EXPLORING ENGLISH LANGUAGE ABILITIES THROUGH MORPHEME USE, READING, AND SELF-REPORTED LISTENING IN SCHOOL-AGE CHILDREN WHO ARE HARD OF HEARING

by

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Abstract

Children who are hard-of-hearing (HoH) are at risk of delays in language development. Three studies are presented in this dissertation that explore the language abilities of elementary-aged children who are HoH using a range of methodologies with this unique population: language sample analysis, regressions, and qualitative interview analysis.

Study 1 investigated morpheme use in conversational language samples and found that children who were HoH produced very similar quantities and types of inflectional and derivational morphemes as same-age typically hearing (TH) children. However, children who were HoH produced more morpheme use errors. The number of different bound morphemes was identified as a useful measure of morpheme use in child language samples. Age was a good predictor of morpheme use in children who were TH but not HoH.

Study 2 examined relationships between language measures (expressive vocabulary, phonological awareness, morphological awareness) and reading measures (non-word reading, reading comprehension) using hierarchical regression analyses. Findings revealed that the same relationships between variables were present in the children who were HoH and slightly younger TH children, matched on word reading abilities.

Study 3 used qualitative analysis of brief conversations in which children who were HOH and TH children responded to questions about how well they could hear and understand other people in educational settings. Findings suggested that, although similar numbers of children in each group reported no difficulties hearing or understanding, children who were HoH with poorer speech discrimination in noise were less able or willing to discuss listening difficulties than children with good speech discrimination in noise. Children in the HoH and TH groups reported similar barriers to listening including background noise, poor quality of a speaker's voice, and inadequate room acoustics.

Together, findings from the three studies suggest that the language and reading abilities of these elementary-age children who were HoH were more similar than different relative to their TH peers. Consistent with the literature, approximately 25% of the group who were HoH had poorer outcomes. Factors that might explain poorer outcomes were not clearly apparent in the findings.

LIST OF ABBREVIATIONS AND SYMBOLS USED

ADHD	attention deficit and hyperactivity disorder
APSEA	Atlantic Provinces Special Education Authority
β	standardized beta-value regression coefficient
d	Cohen's *d* standardized effect size statistic
dB	decibels
d/Deaf or HoH	deaf/Deaf or hard of hearing; having a hearing difference who may use any combination of signed and/or spoken language
deaf	severe to profound hearing levels
Deaf	having active membership in a cultural community of individuals who use signed language
D/HH	deaf or hard of hearing; uses primarily spoken language
HoH	hard-of-hearing; mild to severe hearing levels
IDEA	Individuals with Disabilities Education Act
LSA	language sample analysis
M	mean
MA	morphological awareness
p	*p*-value indicating statistical probability
PA	phonological awareness
PTA-4	pure tone average thresholds for four frequencies (500, 1K, 2K, 4K hertz) weighted by a ratio of 5:1 in favour of the better ear
r	Pearson's product moment coefficient indicating strength of correlation
R^2	coefficient of determination used in regression
RC	reading comprehension
SALT	*Systematic Analysis of Language Transcripts* software
SD	standard deviation
SNR	signal-to-noise ratio
SS	standard score
t	*t*-test statistic used in the comparison of means
TH	typically hearing; normal hearing levels
WR	word reading

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CHAPTER 1. GENERAL INTRODUCTION

In Canada, inclusive education is largely viewed as the optimal learning environment for students of all abilities (Inclusive Education Canada, 2020). Classroom teachers in inclusive settings deliver content primarily through spoken language, which creates a unique access problem for students who are hard-of-hearing (HoH). This subgroup of students has reduced hearing abilities (i.e., hearing levels classified as mild to severe, see Table 1.1) that they use to access and learn spoken language. Forty years ago, a book called *Our forgotten children: Hard-of-hearing pupils in the schools* identified a concerning lack of research to inform how to adapt inclusive educational practices to the needs of students who are HoH (Davis, 1977). Forty years later, this research gap persists (see *Children who are hard of hearing: Still forgotten?* by Moeller & McCreery, 2017). Since they are the minority, students who are HoH in inclusive settings are taught using instructional approaches based on research with typically hearing (TH) children. The language abilities of children who are HoH must be better described to justify our current model of inclusive education for this understudied population. The three studies that I will share with you in Chapters 2 to 4 of this dissertation aim to explore the English language abilities of children who are HoH relative to TH peers from three previously under-explored methodological angles: language sample analysis of bound morpheme use, linear regression to predict relationships between expressive vocabulary and metalinguistic abilities with reading abilities, and qualitative analysis of self-reported listening comprehension.

This General Introduction touches on three issues that informed my dissertation research: 1) unique characteristics of children who are HoH, 2) a closer look at spoken language outcomes of children who are HoH, and 3) the inclusive educational context experienced by children who are HoH in the Atlantic provinces of Canada. Finally, I will introduce the three studies presented in this dissertation.

CHARACTERISTICS OF CHILDREN WHO ARE HOH

The population of children who are HoH is extremely heterogeneous, therefore researchers typically limit the inclusion criteria of their studies with regards to hearing levels, language modalities, types of hearing assistive devices, age of diagnosis and/or intervention, educational placement, and additional disabilities. Variability in the HoH population along these characteristics has accompanied variations in terminology and has lead to great variability in language development and subsequently, academic success. I will first discuss decisions made regarding terminology and child characteristics with regards to this dissertation's methods.

Terminology. A wide variety of terms are used in relation to children who are HoH that often overlap in meaning and tend to reflect differing philosophies. For example, the phrases 'children with a hearing impairment', 'children with hearing loss', and 'children who are HoH' all refer to the same population of children. Also, 'hearing impairment', 'hearing loss', 'hearing difference', and 'hearing level' have been used interchangeably to refer to the decibel level (i.e., intensity) at which the listener can just barely hear a sound at multiple frequencies (e.g., 'mild to moderate hearing loss'). In line with the collaborative mission of the Radical Middle (http://radicalmiddledhh.org), I will use the more neutral phrases 'HoH', 'hearing level', and 'hearing difference' where appropriate in lieu of the more deficit-based phrases 'hearing loss' and 'hearing impairment'. The term 'Deaf' will refer to individuals with atypical hearing who identify as members of a cultural community where signed language is the primary language. I will use the phrase 'd/Deaf or HoH' as a broad term encompassing all individuals with a hearing difference who use any combination of language modalities. This preferred phrasing is used out of respect for requests presented by experts who are d/Deaf or HoH themselves (Benedict, 2011; National Association of the Deaf, 2020). Lastly, I will employ person-first language for members of the minority group (e.g., children who are HoH) to acknowledge that these children are people first and are not defined by their hearing difference.

Hearing levels. Pure tone average hearing thresholds (ranging from approximately -10 to greater than 100 decibels; dB HL) are most commonly grouped into seven categories of hearing level with adjectival labels (see Table 1.1). Although it is generally understood that the classification system of hearing levels is inadequate to fully describe what an individual may hear especially when using hearing assistive devices, it is the most widely used classification system since the early 1970s (J. G. Clark, 1981). Poor hearing levels have historically been associated with poor spoken language and academic outcomes (e.g., Reich et al., 1977). Accordingly, researchers often limit their samples to only one hearing level (e.g., moderate, McGuckian & Henry, 2007) or a limited range (e.g., mild to severe, Tomblin et al., 2015). In this dissertation, my intention was to examine spoken language abilities from a number of angles (language sampling, standardized tests, self-reported language comprehension) in children who were acquiring spoken language using reduced hearing. I expected a range of hearing levels to result in a range of language abilities and this was therefore desirable. All children in Study 1 and 2 were HoH (i.e., had mild to severe unaided hearing levels). One additional child with profound hearing levels and who wore two cochlear implants participated in Study 3.

Table 1.1
Classification of standardized hearing levels (Clark, 1981).

Average Hearing Threshold Level (dB)	Label
-10 - 15	Normal
16 - 25	Slight
26 - 40	Mild
41 - 55	Moderate
56 - 70	Moderately Severe
71 - 90	Severe
91 +	Profound

Language modalities. A variety of language modalities and systems have been organically used among people who are d/Deaf or HoH and taught to children who are d/Deaf or HoH. In communities where individuals who are d/Deaf or HoH are the majority, natural signed languages can evolve over time and are used with all the same linguistic properties and functions as spoken languages (Groce, 1985; Senghas et al., 2004; Stokoe, 1970, 1980). A large body of research has studied how children develop signed languages naturally (Mayberry & Squires, 2006). Spoken language development is often the goal for children who are d/Deaf or HoH, leading to the creation of manual systems being used and studied, such as Signed Exact English (i.e., every English morpheme is assigned a single sign; e.g., Nielsen et al., 2016), total communication (i.e., signing and speaking to one's best ability at the same time; e.g., Geers & Moog, 1992), and cued speech (i.e., speaking while articulating handshapes around the face and mouth to distinguish between similar-sounding phonemes; e.g., Bouton et al., 2011).

In the Maritime provinces of Canada where I collected the data for this dissertation, only a handful of school-age children currently use any signed language or manual system. On the one hand, this meant that the only subgroup that I could study was children who were HoH. On the other hand, this limitation in language options meant that this regional population of children had not already been allocated to different modality streams due to differences in spoken language acquisition, which was advantageous for research purposes. Regardless, the population of children who are HoH is under-studied (Moeller & Tomblin, 2015a), which made these children the ideal population of study for this dissertation.

Hearing assistive devices. It is rare these days to find a school-age child in North America who is diagnosed as HoH and who is not using an appropriately fitted personal hearing assistive device. The most commonly worn devices are hearing aids (which amplify sounds received through the ear canal) and cochlear implants (which convert sounds to electrical impulses transmitted through a wire surgically inserted in the cochlea). Other hearing assistive devices include bone-anchored hearing devices (which transmit sounds to a mechanical driver that vibrates the bone surrounding the cochlea) and soundfield amplification systems (which amplify the speaker's voice received from a microphone to speakers placed around the room). Different hearing profiles are best addressed using different hearing devices and associated programming. For example, babies identified with sensorineural moderately-severe to severe hearing levels in both ears may have better spoken language outcomes through use of hearing aids over cochlear implants (E. M. Fitzpatrick et al., 2012). For this dissertation, I did not limit the type of device in inclusion or exclusion criteria, although the majority of participants wore two hearing aids. I made this decision because my intention was to investigate the language abilities of children who had auditory access to spoken language input regardless of the hearing devices used.

Age of diagnosis and/or intervention. Children who are deaf or HoH are diagnosed and subsequently benefit from interventions at varying ages. In present day, most Canadian provinces and territories aim for infant hearing screenings within three months of birth, however, this has not always been the case (Durieux-Smith et al., 2008). In Nova Scotia and New Brunswick, it is estimated that 96 to 98 percent of infants have their hearing screened (Canadian Infant Hearing Task Force, 2019). Prior to widespread newborn hearing screenings, many children were not identified as HoH until spoken language milestones were not being met in toddlerhood (Patel & Feldman, 2011). Delays in identification increased with decreasing levels of hearing difference, such that children with a mild to moderate hearing difference were diagnosed at later ages than children with a severe to profound hearing difference (Durieux-Smith et al., 2008). Regardless of the types of intervention(s) and language modalities pursued following diagnosis, delayed identification of hearing difficulties leads to significant language delays (Patel & Feldman, 2011).

After a child is identified as deaf or HoH, families must make decisions about hearing device(s), language modalities, and additional intervention services (e.g., speech-language therapy). Delays in implementing the chosen options lead to further delays in language development (Geers & Nicholas, 2013; Moeller, 2000). Research with children who are HoH often gathers detailed hearing backgrounds with regards to diagnosis and intervention either for descriptive purposes or for inclusion in analyses. For this dissertation, I collected information about age of identification and hearing device intervention through parent report and used it to describe the sample. Approximately half of the participants who were HoH were not identified until relatively late (i.e., after two years of age). This suggests that if language delays are identifiable in the methodologies employed in this dissertation, I should find them in this sample.

Additional disabilities. Although it is difficult to determine precise numbers, the prevalence of school-age children who are d/Deaf or HoH with additional disabilities is estimated to be between 40% to 50% (Guardino & Cannon, 2015; C. Nelson & Bruce, 2019) as the cause of atypical hearing can simultaneously cause other intellectual, physical and/or sensory disabilities. This is inarguably much higher than the estimated 4.6% of Canadian children aged 5 to 14 years with a diagnosed disability (Statistics Canada, 2008). Co-morbid intellectual disabilities can lead to broad variability in language outcomes that cannot be attributed directly to the experiences of being HoH. Consequently, most language researchers choose to exclude children who are HoH with diagnosed intellectual disabilities that could impact language development. However, there is a risk of over-identifying language disability, learning disability, and attention deficit and hyperactivity disorder (ADHD) in children who are HoH, as associated symptoms may be similar to the symptoms and consequences of being HoH (Figueras et al., 2008; Redmond, 2016). Therefore, my chosen approach in this dissertation was to exclude children with diagnosed intellectual disabilities for both groups (HoH and TH) but include children who were HoH diagnosed with ADHD, language disability, and/or learning disability.

Educational placement. Children who are HoH are educated in a variety of educational settings. Much like children with other exceptionalities, approximately 80% of children with any degree of hearing difference were educated in separate residential schools in the United States until 1975 when the Individuals with Disabilities Education Act (IDEA) was enacted (Shaver et al., 2014). This set a precedent that encouraged Canadian provinces and territories to develop policies guiding inclusive education (e.g., all provincial and territorial policies describe how to formalize individualized programming, such as the Individual Program Plan in Nova Scotia and the Personalized Learning Plan in New Brunswick), although no Canadian federal law exists to mandate such inclusion (Towle, 2015). In North America, the number of students who are d/Deaf or HoH in the inclusive education stream has steadily increased and today approximately 98% of Canadian children who are d/Deaf or HoH are being educated in inclusive settings (Squires, 2014). Yet, a large proportion of research studies conducted with children who are HoH recruit children in separate schools or programs for students who are d/Deaf or HoH (e.g., Antia et al., 2020). Such research is important given that students who are HoH in separate schools are likely to require more intensive supports than students in inclusive settings.

However, research attention must also focus on students who are HoH in inclusive educational settings, since they now constitute the vast majority of students who are HoH across North America. Research shows that many (but not all) children who are HoH in inclusive educational settings fall behind academically and factors that relate to poor outcomes are unclear (Luft, 2017; Qi & Mitchell, 2012). As stated, the only educational option for children who were HoH in the Maritime provinces of Canada was inclusive education as there are no longer any separate schools or daily group programming for students who were HoH. This means that the pool of eligible participants for the study represented all children who were HoH (without additional exceptionalities) and not subgroups who had already been streamed into separate versus inclusive education settings due to pre-existing differences in hearing, language, or learning abilities.

INCLUSIVE EDUCATION FOR STUDENTS WHO ARE HOH

Inclusive education is the only option for Maritime students who are HoH since the last Maritime schools for the Deaf were closed permanently in 1995 (Amherst, Nova Scotia) and 2010 (St. John's, Newfoundland) (APSEA, 2020). The Atlantic Provinces Special Education Authority (APSEA) is a government-funded organization that was formed to oversee and support the inclusive education of students who are d/Deaf or HoH and/or visually impaired across the Atlantic provinces. APSEA hires itinerant teachers of students who are d/Deaf or HoH and assigns each a caseload of students spread out across a region. Itinerant teachers provide either consultative support to the classroom teacher or direct pull-out support to students and often spend their limited time with students ensuring that hearing technologies such as hearing aids and digital modulation (DM) systems are in functioning order. As well, they may pull the student who is HoH from the classroom for one-on-one teaching sessions to address gaps in learning that are not easily addressed in the classroom. At the time of data collection for this dissertation, the supports provided to each student varied greatly and were mainly decided upon at the discretion of the itinerant teacher (Lori Moore, former APSEA director of programs for students who are d/Deaf or HoH, personal communication, October 2016). In this model, students who are HoH without additional disabilities spend the majority of their time in the regular education classroom learning environment, largely tailored for TH students.

Students who are HoH and learning in inclusive settings must learn to identify when they are having difficulty hearing spoken communication in the classroom and advocate for their needs. All classrooms typically exceed classroom noise and reverberation levels recommended in the *American National Standard Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools, Part 1: Permanent Schools* (Acoustical Society of America, 2010) to ensure adequate access to spoken communication for most TH students, creating unfavorable environments for students who are HoH to succeed (Gremp & Easterbrooks, 2018). What a child can hear in a classroom cannot be easily extrapolated from knowledge of the child's hearing thresholds or listening performance in a soundproof booth (Iglehart, 2016). Since their peers and teachers usually all have typical hearing, the student who is HoH cannot depend on others knowing what he or she can and cannot hear. Scale-based questionnaires such as the *Listening Inventories for Education-Revised* questionnaire (*LIFE-R*; Anderson et al., 2011) measure how well students believe they hear and understand spoken language in the classroom setting using closed sets of responses. Through the *LIFE-R*, students who were HoH have reported greater difficulties hearing teachers and other students at school than TH students (L. H. Nelson et al., 2020). Qualitative analysis of interviews with open-ended questions which allow children to choose what to share would complement these findings. In this dissertation, I conducted brief interviews with students to better understand how children who are HoH[1] and use

[1] One child who was deaf and wears two cochlear implants participated.

their hearing to access instruction at school, specifically, think about their hearing. This information will inform how to best support students who are HoH in explaining their abilities and needs to others.

A CLOSER LOOK AT LANGUAGE OUTCOMES

The primary purpose of this dissertation was to investigate the English language abilities of school-age children who were HoH relative to TH peers. These children are integrated into general education schools where they overwhelmingly enter kindergarten with delayed language abilities (Antia et al., 2020; Guo et al., 2013; Inscoe et al., 2009; Koehlinger et al., 2013). Children who are HoH must therefore continue developing spoken language in the classroom at a faster rate than their TH peers in order to 'catch up' and achieve the language skills needed for successful academic performance. Yet the specific impacts of reduced hearing (and associated experiences) on spoken language development can be subtle and difficult to detect. Current research generally shows that many elementary-age children who are HoH do indeed catch up to their TH peers and achieve comparable linguistic outcomes while a subset of children fall far below age expectations; individual differences are not yet well understood (Moeller & Tomblin, 2015a).

School-age children who are HoH are at risk of delays in vocabulary knowledge, both in terms of vocabulary breadth (i.e., size of the lexicon) and depth (i.e., quality of semantic representations) (Convertino et al., 2014; Luckner & Cooke, 2010; Walker et al., 2019). Vocabulary knowledge is a critical language domain as it correlates highly with broader language development and predicts successful literacy development (Hart & Risley, 2003). While delays in vocabulary breadth relative to TH peers appear to improve over time, delays in vocabulary depth are found to remain stable through the elementary years in children with only a mild hearing difference (Walker et al., 2019). The source of challenges with deep vocabulary learning may lie in understanding the development of sub-lexical components (i.e., phonemes and morphemes) which also have known relationships with reading abilities (Berninger et al., 2010; Carlisle & Goodwin, 2014; Deacon & Kirby, 2004). Moeller and Tomblin (2015) have posited a 'model of inconsistent access' wherein reduced hearing abilities result in inconsistent access to spoken language input that is compounded by inconsistencies in input also experienced by TH children (e.g., effects of varying word frequency). They suggest that "domains of language development that are dependent on processing phonetic details in the input would be especially vulnerable to the effects of hearing loss" (p. 90S). In other words, poorer speech discrimination abilities reduce opportunities to perceive linguistic units (e.g., phonemes and morphemes), especially those that are already less perceptually salient. We can therefore anticipate that children who are HoH are at risk of incomplete or, at the very least, less rich representations of these foundational building blocks of vocabulary.

Although phonology and morphology are both essential domains of language that children who are HoH must acquire, there has been an imbalance in research attention dedicated to phonological versus morphological development. Research investigating phonological development in children with reduced hearing has been relatively extensive, particularly in relation to reading development (for reviews, see Alasim & Alqraini, 2020; Mayberry et al., 2011; Wang et al., 2008). In contrast, the morphological development of children who are HoH has received limited attention (Tomblin et al., 2015; Trussell & Easterbrooks, 2016). In this dissertation, I directly investigated expressive morphology using language sample analysis (Study 1). In addition, I collected several measures expected to be related to, and complement our understanding of, morphological development, namely expressive vocabulary, phonological awareness (PA), morphological awareness (MA), non-word reading, and reading comprehension (Study 1, Study 2). Given that language exposure and development continue through the school years, I also explored real-world access to spoken language at school experienced by children who are HoH in this dissertation (Study 3).

THE THREE STUDIES IN THIS DISSERTATION

The research gaps identified above justify the design of three distinct studies that are presented in Chapters 2, 3, and 4 of this dissertation as manuscripts destined for future publication. To provide context for the research, I will first explain the process that led to the collection of data and its subsequent allocation into three papers. The research proposal was initially developed to investigate the role of MA relative to PA in children's reading abilities, now forming the research questions for **Study 2**. While developing the protocols, I decided to include a conversational language sample (a methodology that I was becoming quite familiar with through other research projects I was involved in at the time) to collect data on morpheme use that would be included alongside PA and MA in the analyses. However, this data was so rich that it was deemed best to separate this information out into its own paper, which forms **Study 1**. As well, while collecting the language sample, I took the opportunity to ask questions about how well children believed they hear and understand in the classroom. Once a papers-based dissertation was decided upon, this unique qualitative data became a natural fit for **Study 3**. The data from most participants are included in all three studies, however none of the three studies includes all the same children due to differences in the research questions. Table 1.2 shows in which studies each child participated.

Table 1.2
Study inclusion status (✓, no) for each child who participated in at least one study.

	HoH group				TH group		
ID#	Study 1	Study 2	Study 3	ID#	Study 1	Study 2	Study 3
D01	✓	✓	✓	H01	✓	✓	✓
D02	✓	✓	✓	H02	✓	✓	✓
D04	✓	✓	✓	H03	no	✓	no
D05	✓	✓	✓	H04	✓	✓	✓
D06	✓	✓	✓	H05	no	✓	no
D07	✓	✓	✓	H06	✓	✓	✓
D08	no	no	✓	H07	✓	✓	no
D10	✓	✓	no	H08	✓	no	✓
D11	no	✓	✓	H09	no	✓	✓
D12	✓	✓	✓	H10	✓	✓	✓
D13	✓	✓	✓	H11	no	✓	✓
D14	✓	✓	✓	H12	✓	✓	✓
D15	✓	✓	✓	H13	✓	✓	✓
D16	no	no	✓	H14	✓	✓	✓
D17	✓	✓	✓	H15	✓	✓	✓
D18	✓	✓	✓	H16	no	✓	✓
D19	✓	✓	✓	H17	no	✓	no
				H18	no	✓	no
				H19	✓	✓	✓
				H20	✓	✓	✓
				H22	no	✓	no
				H23	✓	✓	✓

Notes. HoH = hard of hearing. TH = typically hearing.

In Chapter 2, **Study 1** describes and compares inflectional and derivational morpheme use in children who were HoH and TH aged 7 to 11 years old. Derivational morpheme use in particular has not be investigated in children who are HoH nor compared with that of TH children. And yet, research has identified delays in inflectional morpheme use in children who are HoH, particularly for the -*s* and -*ed* morphemes (see Introduction in Chapter 2 for a literature review). It was therefore reasonable to assume that derivational morphology may also succumb to delayed acquisition, perhaps in direct relation to reduced auditory access. In addition, Study 1 explores individual variability by employing correlational analyses between quantitative measures of morpheme use and other child variables.

In Chapter 3, **Study 2** investigates relationships between sub-lexical metalinguistic (PA, MA) and reading (non-word reading, reading comprehension) abilities controlling for expressive vocabulary knowledge in children who were HoH and TH matched by word reading abilities. No previous research with children who are HoH has included both PA and MA in exploring relationships with reading abilities, let alone compared these results with TH peers. This despite the fact that research with TH children on such relationships is quite extensive and has directly informed educational practice in inclusive classrooms where children who are HoH are learning to read. Investigation into whether these relationships are mirrored in children who are HoH was therefore necessary and hence undertaken in this study. As well, such research will inform further study of language acquisition via language exposure through text, a topic which is particularly relevant for children who are HoH with reduced and inconsistent language exposure through the acoustic signal alone.

In Chapter 4, **Study 3** presents a qualitative analysis of self-reported classroom listening abilities in students who were HoH and TH in Grades 2 to 7. Responses from one child who was technically deaf and wore two cochlear implants was included in the HoH group. Asking open-ended questions to both groups of children and comparing their responses informs what we can expect any child to be aware of, regardless of hearing status. This study is the first of its kind to solicit the thoughts of children who are deaf or HoH early in their educational careers, thereby describing their hearing awareness and suggesting areas for hearing self-advocacy intervention. This is essential to inform the greater conversation about adequate spoken language access for young children with reduced hearing as they continue acquiring spoken language in inclusive classrooms and are simultaneously expected to learn educational content. It is the hope that this research will address some existing research gaps in the language development of children who are HoH in inclusive educational contexts and identify promising questions to guide future research endeavours.

CHAPTER 2. STUDY 1

INFLECTIONAL AND DERIVATIONAL MORPHEME USE IN CONVERSATION WITH CHILDREN WHO ARE HARD-OF-HEARING

ABSTRACT

Purpose: Language sample analysis (LSA) was used to comprehensively explore the inflectional and derivational morpheme use in children who were hard-of-hearing (HoH).

Method: Participants were monolingual English-speaking children aged seven to 11 years old with no diagnoses of intellectual disability. There were two groups: children who were HoH (*n* = 14) and same-age TH children (*n* = 14). Children's inflectional and derivational morpheme use in conversation with an adult examiner was analyzed in depth. Additional measures of hearing, nonverbal reasoning, expressive vocabulary, and MA were collected. To explore individual variability, correlations were conducted between morpheme use measures and age, nonverbal reasoning, parent education, hearing, morphological awareness (MA), and vocabulary.

Results: The two groups produced similar types of morphemes in conversation. While not compared statistically, slightly less advanced morpheme use was suggested for the HoH group relative to the TH group in terms of reduced diversity and productivity of derivational morpheme use and greater errors in inflectional morpheme use. The 'number of different bound morphemes' was the morpheme use measure most related to child variables, mainly in the TH group. The HoH group only showed correlations approaching significance between speech discrimination thresholds with the 'percent different words derived' and the 'number of different bound morphemes'. In contrast, age showed the most significant correlations with morpheme use measures in the TH group.

Conclusions: LSA proved to be a useful method for investigating morpheme use in children who were HoH, revealing similar use of bound morphology in conversation compared to TH same-age peers with a slight group delay. Findings are consistent with the literature in that factors related to morphological development are more heterogeneous in children who are HoH than TH peers and do not relate predictably with age as they do in TH children.

INTRODUCTION

Children who are hard-of-hearing (HoH; i.e. have unaided hearing levels classified as mild to severe but not profound) often do not achieve the same language levels as their typically hearing (TH) peers (see Lederberg et al., 2013 for a review). One area of language development that is of particular interest with school-age children is the use of morphemes, particularly prefixes and suffixes. In the elementary grades, morphological knowledge (i.e., understanding and using morphemes) and morphological awareness (MA; i.e., reflecting on one's use of morphology) play a unique role in the development of academic language and reading for TH children (Anglin, 1993; Deacon et al., 2014; Kirby et al., 2012; Kuo & Anderson, 2006; Singson et al., 2000) however this relationship has not been explored for children who are HoH. Consequently, researchers have identified a "pressing need" to examine and monitor morphological development in school-age children who are HoH as our current understanding of their abilities and educational needs in this area is limited (Koehlinger et al., 2013).

Language sample analysis (LSA) can provide complementary information to that of standardized tests on the language abilities of children with special education needs and/or bilingual children (Blaiser & Shannahan, 2018; Ebert & Pham, 2017), however, further investigation is needed to suggest effective ways of applying this tool to analyze morpheme use. The primary purpose of the present study is to describe inflectional and derivational morpheme use in spoken English conversational language samples in children who were HoH and compare results to those of same-age TH children. The secondary purpose is to explore factors that may relate to individual variability in morpheme use and discuss group similarities and differences in these relationships.

ASSESSING MORPHEME USE WITH LANGUAGE SAMPLE ANALYSIS (LSA)

LSA involves assessing aspects of language use in real-life speaking situations such as conversations and "has unparalleled validity for measuring language use" (Heilmann et al., 2010, p. 84). While constrained by the topic, LSA reveals words and morphemes that children know and choose to produce in a particular context. Although LSA cannot provide a complete picture of the child's lexical and morphological knowledge, it provides a rich picture of a variety of morphemes the child can use. Additionally, the child's use of a bound morpheme, or affix, produced with several different word roots tells us that the child may be developing an awareness of the morpheme independently of the word roots to which the affix is bound (Jarmulowicz & Taran, 2013). Full mastery of each morpheme "is likely a process of discovery for children over time and over many exposures… affixes may not be represented initially as separate entities; rather they emerge from the system as more types of stems are encountered with similar morphophonological patterns" (Jarmulowicz & Taran, 2013, p. 61). By generating lists of morphemes and the number of different word roots to which they are bound, it is possible to get a sense of which morphemes may be in the process of acquisition or mastered. Given the known risk of language delays in children who are HoH and the fact that few standardized measures include children who are HoH in their normative samples, LSA may be especially useful for identifying and supporting children who are HoH struggling with morphological development.

DEVELOPMENT OF INFLECTIONAL AND DERIVATIONAL MORPHOLOGY

TH children. Morphological ability is an important component of academic success. As children progress through elementary school, they are increasingly required to read and understand academic vocabulary to communicate around and think about disciplinary content. Academic vocabulary is more abstract, more morphologically complex, and contains more Latin and Greek word roots than language used in general social contexts (Nagy & Townsend, 2012). In English, bound morphemes include eight inflectional suffixes, which provide obligatory grammatical information to the root (e.g., *cats*), and many derivational affixes, which may change the grammatical category of a word root and/or alter its meaning (e.g., *printer*, *redo*). The eight inflectional morphemes in English occur in obligatory contexts (Brown, 1973). Most native English-speaking 4-year-old children can accurately produce five inflectional morphemes (plural -*s*, 3rd person singular -*s*, possessive -*s*, past -*ed*, and progressive -*ing*) at least 90% of the time (Brown, 1973; De Villiers & De Villiers, 1973).

Several morpheme characteristics are proposed to impact the order of acquisition, studied mainly in second language learners of English (Goldschneider & DeKeyser, 2001). Perceptual salience (i.e., how easy it is to hear or perceive the morpheme), semantic complexity (i.e., how many meanings the morpheme can represent), morphophonological regularity (i.e., how many different phonological forms the morpheme can have, called 'allomorphs'), syntactic category (i.e., which category of syntax the morpheme falls within), frequency (i.e., how often the morpheme is present in the language of exposure), and transfer from a non-English first language may interact differentially in each individual learner. Of the five inflectional morphemes presented above, these factors tend to rank the morphemes -*ing* as most easy to acquire and third person singular -*s* as most difficult. The past participle -*ed* (or -*en* in its alternate form), comparative -*er*, and superlative -*est* may be produced by four years of age but are not mastered until later ages (Berko, 1958; Bishop & Bourne, 1985; Budwig, 1990; Gathercole, 1986; Graziano-King & Smith Cairns, 2005; Nussbaum & Naremore, 1975). The comparative -*er* is not expected to be fully understood and hence used accurately until at least six years of age (Bishop & Bourne, 1985). It is not clear when children would be expected to master these three morphemes as they have received less research attention than the first five inflectional morphemes in TH children.

Derivational morphemes such as *un*- (e.g., *<u>un</u>do*), start being produced in the early preschool period and their development continues through high school (Anglin, 1993; Nippold & Sun, 2008; Windsor, 1994). In a study of TH children's ability to comprehend and define multi-morphemic words, children were estimated to comprehend approximately 1,800 derived words in Grade 1, 5,500 in Grade 3, and over 16,000 by Grade 5 (Anglin, 1993), effectively showing that the elementary grades are times of considerable growth in morphological knowledge. Productivity of a derivational morpheme is evidenced by its family size; a morpheme with a larger family size can be used with a greater number of different word roots (Bauer, 2008). Derivational morphemes are categorized as either neutral, in which the phonological form of the root does not change when a suffix is appended (e.g., *happy*, *happi*<u>*ness*</u>), or nonneutral, in which the phonological form of the word root does change (e.g., *divide*, *divis*<u>*ion*</u>; Chomsky & Halle, 1968). Nonneutral morphemes tend to be less productive and less frequent than neutral morphemes although neutral morphemes can also be infrequent (e.g., *relation*<u>*ship*</u>; Tyler & Nagy, 1989). In general, neutral derivational morphemes with large family sizes develop earlier than nonneutral and less productive ones (Anglin, 1993; E. V. Clark, 2014; Gordon, 1989; Tyler & Nagy, 1989).

Squires, Kay-Raining Bird, Cahill and Cleave (2020) used LSA to investigate developmental differences in derivational morpheme use in TH children. The study compared derivational morphemes used by 12 children of early elementary school age (seven to eight years old) and 11 children of late elementary school age (11 to 12 years old) across three discourse contexts: conversation, narration and exposition. While the numbers of derived words produced were relatively low for all children (comprising one to seven percent of each child's total words), the older children produced more derived words than the younger children. The older group also produced a greater variety of derivational morphemes (28) than the younger group (19). Over half of the older group produced four nonneutral suffixes -*al*, -*ion*, -*ite* and -*ent* in addition to four neutral derivational suffixes that were also used by over half the younger group (-*ly*, agentive -*er*, instrumental -*er*, and -*y*). Additionally, the conversational discourse protocol, a 10-minute conversation with an adult examiner, was found to elicit the greatest quantity and diversity of derivational morphemes compared to the narrative and expository samples. In the present study, LSA of conversational samples will examine the inflectional and derivational morpheme use of elementary school-aged children with and without a hearing difference.

Children who are deaf or HoH using only spoken language. Research on the development of derivational morphology in children who are HoH is limited, however studies investigating inflectional morphology in children who are deaf (wearing cochlear implants) or HoH suggest persistent delays. Group studies of children who were deaf or HoH aged two to six years with auditory access to spoken language have reported delays in the production of past tense -*ed*, plural -*s*, possessive -*s*, and third person singular -*s* (Guo et al., 2013; Inscoe et al., 2009; Koehlinger et al., 2013, 2015; Moeller et al., 2010). By school-age, many of these children were still found to have delays in inflectional morphology relative to same-age TH peers (Cannon & Kirby, 2013; Geers et al., 2002, 2009; McGuckian & Henry, 2007; Nittrouer et al., 2018; Norbury et al., 2001). For example, Norbury et al. (2001) reported that four out of 19 (21%) 5- to 10-year-old children who were HoH produced unusually low percent accuracy (<66%) in third person singular -*s* and past tense -*ed* relative to TH same-age peers using sentence elicitation tasks. Some researchers have found, however, that the sequence and timing of inflectional morpheme development appears to parallel that of TH children if the child's 'hearing age' (i.e., number of years of auditory access starting when the child received appropriately fitted hearing devices until time of testing) is compared to TH children's chronological age (Guo et al., 2013; Inscoe et al., 2009; Koehlinger et al., 2015).

Research using LSA to investigate the inflectional morpheme errors of school-age children who are HoH suggests that children who are HoH are also impacted by the same factors that influence TH morpheme development but to a greater degree due to reduced hearing, which amplifies the effect of these factors over time. These make bound morphemes more difficult to acquire for children with poorer hearing abilities than TH children (Elfenbein et al., 1994; Koehlinger et al., 2013; Tomblin et al., 2015). Highly frequent, acoustically salient, neutral suffixes without allomorphs such as -*ing* were in fact found to be the easiest to acquire for children who were HoH aged five to nine years (McGuckian & Henry, 2007). In contrast, the less acoustically salient yet frequent allomorphs of the -*ed* and -*s* morphemes were produced by children who were HoH aged five to 12 years old with accuracy levels similar to TH children who were younger by a year or more (Elfenbein et al., 1994; Guo et al., 2013; McGuckian & Henry, 2007; Moeller et al., 2010). One exception is the plural -*s* morpheme, which is highly frequent, productive, and semantically simple and is an earlier developing inflectional morpheme (after -*ing*) even for children who are HoH (McGuckian & Henry, 2007; Tomblin et al., 2015). Finally, the less frequently used past participle (produced as allomorphs of -*ed* or -*en* that vary in perceptual saliency), comparative -*er*, and superlative -*est* were found to be used inconsistently with errors or not used at all in children who were HoH aged five to 12 years old (Cannon & Kirby, 2013; Elfenbein et al., 1994).

Despite group-level delays, not all children who are HoH show delays in morphological development. Many of the participants in the reviewed studies were reported to be developing expressive inflectional morphology on par with TH peers (Guo et al., 2013; McGuckian & Henry, 2007; Moeller et al., 2010; Norbury et al., 2001; Walker, McCreery, et al., 2015). Further investigation of individual factors that co-occur with age-appropriate morpheme use is warranted to identify why some children who are HoH struggle to develop inflectional morphology while others do not.

The development of derivational morpheme use in language samples has not been investigated with children who are HoH, but related research suggests that they may show delays. Studies using written multiple choice and sentence completion tasks with signing students who were d/Deaf or HoH revealed derivational morpheme comprehension difficulties that continued through to college age (Gaustad et al., 2002; Trussell & Easterbrooks, 2015). Derivational morphemes all contain at least one syllable but are used less frequently than inflectional morphemes and can be neutral or non-neutral. This means that morpheme frequency, perceptual salience, and neutrality should all impact which derivational morphemes are acquired earlier and used with more facility by children who are HoH. Given the importance of derivational morphology to the development of academic vocabulary in grade school, further research is needed to describe derivational morpheme use in children who are HoH in order to inform the development of appropriate interventions. The present study will address gaps in the literature on inflectional and derivational morpheme use in children who are HoH by describing bound morpheme use in elementary-school-aged children who were HoH using conversational language samples and comparing their use with that of TH children.

INDIVIDUAL DIFFERENCES IN MORPHOLOGICAL DEVELOPMENT

Child-specific variables associated with delayed morphological development in children who are HoH are still being identified, however limited research on inflectional morpheme use suggests potentially related variables. Child characteristics not directly related to hearing ability which explain individual variability in general language ability in children who are HoH, such as age and nonverbal reasoning skills (Geers et al., 2009), and parent education (Nittrouer et al., 2018) will likely do the same for morpheme use. In addition, growing up with reduced hearing levels may directly affect relationships between child-specific variables and morphological abilities in a manner unique to children who are HoH (Tomblin et al., 2015). As discussed above, morpheme development is influenced by morpheme-specific characteristics such as perceptual salience, morphophonological regularity, and frequency of exposure in the ambient environment, effects which are amplified in children who are HoH with inconsistent access to spoken language. Unaided hearing thresholds are therefore expected to relate to morpheme use. However, hearing thresholds have not always been found to uniquely predict performance in measures of morphosyntax (Halliday et al., 2017) or specific measures of morpheme development (Norbury et al., 2001) therefore other factors must come into play. Children who are HoH typically experience delayed access to early language exposure while the child's hearing status is being identified and appropriate hearing interventions implemented (Moeller & McCreery, 2017). For this reason, general language ability and specifically expressive vocabulary, which have both been found to relate to inflectional morpheme use accuracy (Norbury et al., 2001) are other important factors that may explain individual variability in morpheme use. No research was found that investigated child characteristics related to derivational morpheme use in children who were HoH.

THE PRESENT STUDY

LSA is an ideal format for assessing morpheme use in children, however, its use in research on the development of expressive morphology has been limited. The first research step required would be to describe children's abilities before further investigations of assessment and intervention are warranted. Thus far, very little is known about school-age children's spontaneous morpheme use particularly for children who are HoH. For the present study, a comprehensive investigation of all bound morphemes including inflectional and derivational morphemes used in a spontaneous language sample was selected as the ideal method of investigation. Further, bivariate correlations were conducted as preliminary investigations of potential relationships between quantitative measures of morpheme use and potentially-related child variables. Age, nonverbal reasoning, parent education, and measures of hearing ability (hearing thresholds, speech in noise thresholds) are child characteristics that may directly affect language exposure, access, and comprehension in children who are HoH and hence may vary predictably with expressive morphology. As well, two related language measures were included in correlational analyses that would be expected to closely relate to morpheme use: expressive vocabulary knowledge and morphological awareness (MA). Expressive, and not receptive, vocabulary knowledge was used for the present study to avoid the confound of inadvertently measuring listening abilities in a receptive task where the child must understand single words spoken out of context. Instead, the expressive vocabulary test used picture stimuli to elicit vocabulary and therefore should not interact with a child's hearing abilities. Finally, MA assesses awareness of morphemic units and may therefore relate to production of morphemic units. The present study addressed the following questions:

1. *Do English-speaking school-aged children who are HoH differ in the number of bound morphemes, types of bound morphemes, or errors in bound morpheme use from age-matched TH peers?*

2. *Are the relationships between morpheme use and age, nonverbal reasoning, parent education, hearing ability, morphological awareness, and expressive vocabulary different for the two groups?*

METHODS

PARTICIPANTS

Fourteen children who were hard-of-hearing (HoH; 3 girls, 11 boys) ages seven to 11 years old and 14 typically hearing (TH) children (4 girls, 10 boys) participated. Children were eligible for inclusion in the primary study if they: were 7 to 12 years of age, spoke English only in the home, had not attended French immersion prior to Grade 3 (due to a recent change in New Brunswick's educational system where a late French immersion option was being offered starting in Grade 3), and had no diagnosis of cognitive impairment (e.g., autism spectrum disorders). Additionally, children who were HoH were eligible if they had mild to severe average hearing thresholds, wore any type of hearing device, did not use any form of signed language, and were identified as being d/Deaf or HoH by the Atlantic Provinces Special Education Authority (APSEA; an organization that oversees the education of over 900 children who are d/Deaf or HoH across Nova Scotia and New Brunswick). Children who were d/Deaf or HoH could have diagnoses of attention deficit and hyperactivity disorder, language impairment, and/or literacy impairment as these diagnoses could be confounded by the experiences of being d/Deaf or HoH.

Children in the HoH group had mild to severe hearing levels and wore a hearing aid in both ears (n = 12), a bone-anchored hearing device on both ears (n = 1), or no hearing technology (n = 1; by child preference). TH children's hearing abilities were all within normal limits (i.e., hearing thresholds less than 25 decibels). Of the fourteen participants who were HoH, one was reported by a parent to have a diagnosis of ADHD with “learning difficulties”. None of the TH children had a diagnosed disability. One child in each group was homeschooled and the remainder were learning in general education classrooms with support from an itinerant teacher in a consultative and/or direct support model. The type and amount of itinerant teacher support for each child in the present study was not released by APSEA. In the parent questionnaire, in response to the question ‘*Does your child meet regularly with an itinerant teacher to work on goals, outlined in an APSEA Service Plan?*’, eight parents selected ‘*yes’*, one selected ‘*no’*, and five selected ‘*I don’t know*’.

Table 2.1 shows group descriptive statistics for age, grade, nonverbal reasoning, average hearing thresholds, years of parent education, occupational prestige score, and family income. Independent *t*-tests revealed no significant group differences in age ($p = .516$), grade ($p = 1.000$), nonverbal reasoning ($p = .641$), occupational prestige scores (reported for 13 / 14 participants in the HoH group; $p = .165$), or reported family income (11 / 14 participants in both groups; $p = .296$). The groups differed significantly in hearing thresholds ($t = 10.047$, $p < .001$, $d = 3.81$, HoH > TH) and average years of parent education ($t = 2.317$, $p = .029$, $d = 0.91$, HoH < TH).

Table 2.2 provides individual data for all 14 children who were HoH on: age, grade, gender, age of HoH diagnosis, hearing thresholds (left ear, right ear), hearing device(s) worn, duration of device use, speech discrimination of words in quiet (percent words correct), and speech in noise thresholds (dB).

Table 2.1
Descriptive statistics of participant characteristics by group (HoH, TH).

	HoH		TH	
Participant Characteristics	*M (SD)*	*Min - Max*	*M (SD)*	*Min - Max*
Age (years;months)	9;11 (1;3)	7;9 – 11;7	9;7 (1;0)	7;7 – 11;0
Grade	4.2 (1.4)	2 – 6	4.2 (1.1)	2 – 6
Nonverbal reasoning (SS)	10.1 (2.6)	5 – 15	9.6 (3.0)	5 – 16
Hearing thresholds (dB)***	46.5 (13.9)	23.8 – 75.6	7.9 (3.5)	1.5 – 12.9
Parent education (years)*	14.8 (1.5)	13.0 – 18.0	16.3 (1.8)	13.5 – 19.0
Occupational prestige score HoH (n = 13), TH (n = 14)	70.8 (3.9)	64.9 – 77.5	73.0 (4.0)	64.1 – 73.0
Family income HoH (n = 11), TH (n = 11)	3.7 (1.4)	1 – 5	4.3 (0.9)	2 – 5

Notes. Unless otherwise indicated, $n = 14$ for each group. HoH = hard-of-hearing. TH = typically hearing. Hearing thresholds = Pure-tone average thresholds for four frequencies (500 Hz, 1000 Hz, 2000 Hz, 4000 Hz) weighted by a ratio of 5:1 in favour of the better ear. SNR = signal to noise ratio. SS = standard scores. dB = decibels.
Significant group difference: *** $p < .001$. * $p < .05$.

Table 2.2

Individual data for children who were hard-of-hearing (HoH; n = 14).

Child ID#	Age at testing	Grade	Gender	Age of HoH diagnosis	Hearing thresholds		Hearing device(s) worn	Duration of device use (months)	Words in quiet (% words correct)	Speech in noise thresholds (dB)
					Left ear	Right ear				
D01	10;3	4	M	6;10	73.8	30.0	2 HA	39	84	+5.5
D02	9;11	4	M	3;0	20.0	67.5	none	n/a	86	+3.0
D04	9;6	4	F	0;0	42.5	46.3	2 HA	98	98	+2.0
D05	9;10	4	M	4;2	46.3	43.8	2 HA	63	86	+4.5
D06	10;11	5	M	4;0	36.3	32.5	2 HA	59	96	+4.0
D07	7;11	2	M	5;0	30.0	22.5	2 HA	35	96	+4.0
D10	8;0	2	M	0;0	85.0	73.8	2 HA	92	52	+8.5
D12	10;10	6	M	7;0	46.3	48.8	2 HA	38	74	+2.5
D13	10;4	5	F	0;0	60.0	62.5	2 HA	121	92	+2.0
D14	11;0	6	M	1;8	55.0	50.0	2 HA	96	86	+6.0
D15	7;9	2	M	2;4	48.8	50.0	2 HA	60	94	-1.5
D17	11;7	6	M	0;11	55.0	57.5	2 BAHA	107	90	+0.0
D18	10;10	5	M	0;6	42.5	42.5	2 HA	122	96	+1.0
D19	9;10	4	F	0;5	61.3	61.3	2 HA	109	50	+11.0

Notes. All ages are presented as years;months. Only Child D01 had an additional diagnosis identified as attention-deficit and hyperactivity disorder and parent-reported "learning difficulties". dB = decibels. HA = hearing aid. BAHA = bone-anchored hearing aid.

Two language measures were also collected to further describe the two groups. Table 2.3 (found in the Results section) displays group descriptive statistics for measures of expressive vocabulary and morphological awareness (MA) alongside LSA results. Groups did not significantly differ in expressive vocabulary (raw scores: $p = .478$; standard scores: $p = .305$) and MA ($p = .235$). No measures showed floor or ceiling effects in either group.

RECRUITMENT

Following ethics approval from the university and APSEA, children who were HoH were recruited first through APSEA who facilitated the distribution of 106 recruitment packages to eligible participants and subsequently through word-of-mouth and social media posts in Nova Scotia and New Brunswick. APSEA provides audiological and psycho-educational assessment and intervention, technological supports, and supplementary educational programming (as needed) for all students who are identified as d/Deaf or HoH and/or visually impaired across English-speaking school districts and homeschooled students in the Atlantic provinces. APSEA was given the list of eligibility criteria (as described above) but their database search was only able to identify children based on status as d/Deaf or HoH, lack of visual impairments, and age. The remaining inclusion/exclusion criteria were verified by the researcher by phone or email on first contact.

TH children were recruited by distributing a poster to previous research participants who had consented to be recontacted, in media posts, and through word-of-mouth. In total, 17 children who were HoH and 23 TH children were recruited. One child who was HoH was excluded based on cognitive concerns. Despite no diagnosis of intellectual disability, the child scored more than two standard deviations below the mean on the nonverbal reasoning test and observations during testing suggested learning difficulties as well. To enable comparisons of morpheme use, the participant groups were then matched for number (14 in each group) and chronological age resulting in the two oldest children who were HoH and the nine youngest TH children being excluded.

PROCEDURES

Parents/guardians completed a printed questionnaire on the child's language and hearing history prior to testing. Testing was conducted individually. Children were tested by the first author in the child's home (HoH, $n = 7$; TH, $n = 8$) or in a quiet room outside of the home (i.e., the university, APSEA, the library, or at school after school hours; HoH, $n = 7$; TH, $n = 6$). Children were seen for a single session, apart from one TH child whose audio recording was corrupted and was therefore seen five days later to re-record the language sample. Measures of hearing, cognition, language, and reading were collected. First, hearing thresholds were tested. For children who were HoH only, speech discrimination tests (single word accuracy, speech in noise thresholds) were administered after testing hearing thresholds. Next, measures in blocks of language and reading were administered in a counterbalanced order within each group to avoid order effects. Within the language block, phonological awareness, MA, and language samples were internally counterbalanced within each group. Within the reading block, real word reading, non-word reading then passage comprehension were administered, in that order. Finally, the test of non-verbal reasoning followed by an expressive vocabulary test completed the protocol. After testing, the child selected two items from the researcher's 'thank you' grab bag. Performance on speech discrimination of words in quiet, phonological awareness, and reading were not included in analyses and therefore not considered further.

Measures

Language and hearing history questionnaire. A researcher-developed questionnaire was adapted from language background questionnaires used by affiliated researchers (e.g., Kay-Raining Bird, Joshi & Cleave, 2016) used to gather information about child characteristics. Questionnaires for both groups of children collected information about child descriptors (e.g., age, grade, gender); presence of diagnosed cognitive, language, or reading impairments; home language exposure; and socioeconomic status. The HoH questionnaire also asked about hearing-related information (including age of diagnosis, change of hearing abilities over time, etiology, age of acquisition of hearing technologies and their usage), exposure and use of spoken versus signed language, parent report of their child's listening challenges at school, and educational supports. Three measures of socioeconomic status were collected: parent education (number of years), occupation, and income. Parent education was reported as the highest level completed from a list of educational levels. The selected level was converted to the number of years such that '*some high school*' equaled 10 years, '*high school or equivalent*' equaled 12 years, '*vocational/technical school*' equaled 13 years, '*some college*' equaled 14 years, '*bachelor's degree*' equaled 16 years, '*master's degree*' and '*professional degree*' (e.g., doctor of medicine) equaled 18 years, and '*doctoral degree*' equaled 20 years. All participants came from two-parent households except one child in the HoH group who came from a single-parent household. For two-parent households, the average number of years was calculated.

An occupational prestige score was determined by first searching for the parents' reported occupations in the National Occupational Classification tool on the Canadian government site, 2016 Version (http://noc.esdc.gc.ca/English/noc/welcome.aspx?ver=16). Once the classification codes for each parent were identified, the corresponding occupational prestige score calculated by Goyder and Frank (2007) was entered. Goyder and Frank's prestige ratings were based on a national survey of 2,053 respondents conducted in 2005. Respondents rated occupations on a scale of one to nine, with nine being the most prestigious according to the respondent's own understanding of 'social standing'. Occupational prestige ratings were converted to a scale ranging from 0 to 100 and mean converted scores ranged from 52.3 to 80.9. If the classification category was not listed, the next-best category was chosen (e.g., 'homemaker' was coded as 'home support workers, housekeepers, and related occupations'; 'consumer insight specialist' was coded as 'business development officers, marketing research consultants', which also included the similar job title 'marketing research specialist'). If the child had two parents in the home, the average of the two occupational prestige scores was calculated.

Finally, family income was self-reported by the respondent as one of five forced-choice income brackets, which were converted by the first author to an ordinal scale of 1 to 5 ('*less than $30,000*' = 1, '*between $30,000 and $60,000*' = 2, '*between $60,000 and $80,000*' = 3, '*between $80,000 and $125,000*' = 4, '*more than $125,000*' = 5). Three respondents in each group chose not to report their income.

Non-verbal reasoning. Non-verbal reasoning was measured using the *Fluid Reasoning* subtest of the *Stanford Binet Intelligence Scales, Fifth edition* (Roid, 2003). The child looks at an incomplete pattern and selects the missing image from five options.

Basal is an incorrect response in either of the first two items at the indicated start points and ceiling is four consecutive errors. Raw and standard scores were calculated using manual procedures. The test manual reports internal consistency reliability coefficients for the fluid reasoning subtest ranging from .79 to .86 for ages 7 to 12 years.

Hearing thresholds. All participants had their hearing thresholds tested apart from one child, whose parent provided an audiogram conducted by the child's audiologist the previous day. Pure tone thresholds (unaided for children who wore hearing devices) were tested using a portable audiometer at 500, 1000, 2000, and 4000 hertz. Since children's hearing was not always equal in both ears, a pure tone average threshold was calculated as a weighted average of both ears, with a weighting of 5:1 in favour of the better ear (Dobie, 2011).

Speech in noise thresholds. Children who were HoH were tested on their ability to correctly repeat sentences in background noise. The task was administered using an audio-recording played on a MacBook Air laptop computer with a portable mini speaker placed one metre in front of the child. Immediately before administration, the sound was calibrated to 65 dB using a sound level meter held near the child's head. The *Bamford-Kowal-Bench Sentences in Noise test* (Etymōtic Research, 2005a) was used. For this test, the child repeats two sets of 10 sentences spoken by a man's voice accompanied by background babble. The target voice starts at +21 dB signal-to-noise ratio in the first sentence. Background noise increases by three decibels after each sentence to bring the signal-to-noise ratio down to -6 dB by the 10th sentence. The number of keywords repeated accurately was scored during testing. The test provides a signal-to-noise ratio threshold (in dB) averaged across the two sentence lists. The score can be interpreted as how many decibels louder a target voice needs to be relative to background voices for the listener to accurately discriminate a target sentence. The average TH adult requires a signal-to-noise ratio of at least –2.5 dB (standard deviation of 0.8) while the average TH child aged seven to 10 years old requires a signal-to-noise ratio of at least 0.8 dB (standard deviation of 1.2) for accurate discrimination of sentences in noise. There are 10 versions of the test and parallel forms reliability was reported in the manual. Reliability at 95% confidence interval is achieved for two test versions with children aged seven to 10 years old at +/– 1.8 dB and 10 to 14 years old at +/– 1.6 dB. The test is reported to have greater reliability with increased age and greater test variability is expected for children who wear cochlear implants compared to TH children (Etymōtic Research, 2005b). Children who wear hearing aids were not included in reliability testing.

Morphological awareness (MA). MA was measured using items from a sentence completion task originally published in an article by Carlisle (2000) as a list of derivation items and a list of decomposition items. Levesque, Kieffer and Deacon (2017) combined the items from the two lists into two versions of items alternating between derivation and decomposition. The present study used version A of these combined lists, however, a few items that were considered ambiguous (i.e., the sentence could be accurately completed with more than one possible word) by the first author were replaced by items matched by derivational morpheme from version B; the test modifications were approved by Kyle Levesque via personal communication. The task has two practice items and 28 test items. The test items include 14 word roots to be derived and 14 derived words to be decomposed. For this task, the examiner says a word root (e.g., play) or a derived word (e.g., player) then an incomplete sentence. The child must change the word to complete the sentence (e.g., *Assist. The teacher will give you* _____ [assistance].; *Originality. That painting is very* _____ [original]). The items vary in phonological transparency, including 14 items with neutral suffixes (e.g., *teach…teacher*) and 14 items with non-neutral suffixes (e.g., *expand…expansion*). The test is not normed, therefore raw scores out of 28 were used. The internal consistency reliability coefficient (Cronbach's alpha) reported in Levesque, Kieffer and Deacon (2017) was .86 for a sample of 221 children in Grade 3.

Expressive vocabulary. Expressive vocabulary ability was measured using the *Picture Vocabulary* subtest of the *Woodcock-Johnson III Tests of Achievement* (Woodcock, McGrew, & Mather, 2001). In this test, the child says the best word that matches a picture. A measure of expressive vocabulary was preferred over receptive vocabulary to allow for more direct comparisons with expressive morphology. Basal is six consecutive correct responses and ceiling is six consecutive incorrect responses. Raw and standard scores were calculated using manual procedures. The manual reports a median internal consistency coefficient of .77 for this subtest.

Language sample. The morpheme use data were obtained from a conversational language sample that was elicited using standardized protocols and procedures (Miller, 1981; "Conversation—Elicitation Protocol", 2020) in which the examiner followed the child's lead to talk about topics of interest to them. A common set of topics such as family, hobbies and pets were introduced as needed.

Transcription. Conversational samples were transcribed using *Systematic Analysis of Language Transcripts* software transcription conventions (Miller & Chapman, 2012). The transcriber started the transcription at a point in the audio recording soon after the task was introduced when the child seemed comfortable. The transcriber then transcribed for 10 consecutive minutes. All transcriptions were rechecked with audio for accuracy by the same transcriber at a later date.

Morpheme use coding. In order to maximize the number of bound morphemes identified, morpheme counts included mazes, abandoned or interrupted utterances, and utterances containing unintelligible words. Productions of all eight English inflectional morphemes and any derivational morphemes were identified and coded. The past participle was coded only when used with auxiliary verbs in perfect (e.g., *has walked*) and passive (*was broken*) constructions. Past participles acting as adjectives (e.g., *the broken clock*) were not coded.

Derived words were identified following rules developed by Squires, et al. (2019). A word was coded as derived if: 1) it contained an identifiable root (in current usage) with at least one prefix or non-inflectional suffix, 2) the meaning of the root and morpheme(s) were related to the meaning of the derived word, and 3) the derivational morpheme could be applied to other roots of the same grammatical category to have the same semantic and/or grammatical effect. For further description, justification, and application of the rules, see Squires et al. (2019). The same word could be coded as derived and inflected (e.g., *teacher/s*). Morphological blends that contained an incomplete morpheme (e.g., *jazzercise*) and proper nouns (e.g., *Adobe Reader*) were not coded.

Coding reliability. To assess coding reliability, inflectional morphemes and derived words were coded independently for six randomly selected transcripts (three in each group, comprising 21% of all transcripts) by a second doctoral student who had received extensive *Systematic Analysis of Language Transcripts* transcription training.

Agreement for identified inflections and derivations was 83% (241/291). Agreement for the three inflectional morphemes not studied previously (-*er*, -*est*, and past participle -*en*/-*ed*) was 87% (13/15) and for derived words was 77% (83/108), suggesting that there was good to excellent inter-rater coding reliability.

Morpheme use measures. The number of different inflectional morphemes (out of eight), the number of different bound (i.e., inflectional and derivational) morphemes, the total number of inflected words, the total number of derived words, the number of different derived words, and the number of different derivational morphemes produced by each child in each 10-minute conversational language sample were tallied. To control for differences in sample length across children, the total number of inflected words and derived words in a sample were divided by the total number of words in the sample (i.e., % words inflected, % words derived). Similarly, the percentage of different derived words was divided by the number of different words in the sample (i.e., % different derived). The number of different derived words per derivational morpheme was calculated as a general measure of derivational morpheme productivity.

ANALYSES

To address the first research question, descriptive statistics of the number of total and different inflectional morphemes, number of total and different derivational morphemes, number of different bound morphemes, percent words that were inflected, percent words that were derived, percent different words that were derived, and number of different derived words per derivational morpheme were computed and the HoH and TH group means were compared using independent samples *t*-tests. Alpha was set a priori at .05. Given the clinical population and relatively small sample size, ‘trends’ for alpha up to .10 were also of interest. Cohen's *d* effect sizes were calculated for all comparisons of means. Each unique morpheme used by children in each group were compiled then the number of children who used each morpheme and number of unique roots used with each morpheme by the group were tallied.

To address the second research question, Pearson's Product Moment correlations were computed between select morpheme production measures (% words inflected, % words derived, % different words derived, # different derived words per derivational morpheme, # different bound morphemes) and potentially related child variables (age, nonverbal reasoning, parent education, hearing thresholds, speech in noise thresholds, MA, expressive vocabulary) for each group. Pearson's *r* effect sizes of .10 were interpreted as small, .30 as medium, and .50 or greater as large (Cohen, 1992). The Box's *M* test was used to test for statistically significant group differences in the overall homogeneity of covariance. Criteria for a significant difference was set at $p < .10$ based on guidelines recommended by Warner (2013) for small sample sizes. The Box's *M* test is expected to have low power to detect differences in small sample sizes (Warner, 2013), therefore Fisher's *z* transformations (Fisher, 1915) were hand-calculated using an online calculator (*Psychometrica*, https://www.psychometrica.de/correlation.html) for each paired comparison. In addition, correlations are compared descriptively across groups.

RESULTS

Preliminary analyses examined the length and lexical diversity of the 10-minute conversational corpora. Descriptive statistics for the total number of utterances, total words, and number of different words by group (HoH, TH) are shown in Table 2.3. Children produced 79 or more utterances in 10-minute samples containing from 350 to more than 1,000 words. Independent samples *t*-tests for each of these three measures revealed no significant differences between groups. Since the language samples are comparable in size and lexical diversity across the two groups, they can be validly compared in terms of morpheme use.

Table 2.3

Descriptive statistics for test measures, corpus measures, and experimental morpheme use measures by hearing status group (both groups, n = 14). Group comparison of means is reported using Cohen's d effect size and p-values for significance.

Descriptive Measures	**HoH**		**TH**		**Between groups**	
	M (SD)	*Min - Max*	*M (SD)*	*Min - Max*	*d*	*p*
Tests						
Expressive vocabulary (raw)	24.79 (3.38)	18 – 31	25.79 (3.95)	21 – 37	.27	.478
Expressive vocabulary (SS)	100.71 (11.40)	78 – 122	105.14 (11.02)	91 – 136	.40	.305
Morphological awareness (raw)	18.14 (6.72)	5 – 25	20.71 (4.08)	13 – 27	.46	.235
Language Sample Corpus						
Total number of utterances	118.1 (23.6)	79 – 164	122.0 (30.6)	83 – 174	.14	.662
Total number of words	677.2 (177.6)	370 – 875	712.4 (228.6)	350 – 1190	.17	.653
Number of different words	229.1 (39.7)	158 – 276	242.0 (46.7)	147 – 303	.30	.437
Morpheme Use						
# total inflectional morphemes	34.00 (10.85)	17 – 50	36.07 (15.07)	11 – 60	.16	.680
# different inflectional morphemes	6.79 (0.89)	4 – 8	6.43 (1.45)	4 – 8	.30	.442
# total derivational morphemes	18.64 (6.33)	7 – 26	21.86 (10.59)	2 – 49	.37	.298
# different derivational morphemes	6.36 (2.50)	2 – 11	7.93 (2.76)	2 – 13	.60	.126
# different bound morphemes	13.14 (2.93)	9 – 19	14.36 (3.82)	6 – 20	.36	.354
% words inflected	5.00 (0.84)	3.62 – 6.52	5.09 (1.51)	1.76 – 8.04	.07	.854
% words derived	2.73 (0.80)	1.54 – 4.54	3.12 (1.44)	0.57 – 5.13	.33	.385
% different words derived	4.40 (1.05)	1.90 – 6.13	4.83 (1.72)	1.36 – 7.21	.30	.435
# different derived words per DM	1.67 (0.37)	1.30 – 2.60	1.49 (0.30)	1.00 – 2.00	.53	.177

Notes. HoH = hard-of-hearing. *M* = Mean. *SD* = standard deviation. Min = minimum. Max = maximum. TH = typically hearing. SS = standard score. DM = derivational morpheme.

FREQUENCY AND DIVERSITY OF MORPHEME USE IN LANGUAGE SAMPLES

Quantitative morpheme use measures. Descriptive group statistics (including between-group effect sizes and significance values) for all quantitative morpheme use measures are also presented in Table 2.3. Overall, fewer than eight percent of total words were inflected, fewer than six percent of total words were derived, and fewer than eight percent of different words were derived. Independent *t*-tests found no significant differences between groups for any of the nine morpheme use measures.

Types of bound morphemes. The number of children who used each of the eight inflectional morphemes was similar across groups (see Table 2.4). With regards to the three inflectional morphemes that have not been studied as often, comparative -*er* was produced by about three quarters of the children in each group and superlative -*est* by about half. Approximately half the children in each group produced the past participle in passive constructions (e.g., *she was saved by her friend*) compared to a third in each group who produced the past participle in perfect constructions (e.g., *she had saved her friend*). The past participle in the form -*en* (as opposed to -*ed*) was produced by only one child in the HoH group aged 11;0 (*I haven't fallen*) and two children in the TH group aged 9;11 and 10;2 (*they were actually chosen; I've taken*).

Table 2.4
Number of children who were hard-of-hearing (HoH) and typically hearing (TH) who produced each inflectional morpheme at least once in a 10-minute conversational language sample.

Inflectional Morphemes	**HoH (*n* = 14)**	**TH (*n* = 14)**
-*ing* (present participle)	14	14
-*s* (plural)	14	14
-*s* (3rd person singular)	12	14
-*ed* (simple past)	13	13
-*er* (comparative)	12	10
-*s* (possessive)	11	10
-*ed*/*en* (past participle)	10	9
Passive	8	7
Perfect	5	4
-*est* (superlative)	9	6

The different derivational morphemes produced by the children in each group along with the number of children who produced each derivational morpheme and the number of different word roots used with each morpheme (i.e., group-level productivity) are presented in Table 2.5. At least half the children (7 or more) in both groups used the morphemes -*ly* as in *exactly*; agentive -*er* as in *kicker*; and -*y* as in *cloudy*. Seven additional derivational morphemes (-*ion* as in *education*; instrumental -*er* as in *printer*; -*teen* as in *fourteen*; -*ty* as in *sixty*; -*al* as in *magical*; -*ic* as in *specific*; -*th* as in *fourth*) were used by at least a quarter of the children (3 or more) in both groups. The morpheme -*ion* was the only derivational morpheme that may have been used differentially across groups; -*ion* was used with six different roots by six children who were HoH and with nine different roots by 10 TH children. The only prefix used with more than one root was *re*- in the TH group. Sixteen additional derivational morphemes (including one prefix) were produced with only one root by children in the HoH group and 25 additional morphemes (including five prefixes) were produced with only one root by children in the TH group (Table 2.5).

Table 2.5
Number of children who produced each derivational morpheme and number of different word roots (# diff roots) per derivational morpheme for each group (HoH, TH). Derivational morphemes that were produced with only one root (some of which were produced by more than one child, e.g., -ite in 'favourite') are listed at the bottom of the table for each group.

	HoH (*n* = 14)			**TH (*n* = 14)**	
# children	Morpheme	# diff roots	# children	Morpheme	# diff roots
12	*-ly*	25	13	*-ly*	16
12	*-er* (agent)	13	10	*-er* (agent)	3
7	*-y*	8	7	*-y*	8
6	*-ion*	6	10	*-ion*	9
5	*-er* (instrumental)	8	6	*-er* (instrumental)	7
4	*-teen*	5	3	*-teen*	4
4	*-ty*	5	5	*-ty*	5
4	*-al*	4	4	*-al*	5
3	*-ic*	4	5	*-ic*	4
3	*-th*	2	3	*-th*	3
2	*-ful*	2	3	*-ie*	2
2	*-y* (nominal)	2	2	*re-*	2
2	*-ent*	2	2	*-ce*	2
-able, -ally, -ary, -ative, -ee, -en, -ern, -hood, -ie, -ing (noun), -ite, -ment, -ous, re-, -some, -th (noun)		1	*-ally, -ent, -ite, -aire, -an, -dom, -ess, -etic, great-, -hood, -ics, -ish, -ist, -ity, -ive, -ly (noun), -ment, over-, peri-, pre-, -ship, -some, un-, -ure, -y (noun)*		1

Notes. HoH = hard-of-hearing. TH = typically hearing

Morpheme use errors. As a group, children who were HoH were more likely to produce errors in morpheme use than their TH counterparts (Table 2.6), although the individual frequency of errors was generally quite low (only two children, both from the HoH group, produced more than two morpheme use errors). T-test with a Greenhouse Geisser correction to correct for a lack of homogeneity of variance revealed a trend towards a greater number of morpheme use errors in the HoH group (M = 2.21, SD = 2.61, range = 0 to 10) compared to the TH group (M = 0.71, SD = 0.61, range = 0 to 2); t = 2.096, p = .054, d = 0.79. Table 2.6 shows the types of errors produced by children in each group. Children produced errors for all inflections except possessive -*s* or past participle -*ed*/-*en* morphemes.

Table 2.6

Types of morpheme use errors produced in both groups (HoH, TH).

Type of Morpheme Use Error	**HoH** # children / # exemplars	**TH** # children / # exemplars
Inflectional morpheme use errors	11 children / 24 exemplars	7 children / 8 exemplars
3rd person singular -*s* *He looks happy.*	3 children / 7 exemplars *And it just go a little faster.*	1 child / 1 exemplar *My mom grinds up oats and put them in a oat flour.*
Plural -*s* *They're teachers.*	1 child / 1 exemplar *And one of my friend that is on my team in the summer, he got a yellow card.*	3 children / 3 exemplars *It's set in the same world as one of my favourite book serieses.*
Possessive -*s* *His teacher's desk is messy.*	0	0
Simple past -*ed* *She walked away.*	4 children / 6 exemplars *The other one play the trumpet.*	2 children / 2 exemplars *We dived off my raft in the lake.*
Present participle -*ing* (with auxiliary) *They're walking home.*	2 children / 4 exemplars *I trying to fixed it.*	0
Past participle -*ed*/-*en* *They have given it away.*	0	0
Comparative -*er*/-*est* *They're taller than him.* *She's the tallest.*	6 children / 6 exemplars *When I'm not in my classroom, it's so easier.*	2 children / 2 exemplars *It's the popularest game in the world.*
Derivational morpheme use errors	5 children / 7 exemplars *We're going into the champions [championships].*	2 children / 2 exemplars *His glasses and his hair would fit perfect for anything cuz it looks enough like me.*

Notes. HoH = hard-of-hearing. TH = typically hearing.

RELATIONSHIPS BETWEEN MORPHEME USE AND CHILD VARIABLES

Correlations between morpheme use measures and child variables are shown in Table 2.7 for the HoH (shaded rows) and TH (unshaded rows) groups. Box's *M* test of homogeneity of covariance was not significant, $M = 148.139$, $p = .143$. This means that the test could not find a statistically significant group difference across the covariance matrices. Due to the anticipated low power of performing the Box's *M* test with such small sample sizes (Warner, 2013) and for results specific to each individual correlation, paired comparisons were were also statistically explored using Fisher's *z* transformations. Fisher's *z* transformations for each paired correlation (r_{HoH}, r_{TH}) are shown in Table 2.8. The correlations that directly addressed the research question are found in the lower left quadrant of Tables 2.7 and 2.8. Correlations amongst child variables (upper left quadrant) and amongst morpheme use variables (lower right quadrant) will be discussed only as necessary to explain results from the correlations of interest. For the HoH group only, speech in noise thresholds were also included in the correlational analysis.

As can be seen in Table 2.7, the HoH group showed no significant correlations between any morpheme use measures and other child variables whereas the TH group showed a number of significant correlations. While hearing thresholds did not correlate significantly with any of the morpheme use measures, the HoH group showed a large positive correlation between speech in noise thresholds and percent different words derived that approached significance. The number of different bound morphemes was significantly related to the most child variables in the TH group (age, nonverbal reasoning, MA, expressive vocabulary) and approached a significant correlation with MA for the HoH group. Otherwise, the percent words inflected, percent words derived, and percent different words derived showed scattered relationships with a few child variables. The number of derived words per derivational morpheme measure was not correlated with any child variable in either group.

Fisher's *z* transformations (Table 2.8) revealed significant differences across groups for four correlations between morpheme use measures and child variables. The HoH group had significantly weaker correlations than the TH group for two morpheme use measures (% words inflected, # different bound morphemes) with age and two morpheme use measures (% different words derived, # different bound morphemes) with nonverbal reasoning.

Table 2.7

Correlations (r) between child variables and morpheme use measures for HoH group (shaded rows) and TH group (unshaded rows). R-values significant at .05 or greater are shown in bold.

	Group	*Child variables* 1	2	3	4	5	6	7	*Morpheme use measures* 8	9	10	11	12
Child variables													
1. Age	HoH	–											
	TH	–											
2. Nonverbal reasoning	HoH	.15	–										
	TH	.14	–										
3. Parent education	HoH	.07	.34	–									
	TH	-.33	-.19	–									
4. Hearing thresholds	HoH	-.04	-.08	.05	–								
	TH	-.11	-.25	.46†	–								
5. Speech-in-noise thresholds	HoH	-.11	-.48†	-.49†	.31	–							
	TH	–	–	–	–	–							
6. Morphological awareness	HoH	**.54***	.25	.35	-.38	**-.56***	–						
	TH	**.70****	.49†	-.17	.05	–	–						
7. Expressive vocabulary	HoH	.17	.40	.44	-.42	**-.58***	**.82*****	–					
	TH	.49†	**.55***	-.07	.25	–	**.80****	–					
Morpheme use measures													
8. % words inflected	HoH	-.27	-.11	-.09	-.44	-.11	.02	.08	–				
	TH	**.56***	-.15	-.49†	-.20	–	.15	.02	–				
9. % words derived	HoH	.14	.33	-.28	-.02	-.31	.21	.21	.16	–			
	TH	.00	**.75****	-.17	-.16	–	**.54***	**.54***	-.22	–			
10. % diff words derived	HoH	-.02	-.31	-.30	.20	.49†	.05	-.10	.35	.23	–		
	TH	.06	**.76****	-.28	-.26	–	.49†	.47†	-.27	**.93*****	–		
11. # derived words per DM	HoH	-.18	.27	.43	.32	.14	-.38	-.21	.20	-.15	.21	–	
	TH	-.38	.35	-.04	-.04	–	-.13	-.04	-.51†	.39	.45	–	
12. # different bound morphemes	HoH	.05	-.20	-.17	-.28	-.06	.53†	.30	.33	.25	**.61***	-.34	
	TH	**.73****	**.56***	-.46†	-.40	–	**.79****	**.60***	.42	**.58***	**.60***	-.04	

Notes. DM = derivational morpheme. HoH = hard-of-hearing. TH = typically hearing.
Significance values: *** $p < .001$, ** $p < .01$, * $p < .05$. † trend: $.05 > p < .10$.

Table 2.8

Fisher's z transformations for each pair of correlations (r_{HoH}, r_{TH}) between child variables and morpheme use measures across the HoH (n = 14) and TH (n = 14) groups. Z-values significant at .05 or greater are shown in bold.

	Child variables							Morpheme use measures			
	1	2	3	4	5	6	7	8	9	10	11
Child variables											
1. Age	–										
2. Nonverbal reasoning	0.02	–									
3. Parent education	0.97	1.28	–								
4. Hearing thresholds	0.17	0.41	-1.05	–							
5. Speech-in-noise thresholds	–	–	–	–	–						
6. Morphological awareness	-0.62	-0.66	1.26	-1.06	–	–					
7. Expressive vocabulary	-0.89	-0.46	1.27	**-1.65***	–	0.14	–				
Morpheme use measures											
8. % words inflected	**-2.13***	0.10	1.05	-0.63	–	-0.31	-0.14	–			
9. % words derived	0.33	-1.48†	-0.27	0.33	–	-0.92	-0.92	-0.90	–		
10. % diff words derived	-0.19	**-3.09****	-0.05	1.10	–	-1.14	-1.43†	1.51†	**-3.34*****	–	
11. # derived words per DM	0.51	-0.21	1.17	0.87	–	-0.63	-0.41	**1.80***	-1.32†	-0.64	–
12. # different bound morphemes	**-2.06***	**-1.96***	-0.76	0.32	–	-1.13	-0.90	-0.25	-0.96	0.04	-0.74

Notes. Speech in noise thresholds (Variable #5) could not be compared across groups as they were only collected for the HoH group. DM = derivational morpheme. HoH = hard-of-hearing. TH = typically hearing.
Significance values: $^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$. †trend: $.05 > p < .10$.

DISCUSSION

The primary objective of this study was to describe and compare morpheme use in the conversational language samples of children who were HoH and TH. A secondary purpose was to examine child variables that might explain individual variability in morpheme use and compare across the two groups.

MORPHEME USE IN CONVERSATION

Inflectional morphemes. The two groups of seven- to 11-year-old children (HoH and TH) in the present study produced similar total numbers of inflectional morphemes. As well, similar numbers of children in each group used each of the eight inflectional morphemes (see Table 2.4), including the past participle suffix in passive (about half per group) and perfect (about a third per group). Since no differences were found across groups for the lesser studied morphemes (past participle, comparative, and superlative morphemes), the evidence suggests that by seven years of age, these children who were HoH were acquiring them similarly to TH peers. There was no significant correlation between speech in noise thresholds and the percent of words that were inflected, meaning that the listening abilities of school-age children who were HoH did not appear to impact the amount of words being inflected.

Despite these similarities, a greater number of children who were HoH than TH produced inflectional morpheme errors, which appeared to be related to poorer speech in noise and/or hearing thresholds. This is similar to findings in earlier studies which reported that children who were HoH of similar age range, hearing abilities, and language modality as the present study produced inflectional morphemes significantly less accurately than TH same-age peers (Elfenbein et al., 1994; McGuckian & Henry, 2007).

Five out of the 14 children who were HoH (36%; D01, D06, D10, D17, D18) produced errors in the production of the most challenging inflectional morphemes to acquire with reduced hearing (third person singular -*s* and regular past -*ed*) while errors in the other inflectional morphemes were minimal in both groups. Of these five children, three had poorer speech in noise thresholds (+4.0, +5.5, and +8.5 dB signal-to-noise ratio). For these children, their challenges to morpheme development likely stem from late diagnosis of reduced hearing (Child D01 had a severe hearing difference in one ear that was not identified until almost seven years of age while Child D06 had a bilateral mild hearing difference identified at four years of age) or greatly reduced hearing ability (Child D10 had a bilateral severe hearing difference identified at birth). The other two children with errors in the production of third person singular -*s* and regular past -*ed* had good speech in noise thresholds (0.0, +1.0 dB signal-to-noise ratio), suggesting speech discrimination abilities cannot account for all the errors observed. Child D19 had the poorest speech in noise threshold (+11.0 dB signal-to-noise ratio) in the study yet did not produce any inflectional errors during the 10-minute sample. However, she did produce an error with the -*ing* suffix just after the 10-minute transcription cutoff (*No, in music class too. The, everyone's trying to, like, playing it* {instruments}*, like if they're not supposed to*). This child appeared to have a more general language delay, as evidenced by frequent use of nonspecific nouns (e.g., *Oh, we went to the thing, the, the spot where, like, there was lots of people*) and a number of errors in syntax (e.g., *There were only two rooms were like bedroom then bathroom*).

The two children who produced errors in inflection and had good speech in noise thresholds were two of the oldest children in the study (ages 10;10 and 11;7). One of these children produced a single error in bound morpheme use by overgeneralizing the past -*ed* (*and then the cat just goed around her*), which is unusual to find in a child almost 11 years of age. The other child produced two inflectional morpheme errors and both were omissions of obligatory morphemes (*the music teacher turn* {turns} *into a normal teacher; the other one play* {played} *the trumpet*), which are also unusual for this age. Both of these children had a bilateral moderate hearing difference that was identified early at 11 and six months of age, with nine and 10 years of device usage, respectively. These children therefore demonstrated subtle morphological delays that may have betrayed the impacts of inconsistent hearing access over time on morphological development, as suggested by the model of inconsistent access (Tomblin et al., 2015). In contrast, the other five children with good speech in noise thresholds of +3.0 dB or lower (D02, D03, D12, D13, D15) produced one to two bound morpheme errors that were not unusual or unexpected for this age range, such as errors of derivation (e.g., *going into the champions* {championships}) or agreement within more complex phrasal constructions (e.g., *one of my friend* {friends} *that is on my team*).

No errors were identified in either group for the use of possessive -*s* and past participle -*ed* or -*en* morphemes, however this may be because they were used less often in the samples. Also, five children who were HoH (aged 7;9 to 10;11) produced errors in their use of the comparative -*er*, whereas none of the TH children did so. These errors were mostly in the erroneous use of the inflected word with accompanying modifiers (e.g., *very younger than me*; *so easier*). This suggests that these children who were HoH were still acquiring the comparative -*er* (suggesting lower quality representations of the morpheme in the lexicon), which may have been accurately acquired by the TH children.

This suggests its development is negatively impacted by the experience of inconsistent auditory access in the children who were HoH. One child who was HoH produced an error with the superlative -*est* (missing the obligatory article *the*), as did two TH children (aged 9;3 and 9;9; *funnest, popularest*), suggesting no differences between groups. The comparative -*er* and superlative -*est* are known to be later developing due to the complex semantic and syntactic information that links to the morphemes' representations (Gathercole, 1983; Graziano-King & Smith Cairns, 2005). This was confirmed in the present sample.

In sum, children who were HoH showed encouraging similarities in the types and quantities of inflectional morphemes they used compared to TH peers. However, the analysis of morpheme use errors in conversational language samples revealed that children who were HoH with poorer speech discrimination in noise and/or poorer hearing thresholds were more likely to produce inflectional morpheme errors than children with good speech discrimination abilities and TH children.

Derivational morphemes. TH results paralleled and substantiated previous findings with TH children reported by Squires and colleagues (2020) using the same methodology. The 14 TH children in the present study produced on average 3% derived words and 5% different derived words, performance that fell between that of the younger and older elementary age groups in Squires et al. (2020). Accordingly, the present study's participants included ages that spanned those of the younger and older children in the previous study.

The accurate production of derivational morpheme use was remarkably similar across the TH and HoH groups with some subtle differences. The HoH group produced a slightly lower (but not significantly different) mean percentage of derived words (2.7%) and different derived words (4.4%) than the TH group (3.1% and 4.8%, respectively). Similarly, the 14 children who were HoH produced 29 different derivational morphemes and the 14 TH children in the present study produced 38. In Squires et al. (2020), the older group (n = 11) produced 28 different derivational morphemes whereas the younger group (n = 12) produced only 19 different derivational morphemes. These findings show that the children who were HoH may have had slightly smaller derivational morpheme inventories than same-age TH children but not to the degree that they appeared like younger TH children.

In the present study, the children who were HoH showed good productivity in their use of the most common derivational morpheme -*ly* that appeared to be slightly higher than TH children (HoH: 25 roots; TH: 16 roots) but produced fewer single-use morphemes (HoH: 16 single-use morphemes; TH: 25 single-use morphemes). McGuckian and Henry (2007) suggested that the inflectional morpheme -*ing* was produced more frequently by their HoH group than TH controls because it is a frequently used morpheme and was ‘overused’ to compensate for reduced facility in producing other grammatical constructions. The morpheme -*ly* is one of the most frequent derivational morphemes in English and has the greatest family size out of all 241 derivational suffixes listed in the *MorphoLex* database (Mailhot, 2017), which most likely explains its high usage. Otherwise, the numbers of children in each group who produced each derivational morpheme at least twice were strikingly similar (see Table 2.5). Given that the two age-matched groups also scored similarly in expressive vocabulary knowledge, this suggests that similar levels of morpheme use may reflect similar levels of productive vocabulary.

However, when individual results are investigated through correlational analyses, none of the five quantitative measures of morpheme use correlated strongly with expressive vocabulary in the HoH group (r-values: .08 to .30, $p > .10$) yet three did so for the TH group (r-values: .47 to .60, $p < .10$). This suggests that these tallies of total morpheme use may not strongly reflect lexical knowledge whereas an examination of the types of morphemes used may be more informative for exploring lexical knowledge.

The only derivational suffix that may have been used somewhat more frequently in the TH group (10 of 14 children, 71%) than the HoH group (6 of 14 children, 43%) was -*ion*, a nonneutral suffix that is also one of the most frequently used English suffixes in academic discourse (Mailhot, 2017). The suffix -*ion* was also used less frequently by the younger group in Squires et al. (2020) than the older group, suggesting that it is being acquired across this age range. Nonneutral suffixes such as -*ion* are expected to be acquired later in TH children (Tyler & Nagy, 1989; White et al., 1989) due to the inconsistent phonological form of the word roots. This would reduce the number of instances where the child may recognize the patterns of its use. This may make -*ion* especially difficult to acquire for children who are HoH due to their less consistent access to the auditory signal, as per the model of inconsistent access (Tomblin et al., 2015). Given the small sample sizes of the present study, further investigation is necessary to confirm this finding.

Finally, prefixes were rarely used and when they were little productivity was demonstrated. One prefix (*re-*) was produced by a single child in the HoH group and two TH children, while children in the TH group also produced four other prefixes (*great-, over-, peri-, pre-*), each with a single root. This is similar to findings by Squires et al.

(2020) in which prefixes were used almost exclusively by the older elementary-aged TH children. This is consistent with cross-linguistic research with nonsense prefixes and suffixes by Clark (2014) showing that prefixes tend to be more difficult for children to acquire than suffixes. There are also fewer English prefixes than suffixes (Mailhot, 2017), meaning that prefixes occur less frequently than suffixes in language input, which could explain a more extended developmental trajectory.

The identification of errors in derivational morpheme use did not clearly indicate group differences. Since derivational morphemes do not occur in obligatory contexts, the types of errors varied. Five of the six errors identified for the HoH group involved the morpheme -*ly*. These were errors of omission (*I did most [mostly] grade five work; she used to talk quiet [quietly]*), addition (*it got a little crackly [crack] right there*), incorrect semantic use of the root (*fairly [mostly] the same places*), and word order (*my fish, they barely just move*). One TH child also omitted -*ly* (*would fit perfect [perfectly]*). Omission of -*ly* could be a dialectal difference as opposed to an error. Given that the HoH group also produced nine more different roots with the suffix -*ly* than the TH group (25 versus 16) then they may also have had more opportunities to produce it in error compared to the TH children. Therefore, this may not be a meaningful difference. Otherwise, one child who was HoH omitted an article before a derived noun (*which is [an] improvement*) and one TH child showed incorrect semantic use of the root with the prefix *over*- (*it was overfilling [overflowing]*).

In sum, group comparisons in derivational morpheme use suggest overall similarities perhaps reflecting similar levels of lexical knowledge. Subtle delays in morpheme use in this group of children who were HoH may be suggested by: greater use of the highly frequent suffix -*ly*, reduced diversity of single-use morphemes, less frequent use of the most frequent nonneutral suffix -*ion*, and lesser use of prefixes relative to the TH group. The few errors identified in relation to derivational morpheme use did not provide strong evidence of group differences.

Overall morpheme use errors. Compared to morpheme use tallies, the identification of total bound morpheme use errors provided stronger evidence of subtle delays in development of expressive morphology in the HoH group. All 14 TH children and 12 out of the 14 children who were HoH produced two or fewer errors in bound morpheme use, reflecting what might be considered 'typical' for children aged seven to 11 years per 10-minute conversational language sample. As a group, children who were HoH produced twice as many inflectional and derivational morpheme use errors as TH children. Errors produced by TH children appeared to be most often related to morpho-syntactic development (i.e., determining how to effectively and grammatically embed phrases or clauses within a sentence), perhaps showing evidence that the depth of morpheme representations in the lexicons of the TH children was at a more advanced stage (i.e., higher quality representations) than the HoH group.

Quantitative morpheme use measures. Nine quantitative measures of morpheme use were calculated from the language samples, including the numbers of total bound morphemes (inflectional and derivational), numbers of different bound morphemes (inflectional, derivational, and combined), the percent of total words that were inflected, the percent of total and different words that were derived, and the number of different derived words per derivational morpheme. These morpheme use measures were tallies of total usage and did not take into account differences in the individual morphemes used (e.g., whether *-ly* or *re-* were used differently across groups). No significant group differences were found for any of the quantitative morpheme use measures (see Table 2.5).

Performance on types of morphemes used was also similar for the two groups, which may mean that the two groups of children presented with similar morphological abilities. This is in contrast to studies by McGuckian and Henry (2007) and Elfenbein and colleagues (1994), which found that children who were HoH were delayed in inflectional morpheme use accuracy compared to TH peers matched by mean length of utterance in morphemes and chronological age, respectively. In McGuckian and Henry (2007), children who were HoH were on average seven years old while the TH comparison group were about four years younger. In Elfenbein et al. (1994), the sample's age range was much broader than in the present study (five to 18 years old). These age differences suggest that early-elementary and high-school aged children who are HoH (15 to 25 years ago) may have presented with more delays than the middle-elementary aged children (seven to 11 years old) in the present study. In addition, the bound morpheme use measure in the present study included a tally of derivational morphemes, which do not occur in obligatory contexts and occur less frequently than the inflectional morpheme accuracy measures used by McGuckian and Henry (2007) and Elfenbein and colleagues (1994).

Previous research with English-speaking elementary-school-age children with a mild to severe hearing difference has not explored derivational morpheme use in language samples, however, delays in performance on written measures were found for three late-elementary-age children with a severe to profound hearing difference (Trussell

& Easterbrooks, 2015) and 27 middle-school aged youth with a mild to profound hearing difference (Gaustad et al., 2002; Trussell & Easterbrooks, 2015). The children in the present study had milder hearing difficulties overall than the children in those two studies therefore may have had less difficulty acquiring and using derived words to the degree that they demonstrated similar derivational morpheme knowledge as same-age TH children.

RELATIONSHIPS BETWEEN MORPHEME USE AND CHILD VARIABLES

Correlational analyses were conducted between morpheme use measures and child variables in order to examine individual factors that might explain differences in morpheme use. Significant correlations between these measures of interest (lower left quadrant of Table 2.7) were only found for the TH group and not the HoH group. As a general finding, this suggests that the children in the HoH group are more heterogeneous than TH children in the factors that consistently explain use of expressive morphology in conversation. The implications of this finding will be discussed by child variables showing interesting patterns of relationships.

Morpheme use, morphological awareness (MA), and vocabulary. The only correlation found to approach a similar level of significance across groups was that between the number of different bound morphemes and MA (HoH: $r = .53$, $p = .053$; TH: $r = .79$, $p = .001$; $z = -1.13$, $p = .103$). This is not a surprising relationship; we should expect that MA would be related to bound morpheme use since morpheme knowledge is required to identify and manipulate morphemes in the MA task. As well, the meta-cognitive abilities engaged in MA may drive the acquisition of new morphemes, although evidence of this relationship could not be found in the literature. The number of different bound morphemes was also related to a number of other variables in the TH group, notably age and expressive vocabulary. Correlations between age and MA (but not age and vocabulary) were large and significant in both groups, as were correlations for MA and vocabulary. This suggests that children engaged their knowledge of vocabulary during the MA task thereby illustrating the known role of morphology in vocabulary acquisition (Anglin, 1993). They may also have engaged their metacognitive MA abilities during the vocabulary task, however, this is unlikely as the vocabulary task included only a handful of words containing bound morphemes. Or, an unmeasured variable (e.g., enjoyment in the task) may have led to the significant relationship with both. Overall, these findings suggest that the number of different bound morphemes may be the most informative morpheme use measure in the evaluation of morpheme use in TH children's language samples. It may also be an informative measure to reflect purely morphological development in children who were HoH given its apparent relationship with MA but not age, nonverbal reasoning, or expressive vocabulary for this group.

Morpheme use and age. Interesting patterns of relationships with age were found in the TH group that were not evident in the HoH group. In the TH group, a large significant and positive relationship was found for age with two morpheme use measures: percent words inflected ($r = .56$, $p = .038$) and the number of different bound morphemes ($r = .73$, $p < .001$). Both of these correlations were significantly stronger in the TH group than the HoH group by z-values greater than 2.00. The relationship between age and percent words inflected is unexpected in the TH group, as inflectional morphology is not expected to be further developing in the elementary grades for TH children (Berko, 1958; Brown, 1973). It is possible that the present study's novel addition of the less studied morphemes (past participle -*ed*/-*en*, comparative -*er*, superlative -*est*) in LSA demonstrated this effect differently than in prior research looking primarily at development of the other five inflectional morphemes. Since four out of the eight inflectional morphemes are attached to verbs, this finding may also reflect an increase in the number of complex sentences containing multiple verb clauses, which does increase slightly across ages seven to 12 years (Frizelle et al., 2018). For the HoH group, this correlation was negative, meaning that older children who were HoH in general produced slightly fewer inflected words compared to younger children. There is no apparent reason for this as a brief review of the HoH group does not reveal any age-related trends in child characteristics.

A relationship between age and the number of different bound morphemes would be anticipated given that derivational morpheme knowledge in particular increases through the elementary ages (Anglin, 1993; Mahony et al., 2000; Nippold & Sun, 2008; Windsor, 1994). This suggests that the expressive morphology of the TH children was developing with age, but this was not the case for the children who were HoH. Previous research has shown that word learning abilities of preschool-age children who were d/Deaf or HoH (participants used a variety of spoken and signed communication methods) were more strongly correlated with vocabulary size than age (Lederberg & Spencer, 2008). The exceptional performance of the children who had “strong age-lexicon-word learning associations” was suggested to reflect “age-appropriate language learning experiences” in those children (p. 55). In other words, significant correlations between age, lexicon size, and the ability to learn new words should be an indicator of typical language exposure. In fact, the age of HoH identification in the present study sample varied (ranging from soon after birth to seven years of age), with half the group being identified as HoH after two years of age, which is quite late. Therefore, chronological age did not represent years of cumulative linguistic experience (i.e., represented atypical language exposure) in this sample. In general, age is less useful as a predictor of lexical development in children who are HoH than it is for TH children due to this variability in language learning experiences.

Morpheme use and speech in noise thresholds. A medium-large positive correlation between speech in noise thresholds and the percent of different words derived approached significance in the HoH group ($r = .49$, $p = .079$). A positive relationship means that poorer speech in noise thresholds (i.e., higher signal-to-noise ratios) was associated with greater diversity in the production of derived words. This is an unexpected finding since poorer speech discrimination in noise would presumably lead to less consistent exposure to morpheme use (as per the model of inconsistent access, Tomblin et al., 2015), and consequently, *reduced* diversity of derived words. In contrast, speech in noise thresholds showed a large, significant negative correlation with MA and expressive vocabulary, which were also significantly related with each other. It seems that speech in noise thresholds revealed delays in quality of lexical knowledge but not morpheme use. Given the unusual direction of its correlation with the percent of different derived words, it may be a spurious finding due to the limited range of percentages for this morpheme use measure (results ranged from only 2% to 6% of different words derived in the HoH group). This result is therefore inconclusive and difficult to interpret with the present data set. Further investigation of the relationship between speech discrimination in noise and morpheme use in children who are HoH is warranted.

To determine whether a different measure of hearing might yield different results, post hoc correlational analyses were completed usingdata from a speech discrimination in quiet task (Haskins, 1949). However, the pattern of correlations obtained was similar to that for speech discrimination in noise, showing no significant correlations with morpheme use measures (see Appendix A for the HoH correlation matrix).

Morpheme use and nonverbal reasoning. Large significant correlations found for the TH group between three morpheme use measures and nonverbal reasoning merit discussion. All three of these correlations were significantly (or near-significantly) larger than for the HoH group. Considering concerns about several low scores in non-verbal reasoning achieved by otherwise cognitively typical children, there is the possibility that for some TH children especially, the test reflected lower motivation to participate in testing as opposed to lower nonverbal intelligence. If this were the case, then these children may also have produced simpler language during the conversational task. This may mean that the nonverbal scores were more valid for the HoH group than the TH group. Alternatively, if the nonverbal reasoning scores are taken as valid measures of nonverbal intelligence, findings would suggest that the quantity of derived words and number of different morphemes produced are related to nonverbal intelligence but only in TH children and not children who are HoH. This would seem counter-intuitive, as good nonverbal intelligence is found to be a protective factor in the overall language development of children who are HoH (Halliday et al., 2017) therefore a relationship would be expected for this group in particular. The relationship of nonverbal reasoning remains inconclusive with the present study's data and merits further investigation (using a different measure of nonverbal reasoning) on its relationship with morpheme use.

Morpheme use and parent education. Finally, the two near-significant negative relationships of morpheme use measures with parent education are of interest. Neither of these correlations were significantly stronger for the TH group than the HoH group. Given that the relationships only approached significance and that the range of parent education was quite high, especially in the TH group, it is unlikely that these relationships are meaningful on a practical level. It simply means that TH children with parents who had college diplomas or bachelor degrees may have been more likely to produce greater numbers of inflected words and bound morphemes than children whose parents had masters or doctoral degrees, which is not a particularly informative finding for research, clinical or educational purposes.

In summary, the child variables that demonstrated a consistent relationship with morpheme use in children who were HoH were speech discrimination and MA, and even those relationships were weak. Although age was strongly related to morpheme use in TH children, it was not related to measures of morpheme use for children who were HoH. Research is needed that investigates relationships of expressive morphology with speech discrimination and MA in more depth, and that includes additional variables such as hearing age (number of years since the child first received effective hearing intervention to chronological age at testing) and quality of language input to further clarify individual variability for children who are HoH.

CLINICAL IMPLICATIONS

The main clinical implication of this study's findings is that language sampling can effectively be used to gather rich data about the morpheme use of children with any hearing status. The qualitative information gleaned from a child's language sample may guide clinicians in planning expressive morphology intervention. A detailed analysis of morphemes used in a language sample, such as the analysis demonstrated in the present study, generated lists of morphemes. Morphemes shown to be used in a child's language sample could be probed in further assessment to ensure that these morphemes can be generalized to other roots. Morphemes not produced in the language sample could subsequently be probed for comprehension.

In the present study, children who were HoH used similar morphemes as TH peers, however, fewer children who were HoH than TH produced the most frequent nonneutral morpheme *-ion* (*comprehension, education*). This suggests that neutral and frequent morphemes (e.g., *-er*) may be more easily acquired with the language input that children who are HoH can perceive. However, they may experience delays in acquiring nonneutral (e.g., *-ion*) and/or less frequent (e.g., *-ful*) morphemes, suggesting that greater emphasis could be put towards assessing and intervening on nonneutral and less frequent morphemes. This can be accomplished by developing lessons targeting morpheme families containing these categories of morphemes to provide greater exposure and focused attention.

The quantitative information gathered about morpheme use may be most helpful for identifying general areas of weakness and monitoring progress in expressive morphology. The morpheme use measure that appeared to be most informative for this purpose was the number of different inflectional and derivational morphemes. Not only was it found to relate strongly to age in TH children but it was associated with other measures within the semantic domain, notably MA and expressive vocabulary. It may therefore be a good measure of morphological breadth (i.e., the number of bound morphemes a child has in their mental lexicon) in TH children. As well, a benchmark of two or fewer errors in bound morpheme use can be considered typical for elementary-aged children across a 10-minute conversation with an adult. If a child produces more than two errors in bound morpheme use in 10 minutes of conversation, broader challenges with morphological development may be flagged and further probing of morphological knowledge pursued. Language sampling provides valuable information about what the child knows or produces in error but should be supplemented with additional tests and dynamic assessment to further clarify areas of weakness.

In addition, recommendations to improve the consistency of auditory access to spoken language are indicated. Present findings at the individual level suggest children are at a higher risk of producing unusual morpheme errors when they have poorer hearing thresholds (i.e., severe hearing difference or greater) and/or poor speech in noise thresholds (i.e., greater than +5.0 dB), which may be linked to late identification of hearing status. A clinical implication is therefore to reinforce research and advocacy efforts for early hearing screenings and identification thereby enabling appropriate hearing device intervention, if spoken language development is the family's goal (Canadian Infant Hearing Task Force, 2019; Durieux-Smith et al., 2008; Patel & Feldman, 2011). Also, accommodations that improve the consistency of auditory access through improved signal-to-noise ratios, such as consistent use of DM systems in the classroom, should be encouraged. Finally, use of advanced hearing device technologies such as frequency transposition (i.e., digitally transposing higher acoustic frequencies in auditory input to lower frequencies audible within the individual's hearing levels) should offer increased opportunities to perceive higher frequency morphemes such as third person -*s*.

LIMITATIONS

Several limitations of the study should be acknowledged. The sample size for the present study was relatively small with variability in ages seven to 11 years old. Thus, findings should be considered preliminary. Further research is required to offer more specificity about morphological development within and across the ages studied. With a clinical population with different characteristics than normative samples, it is preferable to calculate reliability of measures used on the sample participants. However, at the time of writing, it was not possible to access individual item response data, meaning that measures such as the problematic measure used for nonverbal reasoning could not be verified for reliability within the study sample. Further research should ensure that measures used with children who are HoH are tested for reliability within the sample population studied.

Alongside the small sample size, there was variability within the HoH group in hearing characteristics such as hearing levels, age of diagnosis, etiology, and device use. Grouping children with varied hearing abilities presents a risk of Type 2 error, such that a group effect is not found when in fact, there should be an effect. However, the greater heterogeneity of the group had several advantages that were desirable for the present study. A heterogeneous group is more appropriate when conducting exploratory analyses as results may indicate subtle effects that can be followed by research targeting a more homogeneous subgroup in future research. A heterogeneous group offers results that are more generalizable to the greater population of children who are HoH than if this were a more homogeneous group. Also, both groups were being raised in families with moderately high socioeconomic status in parent education and income, meaning that results are most generalizable to children with average to high socioeconomic status. Although the HoH group's parent education was significantly lower than for the TH group, this is not considered to be an issue in group comparisons considering that the average number of years for the HoH group was still two years more than a high school education. We may find that parent education is an influencing factor on morphological development if the sample were to include parents who did not graduate high school.

Ten-minute conversational language samples were used in the present study. Longer samples would offer greater opportunities for morpheme use. Nonetheless, the 10-minute language samples produced by the 28 children in the present study included between 150 to 300 different words and provided a useful range of morphemes used. Most importantly, language samples tell us words and morphemes the child knows and chooses to use but cannot tell us what the child does not know.

CONCLUSIONS

The analysis of inflectional and derivational bound morphemes produced in a child's spontaneous language offers a rich source of information about the child's morphological development and areas of weakness. The present study suggests that by middle elementary ages, children who were HoH (with middle to high socioeconomic status) produced similar types and quantities of inflectional and derivational morphemes as same-age TH peers. They appeared to be acquiring use of neutral and highly frequent morphemes on par with TH peers, however, may be at risk of delayed development of -*ion*, a frequent yet nonneutral morpheme. For children who are HoH, age is not an appropriate developmental measure expected to relate to morphological development the way it is for TH children, which has major implications for the use of standardized scores in clinical practice and in the selection of age as a control variable in future research. As well, speech in noise thresholds in the HoH group appeared to be related to morpheme use errors and measures of lexical knowledge but not to the quantity of morphemes produced. Further research on the investigation of expressive morphology development using language sampling is warranted to support and expand on present findings. A deeper understanding of children's development of expressive morphology and related variables will allow us to better support children's development of academic vocabulary through elementary school ages and beyond.

CHAPTER 3. STUDY 2

RELATIONSHIPS BETWEEN METALINGUISTIC AND READING ABILITIES IN CHILDREN WHO ARE HARD-OF-HEARING AND TYPICALLY HEARING

ABSTRACT

Background: Elementary-age children who are hard-of-hearing (HoH) are at risk of delayed reading abilities relative to typically hearing (TH) children (Antia et al., 2020; Lederberg, Schick & Spencer, 2013). Morphological awareness (MA) may support early readers with typical hearing who have reading difficulties. There is limited research regarding the MA abilities of early readers who are HoH, and whether or not these abilities relate differently to reading than other suggested predictors such as phonological awareness (PA) relative to typically hearing children.

Purpose: The proposed study will: 1) compare language and reading abilities in children who are HoH and TH with similar word reading abilities, and 2) compare the relationships of PA and MA with reading outcomes across groups.

Methods: Participants were 15 children with a mild to severe hearing difference 7 to 11 years old and a comparison group of 21 TH children matched for word reading raw scores. Testing at a single time point included measures of hearing, cognition, language, and reading. Group scores were compared using *t*-tests. Hierarchical linear regressions explored the contributions of PA and MA controlling for vocabulary on non-word reading and reading comprehension scores. Group interaction terms were calculated to investigate group effects.

Results: Group comparisons revealed no significant differences in raw scores for tests of language or reading but significantly higher standard scores for PA, non-word reading,

and reading comprehension. Combined-group regressions found that the significant roles of PA in non-word reading and MA in reading comprehension were not different for children who were HoH compared to younger TH children with similar word reading abilities.

Conclusions: The present study found similar language and reading abilities across groups matched for word reading ability. Results suggest that the HoH group was using PA and MA to read in a qualitatively similar fashion compared to TH children one year younger, possibly reflecting a slight delay in reading processes for some of the children who were HoH.

INTRODUCTION

Elementary-age children with a hearing difference are at greater risk of delays in language and literacy development than their typically hearing (TH) peers (Antia et al., 2020; Borders et al., 2011; Briscoe et al., 2003; Delage & Tuller, 2007; Halliday et al., 2017; Herman et al., 2017; Lederberg et al., 2013). Hearing difference is categorized into hearing levels based on the severity of the difference compared to 'normal' hearing levels (i.e., mild to profound; Clark, 1981). Children who are hard-of-hearing (HoH) have average hearing thresholds from mild to severe (i.e., 21 to 90 decibels [dB]; Clark, 1981; National Workshop on Mild and Unilateral Hearing Loss: Workshop Proceedings, 2005) and primarily communicate using spoken, not signed, language. Factors that explain individual variability and relate to and support successful literacy development are still being identified for children who are HoH. Two known factors associated with reading ability in TH children are phonological awareness (PA) and morphological awareness

(MA; Berninger et al., 2010; Deacon, 2012; Deacon & Kirby, 2004). It is unclear if the associations of PA and MA with reading ability are the same for learners who are HoH as they are for the TH population and thereby should receive the same degree of emphasis in reading instruction (e.g., see Wang et al., 2008, and the ensuing response by Allen et al., 2009). The purpose of the present study, therefore, was to investigate PA and MA and their relationships to nonword reading and reading comprehension in children who were HoH and compare these relationships with those of TH children matched on real word reading ability.

READING, PA, AND MA IN TH CHILDREN

The Simple View of Reading (Hoover & Gough, 1990; Tunmer & Chapman, 2012) posits that successful reading comprehension requires the development of two skills: language comprehension and decoding. In other words, to fully understand what underlies a child's reading abilities, the child's language and word reading abilities should be evaluated. To read a word, the Dual Route Hypothesis (Coltheart & Rastle, 1994) proposes that the reader employs one of two routes: lexical or nonlexical. In the lexical route, the whole word is identified visually and directly associated with its meaning in the mental lexicon. In the nonlexical route, the letters and letter combinations in the word are 'sounded out', or 'decoded', and the sequence of phonemes is recognized as a known word (Gough & Tunmer, 1986). Grainger and Ziegler (2011) theorized that beginning readers learn new words using the nonlexical route and rely increasingly on the lexical route as they develop reading fluency and automaticity.

A number of language factors have been found to predict the successful development of reading comprehension in TH children, including measures of overall language ability, vocabulary knowledge, and metalinguistic awareness (National Reading Panel, 2000). Of particular interest to the present study are the roles of two metalinguistic abilities: PA and MA. PA refers to the ability to recognize and deliberately manipulate phonological units such as phonemes, rimes, or syllables (Castles & Coltheart, 2004). MA is the awareness of and ability to recognize and manipulate morphemes (Carlisle, 1995). Due to the overlay of phonological, lexical, and syntactic information in morphemes, MA reflects awareness of semantic and syntactic relationships between morphemes within a sentence. PA and MA relate differently to reading decoding and comprehension at different stages of development in TH children.

PA and reading. In the early elementary grades, PA has a well-established association with word reading, non-word reading, and to a lesser extent, reading comprehension. PA abilities, particularly the ability to segment words into phonemes (Torgesen et al., 1994) in kindergarten and Grade 1, are associated with current and later real and non-word reading abilities (Ehri et al., 2002; Hogan et al., 2005; Melby-Lervåg et al., 2012; National Institute for Literacy, 2008). This known association has led to widespread recommendations to teach PA skills in early reading instruction (National Reading Panel, 2000). For children in Grade 2 (seven to eight years old), Leather and Henry (1994) found that a composite PA score accounted for 50% of variance in word reading beyond short-term memory abilities. Hogan et al. (2005) measured 570 children's PA abilities in kindergarten and PA and word reading abilities in Grade 2 (seven to eight years old) and Grade 4 (nine to ten years old). They found that, although PA measured in kindergarten significantly predicted real word and non-word reading abilities in Grade 2, PA in Grade 2 no longer significantly predicted word reading by Grade 4 after taking out the influence of Grade 2 word reading abilities. It is important to note that the relationships between PA and word reading abilities is bidirectional—not only does PA support the development of word reading, but learning to read supports the development of PA (Castles & Coltheart, 2004; Torgesen et al., 1994).

Reading comprehension also is shown to have a significant relationship with PA abilities (particularly phonemic awareness) in elementary school children (Ehri et al., 2002; Engen & Høien, 2002; Kirby et al., 2012; Leather & Henry, 1994), although this relationship is found to be mediated by factors such as vocabulary knowledge and reading fluency (Engen & Høien, 2002; National Reading Panel, 2000). That is, as decoding improves and becomes more automatic (hence, more fluent), the relationship between PA and reading comprehension decreases. By Grade 2, the relative contribution of PA is stronger for word reading than for reading comprehension. For example, in Leather and Henry's (1994) second-grade participants, PA explained only 10% of variance in reading comprehension (beyond vocabulary and short-term memory abilities) compared to explaining 50% of variance in real word reading.

MA and reading. After controlling for PA abilities, studies with elementary-age TH children have found that MA is directly associated with word reading (Kirby et al., 2012; Wolter et al., 2009), non-word reading (Apel et al., 2013; Deacon & Kirby, 2004; Kirby et al., 2012), and reading comprehension (Deacon & Kirby, 2004; Kirby et al., 2012; Levesque et al., 2017) after Grade 2. For example, Kirby and colleagues (2012) investigated the relationships of MA and PA with reading variables in 103 children in Grades 1 to 3 (six to nine years old). In Grade 1, MA was not a significant predictor of word reading or reading comprehension after controlling for the contributions of nonverbal cognition, vocabulary, and PA, but MA did account for additional variance in both reading variables by Grade 3. Singson, Mahony and Mann (2000) found that the contribution of MA to real word and non-word reading increased from Grades 3 to 6 after controlling for age and vocabulary, while PA ceased to be a significant predictor after Grade 3. Deacon and Kirby (2004) investigated similar relationships in children in Grades 2 to 5 and found that MA did not predict reading comprehension in Grade 3 but significantly predicted reading comprehension in Grades 4 and 5 beyond the contribution of earlier word reading, PA and nonverbal intelligence. MA was also found to play a unique role in reading multi-morphemic non-words containing real morphemes (e.g., *mancingful*).

In sum, both PA and MA have been found to contribute unique variance to word reading, non-word reading, and reading comprehension. PA's contribution is greater in the early elementary grades while MA's contribution increases in relative importance through the later elementary grades as children focus increasingly on comprehending what they read.

READING, PA AND MA IN CHILDREN WHO ARE HOH

Children who are HoH are at risk of delayed language and reading development due to differences in acoustic input and language learning experiences compared to TH children (Antia et al., 2020; Borders et al., 2011; Briscoe et al., 2003; Delage & Tuller, 2007; Herman et al., 2017; Lederberg et al., 2013). Even when optimal hearing devices are used, a child who is HoH may still experience lower quality and reduced consistency of spoken language input than TH peers leading to poorer language outcomes (Houston et al., 2012; Koehlinger et al., 2015; McGuckian & Henry, 2007; Tomblin et al., 2015). To illustrate this point, a child who is HoH may only hear the word *cats* clearly in a quiet room with the speaker a few feet away. While increased distance from speaker and environmental noise also reduce the ability of TH children to perceive words clearly, it is likely the impact of these factors is compounded for children who are HoH. Given this, children who are HoH may have greater difficulty building complete phonological and morphological representations relative to TH peers (Herman et al., 2017; Koehlinger et al., 2015). Accordingly, the metalinguistic awareness of these sublexical units (i.e., PA and MA) are also often found to be delayed in children who are HoH (PA: Briscoe et al., 2003; Camarata et al., 2018; MA: Walker et al., 2020).

Reading abilities. In children with a moderate to profound hearing difference, non-word reading abilities are often found to be significantly poorer than TH same-age peers (Herman et al., 2017; N. W. Nelson & Crumpton, 2015). In contrast, studies of children with a mild to moderate hearing difference have found that non-word reading abilities were not significantly different from same-age TH peers (Briscoe et al., 2003; Halliday et al., 2017). For example, Briscoe and colleagues (2003) found that children five to 10 years old with a mild to moderate hearing difference scored close to the normative mean on a standardized test of non-word reading, although performing significantly lower than a TH comparison group. Thus, non-word reading performance appears to decline with poorer hearing levels in studies with children who are HoH. In addition, most studies also document considerable individual variability in the performance of children who are HoH (Briscoe et al., 2003; Camarata et al., 2018; Halliday et al., 2017).

While reading comprehension abilities vary within and across studies, children who are HoH generally have slightly lower but often age-appropriate abilities in elementary and middle school (Briscoe et al., 2003; Camarata et al., 2018; Delage & Tuller, 2007; Herman et al., 2017; Walker, Holte, et al., 2015). For example, Walker et al. (2020) assessed the reading comprehension abilities of 57 children with a mild hearing difference who were 9 to 11 years old (Grade 4) and wore hearing aids. Reading comprehension was assessed using a test of passage reading fluency followed by orally administered comprehension questions. The scores of children who were HoH were not significantly different from a group of age-matched TH children. Similar results were found for other studies of children with a mild to moderate hearing difference who used primarily spoken English aged 5 to 10 years (Briscoe et al., 2003) and 6 to 12 years (Camarata et al., 2018). However, a British study of children with a severe to profound hearing difference who used hearing aids and cochlear implants and primarily spoken English reported significantly lower reading comprehension abilities relative to TH norms, despite age-appropriate word reading abilities (Herman et al., 2017).

Overall, the average real word reading and reading comprehension abilities of children who are HoH are generally within normal limits, although lower than TH same-age peers, while average non-word reading performance tends to be significantly lower. Children with better hearing abilities tend to achieve stronger group results in all measures of reading than children with poorer hearing levels.

The Qualitative Similarity Hypothesis states that the same relationships that exist between language and reading in TH children will hold true for children with a hearing difference (Paul & Lee, 2010). The hypothesis has received some support (Andrews &

Wang, 2015) but the unique challenges created by growing up HoH may also lead to unique differences that affect these relationships. This is illustrated in the following discussion of the relationships between PA and MA and reading abilities in children who are HoH relative to TH children.

PA and reading. The importance of investing time in PA intervention in order to develop reading abilities in children with a hearing difference has been questioned, particularly for individuals with a more severe hearing difference. As Diane Clark stated, "[s]tudies… may find that phonological awareness is necessary for these successful readers [with a hearing difference], or that it may point to phonological awareness as an epiphenomenon that is a result of highly developed reading skills" (response letter published in Allen et al., 2009, p. 343). Children who are HoH are reported to have significantly lower PA abilities relative to TH same-age peers from the time they enter school (Gibbs, 2004; Most et al., 2006), through elementary school (Briscoe et al., 2003; Camarata et al., 2018; Halliday et al., 2017; N. W. Nelson & Crumpton, 2015), and into high school (Halliday et al., 2017; N. W. Nelson & Crumpton, 2015). Despite low PA scores at a group level, these studies also report that some children in their HoH samples achieved average or even higher than average scores relative to TH same-age peers.

Cupples et al. (2014) studied language and early reading abilities of five-year-old children with mild to profound hearing levels who wore hearing aids or cochlear implants and used only spoken English. They found that children with stronger PA abilities also had stronger word reading skills than peers who were HoH with poor PA abilities, even after controlling for vocabulary, nonverbal reasoning and other demographic variables. In the elementary grades, findings are mixed and appear in part related to the children's degree of hearing difficulties. Children with the poorest hearing levels (i.e., moderate to profound) show the strongest relationships between PA and reading abilities (non-word reading, real word reading, reading comprehension) (Harris et al., 2017; Herman et al., 2017; Kyle & Harris, 2010; Luetke-Stahlman & Nielsen, 2003). This is in contrast to TH children who tend to show a *reduced* relationship between PA and reading abilities after the first couple years of elementary school as their reading abilities improve.

N. W. Nelson and Crumpton (2015) investigated the relationships between PA and reading in 43 6- to 18-year-old children and youth with a moderate to profound hearing difference (who wore hearing aids or cochlear implants and used only spoken English) and compared their performance to that of a same-age control group of 43 TH children. Measures included tasks of vocabulary awareness, PA elision (i.e., saying a word with one phoneme deleted, in this case using non-words), nonword reading, and reading comprehension. Regressions revealed that vocabulary awareness entered alone in Step 1 explained 22% of the variance in non-word reading scores for both groups, however, when PA was added in Step 2, group results differed. In the HoH group, PA became the only significant predictor, appearing to mediate the relationship between vocabulary awareness and non-word reading. For the TH group, PA explained significant additional variance in non-word reading over and above the stronger contribution of vocabulary awareness. For both groups, variance in reading comprehension was solely predicted by vocabulary awareness, which explained more variance for the HoH group (65%) than the TH group (41%). The children who were HoH had significantly poorer reading abilities than the TH group, therefore it is possible that the differences in relationships were due to underlying differences in reading ability and not hearing difference.

Findings are mixed for studies of children who were HoH with only a mild to moderate hearing difference (Briscoe et al., 2003; Camarata et al., 2018; Gibbs, 2004). Gibbs (2004) found no significant relationships between PA and real word reading, non-word reading, or reading comprehension abilities in 7- to 9-year-old children with mild to moderate hearing levels. Though they did not use correlational analyses, Briscoe and colleagues (2003) divided their sample aged five to 10 years into two groups based on PA ability (i.e., matching words on the basis of rime or initial phoneme by selecting pictures) and found no difference in reading abilities between children with poor versus good PA abilities. If PA is an essential skill in reading development, as argued by Wang and colleagues (2008), this is an unusual finding. In contrast, Camarata and colleagues (2018) studied PA, word reading, and reading comprehension abilities in a sample of 56 children also with a mild to moderate hearing difference aged six to 12 years old. They found that PA and nonverbal abilities together significantly explained 55% of variance in a combined measure of real and non-word reading abilities, beyond chronological age and nonverbal intelligence. In addition, Camarata and colleagues found that poor word readers had significantly poorer PA abilities than good word readers, further suggesting that PA and word reading abilities are related. There was no TH control group in the study, however, standard scores in reading suggested that the HoH group achieved a wide range of standard reading scores from very poor to exceptional for their ages. The ages ranged from kindergarten to approximately Grade 5, which again raises the question of an anticipated reduced association between PA and word reading abilities found in TH children across this age range. As there was no TH comparison group, it is difficult to ascertain if findings were directly related to differences in hearing or reading abilities.

Differences between PA measures may explain the discrepancies in results across the above three studies. The PA measures used in the Briscoe et al. (2018) and Gibbs (2004) studies both involved tasks whereby children matched pictures by rhyme and word-initial and/or word-final phonemes. Camarata and colleagues (2018) instead used a standardized measure of PA involving segmentation and blending of phonemes. Although rhyme awareness is an element of PA, it is earlier developing and does not reliably relate to reading abilities in TH children whereas the ability to segment and blend phonemes does (Hulme et al., 2002; Torgesen et al., 1994). Therefore, the PA tasks used by Gibbs (2004) and Briscoe et al. (2003) may have been too easy for their participants, which is confirmed by results showing ceiling scores for TH participants and very high scores with narrow ranges for children who were HoH in both studies. The later developing phoneme segmentation and blending task used by Camarata and colleagues resulted in a broad range of PA scores that did not reach ceiling levels and likely addressed relationships between PA and word reading in children who are HoH that were more comparable to studies in the TH literature.

In summary, findings suggest that PA abilities continue to explain unique variance in word reading abilities with children who are HoH through the elementary grades at a time when its role is rapidly diminishing in the reading development of TH children. However, existing evidence did not clarify if any differences in relationships between PA and reading abilities could be attributed to differences in hearing ability and not simply pre-existing differences in reading ability. Further research with children who are HoH is needed to clarify these findings.

MA and reading in children who are HoH. The development of MA abilities in children who are HoH has received limited attention. There is some evidence of delayed morpheme comprehension and use compared to TH same-age peers in school-age children who are HoH, especially inflectional morpheme use (McGuckian & Henry, 2007; Norbury et al., 2001). If morphological abilities are delayed, MA could be as well. Gaustad and colleagues (2002) tested the MA abilities of 27 youth aged 12 to 15 years with a mild to severe hearing difference. While not reported, it can be assumed that the participants knew at least some signed language since the stimuli were controlled with regards to sign equivalents. Compared to TH same-age peers, the d/Deaf or HoH group scored significantly more poorly on two researcher-created written MA tasks. MA was also tested by Walker and colleagues (2020) with 58 fourth grade children (aged nine to 11 years old) with a mild hearing difference. Carlisle's (2000) orally administered sentence completion task was used. The HoH group scored almost one standard deviation lower than TH same-age peers. No studies that assessed MA abilities of elementary-age children with hearing levels in the moderate to severe range were found.

Based on the TH literature, MA has been proposed as an important skill that may support the decoding of multi-morphemic words for children who have little to no hearing ability to a greater degree than for TH children (Gaustad, 2000; Leybaert & Alegria, 1995). Only three studies to date have investigated the relationship between MA and reading abilities in children with a hearing difference (Nielsen et al., 2016; Wang et al., 2016; Walker et al., 2020). Nielsen and colleagues (2016) studied 17 children aged seven to 13 years old with a moderate-severe to profound hearing difference who were taught Signed Exact English in the school setting. SEE is a sign system that aims to represent each English morpheme with a sign, therefore the authors proposed that it should support the development of English morphology and, indirectly, reading ability. MA was measured using a task where the child selected one of four inflected or derived words to complete a sentence (e.g., *That silly behavior is ____ [remature, premature, postmature, immature]*). Correlational analyses confirmed a large significant relationship between the written MA measure and a standardized measure of reading comprehension. This is similar to associations expected for TH children in this age range (approximately Grades 2 to 8).

Wang and colleagues (2016) compared the relative strength of relationships between PA *and* MA on reading comprehension in 45 children who were d/Deaf or HoH. Participants were eight to 14 years old attending a school for students who are d/Deaf or HoH and used varying degrees of spoken and signed language. For the PA task, the child wrote 'yes' or 'no' next to a written word (e.g., *case*, *city*) in response to an examiner's question such as "*Do the following words have the /k/ sound?*". A written MA measure combined a judgment task, a sentence completion derivation task, and a sentence completion decomposition task. Standardized tests of word reading fluency (timed word segmentation) and reading comprehension (sentence completion) tests were also administered, however, reading comprehension was the only outcome variable included in analyses. Regressions found that only MA significantly predicted reading comprehension when entered simultaneously with word reading fluency and PA abilities. There was no TH control group for comparison. The study confirmed a greater role of

MA over PA in reading comprehension that parallels that expected for TH children of this age range (approximately Grades 3 to 9).

Walker et al. (2020) was the sole study identified that measured MA and reading abilities in children who were HoH with no exposure to signed language. Sixty Grade 4 students with a mild hearing difference were tested along with 69 same-age TH peers. MA was measured using an oral sentence completion task (Carlisle, 2000). The HoH and TH groups were found to have similar reading abilities, yet regression results found differing relationships between the three independent variables of language ability (MA, vocabulary, and listening comprehension) and a reading outcome variable (a combined measure of reading fluency and comprehension). For the HoH group, MA made the greatest significant contribution to explaining variance in reading and only expressive vocabulary explained additional significant variance. Listening comprehension explained no unique variance over the other two variables. For the TH group, MA did not explain any additional variance over the significant contributions of vocabulary and listening comprehension. Considered together, these three studies can be extended to suggest that elementary-aged children who are HoH may show similar or possibly stronger associations between MA and reading comprehension abilities than would be expected based on research reviewed above with same-age TH children. Contributions of MA to real and non-word reading abilities have not been investigated in children with a hearing difference regardless of language modality. Although little clarity is offered on the roles of PA and MA relative to each other in explaining variance in non-word reading for elementary-age children who are HoH, literature reviewed above with TH children provides support for the need to explore these relationships further in this population of children at risk of delays in language and reading.

In summary, a review of the literature revealed that investigations into the roles of PA and MA in reading abilities with children who are HoH were limited. It appears that PA continues to be employed during word reading through to late elementary ages in children who are HoH, notably later than TH peers. As well, research with children exposed to signed language and children with only a mild hearing difference suggests that MA could play a role in reading comprehension abilities with children who are HoH that either matches or exceeds the role found for TH children. As well, most studies including children who were d/Deaf or HoH used adapted text-based tasks of PA or MA therefore research with oral PA and MA tasks is warranted in order to dissociate the role of meta-linguistic abilities with reading abilities.

The purpose of the present study was to investigate vocabulary, PA, MA, and reading abilities in children who were HoH aged 7 to 11 years old and their TH peers matched by word reading ability then to examine the concurrent associations between metalinguistic awareness measures (PA, MA) and reading measures (non-word reading, reading comprehension) across groups. Vocabulary was entered as a control variable in regressions to account for its known contributions to reading ability before examining the contributions of PA and MA. While a measure of receptive vocabulary is often used in reading research with TH children (e.g., Kirby et al., 2012), a measure of expressive vocabulary was chosen for the present study. In line with other research conducted with children who are HoH (e.g., Walker et al., 2020), this eliminates the chance that an incorrect response could stem from reduced auditory access to the stimuli and not impoverished lexical knowledge.

Matching on word reading and not chronological age was selected because children of the same ages may be expected to differ in reading abilities across the two groups. If chronological age was used as the matching strategy, results showing group differences would be ambiguous (Goswami & Bryant, 1989) as they could be attributed to underlying differences in reading development and not, as is intended for the present study, to differences in hearing ability. Matched for word reading ability, the HoH group was older and therefore should have the advantage of experience. Yet results showing a *delay* for the HoH group would be more interpretable as a difference related to hearing status. Matching on overall reading ability (i.e., tests of word reading and reading comprehension) is in line with other language-based research with children with a hearing difference who are already expected to experience delays in reading ability relative to TH same-age peers (Bouton et al., 2011; Breadmore et al., 2014; Harris et al., 2017; Kyle & Harris, 2006). In addition, real word reading was specifically chosen as the matching variable because a real word can be decoded by using either a lexical or non-lexical route (Coltheart & Rastle, 1994). The non-lexical route depends more heavily on PA abilities than the lexical route. Due to the known difficulties of children who are HoH in developing PA skills, the dual route has been applied to models of reading in children who are deaf/Deaf with the suggestion that they may achieve skilled word reading primarily through the lexical route (Beech & Harris, 1997). Therefore, matching on real word reading was selected as the matching strategy for the present study so as not to predetermine whether participants had "sounded out" a word (which would depend more greatly on PA skills) or read it as a whole unit.

The study sought to answer two research questions. First, *do expressive vocabulary, PA, MA, non-word reading, and reading comprehension abilities of children who are HoH differ from that of TH peers when matched for word reading ability?* Given that groups were matched on word reading ability, it was hypothesized that vocabulary, MA, and reading comprehension abilities would be similar across groups while PA and non-word reading abilities would be poorer in the HoH group than the TH group. Second, *to what extent are PA and MA associated with reading comprehension and non-word reading in each group after controlling for expressive vocabulary?* Current evidence was too limited to inform hypotheses for this question therefore no predictions were proposed.

METHODS

PARTICIPANTS

Fifteen children who were hard-of-hearing (HoH) and used only spoken English (3 girls and 12 boys) and 21 typically hearing (TH) children (6 girls and 15 boys) were included. The groups were matched by word reading ability using raw scores from the *Sight Word Efficiency* subtest of the *Test of Word Reading Efficiency*, 2nd edition (Torgesen et al., 2012); $t = 0.095$, $p = .925$, $d = 0.03$. Children identified as HoH (mild to severe average hearing thresholds) could be 7 to 12 years of age while TH children were subsequently recruited to be matched in reading abilities and were hence younger. Children in both groups could speak English only in the home; children who used signed language, a different home language (e.g., Chinese), or who were in French immersion starting earlier than Grade 3 were excluded. TH children were excluded if they had a known disability that was expected to impact cognitive, language and/or reading development. However, children who were HoH with a diagnosis of attention deficit and hyperactivity disorder (ADHD), reading disorder or language disorder were included as these diagnoses may directly reflect being HoH.

The children who were HoH (aged 7 to 11 years) were a little more than one year older than the TH children (aged 6 to 11 years) and the age difference was significant; t = 2.723, p = .010, d = 0.92 (Table 3.1). Of the 15 children who were HoH, 12 children wore two hearing aids, one wore a bone-anchored hearing device in one ear, one wore two bone anchored hearing devices, and one wore no hearing technology (by child's choice). Three had started French immersion in Grade 3 (and were in Grade 5 or 6 at the time of testing). One child was reported by a parent to have ADHD and "learning difficulties". Two children were adopted from China as babies where they had not received any assistive hearing devices prior to adoption and could not speak or understand Chinese prior to being adopted. These children acquired their assistive hearing devices at 2 ½ and 3 ½ years of age and therefore experienced delayed access to spoken English.

Two measures of socioeconomic status were reported by parents using a written questionnaire: average parent education and income. The level of parent education was reported from a list of educational levels (e.g., bachelor's degree). The selected level of education was converted to a value in years such that '*some high school*' equaled 10 years, '*high school or equivalent*' equaled 12 years, '*vocational/technical school*' equaled 13 years, '*some college*' equaled 14 years, '*bachelor's degree*' equaled 16 years, '*master's degree*' and '*professional degree (e.g., MD)*' equaled 18 years, and '*doctoral* *degree*' equaled 22 years. If the child had two parents, the number of years was averaged across the two parents. Family income was selected from five income brackets, which were converted by the first author to an ordinal scale of 1 to 5 ('*less than $30,000*' = 1, '*between $30,000 and $60,000*' = 2, '*between $60,000 and $80,000*' = 3, '*between $80,000 and $125,000*' = 4, '*more than $125,000*' = 5). If the parent selected '*Prefer not to say*', the data point was left empty.

Table 3.1 shows group means, standard deviations, and ranges for participant age, grade, average years of parent education, family income, word reading (raw score), nonverbal reasoning (standard score), expressive vocabulary (standard score), and average pure tone hearing thresholds. Levene's test for equality of variance across groups was significant for family income and hearing thresholds. Independent *t*-tests corrected for unequal variance showed that there were significant group differences between average years of parent education ($t = 2.616$, $p = .013$, $d = 0.89$, HoH < TH) and, as expected, hearing thresholds ($t = 10.358$, $p < .001$, $d = 3.73$, HoH > TH) but not grade ($t = 1.840$, $p = .075$, $d = 0.61$), family income (data missing for four children in the HoH group and four children in the TH group; $t = -0.953$, $p = .356$, $d = 0.39$), or nonverbal reasoning ($t = 0.841$, $p = .406$, $d = 0.28$). Although parent education in the HoH group was significantly lower than that in the TH group, both groups had high levels of education (on average 15 years or more). Thus, this was not a considered a meaningful difference. Groups did not significantly differ in scores on standardized tests of nonverbal reasoning and expressive vocabulary[2]. Additional HoH group statistics are provided for

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[2] The non-verbal reasoning scores were at times lower than expected. Several of the TH children, all reported to have normal cognition, scored more than one standard deviation below the mean of the normative sample. This may be because the non-verbal task was administered near the end of each child's testing session, resulting in scores impacted by cognitive fatigue and/or boredom. The expressive

age of HoH diagnosis, speech discrimination accuracy of words in quiet, and speech discrimination thresholds of sentences in noise. Further, Table 3.2 shows individual data for all 15 children in the HoH group on: age, grade, gender, age of HoH diagnosis, hearing thresholds (left ear, right ear), hearing device(s) worn, duration of device use, speech discrimination accuracy of words in quiet, and speech discrimination thresholds for sentences in noise.

vocabulary task used in the present study had been used in previous studies and was found to generate slightly inflated standard scores, therefore it will be used primarily for comparison between groups.

Table 3.1

Participant characteristics by group (hard-of-hearing [HoH], typically hearing [TH]).

	HoH			TH		
Participant characteristics	*n*	*Mean* (*SD*)	*Min - Max*	*n*	*Mean* (*SD*)	*Min - Max*
Age at testing (months) **	15	120.3 (15.5)	93 – 143	21	105.9 (15.9)	77 – 132
Grade	15	4.3 (1.4)	2 – 6	21	3.5 (1.3)	1 – 6
Average parent education (years) *	15	14.7 (1.5)	13 – 18	21	16.1 (1.7)	13.5 – 19.0
Family income level (scale of 1 to 5)	11	3.73 (1.42)	1 – 5	17	4.18 (0.81)	2 – 5
Word reading raw score [a]	15	64.3 (14.3)	26 – 84	21	64.7 (11.1)	44 – 85
Non-verbal reasoning (standard scores)	15	9.7 (3.1)	3 – 15	21	8.9 (2.6)	5 – 16
Expressive vocabulary (standard scores)	15	99.7 (11.7)	78 – 122	21	103.8 (6.4)	91 – 116
Pure tone average thresholds (dB) ***	15	47.7 (14.2)	23.8 – 75.6	21	8.5 (4.3)	1.5 – 19.0
Age of HoH diagnosis (months)	15	30.9 (28.8)	0 – 84	-	-	-
Speech discrimination of words in quiet (% word accuracy)	15	84.1 (14.9)	50.0 – 98.0	-	-	-
Speech discrimination of sentences in noise (dB SNR)	15	3.9 (3.2)	-1.5 – 11.0	-	-	-

Notes. SD = standard deviation. Min = minimum. Max = maximum. dB = decibels. SNR = signal-to-noise ratio. Family income and pure-tone average thresholds did not meet Levene's test for equality of variance therefore corrected results were used.
Significant difference: *$p < .05$, **$p < .01$, *** = $p < .001$
[a] matching variable

Table 3.2

Individual data for children who were hard-of-hearing (n = 15).

Child ID#	Age at testing	Grade	Gender	Age of HoH diagnosis	Hearing thresholds		Hearing devices worn	Duration of device use (months)	Words in quiet (% words correct)	Speech in noise thresholds (dB)
					Left ear	Right ear				
D01	10;3	4	M	6;10	73.8	30.0	2 HA	39	84	+5.5
D02	9;11	4	M	3;0	20.0	67.5	none	n/a	86	+3.0
D04	9;6	4	F	0;0	42.5	46.3	2 HA	98	98	+2.0
D05	9;10	4	M	4;2	46.3	43.8	2 HA	63	86	+4.5
D06	10;11	5	M	4;0	36.3	32.5	2 HA	59	96	+4.0
D07	7;11	2	M	5;0	30.0	22.5	2 HA	35	96	+4.0
D10	8;0	2	M	0;0	85.0	73.8	2 HA	92	52	+8.5
D11	11;11	6	F	2;9	70.0	63.8	1 BAHA	99	82	+5.3
D12	10;10	6	M	7;0	46.3	48.8	2 HA	38	74	+2.5
D13	10;4	5	F	0;0	60.0	62.5	2 HA	121	92	+2.0
D14	11;0	6	M	1;8	55.0	50.0	2 HA	96	86	+6.0
D15	7;9	2	M	2;4	48.8	50.0	2 HA	60	94	-1.5
D17	11;7	6	M	0;11	55.0	57.5	2 BAHA	107	90	+0.0
D18	10;10	5	M	0;6	42.5	42.5	2 HA	122	96	+1.0
D19	9;10	4	F	0;5	61.3	61.3	2 HA	109	50	+11.0

Notes. All ages are presented as years;months. Only Child D01 had an additional diagnosis identified as attention-deficit and hyperactivity disorder and parent-reported "learning difficulties". dB = decibels. HA = hearing aid. BAHA = bone-anchored hearing aid.

Recruitment

Children who were HoH were recruited through the Atlantic Provinces Special Education Authority (APSEA; an organization that oversees the education of over 900 children who were HoH across Nova Scotia and New Brunswick), social media posts and word of mouth. Children on APSEA's caseload receive either direct or consultative services from an itinerant teacher. Eligibility criteria for the study were shared with APSEA staff, who identified children who were HoH in the specified age range by conducting a search of their database. With APSEA's facilitation, packages were sent to parents by mail. Parents who wished to participate contacted the researcher directly by phone, email or by returning the forms from the recruitment package in the mail. Additional inclusion criteria were screened by the researcher after being contacted by interested families. TH children were recruited through previous research participants, social media posts, university news channels, the local children's hospital network, and word-of-mouth. Families who learned of the study contacted the researcher by phone or email to express interest. Incentives were that parents could choose to receive a summary of their child's testing results, the child selected a few items from a 'thank you' grab bag immediately after testing, and the child was entered in a draw for one of six $20 gift certificates to Amazon online.

Testing procedures

Parents completed a language and hearing history questionnaire and signed a consent form prior to testing. A single testing session was conducted individually in a quiet room in the parents' chosen location: a testing room at the university (n = 17), a testing room at APSEA (n = 1), the child's home (n = 17), or a study room at a local library (n = 1). When the child arrived, background noise was measured (not available for one TH child; n = 35, M = 37.2 dB, SD = 5.3 dB) to verify that testing was conducted in a relatively quiet room. Measures of hearing, cognition, language and reading were then collected. First, pure tone average hearing thresholds were tested. For children who were HoH, speech discrimination tests (accuracy of words in quiet, discrimination thresholds for sentences in noise) were administered next. Then blocks of language and reading measures were administered with blocks counterbalanced. The language block included phonological awareness (PA), morphological awareness (MA), and a 10-minute conversational sample counterbalanced within the block to avoid order effects. The reading block included real word reading, non-word reading then reading comprehension in that order. Finally, non-verbal reasoning and then expressive vocabulary tests were administered. Findings related to conversational samples will not be reported in the present study therefore will not be discussed further.

Measures

Language and hearing history questionnaire. A questionnaire adapted from one regularly used by affiliated child language researchers (e.g., in Kay-Raining Bird, Joshi & Cleave, 2016) was developed to gather information about important child characteristics such as the child's hearing and health history and language exposure.

Hearing thresholds. Participants had their hearing thresholds measured during the session by the researcher using a portable audiometer calibrated annually by an audiometry specialist. One child's audiogram was provided by a parent because it was conducted by the child's audiologist the previous day and this reduced the child's testing time by 10 minutes, which the parent preferred. Children in the TH group also had their hearing thresholds tested using the same procedures in order to verify that they were not in fact HoH. The child's pure tone thresholds (unaided for children who wore hearing assistive devices) were tested using a portable audiometer at 500, 1000, 2000, and 4000 hertz. A weighted pure tone average of 5:1 for the better ear was calculated to account for unequal hearing abilities in both ears (as recommended by Dobie, 2011).

Speech discrimination (HoH only). Speech discrimination tests of accuracy of words in quiet and thresholds for sentences in noise were conducted using recordings played from a MacBook Air laptop with a mini portable speaker. Each test was calibrated at 65 dB using the test's calibration tone and a sound level meter held one metre away from the speaker, at about the location of the child's head. Discrimination of words in quiet were tested using the *Phonetically Balanced Kindergarten* test (Haskins, 1949). For this test, the child repeated 50 words spoken by a man's voice. Each word is preceded by the phrase "say the word…" The percentage of phonemes repeated accurately was scored. Discrimination of sentences in noise was tested using the *Bamford-Kowal-Bench Sentences in Noise* test (Etymōtic Research, 2005a). For this test, the child hears two sets of 10 sentences spoken by a man's voice with accompanying background babble (men and women's voices) that increases by three decibels after each sentence (signal to noise ratio: +21 dB to -6 dB). Each sentence is preceded by the word "Ready…" The number of keywords repeated accurately is scored and the test produces a signal-to-noise ratio (in dB) threshold averaged across the two sentence lists. The test manual reports parallel forms reliability needed to achieve 95% confidence interval for two test versions with children aged seven to 10 years old at +/- 1.8 dB and 10 to 14 years old at +/- 1.6 dB. The test is reported to have greater reliability with increased age and specifies that greater test variability is expected for children who wear cochlear implants compared to TH children (Etymōtic Research, 2005b). Children who wore hearing aids were not included in reliability testing.

Non-verbal reasoning. Non-verbal reasoning was measured using the *Fluid Reasoning* subtest of the *Stanford Binet Intelligence Scales, Fifth edition* (Roid, 2003). The child looks at a picture of an incomplete pattern and selects the missing piece from five options. The subtest is discontinued after four consecutive errors. Raw and standard scores were collected for the present study. The manual reports split-half reliability coefficients for the test's fluid reasoning subtest ranging from .79 to .86 for ages seven to 12 years.

Expressive vocabulary. Expressive vocabulary ability was measured using the Picture Vocabulary subtest of the *Woodcock-Johnson III Tests of Achievement* (*WJ-III;* Woodcock, McGrew, & Mather, 2001). In this test, the child says the best word that matches a picture. Testing is discontinued after six consecutive errors. Raw and standard scores were collected for the present study. The manual reports a median internal consistency coefficient of .77 for ages 5 to 19 years for this subtest.

Morphological awareness (MA). The MA task was adapted from a commonly used sentence completion task published by Carlisle (2000) and most recently adapted by Levesque, Kieffer and Deacon (2017). For the latter study, Carlisle's two lists of 28 derivation items and 28 decomposition items were randomly combined to make two lists of 28 alternating derivation and decomposition items. For the present study, one of the 28-item combined lists was used but a few problematic items were replaced by items from the alternate list that targeted the same derivational suffixes. The task has two practice items. The test items include 14 word roots to be derived and 14 derived words to be decomposed. For this task, the examiner verbally presents a word root (e.g., *play*) or a derived word (e.g., *player*) then an incomplete sentence. The child is instructed to change the first word to complete the sentence (e.g., *Assist. The teacher will give you* _____ [assistance]. *Originality. That painting is very* _____ [original]). The items vary by phonological transparency, including 14 "neutral" items that do not involve a phonological change to the root word when the morpheme is appended (e.g., *teach…teacher*) and 14 "non-neutral" items with a phonological change to the root (e.g., *expand…expansion*). As this was not a standardized test, raw scores out of 28 were used. Internal consistency reliability for this task was .86 for a sample of 221 children in Grade 3 (Levesque et al., 2017).

Phonological awareness. Phonological awareness was assessed using the *Comprehensive Test of Phonological Processing, 2nd edition* (Wagner, Torgesen, Rashotte, & Pearson, 2013). Only the *Phoneme Elision* subtest was administered, in which the child removes phonological segments from spoken words to form other words (e.g., *Say cup. Now say cup without saying /k/.* → *up*). Testing is discontinued after four consecutive errors. Raw and standard scores were collected for the present study. The internal consistency coefficients (Cronbach's alpha) for this subtest are reported to range from .87 to .93 for ages seven to 11 years.

Word reading. Word reading was assessed using the *Test of Word Reading Efficiency, Second edition* (Torgesen et al., 2012). The test has two subtests, *Phonemic Decoding Efficiency* and *Sight Word Efficiency*. Both tests are administered by showing the child a list of words that the child reads as quickly as he or she can within a 45 second time limit. The *Phonemic Decoding Efficiency* (PDE) subtest is a list of non-words while the *Sight Word Efficiency* (SWE) subtest is a list of real words. The test takes approximately 5 minutes. Testing stops after 45 seconds for each subtest and the raw score is calculated as the number of words that the child read correctly. Age equivalent scores were collected for the present study. Form A test-retest reliability coefficients reported in the manual were .86 (PDE) and .93 (SWE) for six to seven year olds and .91 (PDE) and .90 (SWE) for eight to 12 years olds.

Passage comprehension. Reading comprehension was assessed using the *Passage Comprehension* subtest of the *Woodcock Reading Mastery Tests, Third edition* (Woodcock, 2011). For this task, the child reads a short passage and provides a missing word. Passages gradually increase in length and difficulty from a single short sentence with a picture to paragraphs containing several sentences and no picture support. Testing is discontinued after four consecutive errors. Raw and standard scores were collected for the present study. Split-half reliability coefficients for this subtest are reported to range from .85 to .94 for ages six to 11 years.

ANALYSES

Research Question #1: *Do expressive vocabulary, PA, MA, non-word reading, and reading comprehension abilities of children who were HoH differ from that of TH peers when matched for word reading ability?* Group comparisons for expressive vocabulary, PA, MA, non-word reading, and reading comprehension were conducted using independent *t*-tests with effect sizes calculated as Cohen's *d*. Effect sizes of around .20 were interpreted as small, around .50 as medium, and around .80 and above as large (Cohen, 1992). Alpha was set a priori at .05. Given the study's exploratory nature and relatively small sample size, results that approached significance ($.05 < p < .10$) were also of interest.

Research Question #2: *To what extent do PA and MA predict reading measures in each group after controlling for expressive vocabulary?* Only raw scores were used in the following analyses. First, Pearson's *r* correlations were conducted for the independent (expressive vocabulary, PA, MA) and dependent variables (reading comprehension, non-word reading). Next, the amount of variance in non-word reading and reading comprehension explained by PA and MA after controlling for expressive vocabulary was analyzed by running hierarchical linear regressions for each reading variable for all participants, resulting in two linear regressions. The enter method was selected for the first step (expressive vocabulary) and the second step (PA and MA). To check for group differences in the contributions of the independent variables to the reading variables, interaction terms (i.e., the product of each centred independent variable with a group dummy variable) were entered in separate regressions as a final step. Pedhazur and Schmelkin (1991) recommend "that a relatively large α (e.g., .10; even .25) be used for tests of interactions" (p. 558) to avoid Type II error. Therefore, given the small sample size and exploratory nature of the study, liberal criteria for exploring a significant difference were set at $\alpha < .25$.

RESULTS

Table 3.3 shows descriptive statistics for raw and standard scores in expressive vocabulary, PA, MA (raw scores only), non-word reading, and reading comprehension. Levene's test for equality of variance was significant for expressive vocabulary and reading comprehension standard scores therefore independent *t*-tests were corrected for unequal variance as necessary. Groups did not significantly differ on raw scores for any measure. Expressive vocabulary standard scores were also not significantly different for the two groups. However, the TH group had significantly higher standard scores than the HoH group with large effect sizes for PA (t = -2.305, p = .027, d = 0.75), non-word reading (t = -2.436, p = .020, d = 0.79), and reading comprehension (t = -2.562, p = .019, d = 0.91).

Table 3.3

Descriptive scores of language and reading measures for children who were hard-of-hearing (HoH) and typically hearing (TH).

	HoH ($n = 15$)				TH ($n = 21$)			
Measures	*Mean* (*SD*)	*Min - Max*	*Skewness*	*Kurtosis*	*Mean* (*SD*)	*Min - Max*	*Skewness*	*Kurtosis*
Standard scores								
Vocabulary	99.67 (11.71)	78 – 122	.017	-.046	103.8 (6.42)	91 – 116	-.144	.253
PA*	9.27 (3.65)	3 – 18	.311	1.539	11.62 (2.48)	8 – 17	.311	-.583
Non-WR*	91.87 (16.27)	55 – 117	-.524	.587	102.71 (10.48)	89 – 125	.411	-.746
RC*	97.53 (20.30)	64 – 134	.072	-.461	111.95 (9.40)	95 – 128	-.196	-1.030
Raw scores								
Vocabulary	24.60 (3.33)	18 – 31	-.410	.385	24.00 (2.35)	20 – 28	.129	-.878
PA	24.07 (7.31)	10 – 33	-.836	-.720	27.05 (5.23)	15 – 33	-1.296	.770
MA	17.87 (6.57)	5 – 25	-.648	-.985	18.00 (4.86)	7 – 25	-.558	-.216
Non-WR	28.07 (12.66)	1 – 48	-.354	-.014	30.48 (10.25)	14 – 48	.194	-1.136
RC	18.27 (5.91)	9 – 29	-.044	-.762	19.48 (5.15)	13 – 28	.385	-1.325

Notes. SD = standard deviation. Min = minimum. Max = maximum. PA = phonological awareness. Non-WR = non-word reading. RC = reading comprehension. MA = morphological awareness.

Significant difference in group means: *$p < .05$.

In the HoH group, individual scores revealed that one child achieved low scores[3] on all measures of language (vocabulary, PA, MA) and reading (non-word reading, real word reading, reading comprehension). Another child had low scores in two out of three measures of language and reading. A third child had low scores in two of out three language measures but average scores in all three measures of reading. Finally, a fourth child who was HoH had low scores in all three reading measures but average scores in two out of three language measures. Thus four out of 15 (27%) children who were HoH scored low in language and/or reading abilities. The remaining 11 children (73%) who were HoH and all 21 of the TH children (100%) had average to above-average scores in at least two out of three measures of language and reading.

Pearson *r* correlations between expressive vocabulary, PA, MA, word reading, non-word reading, and reading comprehension raw scores were completed. All correlations showed a significant large effect size for both groups (see Table 3.4).

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[3] Low score = more than one standard deviation below the normative mean on standardized tests. For the MA task, a low score was defined as more than 1 standard deviation below the TH group mean (M = 18, SD = 5).

Table 3.4

Correlations (r) and significance levels for raw scores of expressive vocabulary, PA, MA, word reading, non-word reading, and passage comprehension measures for the HoH group (shaded rows) and TH group (unshaded rows).

	Group	Vocab	PA	MA	WR	Non-WR	RC
Vocab	HoH	1					
	TH						
PA	HoH	.836***	1				
	TH	.709***					
MA	HoH	.826***	.832***	1			
	TH	.807***	.677**				
WR	HoH	.648**	.734**	.619*	1		
	TH	.677**	.623**	.788***			
Non-WR	HoH	.688**	.799***	.673**	.882***	1	
	TH	.635**	.717***	.704***	.650**		
RC	HoH	.901***	.723**	.818***	.587*	.565*	1
	TH	.840***	.661**	.556*	.834***	.689**	

Notes. Vocab = expressive vocabulary. PA = phonological awareness. MA = morphological awareness. WR = word reading. Non-WR = Non-word reading. HoH = hard-of-hearing. TH = typically hearing.
Significance values: *$p < .05$. **$p < .01$. ***$p < .001$.

REGRESSIONS

Non-word reading. A hierarchical regression was conducted including all 36 participants with non-word reading as the outcome variable (see Table 3.5). Expressive vocabulary was entered in the first step then PA and MA in a second step. The model was significant ($F(3,32) = 14.369$, $p < .001$). Expressive vocabulary significantly explained 36.9% of variance in non-word reading scores when entered alone. However, when PA and MA were entered in the second block, the combination of vocabulary, PA, and MA significantly explained 20.5% more variance. PA emerged as the only significant unique predictor of non-word reading scores ($\beta = 0.538$). Expressive vocabulary and MA each contributed no significant variance in non-word reading after the contribution of the other two independent variables.

Reading comprehension. A second hierarchical regression was conducted including all 36 participants with reading comprehension as the outcome variable (see Table 3.5). Expressive vocabulary was entered in the first step then PA and MA in a second step. The model was significant ($F(3,32) = 30.648$, $p < .001$). Expressive vocabulary significantly explained 69.8% of variance in reading comprehension scores when entered alone. When PA and MA were entered in the second step, the combination of vocabulary, PA, and MA explained slightly more variance (+4.4%) but this was not considered a statistically significant change. Expressive vocabulary remained the strongest predictor beyond the contribution of PA and MA ($\beta = 0.557$). MA (but not PA) explained a significant amount of additional variance in reading comprehension scores ($\beta = 0.342$) beyond the contribution of the other two independent variables.

Table 3.5

Hierarchical regressions predicting non-word reading and reading comprehension for the total sample of child participants (n = 36). Expressive vocabulary (Vocabulary) was entered in Step 1 and phonological awareness (PA) and morphological awareness (MA) were entered in Step 2.

Outcome variable	Predictor variables	R^2	ΔR^2	β	*p*
Non-word reading	Step 1	$.369^{***}$	-		
	Vocabulary			0.607^{***}	.000
	Step 2	$.574^{***}$	$.205^{**}$		
	Vocabulary			0.032	.875
	PA			0.538^{**}	.004
	MA			0.245	.236
Reading comprehension	Step 1	$.698^{***}$	-		
	Vocabulary			0.836^{***}	.000
	Step 2	$.742^{***}$	$.044^{\dagger}$		
	Vocabulary			0.557^{**}	.001
	PA			0.009	.946
	MA			0.342^{*}	.038

Notes. All measures are in raw scores.
Significance values: $^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$, $^{\dagger}.05 > p < .10$.

Age effects. Age is commonly used as an initial control variable in hierarchical regressions. However, the sample size was small, therefore a maximum of only one developmental control variable was desirable. Since the two groups were significantly different in age by about one year, age was not selected as a developmental variable and instead a developmental language variable, vocabulary, was used. Regardless, it could be argued that metalinguistic abilities could be enhanced with increased age and contribute to the results found. To verify the effects of age with caution (considering the subsequent reduction in power) separate regressions for each outcome variable were conducted controlling for age (in months) then expressive vocabulary before entering PA and MA. When entered alone in the first step, age explained 8.6% of variance in non-word reading

(p = .083) and 15.7% of variance in reading comprehension (p = .017). Yet once the contributions of raw scores in expressive vocabulary, PA, and MA were accounted for, age made no significant independent contribution to explaining either non-word reading (p = .635) or reading comprehension (p = .910).

Group effects. To explore group differences in the contributions of each independent variable on the outcome variables, interaction terms were included in the models. First, centred variables for each independent variable were calculated resulting in a mean score of zero for each independent variable. Group variables were set to '1' for the HoH group and '0' for the TH group. Next, interaction terms were calculated as the product of the group variable and each centred independent variable (i.e., Group x Vocabulary, Group x PA, Group x MA). Each interaction term was entered in a separate regression as the final step to determine if group membership led to a significant difference in the contribution of the independent variable to the outcome variable after the contributions of expressive vocabulary, PA, and MA. The group interaction terms did not significantly contribute to variance in non-word reading (p = .485 to .967) or reading comprehension (p = .427 to .557) even under the liberal criteria set at $\alpha < .25$ (Pedhazur & Schmelkin, 1991). In other words, the contributions of expressive vocabulary, PA, and MA to non-word reading and reading comprehension were the same across groups. To visualize the lack of difference across groups, Figure 1 (nonword reading) and Figure 2 (reading comprehension) show partial regression plots with regression lines for each independent variable (z-scores) after controlling for the other two independent variables (z-scores) separately for each group (HoH in upper row, TH group in lower row). Partial regression lines are visibly similar across groups for all independent variables.

Figure 3.1
HoH group (top row) and TH group (bottom row) partial regression plots showing independent contributions for each independent variable (vocabulary, PA, MA; z-scores) to variance in nonword reading (z-scores).

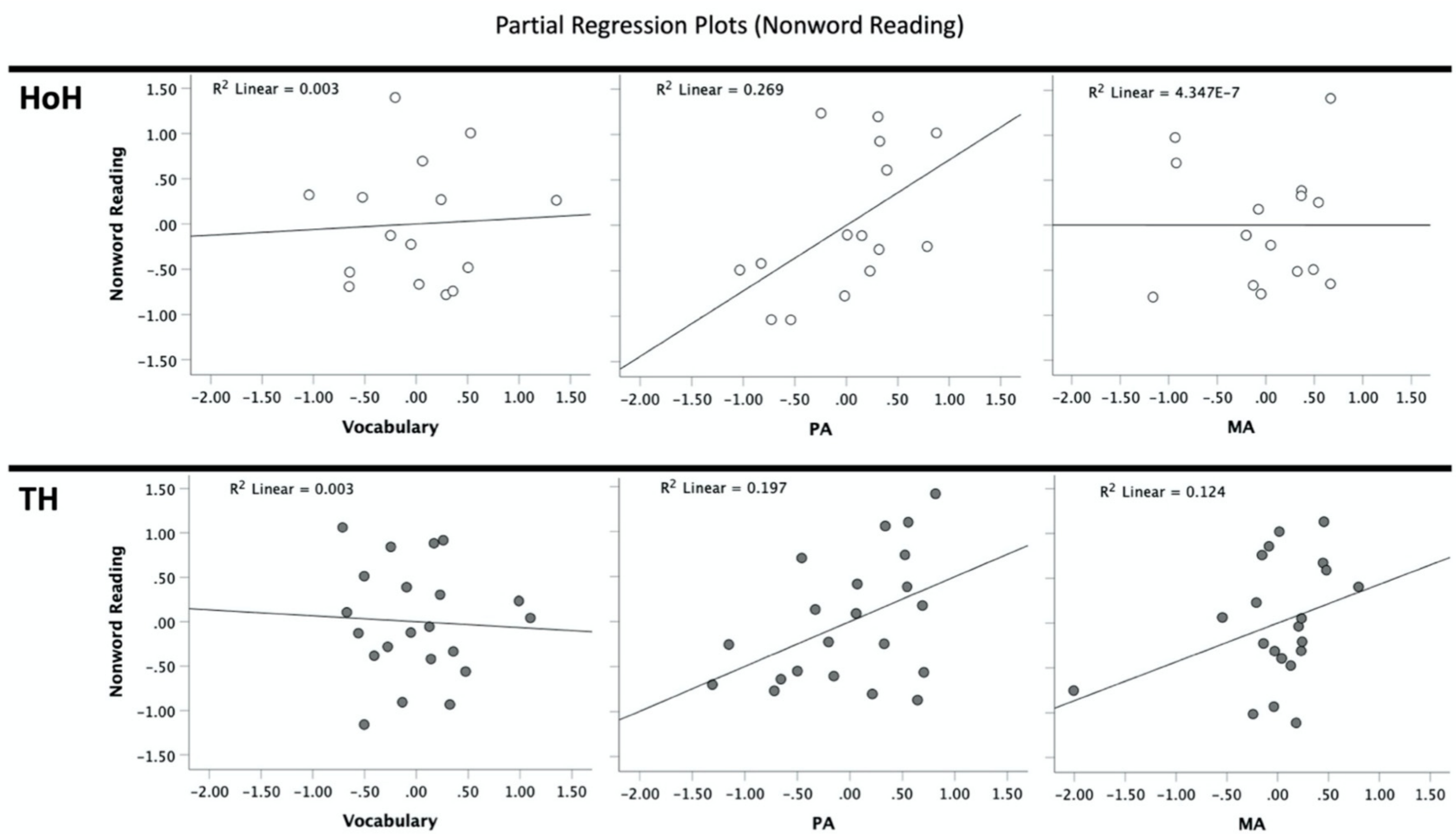
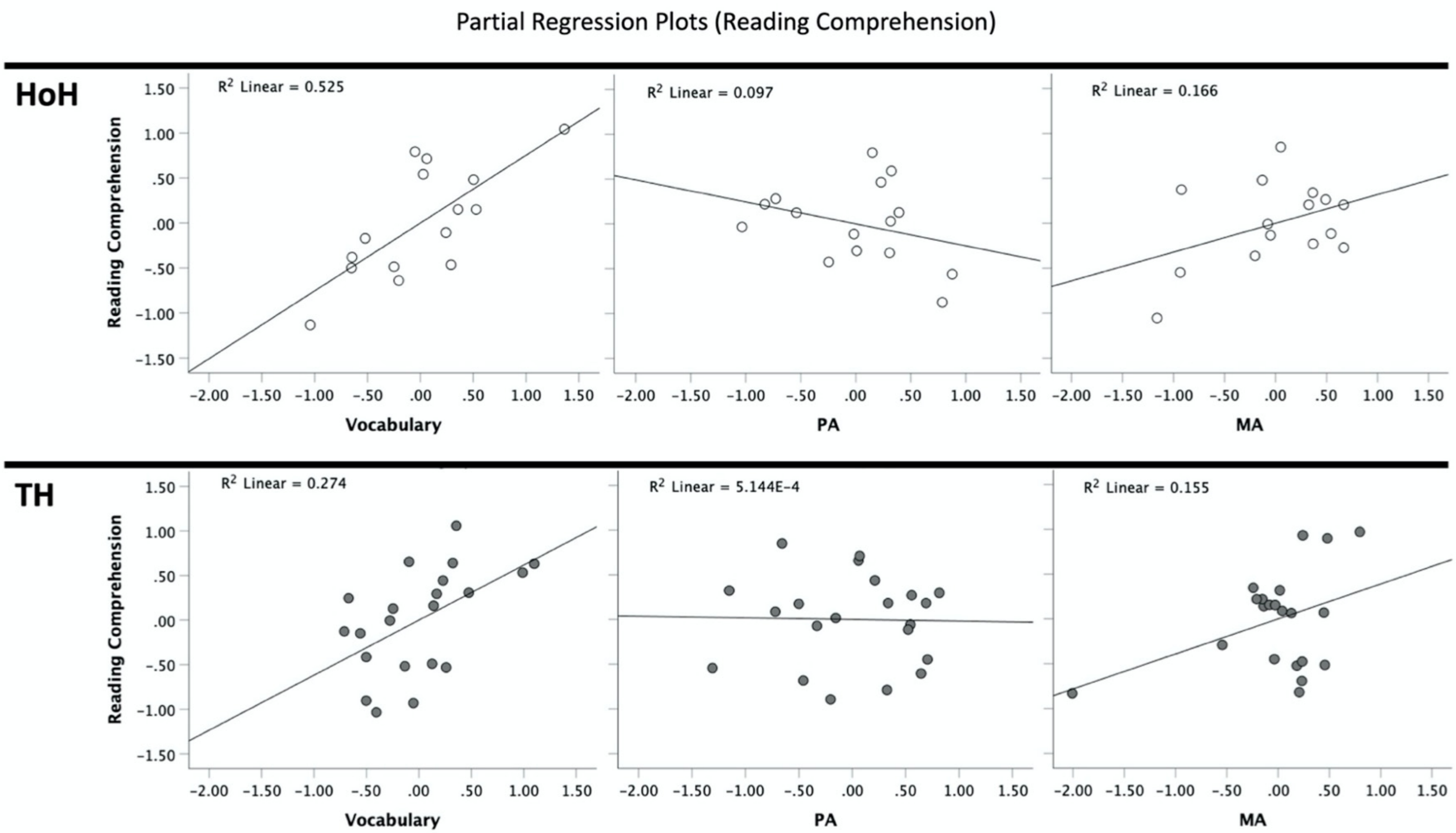


Figure 3.2

HoH group (top row) and TH group (bottom row) partial regression plots showing independent contributions for each independent variable (vocabulary, PA, MA; z-scores) to variance in reading comprehension (z-scores).



Discussion

The purpose of this study was to investigate PA, MA and reading abilities and the nature of the relationships between these measures in children who were HoH in Grades 2 to 6. Abilities of the HoH group are compared to TH children approximately one year younger group-matched on real word reading abilities. First, group comparisons of base abilities are discussed followed by a discussion of variables that best explain variance in reading abilities across the two groups.

Comparisons of Language and Reading Abilities

The raw scores in language and reading of the children who were HoH did not significantly differ from those of the younger TH children. However, standard scores of PA, non-word reading, and reading comprehension were significantly different for the two groups despite the fact that all scores for the HoH group were close to the normative mean on these tests. This likely reflects the age difference of the two groups and the TH group's particularly strong reading comprehension performance (standard score of 110, above the normative mean of 100). These findings are similar to those of Harris et al. (2017) where elementary aged children who were HoH (with a severe to profound hearing difference) and TH children were matched by word reading abilities and also found to have similar reading comprehension abilities. These findings are not overly surprising as word reading abilities are usually largely and significantly correlated with language and other reading abilities in children who are HoH (Camarata et al., 2018; Cupples et al., 2014; Geers & Hayes, 2011; Gibbs, 2004).

The present study's sample of seven- to 11-year-old children who were HoH achieved standard scores in language and reading closer to same-age TH peers than reported for younger five- to nine-year-old children who were HoH (in the 'spoken language only' group) reported by Antia and colleagues (2020). It is possible that the present study's children had poorer abilities at school entry and had largely caught up to their same-age TH peers by middle to late elementary. This recalls findings by Nielsen et al. (2016) that their older participants who were d/Deaf or HoH (in Grades 4 to 8) achieved standard scores closer to the performance of same-age TH peers than did their younger participants (Grades 2 to 3). It is also possible that the children who were HoH in the present study would have had poorer raw scores compared to a same-age TH comparison group, which was not included in the present study. Other research with elementary-age children has also reported group means at or just below TH normative samples in tests of language and reading, often accompanied by poorer PA abilities (Briscoe et al., 2003; Halliday et al., 2017; Norbury et al., 2001; Walker et al., 2020).

Despite relatively strong group means, a quarter of the children in the HoH group scored low on one or more of the language or reading measures, similar to variability reported in other studies (Briscoe et al., 2003; Camarata et al., 2018). Briscoe et al. (2003) reported that four out of 19 children (21%) who were HoH met the authors' criteria for language impairment (i.e., scores below the 10^{th} percentile) in at least two out of four core language measures. Similarly, Camarata et al. (2018) reported that 16 out of 56 children (29%) in the HoH group were poor readers, in decoding and/or reading comprehension. These findings suggest that 20% to 30% of elementary-aged children who are HoH are at risk of significant language and/or reading difficulties. It is possible that children with poorer outcomes were demonstrating the cumulative influence over time of inconsistent access to the formal properties of spoken language input (i.e., phonetic content), as suggested by Moeller and Tomblin (2015b). Further investigation is needed to confirm this causal relationship.

RELATIONSHIPS BETWEEN PA, MA, AND READING ABILITIES

Non-word reading. Regression analysis results revealed a large role for PA that exceeded that of vocabulary and MA in explaining variance in non-word reading scores for the combined group of children who were HoH and TH aged six to 11 years. The contributions of the three independent variables were not significantly different across children who were HoH compared to TH. Although vocabulary initially explained 37% of variance in non-word reading scores when entered alone, its contribution appeared to be fully explained by the relationship between vocabulary and PA. MA made a small and non-significant contribution to non-word reading scores, which suggests that its contribution was largely overlapping with those of vocabulary and PA. Together, vocabulary, PA and MA explained 57% of variance in non-word reading. These findings are similar to findings by Leather and Henry (1994) in their study of 7-year-old TH children (in the younger end of the age range included in the present study), where PA abilities explained 50% of variance in real word reading accuracy (beyond 7% explained by short term memory). When vocabulary was entered at a later step in the model, it contributed no additional variance in word reading accuracy.

Although differences were not found between the contributions of vocabulary, PA and MA to non-word reading across the HoH and TH group in the present study, this suggests that the reading processes of slightly older children who were HoH were delayed (by about a year) relative to the TH children. Findings were similar for children and youth who were HoH with a severe to profound hearing difference aged six to 18 years in the study by N. W. Nelson and Crumpton (2015). They also found that PA took all variance previously explained by vocabulary with a β-value of .49, very similar to the contribution of PA to non-word reading found in the present study (β = .54) for children who were HoH and TH. N. W. Nelson and Crumpton's study included much older children than in the present study, which makes it surprising that PA played such a strong role as it is expected to play a decreasing role in non-word reading past Grade 2 (Hogan et al., 2005). The HoH group in N.W. Nelson and Crumpton (2015) had poor mean PA and non-word reading scores with great variability, suggesting that several children had very low scores in PA and non-word reading. Their TH participants had stronger and less variable PA scores than their HoH group, suggesting they had few, if any, poor PA scores. In contrast to the greater role of PA found for their HoH group, their TH children's vocabulary remained the strongest predictor of non-word reading with PA explaining some additional variance. N. W. Nelson and Crumpton's differing results across groups may reflect a delay in the reading abilities of their HoH sample, where disproportionately poorer PA abilities related more strongly to poorer non-word reading abilities.

Perhaps children who are HoH are at risk of experiencing delays in fluency and automaticity in word reading relative to their TH peers. This would mean that at least some children who are HoH rely on the less efficient nonlexical route that depends largely on PA abilities according to the dual route hypothesis (Coltheart & Rastle, 1994; Grainger & Ziegler, 2011). This would explain the results from the present study's slightly older HoH group paralleling the younger TH group. It also explains the group differences found in N. W. Nelson and Crumpton's (2015) study that included much older children with poorer hearing levels who also achieved poorer PA and non-word reading abilities than children in the present study. It seems that PA plays an important role in non-word reading for children who are HoH at various ages and with varying degrees of hearing ability that parallels its role in non-word reading for TH children at younger ages.

In sum, PA played a dominant role in reading non-words beyond the roles of vocabulary knowledge and MA for all child participants. The contributions of the three independent variables to non-word reading were not significantly different for the older HoH group compared to the younger TH group. This suggests the processes involved in non-word reading may be slightly delayed by about one year but not qualitatively different compared to the TH comparison group.

Reading comprehension. For all child participants, MA played an important role in explaining additional variance in reading comprehension scores beyond the contributions of vocabulary and PA. PA made no unique contribution after the contributions of vocabulary and MA. A unique contribution of MA to reading is consistent with previous research with TH children in Grades 3 and above (Deacon & Kirby, 2004; Kirby et al., 2012; Levesque et al., 2017). Comparable results with regards to the role of PA and vocabulary in reading comprehension were found by Leather and Henry (1994) with 7-year-old TH children where vocabulary (and non-word repetition) contributed to significant variance in reading comprehension and PA explained no additional variance. Similarly, N. W. Nelson and Crumpton (2015) found that vocabulary remained the sole predictor of reading comprehension abilities for elementary- to high school-age children who were HoH and TH children after controlling for PA. In their study, the model explained greater variance in reading comprehension for the HoH group (65%) than the TH group (41%). In the present study, the model (which, unlike N. W. Nelson and Crumpton's study, included MA) did not show significant group differences in the contributions of PA, MA or vocabulary to reading comprehension. As discussed above for non-word reading, the children in N. W. Nelson and Crumpton's study had much poorer PA and reading abilities than the TH children. Those differences in reading development may have led to the differences in relationships between language and reading variables, whereas in the present study, word reading and reading comprehension scores were similar across groups. Overall, the prominent role of vocabulary in reading comprehension for children who were HoH and TH was consistent with the literature. Findings indicating a supporting role for MA in reading comprehension was similarly important for HoH children as for TH children with similar reading abilities.

Contrary to present findings, research by Walker et al. (2020) found differences in the contribution of MA to reading comprehension for children who were HoH versus TH. Specifically, they found that MA and vocabulary (and not listening comprehension abilities) made significant contributions to reading comprehension for Grade 4 children who were HoH with MA being the stronger predictor. For the TH control group, MA was not a significant predictor beyond vocabulary and listening comprehension abilities. Interestingly, findings from the present study of the combined HoH and TH groups were more closely aligned with the HoH group in Walker et al's study. Note that there was a difference of age across these two studies, with Walker et al. including a narrower range of children only in Grade 4 that sat in the middle of ages in the present study's sample, which could lead to differences contributed by the younger and older children. While the measures used for expressive vocabulary and MA were similar across these two studies, Walker at al.'s reading comprehension measure included timed reading of passages followed by orally-administered comprehension questions as opposed to a sentence cloze procedure used in the present study. The added cognitive load of oral reading while under time pressure may have revealed disparities in the HoH and TH groups that were not taxed in the same way for the present study, where children could view the entire passage while they thought of a word that fit the blank in the sentence/passage.

Implications for the Qualitative Similarity Hypothesis. The present study's findings do not contradict the Qualitative Similarity Hypothesis (Paul & Lee, 2010) yet lend only tentative support for it. According to Goswami and Bryant (1989), results showing a lack of difference across groups matched on reading level but differing in age are "impossible to interpret" (p. 417) while results rejecting the null hypothesis would be more conclusive. They argue that other cognitive and metacognitive skills acquired by the older group of children may compensate for reading difficulties resulting in inflated scores on the reading task. This is possible in the present study since the HoH group also had slightly higher nonverbal reasoning scores than the TH group. However, the nonverbal reasoning task was found to produce some unexpectedly low scores in the TH group, which may have reflected low motivation as opposed to poor nonverbal intelligence. As well, raw scores on the metalinguistic measures of PA and MA were not significantly different across groups, suggesting children in both groups may have had similar metacognitive capacities. Regardless, it remains possible that at least some of the older children who were HoH did indeed have delayed reading processes but were able to compensate by using more mature strategies not measured in the present study. While the reading comprehension raw scores of the HoH group were the same as those of younger TH children, the task was not timed. The HoH group may have achieved similar reading comprehension scores by taking more time to read the passages during the task (during which they may have employed more mature cognitive strategies), which cannot be verified with the data available.

In sum, the groups showed remarkably similar contributions of vocabulary, PA, and MA on reading abilities. In view of the age difference across groups, it remains possible that the children who were HoH demonstrated minor delays in reading processes (had they been compared to same-age TH peers) but not qualitatively different processes.

STUDY LIMITATIONS

Several limitations of the study need to be considered. First, the sample size of both groups was small, leading to low power (Cohen, 1992). Despite the liberal significance criteria set to increase the power of finding a difference if one were to exist (i.e., to avoid a Type II error), significant differences were still not found in the group interactions. Findings should be considered preliminary and require further substantiation from future studies with larger samples and more stringent criteria. Second, the group of children who were HoH was homogeneous in some ways and heterogenous in others. While the group included only children with speech as their primary mode of communication who were being schooled in inclusive settings, a range of hearing thresholds and types of devices were represented. As the majority of participants who were HoH wore two hearing aids, findings are most applicable to children who wear two hearing aids. Additionally, both groups had limited racial diversity and higher levels of parental education relative to the general population. The latter attribute may be related to the above-average reading comprehension abilities of the TH children in the present study. As well, stronger socioeconomic status has been identified as a protective factor for children who are HoH (Halliday et al., 2017) and may have led to stronger language and reading abilities. The lack of study participants from low socioeconomic status households may in fact have removed the confounding effect of low socioeconomic status on language and reading development (Hart & Risley, 2003; Pace et al., 2017) and therefore isolated the impact of reduced hearing. Regardless, it is recommended that results be generalized mainly to children from middle to high socioeconomic status households. Further research should investigate and compare relationships between language and reading outcomes across differently diverse subgroups of children such as those from lower socioeconomic status households and multilingual/multicultural backgrounds. As well, given the challenge interpreting null results in groups matched by reading level (Goswami & Bryant, 1989), further research comparing age-matched versus reading-matched groups may provide clearer guidance for longitudinal and intervention research designs needed for the next step in research on factors related to reading success in children who are HoH.

Finally, the nonverbal reasoning measure produced several unexpectedly low scores in both groups despite reportedly good criterion validity (r = .78 to .90). Of particular concern for the present study was that four TH children obtained standard scores greater than one standard deviation below the normative mean despite achieving average to above-average scores in all language and reading measures. It is possible that because the task was administered towards the end of testing, some children may have not shown their true abilities on this task as they were fatigued or unmotivated. It would also have been informative to calculate inter-item or split-half reliability for all measures used with this clinical sample. Unfortunately, individual item response data were not available at the time of writing, which limits the interpretation of the unusual nonverbal reasoning scores, in particular. Partly for this reason, the test was not selected for inclusion in the regression analyses. A different test of nonverbal reasoning and calculations of internal reliability on the sampled clinical population are recommended for future research.

EDUCATIONAL IMPLICATIONS

Despite being preliminary, this study's findings have implications for educational and clinical practice. Findings suggest that children who are HoH seem to learn to read non-words and comprehend passages using a similar reliance on expressive vocabulary knowledge, PA abilities and MA abilities as TH children with the same word reading abilities. This means if a child who is HoH is not developing reading skills at the same rate as their TH peers, reading intervention could embrace reading strategies used with TH children at an earlier stage in reading development, such as instruction in PA or MA, to improve reading fluency.

CONCLUSIONS

The present exploratory study found mainly similarities in base language and reading abilities and in the relationships between PA and MA with reading abilities for children who were HoH and TH with the same word reading abilities. Findings mostly replicated and brought together isolated findings from other research with children who were HoH and TH on relationships of PA with non-word reading and reading comprehension. Questions remain about the applicability of the present findings to a more diverse group of children who are HoH. Minor delays in reading processes were indicated in elementary-age children who were HoH. Finally, the Qualitative Similarity Hypothesis (Paul & Lee, 2010) was tentatively supported (or at least not rejected) with regards to relationships of PA and MA with reading abilities.

CHAPTER 4. STUDY 3

SELF-REPORTED ABILITY OF CHILDREN WHO ARE DEAF OR HARD-OF-HEARING TO HEAR AND UNDERSTAND SPOKEN LANGUAGE IN SCHOOL

ABSTRACT

The present qualitative study reports on 32 children's self-reported ability to hear and understand their teachers and other students in an educational setting. Participants were seven to 12 years old (Grades 2 to 7) and represented two monolingual English-speaking groups of children based on hearing status: deaf or hard-of-hearing (D/HH; *n* = 16) and typically hearing (TH; *n* = 16). Children responded to questions about whether or not they had difficulty hearing or understanding the teacher, other students, or people in different areas of the school. Responses were analyzed thematically. Groups were similar in how often children reported no difficulties in response to the scripted questions. The self-reported difficulties of children in both groups were strikingly similar in the identification of listening barriers related to speaker and environmental characteristics. Within child characteristics, children who were D/HH were more likely to talk about their own hearing limitations while TH children often identified factors unrelated to hearing ability. Only children who were D/HH reflected on hearing technologies. Findings suggest that many issues around effective listening are identifiable by all children without any focused intervention. Further investigation of self-reported barriers to listening in school environments could identify areas of self-advocacy for all students but particularly for students who are D/HH.

INTRODUCTION

For decades, students who are d/Deaf or hard-of-hearing (with a hearing difference who use any combination of signed and spoken language) have been identified as a population at risk of poor academic achievement (Antia et al., 2020; Qi & Mitchell, 2012; Traxler, 2000). Children with a hearing difference who use only spoken language (i.e., do not use a manual system or signed language, hereafter referred to as D/HH) must be aware of when they were not able to hear or understand what was spoken and advocate for accommodations. Despite the recognized importance of self awareness and self advocacy for this unique population (Michael & Zidan, 2018; Reed et al., 2008; Smith, 2013), no research has explicitly asked children in the elementary grades what they can and cannot hear in educational environments. Such research could provide a starting point for identifying issues most children can work through without intervention versus issues where they may need guidance in developing awareness and self-advocacy.

Classrooms typically have poor acoustic environments for learning (Anderson, 2004; Neuman et al., 2010; Shield & Dockrell, 2003). Children who are D/HH cannot understand spoken communication in background noise as well as TH children even when their hearing difficulties are relatively mild (Alasim, 2018; Borders et al., 2011; Goldsworthy & Markle, 2019; Zheng et al., 2001). The *Classroom Participation Questionnaire* (Stinson et al., 2006) measures children's self-reported ability to understand and be understood in the classroom and was designed to be completed by students who are d/Deaf or hard of hearing and use spoken or signed language. It correlates strongly with measures of academic achievement such as standardized tests of reading, math, and language (Antia et al., 2007, 2009) and measures of social skills

(Antia et al., 2011). This suggests that effective listening in the classroom is crucial to the academic success of students who are d/Deaf or hard of hearing. In order to ensure success, appropriate accommodations must be provided. Educators need to know when a child is experiencing difficulties listening and understanding and in which contexts to provide accommodations.

Parents also integrally impact a child's academic success (Mather et al., 2011; Reed et al., 2008). They can provide important information about their child's access and participation in noisy environments like the classroom (Antia et al., 2009; Haukedal et al., 2018; Hornsby et al., 2007). However, parental report should not be the only measure of a child's auditory access in school as it sometimes provides contradictory information to that of their children. For example, Hornsby and colleagues (2007) assessed listening fatigue through reports of sixty 6- to 12-year-old children who were D/HH and their parents using questionnaires and found that parents tended to underestimate their children's listening challenges and associated fatigue relative to their children's self-report. Teachers and TH peers are also reported to underestimate the challenges experienced by students who are D/HH (Zheng et al., 2001).

Children of all hearing abilities appear to be aware of a variety of barriers to listening and understanding in learning environments. Through research using questionnaires and surveys, TH children report challenges hearing when there is a substantial amount of background noise, especially from other students (Brännström et al., 2017; L. H. Nelson et al., 2020). Nelson et al. (2020) retrospectively analyzed survey responses by 3,584 children and youth who were D/HH and TH in Grades 3 to 12. They found that students who were D/HH reported greater listening difficulty overall than TH peers and that challenges were greater for all children in Grades 3 to 6 than in higher grades. The most challenging listening contexts reported by children who were D/HH and TH (according to responses solicited through Likert scales) were other students making noise and large rooms or assemblies where no microphone was used. The least challenging context by far was listening to the teacher speaking at the front of a quiet room.

Qualitative research using interviews with school-age children has been limited. Reed and colleagues (2008) interviewed 22 students who were d/Deaf or hard of hearing in Grades 3 to 8, along with their parents, teachers, and various associated educational staff about facilitators and detractors to student success. Although interviews with the adult participants were analyzed thematically, children's responses were not reported as they were "brief and yielded no significant information" (p. 491). Interviews with the adult participants revealed that the top two facilitators of student success were student attentiveness in class and motivation to succeed and the primary detractor was children's inconsistent use of hearing devices at school. Byrnes (2011) interviewed 73 Australian students who were d/Deaf or hard of hearing in Grades 7 to 12 to solicit their thoughts and opinions about learning in inclusive versus separate education settings. While the interview questions more directly addressed issues of preferred placement and identity, some students who were d/Deaf or hard of hearing reported believing they could get a good education in an inclusive education setting but only if accommodations were made so that they could effectively hear the teacher and other students. Kent and Smith (2006) found that the central theme that guided 12- to 17-year-old youth's willingness to wear their hearing aids was the perception of whether hearing aid use was "normal".

Therefore, real or perceived social stigma is an additional barrier to listening and understanding at school.

Other qualitative analyses of interviews with children who were D/HH have reported challenges listening and learning in noisy environments and in classrooms where teachers did not facilitate effective communication accommodations. In interviews with 15 youth aged 10 to 18 years old who had recently acquired a second cochlear implant, Mather and colleagues (2011) reported that noisy environments remained challenging with the second implant. Noisy environments and the constant need to advocate for themselves were also reported to cause challenges for 16 youth who were D/HH ages 12 to 17 years old interviewed by Kent and Smith (2006). Zaidman-Zait and Dotan (2017) interviewed 30 students who were D/HH in Grades 7 to 12 about everyday stressors. Participants reported challenges following teachers' explanations, difficulties with teachers who did not understand and/or respect their communication needs, and poor acoustics and background noise leading to difficulties participating in classroom communications. No studies were found on the self-reported awareness of listening abilities in TH children only or comparisons of TH children and those who are D/HH.

In sum, classrooms typically present with poor acoustics for learning and educators need to know when students cannot hear and understand what is being said. The literature suggests that students who are D/HH from 10 to 18 years of age experience challenges learning in noisy environments, in locations with poor acoustics, when teachers did not facilitate the necessary accommodations, and with the frequent need to self-advocate. Self-reported listening abilities and challenges have not been investigated with younger school-age children nor compared across students who are D/HH and TH peers, which would clarify issues unique to younger students who are D/HH. To address these gaps, the present study used brief interviews to address the following research questions:

1. *What do elementary-aged children say about their ability to hear and understand people at school?*
2. *How do children who were D/HH and TH differ in their self-reports?*

METHODS

Scripted questions about communication were embedded within a larger conversation, as part of a study investigating morphology and reading abilities of children who were hard-of-hearing and typically hearing.

RESEARCHER POSITIONING

The personal and professional background of the author impacted interpretation of results. She is a typically hearing researcher and certified speech-language pathologist who has worked for 20 years with adults and children who are d/Deaf or hard of hearing as a tutor, ASL/English interpreter, captioner, and research assistant. As an Ally with typical hearing, she holds a neutral position on issues of language modality (i.e., spoken and/or signed language).

PARTICIPANTS

Sixteen children who were deaf or hard of hearing (D/HH) and 16 TH children aged 7 to 12 years old (Grades 2 to 7) participated in the present study. There were five girls and 11 boys in each group. There were no significant differences ($p > .05$) between groups in age, grade, nonverbal reasoning standard scores, expressive vocabulary standard scores, or number of years of mother's education (see Table 4.1 for group descriptive statistics). Mothers were generally well-educated with at least a high school education. All participants were Caucasian except for two children who were D/HH of Chinese heritage, adopted from China at two and three years of age. All children who were D/HH were tested in the Maritime Provinces of Canada, while 11 TH children were tested in the Maritimes and five in British Columbia. Fifteen children in each group were educated in public school settings and one child in each group was homeschooled. The children who were D/HH were all on the caseload of an itinerant teacher of the Atlantic Provinces Special Education Authority (APSEA). APSEA supports over 900 children identified as d/Deaf or hard of hearing in K-12 public schools across Nova Scotia and New Brunswick. APSEA itinerant teachers provide direct in-person teaching and/or hearing technology support using a pull-out model and/or consultative support to classroom teachers with students who were d/Deaf or hard of hearing. APSEA also provides psychological assessment when children are first identified as d/Deaf or hard of hearing and ongoing audiological support to these students.

Table 4.1
Descriptive statistics by group (D/HH, TH) for participant characteristics and corpus measures of the children's transcripts.

	D/HH (n = 16)		TH (n = 16)	
	Mean (SD)	*Min - Max*	*Mean (SD)*	*Min - Max*
Participant characteristics				
Age (months)	122.1 (16.2)	93 – 147	113.3 (13.1)	87 – 132
Grade	4.5 (1.5)	2 – 7	4.1 (1.1)	2 – 6
Non-verbal reasoning (SS)[1]	8.94 (3.59)	2 – 15	9.19 (3.02)	5 – 16
Expressive vocabulary (SS)	99.7 (11.5)	78 – 122	104.8 (10.3)	91 – 136
Mother's education (years)	15.13 (1.46)	12 – 18	16.69 (2.70)	13 – 22
Corpus measures				
Number of utterances	19.0 (9.8)	4 – 49	16.7 (11.3)	3 – 52
Total number of words	108.4 (73.2)	9 – 318	90.9 (69.5)	3 – 270
Duration (minutes:seconds)	1:46 (0:46)	0:27 – 3:09	1:24 (0:33)	0:27 – 2:56

Notes. D/HH = deaf or hard-of-hearing. TH = typically hearing. SD = standard deviation. Min = Minimum. Max = Maximum. SS = standard scores.

There were no significant differences (p < .05) between groups on any measures.

[1] The non-verbal reasoning test was the *Fluid reasoning* subtest of the *Stanford-Binet Intelligence Scales*, 5th edition (Roid, 2003). The mean standard score of the normative sample is 10 and one standard deviation is 3. The test seemed to generate an unexpectedly low standard score, given that several TH children who were reported not to have any intellectual disability score lower than one standard deviation below the normative mean. Consequently, standard scores are shared only for the purpose of comparison across groups.

PARTICIPANT RECRUITMENT

Children were eligible for inclusion if they: were 7 to 12 years of age, spoke English only in the home, did not attend French immersion prior to Grade 3, had no diagnosis of cognitive impairment (e.g., autism spectrum disorders), had been asked the scripted interview questions, and had responded directly to the questions. Children who were D/HH with diagnoses of attention deficit and hyperactivity disorder, language impairment, and/or literacy impairment were included as these diagnoses are based on child behaviours (i.e., attending to directions, responding to language prompts) that may have resulted from being D/HH.

Children who were D/HH were recruited initially with APSEA's facilitation. APSEA was given a list of criteria and conducted a database search to identify children that matched the larger study's criteria. Next, the children's families were mailed a recruitment package containing a summary of the study, a consent form, a questionnaire, and a pre-paid return envelope. Children who were D/HH were also recruited via Facebook posts and word of mouth. TH children were recruited by emailing families of previous research participants and by posting on Facebook, university news channels, the local children's hospital network, and word-of-mouth. Seventeen children who were D/HH and 23 TH children were tested for the larger study; 16 children in each group participated in the present study. Although there were initially 19 TH children who met the present study's criteria and therefore provided responses to the scripted questions, the three youngest TH children were excluded to match the groups in number and age.

PROCEDURES

Parents signed consent forms and completed language and hearing questionnaires prior to testing. Children were seen for one testing session that lasted up to 75 minutes. Before beginning testing, the examiner obtained the child's assent. Hearing tests (hearing thresholds, speech discrimination for words in quiet and sentences in noise) were administered first and nonverbal reasoning then expressive vocabulary tests were administered last. Blocks of language (phonological and morphological awareness, language sample) and reading measures (real word reading, non-word reading, and passage comprehension) were completed in between, counterbalanced. For the purposes of the present study, only the parent questionnaires, hearing tests, language sample, expressive vocabulary test and nonverbal reasoning test are considered further.

Language and hearing questionnaire. A parent/guardian completed a questionnaire that collected information about child age, gender, presence of any diagnosed cognitive, language or reading impairments, home language exposure, and socioeconomic status. Questionnaires were adapted from language background questionnaires regularly used by child language researchers (e.g., Kay-Raining Bird, Joshi & Cleave, 2016). The questionnaire for children who were D/HH also requested hearing-related information (i.e., age of diagnosis, change of hearing abilities over time, etiology, types of hearing technologies, and age of technology acquisition), exposure and use of different language modalities (i.e., spoken and signed language), educational supports, and parent report of child's listening challenges at school. With regards to the latter, the parent was asked: 'Does your child have any difficulties understanding spoken language in the classroom?' The parent/guardian selected one of three options: 'Yes' (resulting in further prompting to 'please describe the difficulties'), 'No', or 'I do not know'.

Hearing thresholds. Children's unmasked, unaided hearing thresholds (500, 1000, 2000, and 4000 Hertz) were measured using a portable audiometer with supra-aural TDH headphones. A pure-tone average threshold ratio of 5:1 for the better ear was calculated to take into account varying abilities in both ears (Dobie, 2011). Four children who were D/HH did not have their thresholds measured in the testing session as three parents chose to provide a recent audiogram and one child wears two cochlear implants therefore is profoundly deaf when unaided.

Speech in noise thresholds. Children who were D/HH completed the *Bamford-Kowal-Bench Speech in Noise* test, List 1 (*BKB-SIN*) (Etymōtic Research, 2005) using an audio-recording played from a MacBook Air laptop computer. A portable speaker was calibrated at approximately 65 decibels measured at one metre distance from the speaker to the child's head. The test includes two lists of 10 sentences spoken by a man's voice in background speaker babble. The signal-to-noise ratio (SNR) of speaker to background noise starts at +21 dB and decreases to -6 dB for each list. The *BKB-SIN* score is the average SNR for the two lists. The score represents the SNR that the child requires in order to accurately discriminate speech in background noise. The typical range for the SNR score of a TH child aged 7 to 11 years old is -0.6 to +2.0 dB (Etymōtic Research, 2005a).

Nonverbal reasoning. The *Fluid Reasoning* subtest from the *Stanford Binet Intelligence Scales*, 5th edition (Roid, 2003) tested nonverbal reasoning skills. The subtest presents patterns of increasingly complex shapes and sequences and the child selects a shape from five options to complete the pattern. Standard administration procedures were followed according to the manual. Raw and standard scores were calculated.

Language sample. A conversational language sample was collected, initiated by the prompt: *Now we are going to have a conversation together for a few minutes. All we need to do is talk. We can talk about anything you like. What would you like to talk* *about?* During the conversation, the examiner followed a standardized protocol (Miller, 1981) that involves following the child's lead on topics that interested the child and introduced other topics such as family, hobbies, and vacations as needed. The three scripted questions that explored the communication experiences of the child and are of interest here were introduced partway through the conversational sample. Thus, the children were already comfortable conversing with the examiner by the time the questions were asked. The examiner introduced the questions by saying for example, "*Now I'm going to ask you some questions that I ask all the children, ok?"* The examiner awaited an affirmative response before proceeding. The three questions were: 1) *Do you find it hard sometimes to hear or understand the teacher in class?* 2) *Do you find it hard sometimes to hear or understand other students in class?* and 3) *Do you find it harder to hear or understand people in different areas or rooms at school?* The questions were presented as yes/no questions and if the child responded in the affirmative they were asked to elaborate with, for example, *What do you mean by that?* or *Can you tell me more about that?* If a child said 'no' or indicated they did not wish to elaborate further after gentle prompting , the next question was asked. For the two homeschooled children, the questions were adapted to remove the reference to school. The child was first asked to think of their experiences in a group learning context where an adult and other children communicated. Then the questions were adapted to fit the context offered by the child (i.e., 'teacher' was replaced with 'your dad' for one child and 'your coach' for the other child).

ANALYSIS

Transcription. The conversation directly related to the scripted questions was transcribed and later reviewed with audio to verify the accuracy of the transcription by the first author. *Systematic Analysis of Language Transcript* (*SALT*) (Miller & Chapman, 2012) software and transcription conventions were used. The child's total utterances (i.e., "communication units" defined as one main clause with all dependent clauses attached to it; Miller & Chapman, 2012), total words, and duration in minutes and seconds of the interaction around the questions were generated by *SALT*. There were no significant differences between groups on any of these measures (see Table 4.1).

'*No difficulty*' *responses.* The number of children who reported that they experienced no difficulty in response to each scripted question were tallied and compared across groups.

Parent-child response comparisons. The responses of the children who were D/HH were compared to their parents' response to the parallel question in the parent questionnaire.

Analysis of responses acknowledging difficulty. Inductive thematic analysis (Braun & Clarke, 2006) was used to identify themes and subthemes in the children's positive responses that, yes, they experienced difficulty. This form of analysis involves a dynamic, iterative process where themes and subthemes are identified and refined through discussion and review of the data. For each group, a table was constructed containing themes and sub-themes along with transcript excerpts that were representative of each. To address the dependability and confirmability of the thematic analysis, the first and second authors discussed and revised the thematic structure and representative excerpts repeatedly until consensus was reached.

RESULTS

‘NO DIFFICULTY’ RESPONSES

Children frequently reported having no difficulties in response to one or more of the scripted questions. Specifically, children in the D/HH group reported having ‘no difficulty’ in response to 35.4% (17 of 48) of the scripted questions and TH children in response to 41.7% (20 of 48) of the questions. One child in each group reported ‘no difficulty’ in response to all three questions.

Contrary to what may seem intuitive, children with ‘poorer’ speech in noise thresholds (i.e., scored +4.0 dB to +11.0 dB on the *BKB-SIN* test; n = 8) reported ‘no difficulty’ more often (12 out of 24 responses) than children with ‘good’ speech in noise thresholds (i.e., scored up to +3.0 dB on the *BKB-SIN* test; n = 8; 5 out of 24 responses). The one child in the D/HH group who reported ‘no difficulty’ for all three questions had ‘poorer’ speech in noise thresholds.

PARENT-CHILD COMPARISONS

Although parent report of ‘no’ difficulty was mostly in line with their child who was D/HH’s speech in noise thresholds, children were more likely to report some degree of difficulty than would be predicted based on parent report alone (see Figure 1 for parent and child responses by speech discrimination in noise subgroup). Parent-child agreement was determined when the parent responded ‘yes’ and their child responded affirmatively to at least one question or a parent responded ‘no’ and their child responded ‘no difficulty' to all three questions. By this definition, agreement was met between parent and child for one pair in each subgroup.

Figure 4.1
Matrix of parent and child responses to whether or not the child has difficulty hearing or understanding in class grouped by 'good' speech in noise thresholds (i.e., SNR scores of +3.0 dB or lower) or 'poorer' speech in noise thresholds (i.e., SNR scores of +4.0 dB or higher). Children's verbal responses are categorized as responding affirmatively to at least one question ('1 to 3 yes') or 'no difficulty' to all three questions ('3 no').

Child Response

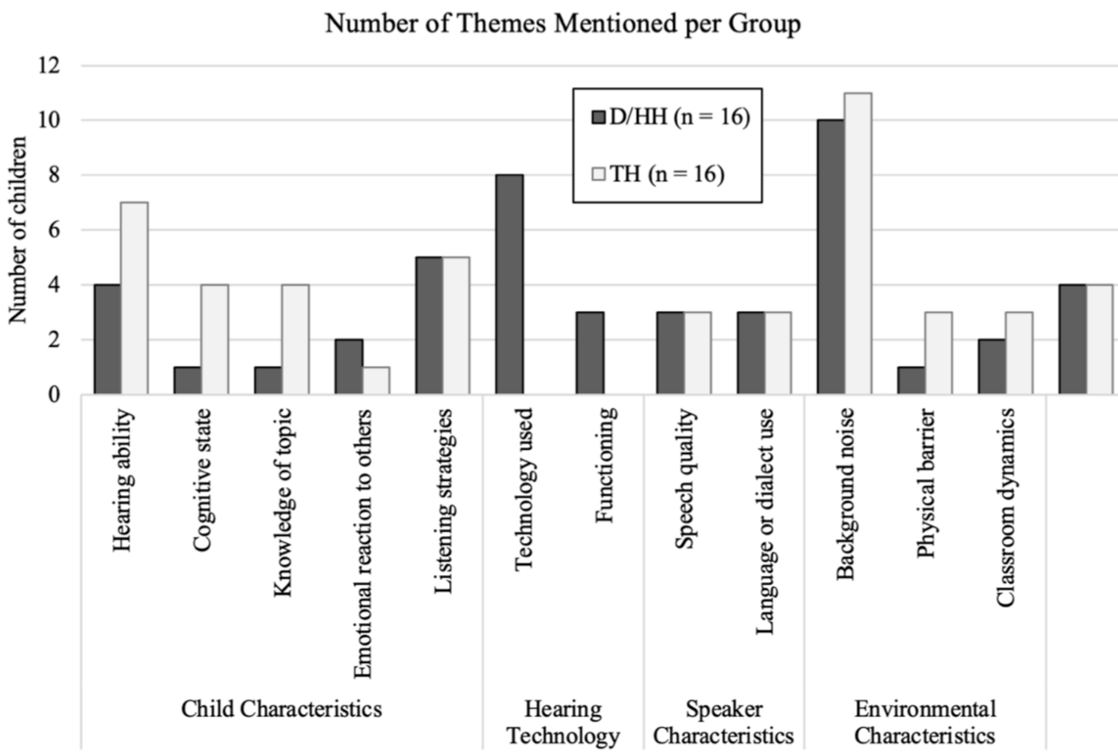
Parent Response	'Good' speech discrimination (n = 8)		'Poorer' speech discrimination (n = 8)	
	1 to 3 yes	**3 no**	**1 to 3 yes**	**3 no**
yes	1	0	1	1
IDK	0	0	4	0
no	7	0	2	0

Parent-Child Agreement

THEMATIC ANALYSIS

Four themes and thirteen subthemes were identified in the analysis (see Figure 2 for the number of children per group who contributed to each subtheme). The four identified themes were "Child Characteristics", "Hearing Technology", "Speaker Characteristics", and "Environmental Characteristics".

Figure 4.2
The number of children in each of the deaf or hard-of-hearing (D/HH) and typically hearing (TH) groups who mentioned each of the sixteen subthemes that fit within four categories.



Child Characteristics. Children discussed how personal abilities and difficulties impacted their ability to function in the classroom and other contexts. Five subthemes were identified: hearing ability, cognitive state, knowledge of the topic, emotional reaction to others, and listening strategies.

Hearing ability. Four children who were D/HH discussed that they did not hear as well as their TH peers. One child attributed her hearing challenges to the limitations of her hearing aids: "*Even if they're just across the table or beside me, I can't hear what they're saying very good… cuz the hearing aids, they take in not just the person you're* *talking to but everybody's voice! (D04)*". Three TH children also expressed hearing difficulties that they couldn't explain, as in the following quote:

> *"It's kinda hard to understand. It's like they're like "dralalala!" and I'm like, "what did you say?" And then they're like "yeah!" and then I'm like "I can't hear you!" And then they think I'm like saying like sarcastically but I'm actually not. I'm like, "I actually can't hear you right now!" (H16)*

In contrast, three other TH children explicitly stated that they are good at hearing while no children who were HoH said this. For example, one TH child said, "*I can hear them perfectly… like I can hear my teacher and my c-, in my class perfectly (H18)"* and another confidently asserted, "*I'm really good at that… I'm always hearing and understanding (H08)*."

Cognitive state. Some children expressed an awareness of how their cognitive state could impact their ability to hear or understand at a particular point in time. One child who was D/HH for example admitted they don't hear well "*sometimes, when I'm not really paying attention… other times I can hear good (D18).*" Three TH children also mentioned that not paying attention or being distracted impacted their ability to hear and understand, as in: "*Like sometimes she'll be talking, and I just miss a part… Like, maybe I'm just not listening. I try to listen (H23).*"

Knowledge of topic. Four TH children but no children in the D/HH group discussed how their knowledge of the subject matter affected their ability to understand what was being discussed. For example, one TH child said: "*Sometimes I just don't know what the um, they, I don't know what they mean… So I don't, my work doesn't turn out that good (H12)."*

Emotional reaction to others. A few children expressed emotional reactions related to other people's responses to their ability to hear or understand. Two children who were D/HH talked about being teased by classmates and how hurtful that could be, as in this example: *"Snacktime, everybody being mean. .... First it kind of hurts my feelings, makes my hearing aids suck (D19)."* One TH child expressed a need to hide the fact that she couldn't hear what her peers were saying, stating, "*And I just pretend like I heard them because I don't wanna, like, annoy them anymore (H06)."*

Listening strategies. Five children in each group talked about strategies they used to help them hear and understand what a person was saying. Children who were D/HH were more likely than TH children to change their own behaviour to manage the situation by turning off their hearing aids or moving closer to the speaker, as in: *"Usually I sit up in the front and I can just hear her normally…. They're, some of them* [teachers], *I sit in the back but I can still hear perfectly fine (D17)."* In contrast, TH children stated that they would walk away from a situation when they did not understand or tell the speaker that they could not hear them, as with the child who said, "*I'm always telling them to like lower their volume so that I can understand. If they don't wanna hear things, they don't want to, they can make that decision. But I wanna hear (H10)."*

Hearing Technology. Nine children who were D/HH talked about the type of hearing technology they used and how it functioned. Not surprisingly, no TH children discussed these subthemes.

Technology used. Children who were D/HH talked about their hearing aids, FM/DM systems, pass-around microphones, and soundfield speakers. The children tended to be knowledgeable about how the technology worked and when each was useful, for example, "*I, uh, we rarely use the FM stuff. E: So if they're not using the FM… C: Well {makes thinking mouth sounds} well it's easy to hear her (D05).*"

Functioning. Three children discussed how technology did not always work or was not consistently used by the teacher. For example: Examiner: *"So the teacher speaks into this little microphone?"* Child: *"Yeah, but it doesn't work."* E: *"Oh, what do you mean?"* C: *"They have to get it fixed."* E: *"Oh, yeah. That happens too."* C: *"A long time (D08)."*

Speaker Characteristics. Several children talked about how speech and the language characteristics of the speaker led to difficulties hearing and understanding.

Speech quality. Many children were aware that the speaker's speech quality could impact the child's ability to hear and understand what was said. Four children who were D/HH specifically mentioned voice volume as a factor. For example, one child who was D/HH said, "*And when people talk very, like, quietly, I don't hear them as much. But for the most part, I can hear most kids (D16).*" Two TH children discussed volume as well, as when this child discussed not hearing well: "*If [students are] talking like {whispering noises}. If they're talking like that but not if they're, like, talking louder (H17).*" One child who was D/HH mentioned that children with "*retainers and stuff on their teeth*" are harder to understand and one TH child mentioned that her teacher was harder to understand when "*she's like talking fast (H16)*".

Language or dialect use. Children also talked about the impact a speaker's choice of words, the language spoken, or accented English had on hearing and understanding what was said. Two children who were D/HH and one TH child talked about not understanding when teachers spoke in French. One child who was D/HH and two TH children mentioned accents negatively influencing understandability. For example, the child who was D/HH stated, "*It depends on the person. Like, I probably find it harder when someone has an accent than other people (D16).*" One TH child seemed aware that the choice of vocabulary used could impact his comprehension when he said, "*Well understanding what [other students are] saying is kind of understandable since we're in school and we don't know re-, really words that fit the description (H14).*"

Environmental Characteristics. Children also recognized that their ability to hear or understand was influenced by background noise, physical barriers, classroom dynamics, and room acoustics.

Background noise. The impact of background noise was the most frequently discussed environmental factor. Ten children in each group explained that it's harder to hear or understand when there is speech and/or non-speech background noise as illustrated in the following excerpts: *"When, if there, if there's a lot of talking in the background, yeah. But normally if there, if there was just us, no (D18)"* and "*I can't, if there's a bunch of sounds going on at once, I can't pick out a certain sound. But I can, if there's just one person talking, I can understand what they're saying (H08)."* Children in both groups mentioned similar types of non-speech background noise as factors. Three children who were D/HH mentioned loud stomping in the gym, noise from a nearby workout room, or "*playing [instruments], like if they're not supposed to*" in music class while three TH children mentioned loud music in the gym, noisy "*pots and pans*" from the nearby music room, or a garbage truck that passes outside daily. One TH child alluded to the combination of distance from the speaker and nearby noise impacting the ability to understand, "*I do hear [the teacher] most of the time unless the people beside me are talking (H10)*."

Physical barrier. Three TH children and one child who was D/HH discussed how physical barriers sometimes prevented them from hearing or understanding. The child who was D/HH discussed how having the flu caused his ears to become blocked. The TH children talked about not hearing when they were wearing headphones, were not looking when someone was speaking, or had their head underwater.

Classroom dynamics. Participants recognized that the influence of dynamics between individuals affects how well students hear or understand others at school. One TH child mentioned that it is noisier in music class because the students do not like the teacher. Two children in each group mentioned that rules about noise levels existed. They suggested that it was harder to hear or understand when the rules were not followed.

Room acoustics. Children were aware that the physical characteristics of rooms impacted their acoustics. Two children who were D/HH and three TH children discussed how big rooms make it harder to hear and understand. For example, "*It, like, there's like, it's so, it's big and it's open so that it echoes. Their ceilings are pretty high and they all open up into the, they're all open so, so it's pretty hard to hear (D04)*" or "*I mean, some rooms have a weird echo, like the gymnasium has a bi-… it's the biggest room in the school, so it has an echo (H08)."* Others talked about how large rooms also often meant the speaker was farther away from the child, making hearing more difficult.

Several spaces were identified as especially problematic listening areas. The gymnasium was by far the most problematic room, mentioned by 10 children who were D/HH and five TH children. In addition, the music room, the cafeteria, the hallway, outside on the playground, and any large room were each mentioned by between one to three children in both groups.

Discussion

This study briefly interviewed children who were deaf or hard-of-hearing (D/HH) and typically hearing (TH) aged seven to 12 years old. Children's responses to three questions about how well they heard and understood others in educational settings were quantitatively and qualitatively analyzed, and subsequently compared to parents' reports of difficulty. Multiple similarities and some group differences were documented.

Reported hearing difficulty

First, a similar number of children in each group stated that they did not have difficulty hearing or understanding in school. This is surprising, given that other research has shown elementary-aged children who are D/HH tend to have more difficulties following classwide verbal prompts based on classroom observations (Borders et al., 2011) and adolescents report difficulties understanding the teacher based on questionnaires (Zheng et al., 2001). Even children who are D/HH with appropriately fitted hearing devices experience more challenges listening in background noise than TH children (Goldsworthy & Markle, 2019). Perhaps these younger elementary-age children who were D/HH in this study who claimed they had no difficulty were not reliably reporting their experience; no evidence in the literature was found to confirm this possibility. In Nelson et al. (2020), children selected from a list of actions they would do if they could not hear others speaking. The option to 'do nothing' was reported by 12 to 29 percent of children in Grades 3 to 6 when the child could not hear the teacher or another student's voice. They also reported taking proactive steps such as asking the speaker to repeat themselves or modifying the environment, although proactive steps were slightly more commonly reported by youth in Grades 6 and up than children in Grades 3 to 6. No significant differences were found between children who were D/HH and TH children in the actions children reported taking if they could not hear. Children who would report 'no difficulty' in the present study were also likely not to take action, so it appears that this is a common reaction for elementary-age children and may depend at least in part on personality.

Strangely enough, the poorer the child's speech in noise thresholds, the more likely the child was to state they experienced no difficulties. This finding was not consistent with findings by Nelson et al. (2020) that children with poorer hearing thresholds reported greater listening difficulties. That may be because, regardless of unaided hearing abilities, children's personal hearing devices provide varying degrees of audibility, which may be more accurately measured by aided speech discrimination scores as in the present study. This suggests that either some young children who were D/HH with poor speech discrimination in noise were less aware of what they did not hear or they were unwilling to share their experiences with the adult examiner. It is also possible that when a child who is D/HH is better able to discriminate speech in noise they are more able to identify specific situations in which they do not hear well because their difficulties are less pervasive. Consequently, they are more able to reflect on and share their difficulties when asked. The examiner did not notice any particular differences in children's behaviours that would support this hypothesis and supportive evidence could not be found in the literature. Consequently, further investigation is warranted to identify child factors that may be associated with a lack of awareness of hearing challenges or a greater reluctance to report difficulties.

PARENT-CHILD REPORT COMPARISONS

Parental assessment of their child's ability to understand the teacher in class were not always aligned with their children's self-report, with full parent-child agreement found in only one out of eight pairs per subgroup of 'good' versus 'poorer' speech discrimination in noise (see Figure 1). This lack of alignment is consistent with a study by Hornsby and colleagues (2007), who found that children six to 12 years old self-reported greater listening fatigue at the end of a school day than parents reported for their child. It is possible that parents are less accurate in their estimations of listening difficulties than their children because they base judgements on their observations of their children's listening abilities in the home where the context is quite different.

QUALITATIVE THEMES

The qualitative analysis of responses to three scripted questions revealed several differences between children in the two groups. Children who were D/HH were more likely to attribute difficulties to their hearing abilities than TH children, who were more likely to attribute difficulties to other factors such as a physical barrier, not paying attention, or poor comprehension of the subject material. This is likely an accurate reflection of the different experiences of children in the two groups. Further, when children were not able to hear or understand, TH children seemed more likely to tell others that they could not hear, whereas children who were D/HH seemed more likely to change their own behaviour to improve their ability to hear the speaker. The observed differences in strategies may result from children who are D/HH more frequently experiencing difficulties hearing and tiring of self-advocating and/or not wanting to draw attention to themselves, as found by Kent and Smith (2006). In their study, 10- to 17-year-old youth were unwilling to wear their hearing aids if they perceived them as “not normal”. The 10- to 12-year-old children in the present study may have also been concerned with fitting in. Additionally, it is possible that children who are D/HH may see themselves as the problem when a communication failure arises and therefore focus upon modifying their own behavior more than TH children would.

The children who were D/HH were often willing to discuss the hearing technology they used. They also reported that some technologies, such as DM systems, were available but not being used or were dysfunctional. Teachers’ knowledge of classroom hearing technologies has been found to be the greatest facilitator to their use (Miranda et al., 2018). Therefore, classroom teachers should be properly trained and encouraged to check regularly to ensure technological supports are working adequately. This could present an opportunity to encourage children who are D/HH to educate other students or teachers about the hearing technologies and to encourage their use in the classroom.

Children in both groups spoke similarly about speaker and environmental factors that negatively impacted their ability to hear and understand. Although it might be expected that children who were D/HH would be aware of the impact that a speaker’s accent or speech quality or the room acoustics have upon listening and understanding, this is the first study using interview data to report that TH children have a similar awareness, consistent with findings suggested by survey data (L. H. Nelson et al., 2020). Consistent with previous literature (Kent & Smith, 2006; Mather et al., 2011; L. H.

Nelson et al., 2020; Zaidman-Zait & Dotan, 2017), the majority of children who were D/HH mentioned background noise, including other students talking, as a common barrier to hearing and understanding. The next most commonly mentioned barrier in the present sample was room acoustics, especially rooms that were particularly large. These findings are directly in line with those by Nelson et al. (2020), where the most challenging listening contexts rated on a questionnaire were other students making noise and large rooms or assemblies where no microphone was used, in that order. There is a known link between poor classroom acoustics and listening fatigue (Bess & Hornsby, 2014). The present findings re-emphasize the need to control noise levels and classroom acoustics, for the benefit of all children.

Limitations

Several limitations need to be acknowledged. First, the participants provided relatively brief responses to the scripted questions (ranging from three to 52 utterances across children). This may be characteristic of the responses that can be expected from elementary-aged children up to approximately Grade 6 (i.e. 12 years of age and younger); interviews were previously attempted by Reed and colleagues (2008) with children in Grades 3 to 8 but it was reported that the children's responses were too brief for analysis. Other qualitative studies of children who were d/Deaf or hard of hearing (ranging in age from 10 to 18 years) reviewed in the present article did not report the amount of utterances or words produced in the participants' responses, so no direct comparisons can be made. Finally, children in the present study came from quite educated homes, suggesting that findings are generalizable to children of middle- to upper-class socioeconomic backgrounds. Further research with children with more diverse demographic characteristics is warranted to support and elaborate on present findings.

CONCLUSIONS

The most intriguing and novel finding of the present study may be that TH students aged seven to 12 years old (Grades 2 to 7) reported barriers to effective listening that were quite similar to those encountered by students who were D/HH. It appears that many issues around effective listening are identifiable by children with and without a hearing difference, without any focused intervention. Most children who were D/HH in this study were aware of their own hearing limitations and how they could modify their own behaviours to mitigate these limitations. However, children who are D/HH may benefit from considering how their hearing abilities *interact* with other factors such as distance from the speaker, background noise, their knowledge of the topic, and attentiveness. Future research on how the factors identified in the present study may interact to cause listening difficulties in educational settings could be helpful for developing interventions designed to deepen children's understanding of their own hearing-related strengths and limitations. As well, further investigation of student reflections on listening abilities in elementary school is warranted to identify areas in which all students, but particularly students who are D/HH, could advocate for improved listening contexts to maximize their individual hearing abilities.

Chapter 5. General Discussion

My primary goal for this dissertation was to investigate the English language abilities of elementary-aged children who were hard-of-hearing (HoH) relative to a typically hearing (TH) comparison group from three distinct methodological angles: language sample analysis of morpheme use, regressive relationships between tests of expressive vocabulary and metalinguistic abilities with reading abilities, and qualitative analysis of self-report listening comprehension. In this General Discussion, I will begin by summarizing findings from the three studies. Next, I will address implications of this research with regard to theories of language and reading development mentioned throughout this dissertation, and subsequently on educational practice. Finally, I will look ahead to the future directions indicated by this research.

Summary of results from each study

Study 1 described the expressive inflectional and derivational morphology of 14 children who were HoH aged seven to 11 years old with 14 same-age TH children. Inflectional morphemes used in conversation were found to be quite similar across groups. Derivational morphemes used by at least half the children in each group were -*ly*, -*er* (instrumental and agentive), and -*y*, and for the TH group only (10 children), -*ion*. Six children who were HoH produced -*ion*. About a quarter of each group (three or more children) produced -*teen*, -*ty*, -*al*, -*ic*, and -*th*. The HoH group produced two thirds as many derivational morphemes with a single root (16 morphemes) compared to the TH group (25 morphemes). An unusually high number of morpheme use errors were produced by two children who were HoH. For the HoH group, there were no significant correlations between morpheme use and child variables. Of interest in the TH group, chronological age showed a large significant correlation with percent of words inflected and the number of different bound morphemes; these correlations were significantly stronger in the TH group than the HoH group. The number of different bound morphemes was identified as a potentially useful assessment measure of morpheme use for children who are HoH and TH.

Study 2 explored language (expressive vocabulary, PA, and MA) and reading (non-word reading, reading comprehension) abilities in 15 children who were HoH (aged seven to 11 years old). Twenty-one TH children formed a comparison group matched by word reading abilities and were about a year younger than the HoH group. Raw scores in language and reading measures were similar across groups although the HoH group had lower standard scores in phonological awareness (PA), non-word reading, and reading comprehension compared to the TH group. When the three language variables were entered in combined group regressions to explain reading outcomes, PA was the only significant contributor to variance in non-word reading. For reading comprehension, vocabulary was the strongest significant predictor and MA significantly explained additional variance over vocabulary. The HoH group showed the same relationships between language and reading variables as the reading-matched TH group.

Study 3 presented a qualitative analysis of interviews with 16 children who were deaf or hard of hearing (D/HH) who used only spoken language and 16 TH children (in Grades 2 to 7). During conversation, children were asked three questions about how well they hear and understand others at school. Similar numbers of children in each group reported having no difficulties. Further, children who were D/HH with poorer speech discrimination in noise were more likely to report having no difficulties than children with relatively good speech discrimination in noise. Children in both groups talked about similar barriers to hearing and listening, such as multiple people talking, background noise, and room acoustics. Only children who were D/HH discussed the use of hearing technologies and being teased by classmates for their differences in hearing status and hearing device usage.

THEORETICAL IMPLICATIONS

Model of Inconsistent Access. Moeller and Tomblin (2015b) have proposed a Model of Inconsistent Access to explain differences in language development in children with reduced hearing. The authors claimed that "inconsistent access to linguistic input over time would lead to variations in cumulative linguistic experience among [children who are HoH] with consequent variations in language outcomes" (p. 93S). They suggest specifically that language domains dependent upon the perception of phonetic details, such as phonology and morphology, should be most affected. The children studied in this dissertation presented with a broad range of unaided hearing levels, speech discrimination abilities, and ages of diagnosis of hearing status. Therefore access to linguistic input would be expected to vary within the group and, according to the model of inconsistent access, relate to variability in language outcomes.

Although group differences in language outcomes were not tremendously evident in the three studies, four out of 15 children who were HoH included in Study 2 (27%) achieved low scores[4] in PA plus vocabulary and/or MA. Incidentally, three of these four children were the only children in the study to also achieve low test scores in at least two

[4] Criteria for a 'low score' in the standardized tests of expressive vocabulary, PA, non-word reading, real word reading, and reading comprehension was greater than one standard deviation (> 1 *SD*) below the test's TH normative sample. As the MA task was not a standardized test, criteria for a 'low score' in MA was considered to be > 1 *SD* below the mean based on scores for the TH group performance.

of the three reading measures. This proportion is remarkably similar to the 26% of children who were HoH (12 out of 46 children) in Halliday et al. (2017) who met the authors' criteria for language and/or reading impairment[5]. In my dissertation research, all four of the children with low language scores had poor speech in noise thresholds (greater than +5.0 dB signal-to-noise ratio). Three of these children were included in Study 1, of whom two produced bound morpheme errors. These two children were also the only two children to produce more than two morpheme use errors (the maximum number produced by any one TH child). Poor speech discrimination in noise may have been related to their difficulties, although one child was reported by the parent to have learning difficulties (a formal diagnosis was not specified). The third child was discussed in Study 1 as a child who demonstrated language delays in vocabulary knowledge and syntax, just not in morpheme use, during the 10-minute language sample. Taken together, these findings suggest that poor speech discrimination of sentences in noise appeared to be associated with language difficulties, which provides support for the model of inconsistent access.

In Study 3, an interesting connection was found between poorer speech in noise thresholds and a reported lack of hearing difficulties in the educational context. Children with poorer access to spoken language were either less aware of what they did not hear or unwilling to admit to listening difficulties. I proposed that the children with good speech discrimination in noise were more able to identify isolated instances in which they could or could not hear what was said, leading to a greater awareness that appeared similar to

[5] Halliday et al.'s (2017) criteria for language impairment was a standard score > 1 *SD* below the mean of the test's normative sample in least two out of four spoken language tests (non-word repetition, receptive vocabulary, receptive grammar, recalling sentences). The criteria for reading impairment was a standard score > 1 *SD* below the mean of the test's normative sample in least one out of two reading tests (non-word reading, real word reading).

that expressed by TH children. This dissertation's findings were therefore complimentary to the model of inconsistent access, showing that a child's speech in noise threshold, as measured by the *Bamford-Kowal-Bench Speech-in-Noise Test* (Bench et al., 1979), may be an objective measure that reflects the degree of spoken language access that the child has experienced over time.

Lexical Quality Hypothesis. The most recent version of the Lexical Quality Hypothesis (Perfetti, 2007; Perfetti & Hart, 2002) maintains that high quality lexical representations include rich and interconnected information about four components: orthography, phonology, semantics, and to a slightly lesser degree, morphology. Together these components contribute to vocabulary depth, or essentially how well a child knows a word. If the model of inconsistent access (Moeller & Tomblin, 2015b) is accurate, then we should expect that children who are HoH would present with poorer quality lexical representations (i.e., reduced vocabulary depth) than TH children.

In this dissertation, children who were HoH were found to have the same expressive vocabulary breadth, as reflected in a picture naming task, as the TH children. Nonetheless, a measure of vocabulary depth, such as the 5-point semantic quality scale used by Walker et al. (2019), may have revealed lower quality of lexical representations in this group, as would be expected based on such findings by Walker et al. (2019) who compared vocabulary size and vocabulary depth in 7- to 9-year-old children with a mild hearing difference. The children who were HoH in this dissertation research had more greatly reduced hearing than in Walker et al.'s (2019) study, therefore they would be expected to have even poorer vocabulary depth. In Study 1 there were hints that at least some of the children who were HoH may have had lower quality lexical representations than the TH children as evidenced by errors in the inflectional morpheme use produced by greater numbers of children who were HoH and the fewer derivational morphemes produced with a single root. Also, in Study 2, the HoH group had poorer PA standard scores (as measured by phoneme deletion using real words) than the TH group. Together, these morphology- and phonology-related findings suggest that lexical quality could be impacted. Research looking more deeply at vocabulary depth in children who are HoH with a broader range of hearing abilities than just a mild hearing difference is warranted.

Simple View of Reading. The Simple View of Reading (Gough et al., 1996; Hoover & Gough, 1990) states that reading comprehension abilities are the product of decoding and spoken language comprehension abilities. This model has been heavily studied in TH children (Hogan et al., 2014; Kendeou et al., 2009; Stuart et al., 2008) and should be applicable to children who are HoH as well. This population is perhaps ideal to include in research investigating the simple view of reading due to greater variation in language outcomes than found in TH children.

Study 2 in this dissertation was not designed to test the simple view of reading but included components of the model. Regressions entered reading comprehension as the outcome variable and vocabulary, PA, and MA as predictor variables. While the HoH group was about one year older than the TH group, the groups were matched for word reading abilities and found to also have similar raw scores in all language and reading measures (with slightly greater variance in scores for the HoH group particularly in the lower range). With both groups included in combined-group regressions, expressive vocabulary and MA (with little to no unique contribution from PA) explained 74% of reading comprehension abilities, which is an impressive effect. Word-level language abilities (receptive and expressive) clearly played a large role in explaining variability in reading comprehension for all children, although the larger contribution was made by expressive vocabulary. If decoding (i.e., nonword reading) scores had been entered in as well, the simple view of reading predicts that we should have seen an increase in explained variance. A separate regression revealed PA as the largest predictor of decoding scores and suggested that each one-point increase in a child's PA score predicted a half point increase in nonword reading beyond any contribution of vocabulary knowledge and MA. This is a strong relationship but certainly did not suggest a one-to-one proxy of PA and decoding abilities. In addition, PA was not a significant unique contributor to the model explaining reading comprehension, suggesting either that PA was not a good proxy for decoding or that decoding would not have played as large a role in reading comprehension for these children. Regardless, the similarly large roles of vocabulary and MA in explaining reading comprehension scores for both groups suggests that the simple view of reading should apply equally as well to children who are HoH as to TH children.

Dual Route Hypothesis. The Dual Route Hypothesis (Coltheart & Rastle, 1994) posits that a person reads a word either through a lexical or a nonlexical route. The lexical route involves associating the visual image of the whole word with a meaning in the lexicon. The nonlexical route involves associating the word's letters with sounds and blending these together (i.e., applying PA) to create a phoneme string that is recognized as a word in the lexicon. Newer readers initially depend on the nonlexical route and gradually move towards the lexical route as they acquire greater familiarity with written words (Grainger & Ziegler, 2011). Both routes access vocabulary knowledge once the written word is recognized. There is a role for MA in the dual route hypothesis as well. The reader may identify a familiar morpheme within the word using the lexical route but still engage the nonlexical route to read other less familiar morphemes in the word (Grainger & Ziegler, 2011; Rastle & Davis, 2008). For example, upon seeing the word *disengage*, the reader may first recognize the prefix *dis*- using the lexical route but need to sound out the less familiar root *engage* using the nonlexical route in order to decode the full word. Deaf readers (i.e., with little to no hearing ability) are suggested to rely largely on the lexical route, due to their less developed spoken phonological systems (Mayberry et al., 2011).

The question therefore arose for me as to what degree children who were HoH may rely on the nonlexical route relative to a TH comparison group with the same word reading abilities. Study 2 provided some insight into this question using regressions with non-word reading as the outcome variable. I was interested in the relative contributions of PA and MA to non-word reading and initially wondered if the contribution of PA would be less important (and MA more important) for the children who were HoH than would be found for the TH group. I found that PA was the only significant unique predictor of non-word reading abilities after the contributions of vocabulary and MA for all children combined. The two groups of children with the same real word reading abilities showed no difference in the contributions of PA and MA to non-word reading, suggesting that the nonlexical route was equally employed for the two groups. Since the HoH group was slightly older than the TH group, this suggests at least some of the children who were HoH were at a less automatic stage in their processing of non-word reading compared to

TH children their age, as these relationships appeared similar to those expected for younger readers. Further investigation of this assumption is indicated.

Qualitative Similarity Hypothesis. The Qualitative Similarity Hypothesis (Paul & Lee, 2010) proposes that reading abilities depend on the same processes for children who are d/Deaf or HoH and TH. These processes include critical roles for language skills (such as vocabulary knowledge, PA, and MA) and literacy skills (such as decoding, spelling, and reading fluency) (National Institute for Literacy, 2008). The qualitative similarity hypothesis presupposes that these skills must be acquired for children who are HoH with the same ratio of importance and in the same developmental order as for TH children. Apparent differences in reading abilities should be attributable to a delay and not a qualitative difference in reading development, and therefore reflect the process of earlier readers. In the present research, when vocabulary, PA, and MA were investigated as factors relating to reading comprehension, PA and MA contributed similarly to reading abilities across groups.

On first glance, it may appear that the qualitative similarity hypothesis is supported simply because a lack of difference implies similarity. However, the findings support the null hypothesis, which means only that a difference was not found. It is arguably possible that a qualitative difference in reading processes existed across these two groups but was not found due to a lack of sensitivity in the methodology employed (e.g., low statistical power, inappropriate choice of measures). Given that the groups were slightly different in age, the older children who were HoH may have compensated for delayed reading processes by using more mature metacognitive abilities in order to achieve the same reading level as the TH children, as argued by Goswami & Bryant

(1989). On one hand, the evidence suggests this is not the case as the metacognitive abilities of children in the HoH group (as measured using PA and MA) were not significantly different than for the TH group. Truly, the only developmental difference across the two groups appeared to be in chronological age, which can only suggest a developmental delay in the older HoH group relative to the younger group. On the other hand, the reading comprehension abilities of the TH children were higher than expected for their ages, which could mean that the children who were HoH were actually performing at age level, reflecting reading processes found in slightly precocious younger TH children. In addition, findings from Study 1 also showed no evidence of a HoH group delay as measured in number or types of derivational morphemes used. Whether the HoH group had similar or delayed reading processes, the qualitative similarity hypothesis holds, as there were no group differences in the *relative contributions* of each language variable to reading abilities.

When I set out to conduct this research, I expected to find that children who were HoH would have qualitatively different processes of reading (to be demonstrated through relationships between language and reading variables) than TH children due to underlying differences in language development. Through this research and more thorough and careful reading of the state of the literature, I have come to realize that the reading process of children who are HoH is more likely to be qualitatively similar than different. However, the effect of delayed and inconsistent language exposure, tragically common for children who are HoH, can critically impact the reading acquisition process in ways that appear to be qualitatively different. LaSasso and Crain (2015) argue that any qualitative difference in reading processes should not be associated with hearing status (i.e., nature) and instead be associated with the qualitatively different acquisition and instruction in language and reading experienced by many children with a hearing difference (i.e., nurture). Most of the children who were HoH who participated in this dissertation research performed similarly to TH peers in all three studies. The children who seemed to struggle were also experiencing poorer access to spoken language as measured through hearing thresholds and speech in noise thresholds. A child's speech discrimination in noise abilities reflect a combination of hearing and language comprehension abilities, which would betray inconsistent access to language over time. I propose that the poorer a child's speech discrimination in noise thresholds, the more likely we will find that the child's reading processes are qualitatively different. However, this difference will approach qualitative similarity the closer the child's speech discrimination in noise abilities approach typical performance.

EDUCATIONAL IMPLICATIONS

A comprehensive language sample analysis of morpheme use, as demonstrated in Study 1, can be used to monitor progress over time, set learning goals, and develop intervention plans. If a morpheme use measure is taken as a valid reflection of morpheme use, it should relate to other morphology-related measures and less strongly to measures not directly related to morphology. A tally of the number of different bound morphemes used was the only morpheme use measure found to relate to MA. The number of different bound morphemes related less strongly to vocabulary than MA, the only morphology-related child variable. There was also a satisfying amount of variability in scores for this morpheme use measure, with children producing between six and 20 bound morphemes in a 10-minute conversation. As well, the measure of MA used in this dissertation research (a verbal sentence completion task requiring composition and decomposition of derived words adapted from Carlisle, 2000) was indicated as appropriate for use with elementary-age children who are HoH. Compared to TH peers matched by word reading abilities, these children who were HoH achieved a similar range of scores in MA and similar associations between MA with reading abilities.

Children who are D/HH who use only spoken language (like those in Study 3) often experience greater challenges listening and learning in inclusive classrooms (Alasim, 2018; Borders et al., 2011). Several children who were D/HH in Study 3 were less aware of and/or less willing to discuss their listening challenges. Interventions for children such as these could identify situations in which each child who is D/HH may need to advocate for better listening environments and in doing so, could mention that TH children also experience these challenges but to lesser degrees. Students found to have poorer speech in noise thresholds may need greater support to learn to advocate for themselves more assertively. They were less likely to pinpoint isolated contexts that were challenging and could benefit from learning about how different listening contexts may interact with their unique hearing profiles and cause them to miss out on other people's spoken communication. They may specifically require support in learning how and when to request clarification when they realize they have not understood what was said (E. T. Fitzpatrick et al., 2020).

TH students also benefit from improved acoustic learning environments (Klatte et al., 2010; Millett, 2015; Rosenberg et al., 1999), especially students for whom English is a second language (Mayo et al., 1997) and students with language and/or behavioural impairments (Klatte et al., 2013). Similarly to students who are D/HH, these TH students with exceptionalities are being increasingly educated in inclusive educational settings (Guardino & Cannon, 2015). Class discussions may be warranted to identify hearing contexts that make it hard to hear what people are saying, and corresponding solutions can be discussed as a class not to single out the student with atypical hearing but to support the learning of all students. In addition, while improved classroom acoustics and the installation of class-wide (i.e., soundfield) amplification systems are found to support the learning of all students (Duarte da Cruz et al., 2016; Neuman et al., 2010), students who are D/HH may be most likely to notice when these helpful hearing assistive technologies are not being used or are not functioning properly. Teachers could welcome and encourage the feedback of students who are D/HH to monitor the use of not only the hearing technologies that affect the student who is D/HH more directly (e.g., personal FM systems) but also classroom amplification systems. Hopefully, classroom teachers will seek to improve classroom acoustics and initiate class discussions on the impact of listening difficulties and recognize the benefit to all students.

FUTURE RESEARCH DIRECTIONS

Findings from this dissertation offer previously unstudied descriptions of morpheme use, relationships between language and reading variables, and self-reported awareness of hearing difficulties in children who are primarily HoH. These findings also highlight remaining gaps in the literature that warrant further research. Sample sizes for the present research were relatively small. Further investigations are required with larger sample sizes, a broader range of parent education, and greater racial and cultural diversity to more deeply explore and allow greater generalization of findings from the present research.

The two groups who participated in this research performed similarly in morpheme use and MA abilities and most children who were HoH produced few morpheme use errors. However, a small number of these children demonstrated persistent difficulties in morpheme use not expected by school age. It is possible that other indicators of morphological delay were not revealed with the single measure of morpheme use collected through a 10-minute conversation with a competent adult examiner. Additional research on morpheme use in a greater variety of language sampling contexts is indicated to confirm and extend findings. For example, language samples that are longer, include interactions with child peers, and/or elicit more than one discourse genre could allow for even richer analysis of errors and morpheme types. Further use of language sampling to investigate the syntactic role of morphemes may also be used to complement findings on morphological development in elementary-age children who are HoH. Although Squires et al. (2020) found that conversational samples yielded more morphologically complex language than narrative and expository discourse, more syntactically complex utterances are found in expository discourse (i.e., language used for description and explanation) over conversational (Nippold, 2009; Nippold et al., 2005). Therefore, I would recommend that research investigating the morphosyntactic abilities of children who are HoH collect both conversational and expository language samples.

As well, the validity of morpheme use measures in LSA as measures of morphological development could be assessed by comparing results with other morphology-related tasks known to document developmental change. Relevant criterion measures could include accuracy on MA task items containing neutral versus non-neutral morphemes or vocabulary tests that manipulate multi-morphemic composition. As well, for older students, a morpheme use criterion measure could include a task using morphologically complex academic vocabulary such as the Reading Vocabulary subtest of the Gates-MacGinitie Reading Test, Fourth Edition (MacGinitie et al., 2000), in which students identify synonyms of words common in texts for increasingly older grades. Such research could simultaneously pursue further identification of the order of acquisition for derivational morphemes, which would inform an appropriate morpheme order to use for scaffolding in morphological interventions designed for students who are HoH or TH. Based on tentative findings in Study 1, order of acquisition for derivational morphemes may be most usefully ranked within sets of morphemes, such as neutral + frequent (e.g., -*ly, re*-), nonneutral + frequent (e.g., -*ion, -al*), neutral + infrequent (e.g., -*ful, -ship*), and nonneutral + infrequent (e.g., -*ity*, -*ous*).

In Study 2, the reading comprehension task administered was not timed, therefore an assessment of children's sentence-reading fluency could not be evaluated. A child could theoretically achieve a good score on the task by first labouring slowly through the words using sub-lexical processes of decoding (i.e., breaking words down into smaller parts by engaging PA and MA) then blending all the decoded words into a sentence to understand the sentence. In fact, several children were observed to spend more time than other children reading through the sentences before deciding on a response (i.e., a word that accurately filled in the blank). The finding that older children who were HoH achieved similar scores in reading comprehension than TH children using similar associations with PA and MA was ambiguous with regards to the more advanced aspiration of greater reading fluency. To allow for this level of interpretation, future research should include a measure of reading comprehension fluency, either by timing a reading comprehension task and documenting differences in total time, or using a measure with a predetermined time limit. In order to determine if children who are HoH are employing a slower path of word-level decoding using PA and MA abilities, the number of multi-morphemic words per item in a reading fluency task could be manipulated and the effect on reading rate examined.

In light of the null findings from Study 2 with reading-matched TH controls, further studies investigating the qualitative similarity hypothesis by comparing age-matched *and* reading-matched children are warranted. In addition, as noted in Chapter 3, children who are HoH are a unique population with which to test the simple view of reading, as their spoken language abilities vary more greatly than those of TH children. Research with this population and purpose may provide novel insights to the field of reading research.

Correlations between hearing-related variables (hearing thresholds, speech in noise thresholds) and language measures were expected but not found in this group of children with a wide range of hearing profiles. I could have included different hearing-related variables in the correlational analyses, such as children's age of diagnosis of hearing status and age of intervention with the present hearing devices. In Study 1, eight out of 14 children were diagnosed between two to seven years of age, which is later than the recommended age of two years. In hindsight, age of diagnosis may have been an important measure to include in correlations, particularly when so many participants experienced unaided reduced hearing for so long. Another hearing-related measure that I could have calculated with my data was 'hearing age', which is the child's chronological age minus the age of hearing device intervention. These three hearing-related measures may have been more informative than I had anticipated and should be prioritized in future research on the language development of children who are HoH.

CONCLUSIONS

The three studies presented in this dissertation employed novel methods to investigate the English language abilities of elementary-age children who were primarily HoH (one child who participated in Study 3 was deaf with two cochlear implants and used only spoken English as well). Many of these children who were primarily learning in inclusive settings were acquiring English language and reading abilities commensurate with TH peers, however about a quarter were not. Children who are HoH therefore require special attention to ensure that they do not fall behind TH peers in academic outcomes. It is my hope that findings from this research complement current and future research efforts to support children who are HoH in inclusive settings towards achieving their optimal linguistic, social, academic, and vocational potential. Considering this research alongside the tireless research efforts of other academics reviewed throughout this dissertation, I can confidently state that children who are HoH are no longer 'forgotten'.

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APPENDIX A – STUDY 1 HOH CORRELATIONS WITH WORDS IN QUIET

Correlations (r) between speech discrimination of words in quiet accuracy (variable 5b, in shaded cells), other child variables, and morpheme use measures for the hard of hearing (HoH) group only. R-values significant at .05 or greater are shown in bold.

	Child variables								*Morpheme use measures*				
	1	2	3	4	5	5b	6	7	8	9	10	11	12
Child variables													
1. Age	–												
2. Nonverbal reasoning	.15	–											
3. Parent education	.07	.34	–										
4. Hearing thresholds	-.04	-.08	.05	–									
5. Speech-in-noise thresholds	-.11	-.48†	-.49†	.31	–								
5b. Words in quiet accuracy	.17	.44	.38	**-.65***	**-.79****	-							
6. Morphological awareness	**.54***	.25	.35	-.38	**-.56***	**.68****	–						
7. Expressive vocabulary	.17	.40	.44	-.42	**-.58***	**.69****	**.82*****	–					
Morpheme use measures													
8. % words inflected	-.27	-.11	-.09	-.44	-.11	-.03	.02	.08	–				
9. % words derived	.14	.33	-.28	-.02	-.31	.22	.21	.21	.16	–			
10. % diff words derived	-.02	-.31	-.30	.20	.49†	-.41	.05	-.10	.35	.23	–		
11. # derived words per DM	-.18	.27	.43	.32	.14	-.33	-.38	-.21	.20	-.15	.21	–	
12. # different bound morphemes	.05	-.20	-.17	-.28	-.06	.27	.53†	.30	.33	.25	**.61***	-.34	

Notes. DM = derivational morpheme.

Significance values: ** $p < .01$, * $p < .05$. † trend: $.05 > p < .10$.