 34 language samples were reviewed for accuracy at the morpheme level by a second examiner – the thesis author. Initial inter-judge agreement was 90%. Further disagreement was settled by a third inter-rater judge, a second-year graduate student knowledgeable in language sampling transcription and coding. Final inter-judge agreement was 96%. The remaining 4% of utterances were deemed too unintelligible to be included in the data analysis.

Errors were coded as omissions, additions, substitutions and over-regularizations by the thesis author. Every tenth utterance was reviewed for coding reliability by a second examiner, a second-year graduate student familiar with morphology and transcription coding. Final inter-judge agreement was 98%, with the remaining 2% discussed to concurrence.

Results

Mean length of utterance across time

Mean length of utterance (MLU) was compared at Time 1 and Time 2 to examine the overall growth of children's productions over time. Overall, the participants' MLU increased over time with a mean MLU of 2.91 (*SD* = 1.82) at Time 1 and a mean MLU of 3.71 (*SD* = 1.50) at Time 2. The differences between the two times can be seen for individual children in Figure 1. Of the total participants, three participants doubled their MLU from Time 1 to Time 2; nine participants increased their MLU at Time 2; two participants had the same MLU; and three participants' MLUs decreased at Time 2 compared to Time 1.

Obligatory Contexts

Given the fact that the data was collected via spontaneous language samples, it was necessary to assess the number of obligatory contexts present at each of the time points. The number of obligatory contexts that were present for each morpheme at Time 1 and Time 2 were tallied and are shown in Table 2. At Time 1, the total number of obligatory contexts for all participants was 568, with 420 accurate productions yielding an average proportion correct of .686, *SD* = .272. The three morphemes with the most obligatory contexts at Time 1 were *articles* (n = 186), *plural – s* (n = 74), and *progressive – ing,* (n = 53). At Time 2, the total number of obligatory contexts for all participants was 844, with 636 accurate productions yielding an average proportion correct of .713, *SD* = .239. At Time 2 the three morphemes with the most obligatory contexts were *articles,* (n = 243), *progressive – ing,* (n = 107) and *uncontractible copula,* (n = 103).

To examine the first research question, a 2 x 2 repeated measures analysis of variance (ANOVA) with Time (i.e., Time 1 and Time 2), $Morpheme_{oc}$ (i.e., number of obligatory contexts that existed for each of the target morphemes), and Time x $Morpheme_{oc}$ interaction was conducted to assess if mean differences existed on the morphemes' obligatory contexts over time. There was a statistically significant main effect for $Morpheme_{oc}$, F (14, 151) = 18.44, $p <$ .0001, indicating that some morphemes had a greater number of obligatory contexts than others. A Duncan's post hoc analysis was performed to examine which morphemes were present in the language samples more than the other morphemes. There were statistically significant differences ($p < .05$) for the following morphemes: *articles,* (M = 13.406); *progressive – ing,* (M = 10.000); *uncontractible copula,* (M = 5.536); *plural – s,* (M = 5.400); *contractible copula,* (M = 4.958); *past tense – ed,* (M = 4.000); *preposition – in,* (M = 3.600); *contractible auxiliary,* (M = 3.235); *irregular past tense,* (M = 3.150); *auxiliary – Do,* (M = 3.000); *uncontractible auxiliary,* (M = 2.824); *preposition – on,* (M = 1.889); *third person singular – s,* (M = 1.750); *third person irregular,* (M = 1.600); and *possessive – 's,* (M = 1.429). There was no statistical significance for Time, F (1, 14) = 1.01, $p < 0.3$ or for Time x Morpheme interaction F (14, 62) = 0.81, $p < 0.6$.

Accuracy in production of morphemes

To examine the second research question, a 2 x 2 repeated measures analysis of variance (ANOVA) with Time (i.e., Time 1 and Time 2), $Morpheme_{pc}$ (i.e., proportion of correct production for each of the target morphemes), and Time x $Morpheme_{pc}$ interaction was conducted to assess if mean differences existed in the children's ability to accurately produce the target morphemes over time. Table 3 shows morpheme accuracy for each participant at Time 1 and Time 2. To take into account the variability in the obligatory contexts that occurred for

various morphemes (as shown above), morphological accuracy was measured as a proportion. That is, proportion correct was defined as the number of morphemes produced accurately within the spontaneous language sample divided by the number of obligatory contexts provided. The main effects of Time, Morpheme_{pc} and a Time x Morpheme_{pc} interaction were included in the model.

The main effect for Morpheme_{pc} was significant, F (14, 151) = 7.91, $p < .001$, indicating a statistically significant difference in accuracy between specific morphemes. A Duncan's post-hoc analysis was performed to examine the difference in the overall accuracy of individual morphemes, regardless of time. The overall mean for each target morpheme was reported as: *third person irregular*, (M = 1.0000); *preposition – on*, (M = .9815); *Preposition* – in, (M = .9500); *progressive – ing*, (M = .9168); *past tense – ed*, (M = .8131); *auxiliary – Do*, (M = .7437); *articles*, (M = .7205); *plural – s*, (M = .7032); *contractible copula*, (M = .6538); *third person singular – s*, (M = .5104); *uncontractible auxiliary*, (M = .4980); *irregular past tense*, (M = .4945); *uncontractible copula*, (M = .4511); and *possessive – 's*, (M = .2143); indicating that certain morphemes are significantly different from each other.

There was no statistical significance for the main effect of Time, F (1, 14) = 1.10, $p < .75$, indicating accuracy levels overall were the same between Time 1 and Time 2.

The Time x Morpheme_{pc} interaction was statistically significant, F (14, 62) = 2.04, $p < .02$, indicating a difference in accuracy of certain morphemes between Time 1 and Time 2. A series of paired t-tests was conducted in post-hoc analysis to determine which morphemes had significantly changed in accuracy levels over time. Figure 2 shows accuracy levels for morphemes across time. Three of the fifteen target morphemes demonstrated statistically significant change. *Irregular past tense*, t (6) = -2.37, p = .05, and *uncontractible copula*, t (11)

= -2.31, p = .04, indicated a significant increase in accuracy from Time 1 to Time 2. However, *contractible auxiliary*, t (2) = 5.20, p = .03 indicated a significant decrease in accuracy from Time 1, M = .7 to Time 2, M = .0. Participants achieved near mastery of *progressive – ing*, *preposition – on* and *preposition – in* at both Time 1 and Time 2. *Third person irregular* had a 100% accuracy rate, while *possessive – 's,* demonstrated the lowest accuracy among the target morphemes.

Error Types

Omissions comprised the majority of morpheme errors made in obligatory context for Time 1 (n=108) and Time 2 (n=160), as well as for the overall time points combined. A total 76% omission rate occurred over Time 1 and Time 2. The five most omitted morphemes at Time 1 were: *uncontractible copula* (n = 29, 27%), *articles* (n = 24, 22%), *plural – s* (n = 10, 9%), *past tense – ed* (n = 9, 8%) and *contractible copula* (n = 9, 8%). Time 2: *articles* (n = 43, 27%), *uncontractible copula* (n = 40, 25%), *contractible auxiliary* (n = 17, 11%), *uncontractible auxiliary* (n = 15, 9%), and *contractible copula* (n = 14, 9%). Following omissions, equal error rates over time were noted for substitutions (n = 42, 12%), and additions (n = 42, 12%). No over-regularization errors were produced at Time 1, and only one over-regularization error was made at Time 2.

Relationship between demographic, hearing and intervention variables and performance

A Pearson Correlation was conducted to determine if demographic, hearing and intervention variables contributed to production accuracy over time. At Time 1, a statistically significant relationship was found for the following variables and morpheme proportion correct: age identified with hearing loss and *contractible auxiliary* (r = -.89, p < .02, n = 6); degree of hearing loss and *uncontractible auxiliary* (r = .6157, p < .03, n = 12); age fit with technology and

contractible auxiliary (r = -.9, p < .01, n = 6); primary language spoken in the home and *articles* (r = .5349, p < .04, n = 15); length of intervention between language samples and *plural – s* (r = .67, p < .008, n = 14); and *past tense – ed* (r = .9977, p < .0001, n = 5). No significant relationship existed at Time 1 for age of participant, gender, degree of loss, or the type of technology used.

At Time 2, a positive relationship occurred for the following variables and morpheme proportion correct: type of hearing loss and *auxiliary – Do* (r = -.799, p < .02, n = 8), *progressive – ing* (r = .855, p < .0004, n = 12), and *uncontractible copula* (r = -.5, p < .05, n = 16); degree of hearing loss and *uncontractible auxiliary* (r = .8168, p < .002, n = 11); age fit with technology and *possessive – 's* (r = .99, p < .009, n = 4) and *contractible auxiliary* (r = -.90, p < .01, n = 6). No significant relationship existed at Time 2 for age of participant, gender, age identified with loss, the type of technology used, length of intervention or the primary language spoken in the home.

Discussion

This study examined if children who are DHH demonstrate improved accuracy in morphological production over time, and if all morphemes change in the same manner. Efficacy of intervention was also examined for correlations between services and improved morpheme production over time. In general, the language samples collected during Time 2 yielded more favorable results regarding MLU, number of obligatory context opportunities, morpheme proportion correct, and number of errors. These gains are likely attributed to both intervention and development.

The preschool children who participated in this study are still acquiring grammatical morphemes as demonstrated by the inconsistent accuracy of *articles*, (72%) and *plural – s* (70%), morphemes that are generally attained between the ages of 27 – 46 months. Elfenbein et al. (1994) and McGuckian and Henry (2007) reported *articles*, and *p*lural – *s*, as notable errors for children who are DHH, but not for their hearing peers. The children who are DHH in the McGuckian and Henry (2007) study produced more *articles* than the control group, which consisted of ten typically developing preschool children matched via MLU. However, despite a larger proportion of production of *articles* between the groups, the children who are DHH did not demonstrate mastery of the use of *articles.* Conversely, the control group in the same study produced more *plural – s* morphemes in obligatory contexts than the children who are DHH, and exhibited few errors in their productions.

Copula Be and *auxiliary Be* were among the morphemes with the lowest proportion correct over time (*contractible copula*, .6538, *uncontractible auxiliary* .4980, *uncontractible copula*, .4511, *contractible auxiliary* .2500). This difficulty with morphemes marking tense demonstrates a lack of proficiency with tense markers that are generally acquired between the ages of 28 – 50 months. The results for the children in the present study were similar to the findings of Moeller et al. (2010) who noted that the hearing children in their longitudinal study demonstrated productive use of *copula Be* by 36 months; whereas the children who are DHH did not demonstrate initial productivity for *copula Be* until closer to 48 months. Conversely, McGuckian and Henry (2007) found marginal differences between the children who are DHH and the control group for *copula Be* and *auxiliary Be* production accuracy, noting that for the control group, tense morphemes appeared lower in the order of accuracy compared to non-tense morphemes; a pattern reported in other studies of typically developing children (Rice & Wexler,

1996; Rice et al., 1998). These lower accuracy patterns of morphemes marking tense for typically developing children in other studies, may suggest that preschool children without a hearing loss can also be vulnerable to tense errors during this period of language development.

Children from this sample demonstrated an increase in obligatory contexts for *third person singular – s,* another morpheme marking tense, from Time 1 (n = 10) to Time 2 (n = 18). Grammatical context dramatically controls obligatory context as demonstrated by an increase in the number of participants using the target morpheme in spontaneous conversation; Time 1 (n = 6), Time 2 (n = 10). However, because the current study did not control for conducive contexts, it is difficult to interpret the children's usage of *third person singular – s.* While no statistical significance was shown for *third person singular – s*, the reported accuracy rate over time of 51% indicates that participants are still striving for proficiency of *third person singular – s*. A delay in the proficiency of this morpheme by children who are DHH is likely contributed to the low perceptual saliency of /s/. In contrast, the participants demonstrated a high frequency of use and accuracy for *progressive – ing*, a more perceptually salient morpheme, over Time 1 and Time 2 in obligatory contexts (91%). *Progressive – ing* is a morpheme that children, especially children who are DHH, often substitute for *third person singular – s* in a less complex sentence structure. Moeller et al. (2010) noted that *third person singular – s* emerged later than the suggested 26 months in typical development for not only the children who are DHH in their study, but the hearing control group as well. Again, these results may likely be attributed to *third person singular – s*' high sensitivity to context.

Possessive – 's had the lowest level of accuracy (21%) over time than any of the other target morphemes. Due to the low frequency of obligatory contexts (n = 10) for *possessive – 's* among the participants, it is difficult to ascertain whether this low level of accuracy is a product

of difficulties in production of the morpheme, limited opportunities, or a combination of both. However, of the opportunities to use *possessive –'s* in obligatory contexts (n = 10), there was a total of eight omissions – four omissions at Time 1 and four omissions at Time 2. McGuckian and Henry (2007) found similar findings – children who are DHH omitted *possessive – 's* more than their same-age hearing peers who exhibited few errors when marking and accurately producing *possessive – 's*. Emergence of *possessive –'s* typically occurs between 26 – 40 months of age. With only eight productions across time in obligatory contexts, *third person irregular* presented as another morpheme that may have lacked sufficient opportunities to adequately warrant the highest proportion correct (100%). The low production rate among the participants could likely be attributed to the fact that the English language is limited to approximately three verbs that are irregular in their *third person singular* forms; namely, says, does and has. Most language sampling contexts limit production opportunities for *third person singular* overall, because English tends to use the present progressive more than the simple present, and language samples usually elicit language in the past tense, as in, "What happened?" Consequently, less obligatory opportunities for *third person* was evident in the spontaneous speech samples of the participants.

Given the lack of opportunity in obligatory contexts leading to lower production and therefore a lower or higher proportion correct than may be warranted, it is not unreasonable to question whether or not a language sample should purposefully elicit the specific morphological errors that children who are DHH often make. For some low frequency morphemes limited by properties of the English language in obligatory contexts, it could be beneficial to utilize probes to supplement the language sample analysis through greater environmental control of stimuli. McGuckian and Henry (2007) utilized both spontaneous and elicited samples from children who

are DHH. They concluded no significant difference in morpheme results; noting that correct production was similar in both contexts. However, the current study did not result in enough obligatory contexts via spontaneous speech to adequately produce a wide range of the target morphemes and could have benefited from more structured elicitation. Over time, the participants as a whole exhibited the following persistent morphological errors (proportion correct = < .70) from most to least: *possessive –'s, contractible auxiliary, uncontractible copula, irregular past tense, uncontractible auxiliary, third person singular – s,* and *contractible copula.*

The most prevalent error type was the omission of morphemes in obligatory context, with a total 76% occurrence across Time 1 and Time 2, indicating that morphemes are not acoustically salient. Ten of the fifteen target morphemes analyzed for predominant error type at Time 2 surfaced primarily as omissions. Due to a low production rate, *Third person irregular* did not account for any errors at Time 2. Elfenbein et al. (1994) likewise reported omissions as the majority of morphological errors in obligatory context in their study. Interestingly, McGuckian and Henry (2007) reported omissions as the most frequent error type for both the children who are DHH and the control group. The equality of omissions between the populations supports the tenuous nature of emerging language production of preschoolers in general.

Preschool children who are DHH exhibited omissions at Time 2 that mostly comprised morphemes marking tense (*copula Be, auxiliary Be*). These results support the findings of Koehlinger et al. (2013) who reported that the children who are DHH in their study produced fewer obligatory verb morphemes than the hearing control group. They also noted that children who are DHH are less likely to correctly use finite verb morphology when compared to their same-age hearing peers. They reported that the control groups (ages 2;11 – 3;8 and 5;9 – 6;8)

had a higher overall correct production rate for *copula Be, auxiliary Be, third person singular – s,* and *past tense – ed* than the children who are DHH. Moeller et al. (2010) found that the onset and productive use of morphemes marking tense was delayed in children with mild-moderate sensorineural hearing loss. Elfenbein et al. (1994) likewise reported greater morpheme tense errors among children who are DHH than hearing peers.

The difficulty that children who are DHH exhibit with morphemes marking grammatical inflections such as *possessive –'s,* and morphemes marking tense such as *third person singular – s,* creates a similar language profile to that of children with SLI, where morphology deficits are generally considered a hallmark of the impairment. The mismatch between productive morphological use and developmental timelines of children who are DHH and their same-age hearing peers, prompts consideration as to whether or not children who are DHH lack morphological accuracy due to language ability, auditory access or a combination of both. When examining the highest performers in the study – those participants who scored .90+ proportion correct on their final language sample (R3, R8, R10, R13, P2), results showed that they were equivalent to developmental norms, as typically developing preschool children would likely also achieve .90%+ accuracy as well. The higher performers demonstrated at least one or more errors regarding morphemes marking tense such as *third person singular – s,* and *past tense – ed,* indicating that even the highest performers continue to demonstrate vulnerabilities related to perceptually high frequency morphemes. The two variables that remained the same over the two time points for contributing to higher accuracy in morpheme production were degree of loss and age fit with hearing technology.

The type of hearing loss, degree of hearing loss and age fit with technology were the variables that demonstrated a significant relationship for accuracy at Time 2. *Auxiliary – Do,*

progressive – ing, and *uncontractible copula* were the morphemes most correlated with accuracy and the impact of type of hearing loss at Time 2. There were more participants with a bilateral (n = 11) than a unilateral hearing loss (n = 6), suggesting that despite the lack of any natural hearing ability, children who are DHH with a bilateral loss can increase accuracy of spoken language given early access to proper technology. *Uncontractible auxiliary* was most correlated with accuracy and the impact of degree of hearing loss at Time 2. The majority of the participants had a mild to moderate hearing loss (n = 10), indicating that children with milder hearing losses may have increased access to salient auditory cues than those children with more severe to profound losses, and consequently perform better. *Possessive –'s* and *contractible auxiliary* were the two morphemes most correlated with accuracy and age fitted with technology. This finding supports the benefits of providing consistent auditory access to children who are DHH as early as possible in order for them to detect and acquire perceptually low salient morphemes during language development. The overall increased rate of accuracy of morphemes used in obligatory contexts over time provides an encouraging trend for early identification, amplification, and intervention.

Omissions of morphemes in obligatory contexts comprised the bulk of morphological errors for the highest performers. The persistent errors noted for the highest performers at Time 2 included: (1) *copula Be,* (2) *auxiliary Be,* (3) *auxiliary – Do*, (4) *third person singular – s*, (5) *past tense – ed,* and *plural – s*. These findings support the results reported by Moeller et al. (2010), who noted *contractible copula, contractible auxiliary, third person singular – s,* and *past tense – ed* as the most persistent morpheme errors to continue after 54 months of age for children who are DHH.

This study supports the results of previous studies that have documented the weaknesses that occur in the morphological foundations of children who are DHH. Several morphemes that preschool children who are DHH demonstrated vulnerability with are high frequency in nature, such as /z/, /s/, and /t/. Deficiencies in the use of these high frequency morphemes cannot always be identified by standardized measures alone. Therefore, language samples are a valuable tool in contributing individualized, detailed information regarding the morphological strengths and weaknesses of children who are DHH. Language samples are an important part of the analysis of a child's communication and progress monitoring.

Due to data collected over time rather than in one production, this study offers a unique perspective of the accuracy and errors made in obligatory contexts by preschoolers who are DHH and the influence of intervention on accuracy across time. After seven months of school and intervention between Time 1 and Time 2 language samples, a strong pattern of proportion correct in terms of the main effects for Morpheme and Time x Morpheme interaction was evident among the majority of participants. However, results of the current study indicated that overall, when given individual treatment and classroom intervention for 3 hours a day / four days a week focusing on listening and spoken language, a gap still exists between the preschool children who are DHH and their same-age hearing peers, who typically acquire the target morphemes by 50 months of age. While the participants made progress over time in the number of morphemes used in obligatory contexts, they still continued to demonstrate lower accuracy than their hearing peers, indicating that despite intervention, the target morphemes are still in a state of development within each of the participants' morphological inventories.

Limitations and Future Direction

Limitations included several factors. First, there was variability regarding the length of time between some of the language samples analyzed for the study. The study scanned the months of November to May, allowing most of the participants seven months from the first to the last samples collected. Due to a few of the participants entering or exiting IESDB during the course of the study, the length of intervention between samples was not consistent for all participants. The average number of months between Time 1 and Time 2 was 6.05 months. The inclusion of two bilingual second language learners with Spanish as the primary language spoken in the home influenced outcomes. Variability also occurred in the language samples collected at Time 1 and Time 2 based on extraneous variables such as age, participant cooperativity, and clinician - child rapport. Regarding demographic data, the author did not have access to information regarding any other early intervention services prior to the participants' enrollment at IESDB; which prohibited an extensive demographic analysis and comparison. Further limitations occurred in the generalizability of the research findings. When analyzing which play-based context produced a higher proportion of morphological opportunities in obligatory contexts, not all of the language samples included in the analysis represented an equal distribution of the play-based elicitation tasks due to the children choosing their own preferred activity. Consequently, more structure during the sampling process may prove beneficial. Additionally, some of the target morphemes may not have occurred frequently enough in spontaneous conversation to adequately support analysis, such as *possessive –'s* and *third person* forms. Future directions would suggest the provision of increased opportunities during language sample collection in obligatory contexts via greater control of stimuli, modeling and/or

questions. In addition, valuable information could be gained by comparing the performance of the participants to the performance of hearing peers as well as to compare the language samples in terms of performance/morpheme production during standardized tasks. Intervention studies may be warranted to examine how accuracy of production changes over time with more focus on grammatical morphemes in individual sessions.

Conclusions

Preschool children who are DHH in the current study exhibited morphological delays when compared to typically developing preschoolers, who generally achieve morphological competence by 50 months of age. Due to their low perceptual saliency, voiceless, high frequency morphemes such as *possessive – 's* and *third person singular – s*, as well as other morphemes marking tense proved the most problematic for the participants to accurately produce – or to produce at all, in obligatory contexts. When given individual treatment and classroom intervention focusing on listening and spoken language, a gap still exists between the preschool children who are DHH and their same-age hearing peers, indicating that despite intervention, the target morphemes are still in a state of development within each of the participants' morphological inventories. These morphemes should be targeted in early intervention and across contexts to provide ample exposure and production opportunities.

The results of the study correspond to findings from previous studies. This correlation supports the need for language samples as part of the assessment process in order to adequately determine the language profile of a child who is DHH as well as to assist in progress monitoring. A favorable link between early detection, amplification, and intervention and improved language

development can be established as shown by the participants' increased morpheme production and accuracy across time.

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APPENDIX A. Emergence and Acquisition of Morphemes in Typically Developing Children

Morpheme	Acquisition in months	Example
Progressive - ing	19 - 20	Baby cry**ing**
Preposition - in	27 - 30	Girl **in** house
Preposition - on	27 - 33	Cat **on** bed
Plural - s	27 - 33	Boy**s** are fast
Irregular Past Tense	25 - 46	**Came, went, fell, ate, ran**
Possessive – 's	26 - 40	Daddy**'s** car
Uncontractible Copula	28 - 46	This **is** hot
Articles – a, the	28 - 46	I see **the** toy
Regular Past Tense - ed	26 - 48	He jump**ed**
Regular Third Person - s	28 - 50	She sing**s**
Irregular Third Person	28 - 50	**Does, has,**
Uncontractible Auxiliary	29 - 48	Mommy **is** going
Contractible Copula – 's	29 - 49	He**'s** big
Contractible Auxiliary – 's	30 - 50	She**'s** walking
Auxiliary Do[*]	31 - 32	I will **do** it

Brown, R. (1973). *A first language: The early stages.* London: George Allen & Unwin. Acquisition in months reflects at what age each morpheme typically emerges. [*]Excluded from Brown's morphemes.

APPENDIX B. Language Sample Play-Based Contexts

Context	Description
Play-Doh	The child uses Play-Doh without other stimuli
Toys	Small, plastic figurines such as a chair, wagon, cat, girl etc.
Play-Doh & toys	Small, plastic figurines used in conjunction with Play-Doh
Book	An age appropriate book familiar to the child provided by the IESDB teacher
Conversation w/o stimuli	Initiated by the child during transition times / trading preferred stimuli

Note: In each context, the clinician utilized prompts when needed such as open-ended questions and information talk.

APPENDIX C. Target Morphemes for Data Analysis

Morpheme
1 *Present Progressive – ing*
2 *Preposition – on*
3 *Preposition - in*
4 *Plural – s*
5 *Irregular past tense*
6 *Possessive – 's*
7 *Uncontractible copula*
8 *Auxiliary – Do*
9 *Articles*
10 *Regular past tense – ed*
11 *Third person singular – s*
12 *Third person irregular*
13 *Uncontractible auxiliary*
14 *Contractible copula*
15 *Contractible auxiliary*

APPENDIX D. Definitions of Accurate and Errored Morphemes in Obligatory Context

Accuracy / Error Types	Definition	Example
Accurate	The morpheme is present, complete and grammatically correct.	He run**S** away. (*Third person singular – s* is correctly marked)
Omission	The morpheme is completely missing from the word or utterance.	Put **__** car here. (Omission of *article*, the)
Addition	The incorrect addition of a morpheme to the word or utterance.	That's one cat**S**. (Addition of *plural – s*)
Substitution	A morpheme is incorrectly substituted for another morpheme in a word or utterance.	He walk**ING** fast. (Given in response to the question, what did he do?) (Substitution of *ing* for *past tense – ed*)
Over-Regularization	The morpheme is over-generalized to the word or utterance and is grammatically incorrect.	He cam**ED** home yesterday. (Over-Regularization of past tense – ed on an irregular past tense verb)

Note. These definitions correspond to the definitions used by McGuckian and Henry (2007).

Table 1. *Participant Demographics*

Participant	Age in Months	Gender	Type of Loss	Degree of Loss	Age Identified with Loss in Months	Technology used	Age of Implant or Fitted with Technology in Months	# of Months of Intervention Between Language Samples	Primary Language Spoken at Home
R1	47	M	Unilateral	Moderate	24	Hearing Aid	30	7	English
R2	60	F	Bilateral	Mild / Moderate	2	Hearing Aid	5	7	Spanish
R3	42	F	Unilateral	Moderate - Severe	24	Hearing Aid	24	7	English
R4	45	M	Bilateral	Moderate	35	Hearing Aid	36	7	English
R5	36	M	Bilateral	Mild / Moderate	1	Hearing Aid	6	7	English
R6	39	M	Bilateral	Moderate	2	Hearing Aid	23	3	Spanish
R7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
R8	64	M	Bilateral	Severe / Profound	Birth	Hearing Aid & CI	2 – HA 12 - CI	7	English
R9	59	F	Unilateral	Mild	Birth	Hearing Aid	2	6	English
R10	47	M	Unilateral	Severe	Birth	No Aid	N/A	7	English
R11	51	F	Unilateral	Moderate - Severe	28	BAHA	30	6	English
R12	62	F	Bilateral	Moderate - Severe	1	Hearing Aid	1	7	English
R13	46	F	Bilateral	Mild	6	Hearing Aid	6	4	English
R 14	45	M	Bilateral	Moderate - Severe	1	Hearing Aid	1	4	English
R15	36	M	Bilateral	Moderate - Severe	Birth	Hearing Aid	1	4	English
P2	37	M	Unilateral	Moderate	Birth	Hearing Aid	9	7	English
P7	50	M	Bilateral	Moderate	24	Hearing Aid	30	6	English
P8	44	M	Bilateral	Mild / Moderate	Birth	Hearing Aid	3	5	English

Note. R7 exited the study prior to data collection. CI = cochlear implant. BAHA = bone anchored hearing aid.

Table 2. *Target Morpheme Proportion Correct in Obligatory Contexts*

	Time 1			Time 2		
Morpheme	# of Obligatory Contexts	# Accurate	Proportion Correct	# of Obligatory Contexts	# Accurate	Proportion Correct
Progressive - ing	53	47	.8867	107	98	.9158
Preposition – on	12	12	1	22	21	.9545
Preposition - in	32	32	1	40	39	.9750
Plural – s	74	57	.7702	61	47	.7704
Irregular past tense	21	7	.3333	42	29	.6904
Possessive – ‘s	4	0	0	6	2	.3333
Uncontractible copula	52	23	.4423	103	58	.5631
Auxiliary - Do	14	10	.7142	34	27	.7941
Articles	186	148	.7956	243	194	.7983
Past tense - ed	25	16	.6400	23	21	.9130
Third person singular – s	10	6	.6000	18	6	.3333
Third person irregular	3	3	1	5	5	1
Uncontractible auxiliary	22	13	.5909	26	9	.3461
Contractible copula	44	34	.7727	75	60	.8000
Contractible auxiliary	16	12	.7500	39	20	.5128
TOTAL	568	420		844	636	
Mean			.6863			.7133
Standard Deviation			.2726			.2392

Note. # of obligatory contexts equals the number of opportunities for production of a morpheme. Proportion correct equals the number of morphemes produced accurately divided by the number of obligatory contexts.

Table 3. *Time 1 and Time 2 Morpheme Proportion Correct by Participant*

Participant	Time 1		Time 2	
	# Obligatory Contexts	Proportion Correct	# Obligatory Contexts	Proportion Correct
R1	34	.8235	67	.7014
R2	29	.6206	34	.5294
R3	36	.8333	64	.9062
R4	34	.6176	78	.7179
R5	7	0	35	.2857
R6	0	0	12	.6666
R7	N/A	N/A	N/A	N/A
R8	72	.9027	101	.9306
R9	68	.6470	40	.55
R10	43	.9302	55	.9272
R11	56	.7142	53	.6603
R12	49	.7551	88	.8636
R13	34	.8823	75	.9733
R14	33	.7272	40	.75
R15	4	.75	12	.75
P2	27	.8148	34	.9117
P7	0	0	15	.2
P8	41	.3902	45	.5111

Note. R7 exited the IESDB program prior to data collection. Proportion correct was defined as the number of morphemes produced accurately divided by the number of obligatory contexts provided within the spontaneous language sample.

Figure 1. MLU for Participants at Time 1 and Time 2

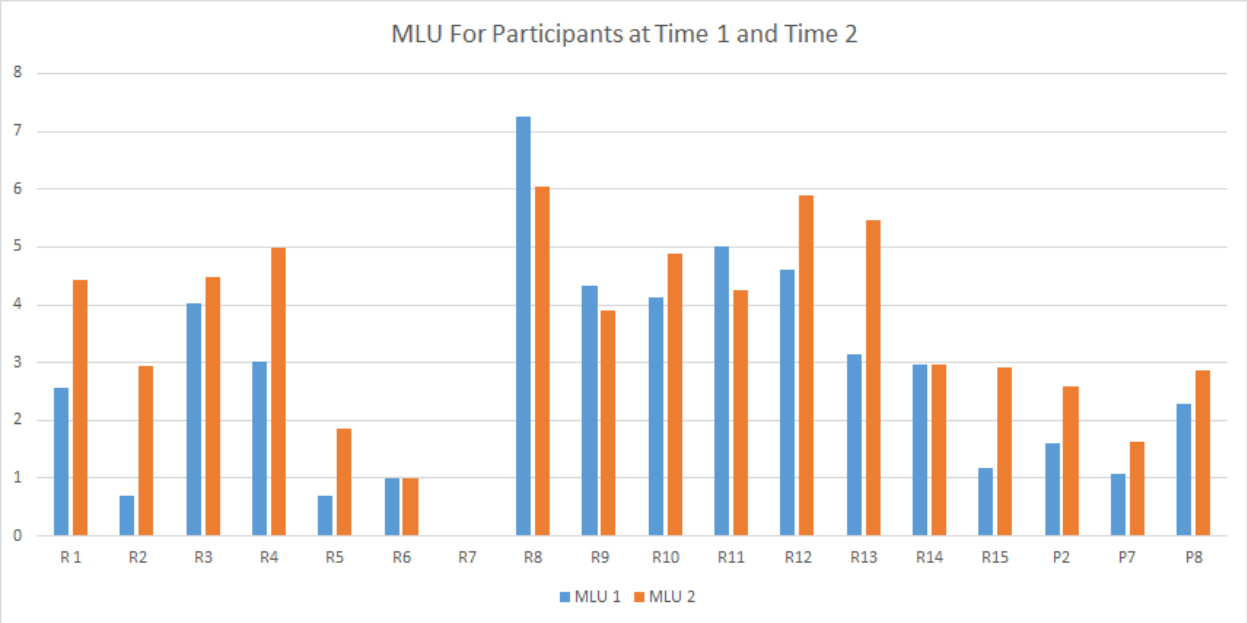

Figure 2. Target Morpheme Proportion Correct at Time 1 and Time 2

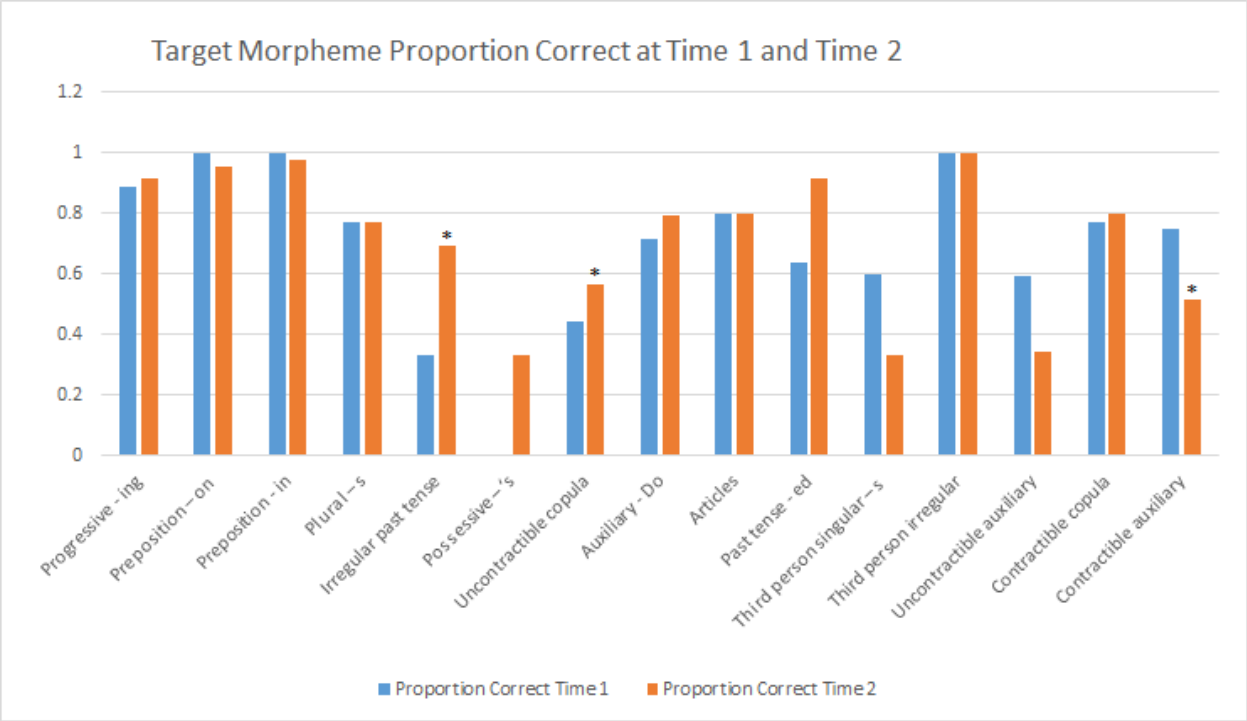

Figure 2. * $p < .05$