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An Analysis of Mental State Verbs in Children with Hearing Loss

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by

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Abstract

Mental state verbs (MSV) require unique cognitive and linguistic knowledge compared to lower level function words (Shatz et al., 1983). These cognitive and linguistic demands are thought to be difficult for children with hearing loss (CHL) due to deficits in word learning (Werfel, 2017; Lund, 2016), limited depth of vocabulary knowledge (Walker et al., 2018) and deficits in complex syntax (Werfel et al., 2021). The present study recruited 73 preschool children (23 CHL-CI, 22 CHL-HA and 28 CNH) to participate. Our analysis examined the frequency, lexical diversity and use of MSV within required complex syntax structures.

Table of Contents

List of Tables

Chapter 1: Review of Literature

What is a Mental State Verb?

Mental state verbs (MSV) describe the internal condition of the speaker or another person. As defined by Hall and Nagy (1986) these internal state words focus on perceiving something not perceivable, refer to psychological rather than physical states and represent short-term conditions rather than long-term (as cited in Booth et al., 1997). Essentially, these words focus on aspects of the mind that cannot be observed. For this reason, production and identification of MSV requires unique linguistic and cognitive skills compared to other low frequency words (Shatz et al., 1983).

MSV production often requires the use of complex syntax. These complex syntax structures tend to exist before the acquisition and use of MSV vocabulary (Shatz et al., 1983). MSV do not appear until later with their syntactical counterparts since one must associate mental states with other people (Barak et al., 2012). There is also a requirement to comprehend the cognitive functions of these verbs. Understanding the use of MSV occurs on a spectrum. For example, the word “know” has six different functions: perception, recognition, recall, understanding, metacognition, and evaluation (Booth et al., 1997). Booth et al. (1997) found that the frequency of MSV with lower functions decreased with age and the frequency of MSV with higher functions increased. The sentence lengths for these older children were longer, as well, which suggests that there was a need for more sophisticated vocabulary to use these words for a higher level of functionality. The reference for the MSV also changed with age in this study. Older children from 51-57 months referenced others and themselves with equal frequency. Before this age, the self was the most common reference. Barak et al. (2012) used a computational model to test the acquisition of MSV given the gradual improved use of syntactic and semantic cues with age. This model found that children used action or physical verb rather than MSV in MSV contexts, which suggests that children pay attention to more observable cues. Comprehension of MSV requires more referential information compared to observable information, making the relevant information about the MSV difficult to identify (Barak et al., 2012).

Given the linguistic requirements behind MSV productions, the exact order and age of acquisition is still unknown. Shatz et al. (1983) conducted a case study and found that “think” and “know” were the most commonly used MSV in a single sample. Verbs that represented a mental state started emerging at 2;8. This case study was followed up with the analysis of 20 additional language samples to confirm these results. In the new samples, “know” and “forget” were the first MSV to emerge compared to “think” in the previous study. These samples also revealed that MSV existed in a conversational form, specifically to “direct the interaction”, before they were used to represent metal states. Most of these interactions included rote phrases. The McArthur-Bates Communicative Development Inventory compiled its data into a word bank to show item trajectories of words tested on the exam. By 30 months, 50% of children produced the word “think” (Frank et al., 2016), but the syntactical context of this production is unknown.

Language Deficits and Hearing Loss

Children with hearing loss (CHL) have been documented to have delayed language skills compared to children with normal hearing (CNH) (Nikolopoulos et al., 2004; Werfel, 2017; Koehlinger et al., 2013). These delays start to emerge in some of the earliest language processes found in emergent literacy, specifically oral language, phonological processing and print knowledge (Werfel, 2017). Over a 6-month period, the rate of change was not significant enough in phonological awareness or concepts of print to reach the level of CNH due to the initial low performance (Werfel, 2017). Combined, all of these language skills affect reading development, which averages around the fourth-grade level (Qi & Mitchell, 2012).

Vocabulary is a part of oral language where CHL face developmental differences, both in its acquisition and depth of knowledge. CHL are delayed in vocabulary development and experience deficits in word learning (Werfel, 2017; Lund, 2016). Part of this delay may result from inadequate access to sound (Nikolopoulos et al., 2004). Audition is a primary vocabulary learning modality, which subsequently delays initial vocabulary learning. As a result, CHL must acquire vocabulary at a higher rate than their peers (Lund, 2016). A meta-analysis by Lund (2016) showed that CHL have lower expressive and receptive vocabulary skills. These simultaneous delays affect vocabulary understanding and production. A slower rate of vocabulary development not only affects spoken language at the single-word level, but at the utterance level, as well. On average, CHL fall in the 25th percentile compared to CNH on mean length of utterance in words (Koehlinger et al., 2013). These shorter utterances may result from a lack of vocabulary in the lexicon.

Conceptual difficulties with vocabulary structures may also affect the use of MSV. CHL have documented deficits that remained significant over time in the depth of their vocabulary knowledge compared to CNH (Walker et al., 2018). An underdeveloped semantic network makes word retrieval less efficient and understanding concrete language difficult (Kenett et al., 2013). One such language concept where CHL struggle is theory of mind. CHL perform at the level of CNH on certain concepts of theory of mind, but fall behind on more language-based concepts (i.e., acknowledging others' beliefs) (Netten et al., 2017).

Another skill that is difficult for CHL is morphosyntax. CHL have been described like children with SLI in terms of their morphosyntax usage (Koehlinger et al., 2013; Werfel, 2018). This presentation may partially be attributed to access to sound (e.g., high frequency morpheme /s/) (Nikolopoulos et al., 2004). Werfel (2018) suggests this difficulty comes from combined deficits in both tense and duration of the morpheme structure. Results from this study showed that CHL performed lower than age- and language-matched CNH peers on regular plural, regular past tense, regular third-person singular and irregular third-person singular. These findings were similar to Koehlinger et al. (2013) who showed that CHL were more likely to use morphemes incorrectly compared to CNH at ages 3 and 6.

CHL Deficits and Mental States

When these language delays are combined together, it impacts complex syntax. Complex syntax is defined as “utterances that consist of more than one clause, either through coordination, subordination or embedding” (Schuele & Dykes, 2005). Metal state utterances are one type of complex syntax explored in this paper. Mental state utterances include WH non-finite clausal complements (e.g., I know how to bake), WH finite clausal complements (e.g., I wonder where I can find the purse) and full propositional complements (e.g., She knows that I like cake) (Schuele, 2009). Each of these mental state utterances requires use of vocabulary and morphosyntax to successfully form a cohesive thought.

Delays in vocabulary have an immediate effect on complex syntax since CHL may not have the expressive vocabulary skills to fully form a complete utterance. If a child does not have a certain word in their lexicon, then he or she is unable to use that verb form (e.g., MSV must be encoded in the lexicon in order to form utterances requiring them). Even if a word is encoded in the lexicon, the depth of knowledge surrounding the word may vary. CHL have trouble with distant meanings or multiple meanings of words (Kenett et al., 2013). The metaphoric language found in mental state vocabulary could be difficult for CHL since it is not easily observable. This idea is supported in Peters et al. (2009) where CHL used more perception-based syntax structures (e.g., “The baby is sad”) rather than cognition-based syntax structures (e.g., “He knows”) in an expressive language sample. de Villiers and de Villiers (2000) reported that CHL were unable to process the use of mental states (as cited in Peters et al., 2009). This suggests that vocabulary processing, not just the syntactical language skills, is important in the use of mental state vocabulary.

Deficits in morphosyntax also affect the production of mental state utterances and other forms of complex syntax. If CHL do not have mastery of earlier verb structures and simpler forms of complex syntax, then more advanced structures, like MSV, may not emerge until later compared to CNH. As a result, CHL appear to be “younger” in terms of their oral language due to the use of simple complex syntax structures, omission of morphosyntax structures or decreased mean length of utterance (Koehlinger et al., 2013).

Current Study

Limited research exists about MSV used by CHL in complex syntax; however, research shows this skill could be affected by vocabulary and syntax. Nikolopoulos et al. (2004) found that only 2% of CHL scored above the lowest percentile of CNH on a receptive language task before cochlear implantation compared to 67% after implantation. Although this study shows progress toward CNH, it did not evaluate the expressive language ability and it failed to record a pre-implantation score for 38 of the 82 participants due to the standardization age-range on the test. Furthermore, research on MSV is limited to the context of theory of mind. These studies evaluate the understanding of MSV, not necessarily its usage in a naturalistic sample or within complex syntax. However, de Villiers and de Villiers (2000) concluded that a child needs to have the proper syntax structures in order to express thoughts about the mind (as cited in Peters et al., 2009). Given the lack of research and the documented language deficits in CHL this study aims to answer three questions:

1. What is the frequency of MSV in CHL compared to CNH? Furthermore, do these frequencies differ in CHL with cochlear implants (CI) versus hearing aids (HA)? Given the language deficits found in CHL vocabulary, we hypothesize CHL will use fewer total MSV.
2. What is the lexical diversity of MSV usage in CHL-CI and CHL-HA compared to CNH? We expect that CHL will use less variety of MSV in the sample.
3. What is the frequency of complex syntax forms that require MSV in CHL-CI and CHL-HA compared to CNH? We expect that CHL will use MSV more simple utterances compared to complex utterances, which would impact the frequency of MSV productions.

Chapter 2: Methods

All participants were part of the Early Language and Literacy Acquisition (ELLA) study conducted through the University of South Carolina and Texas Christian University. Experimental procedures were approved by the Institutional Review Board at the University of South Carolina with agreement from Texas Christian University. At study entry, researchers attained a signed consent form. Before each session, researchers attained assent from each participant for participation in the ELLA study.

Participants

73 preschool children participated in this study. There were three groups: children with hearing loss who wore cochlear implants (CHL-CI), children with hearing loss who wore hearing aids (CHL-HA) and children with normal hearing (CNH). The CHL-CI group included 23 children (Mean age=54.65 months; range= 51-58 months). Hearing loss ranged from severe-profound to profound. The CHL-HA group included 22 children (Mean age=54.65 months; range= 52-56 months). Hearing loss ranged from mild-moderate to severe-profound. Participants in both groups with hearing loss were diagnosed with permanent hearing loss by a certified audiologist. The median age of identification and age of first hearing aid was not statistically significant; however, Cohen effect sizes indicated a medium effect for both age of identification (-.520) and age of first

hearing aid (-.580). Degree of hearing loss between groups was statistically significant. The CNH group included 28 children (Mean age= 53.71 months; range=50-58). Prior to beginning the study, the CNH group completed a bilateral hearing screening. All participants who participated in the study passed.

Table 2.1 Audiologic information for CHL-CI

Variable	Age of ID (months)	Age of first hearing aid	Age of first implant	Degree of hearing loss
M	7.50	10.05	19.65	Severe to profound-4
SD	10.49	10.43	10.28	Profound-19
Range	0-36	1.5-39	9-48	
Median	1.75	5.00	16.00	

Table 2.2 Audiologic information for CHL-HA

Variable	Age of ID	Age of first hearing aid	Degree of hearing loss	
M	14.47	17.68	Mild-Moderate-5	
SD	15.67	15.49	Moderate-3	Mild-Moderately Severe-1
Range	0-45	1.5-48	Moderately severe-9	Severe-1
Median	12.00	14.00	Severe-Profound-1	

Participants in each of these three groups reported English as their primary home language (>70%) and no other conditions that would affect speech or language (e.g., autism, Down syndrome) other than hearing loss in the CHL groups. Distributions for gender, ethnicity, and race were not statistically significant. There was a main effect for maternal education. CHL-CI were significantly different than CHL-HA, but neither group was different than CNH. All children scored in the highest category for speech perception of monosyllabic words. Scores for nonverbal intelligence were not statistically significant. As expected, measures of language showed significant differences between groups. Spoken language quotient, expressive vocabulary and morphosyntax scores showed significant differences between CNH and both CHL groups, but not between CHL-CI and CHL-HA. Receptive vocabulary and speech sound production scores showed significant differences between CHL-CI and CNH with no other significant differences between groups.

Table 2.3 Descriptive Measures by Group

Variable	CHL-CI (n=23) M (SD)	CHL-HA (n=22) M (SD)	CNH (n=28) M (SD)	p
Age in months	54.65 (1.80)	53.77 (1.27)	53.71 (2.36)	.172
Maternal education in years	16.26 (1.81)	17.59 (1.56)	17.54 (2.33)	.037 *CNH-CI:* .096 *CNH-HA*: 1.00 *CI-HA*: .034
Nonverbal intelligence	107.57 (18.69)	109.82 (17.39)	116.39 (10.35)	.113
Speech sound production	80.81 (15.79)	88.83 (17.84)	92.59 (10.66)	.037 *CNH-CI:* .022 *CNH-HA: .823* *CI-HA*: .384
Spoken language quotient	92.87 (21.21)	102.95 (12.52)	115.93 (14.65)	<.001 *CNH-CI:* <.001 *CNH-HA: .004* *CI-HA*: .166
Expressive vocabulary	98.22 (15.13)	104.18 (16.01)	120.32 (11.35)	<.001 *CNH-CI:* <.001 *CNH-HA: .001* *CI-HA*: .500
Receptive vocabulary	93.36 (15.30)	103.82 (20.10)	114.89 (21.90)	.001 *CNH-CI:* .001

				CNH-HA: .194 *CI-HA*: .168
Morphosyntax	46.93 (33.55)	54.29 (34.57)	89.50 (11.89)	<.001 *CNH-CI:* .001 *CNH-HA: .002* *CI-HA*: .911

Measures

The Primary Test of Nonverbal Intelligence (PTONI; Ehrler & McGhee, 2008) is a standardized measure used to calculate nonverbal intelligence. Children were asked to identify which item did not belong on each page. Standardized scores were calculated per the test manual.

The Arizona Articulation Proficiency Scale-Fourth edition (Fudala & Stegall, 2017) was used to measure each child's level of speech sound production. Children were asked to identify pictures using single words. Stimuli items measured vowel and consonant productions. Standardized scores were calculated per the test manual.

The Test of Early Language Development-Fourth edition (TELD; Hresko et al., 2017) was used to measure receptive and expressive language abilities. Children were administered both subtests of this measure. These subtest scores were used to calculate the overall spoken language quotient, which was determined per the test manual.

The Expressive One Word Picture Vocabulary Test-Fourth edition (EOWPVT-4; Brownell, 2011) was used to measure expressive vocabulary.

Children were asked to name pictures of items. Standardized scores were calculated per the test manual.

The Peabody Picture Vocabulary Test-Fifth Edition (PPVT-5; Dunn, 2018) was used to measure receptive vocabulary. Children were asked to listen to a stimuli word given by the examiner and point to that picture in a set of four. Standardized scores were calculated per the test manual.

The Test of Early Grammatical Impairment Screener (TEGI; Rice & Wexler, 2001) was used to measure morphosyntax production of third person singular and past tense. In the third person singular subtest, children were shown a picture of an adult as asked what each person does (e.g., "This is a teacher. Tell me what a teacher does. She _____.; Target: She teaches.) In the past tense subtest, children were shown two pictures of children. In one picture, the child is currently doing an action. In the other picture, the child has completed the action. The examiner explained the first picture and then asked what each child did (e.g., "Here he is raking the leaves and now he is done. Tell me what he did. He____; Target: He raked the leaves.). This subtest examined both regular and irregular past tense verb production. Percentage correct from each subtest was used to calculate the overall screener score, which was calculated per the test manual.

Language samples

A 12-minute conversational language sample was collected utilizing the 3-part Hadley (1998) protocol. Procedures for language sample analysis are described below.

Language sample elicitation

The Hadley (1998) protocol was selected for standardization of collection. The duration of this protocol allowed for a large range of conversational topics, complex utterance opportunities and conversational styles (e.g., expository, story retelling). Pictures were utilized during elicitation due to the young age of the participants (Heilmann, Nockerts, & Miller, 2010).

Each sample was approximately 12 minutes and was divided into three blocks. The first four-minutes block included personal narratives about a child's birthday, family, or siblings. The second four-minute block was an expository explanation of what a child likes to do at school, what games they like to play at home, and how to play these games. The final four-minute block included story retells of a child's favorite movie, book or TV show.

Procedures

Language sample elicitation was embedded in an, approximately, two-hour testing session. Sessions were conducted in a participant's private home, public library or a private research lab at the University of South Carolina or Texas Christian University. Administration of study measure described was randomized and predetermined. Standardized measures were administered simultaneously with the language sample or within six months of entry into the study.

Language sample transcription

Language samples were transcribed by trained members of the Written Language Lab (WLL) or employees of SALT transcription services. The language samples were first transcribed for gross dialogue. A second transcriber then fine-tuned the details of the document. A final transcriber viewed the transcript for accuracy. Werfel and Douglas (2017) was used for utterance division protocol.

Members of the WLL were trained on transcription protocol prior to starting. Each member of the WLL read the lab's language sample transcription manual, transcribed an example participant, and met with a senior member of the WLL to discuss their transcription in relation to the key. Any consistent errors were addressed. SALT transcription services provided an example transcription, which was compared to a transcription completed by lab members. SALT services and lab members reached >95% accuracy before beginning services for the study.

Language sample coding procedures

After the transcription process was complete, samples were coded for complex syntax (Scheule, 2009) and grammatical morphemes Werfel (2016).

Grammatical morphemes

Child utterances were coded for grammatical morphemes based on guidelines from Werfel (2016). All WLL members were trained prior to coding for grammatical morphemes. This coding procedure went through a three step coding process, similar to language sample transcription. Final transcripts reached 100% consensus between lab members.

The Standard Measures Report and Summary of Utterances Types were used to record MLU in words and morphemes, number of different words (NDW), length of each sample, intelligibility, number of utterances, percentage of mazes/omissions and number of total words in the sample.

Complex syntax

Child utterances were coded based on the categories outlined in Schuele (2009). All WLL members were trained prior to coding for complex syntax. Similar to language sample transcription, the complex syntax coding procedure followed a three-step process. Final transcripts reached 100% consensus. Complex syntax was coded by first identifying a phrase with two or more verb phrases. Each of these phrases received the code [cs] to represent complex syntax. Next, the trained lab member identified key grammatical features that represented different categories of complex syntax. These complex syntax code(s) were placed after the [cs] code. If there was an error in the complex syntax production (e.g., missing morphemes, omission of obligatory to/what/that), then the [err] code was placed to signify an error.

Language sample analysis procedures

After transcription and coding procedures were completed, SALT 18 software (Miller & Iglesias, 2012) was used to analyze complex syntax. Analysis was completed with the total utterances found in the language sample document. This means that utterances that were incomplete or included unintelligible words were also included in the analysis. We chose to use the total utterances to monitor development of MSV and monitor the context in which it appears between the two groups. With a preschool population, we are interested more in the emergence of complex syntax rather than complete and accurate utterances

The Explore feature was then used to search for MSV in the sample. The present, third person, present progressive and past tense forms of these verbs was searched. The verbs included in this search are listed in Appendix A. In addition to specific MSV usage, the Explore feature was also used to monitor the context of MSV by searching for the codes [WNFC], [WFC] and [FPC]. Usage in simple versus complex syntax was monitored, as well.

Chapter 3: Results

This study aimed to discover the frequency, lexical diversity and complex use of MSV in CHL compared to CNH. Analysis of general complex syntax use is displayed in Table 4. A univariate Analysis of Variance (ANOVA) showed the total number of utterances was not statistically significant; therefore, any differences in complex syntax (CS) could not be attributed to the length of the sample collected. An *H* Test revealed that percentage of utterances containing CS errors was not significantly different. Percentage of utterances containing CS attempts, percentage of utterances with correct CS and CS density were significantly different (p=<.001). Both the CHL-CI and CHL-HA group were different from the CNH group, but not from each other.

Table 3.1 Complex Syntax Measures

Variable	CHL-CI (n=23) M (SD) Median Range	CHL-HA (n=22) M (SD) Median Range	CNH (n=28) M (SD) Median Range	P
Total number of utterances	115.09 (28.71) 121.00 71-191	117.18 (28.09) 125.50 56-155	132.82 (33.31) 129.50 56-224	.079
Percent Utterance: CS Attempts	9.00 (7.45) 7.81 0-24.00	11.39 (8.79) 10.76 0-27.60	21.27 (10.49) 19.53 3.40-47.10	<.001 *CNH-CI:* <.001 *CNH-HA: .002* *CI-HA*: .453

Percent Utterance: CS Errors	1.50 (1.80) 1.28 0-7.90	1.12 (1.53) 0 0-4.70	0.73 (0.88) 0.25 0-2.96	.236
Percent Utterance: CS Correct	8.52 (6.77) 6.80 0-23.10	10.85 (8.98) 8.99 0-30.00	20.54 (10.09) 19.53 2.80-45.20	<.001 *CNH-CI:* <.001 *CNH-HA: .001* *CI-HA*: .544
CS Density	0.11 (0.10) 0.07 0-0.34	0.14 (0.11) 0.13 0-0.40	0.31 (0.17) 0.30 0.03-0.68	<.001 *CNH-CI:* <.001 *CNH-HA: <.001* *CI-HA*: .559

Research Question One: MSV Frequency

Group differences were revealed in total MSV usage using a univariate ANOVA where p= <.001. A follow-up post-hoc test revealed that CHL-CI and CHL-HA, 11.48 (p= <.001) and 14.86 (p=.015) respectively, produced significantly few utterances utilizing MSV than CNH, 22.93. The frequency of MSV use was significantly coordinated with expressive vocabulary (p=<.001) for the cochlear implant group.

Within the total use of MSV, we were interested in MSV use for different syntactic structures. Group differences were revealed in MSV usage in utterances that required CS using an ANOVA. A follow-up post-hoc test revealed that CHL-CI and CHL-HA, 1.57 (p= .005) and 1.73 (p=.008) respectively, used significantly few utterances that required FPC/WNFC/WFC than CNH, 4.79. Use of MSV in other forms of complex syntax was also significantly lower for CHL-CI and CHL-HA when compared to CNH, <.001 and .003 respectively, but not when compared to each other. No significant differences were observed for the use of MSV in simple sentences.

Table 3.2 Total MSV

Variable	CHL-CI (n=23) M (SD) Range	CHL-HA (n=22) M (SD) Range	CNH (n=28) M (SD) Range	p
Total MSV in Sample	11.48 (7.88) 0-36	14.86 (9.50) 0-42	22.93 (9.75) 5-41	<.001 *CNH-CI:* <.001 *CNH-HA: .015* *CI-HA*: .491

Table 3.3 MSV Across Syntax Types

Variable	CHL-CI (n=23) M (SD) Range	CHL-HA (n=22) M (SD) Range	CNH (n=28) M (SD) Range	p
MSV in Simple	7.35 (4.89) 0-20	9.00 (6.87) 0-29	9.57 (4.77) 1-22	.348
MSV in FPC/WNFC/ WFC	1.57 (2.11) 0-9	1.73 (2.07) 0-7	4.79 (4.50) 0-20	.001 *CNH-CI:* .005 *CNH-HA: .008* *CI-HA*: .992
MSV in Other CS	2.57 (3.38) 0-12	4.14 (3.64) 0-14	8.57 (5.29) 1-22	<.001 *CNH-CI:* <.001 *CNH-HA: .003* *CI-HA*: .367

Research Question 2: Lexical Diversity of MSV

Group differences were revealed in the lexical diversity of MSV usage using a univariate ANOVA where p= <.001. A follow-up post-hoc test revealed that CHL-CI and CHL-HA, 4.74 (p= .001) and 5.73 (p=.018) respectively, used significantly less variation of MSV than CNH, 8.14.

Table 3.4 Lexical Diversity of MSV

Variable	CHL-CI (n=23) M (SD) Median Range	CHL-HA (n=22) M (SD) Median Range	CNH (n=28) M (SD) Median Range	p
Number of Different MSV	4.74 (2.80) 4.00 0-11	5.73 (2.69) 6.00 0-12	8.14 (3.24) 8.00 2-15	<.001 *CNH-CI:* .001 *CNH-HA: .018* *CI-HA*: .551

Table 3.5 MSV Frequency by Group

MSV	CHL-CI	CHL-HA	CNH
Ask	0	2	3
Believe	0	0	1
Consider	0	0	0
Decide	1	0	0
Discover	0	0	0
Figure (out)	0	0	2
Find	2	2	14
Finish	1	0	0
Forget	0	2	8
Guess	0	5	7
Hate	0	0	3
Hear	0	3	3
Hope	0	1	0
Know	17	20	26
Like	14	19	25
Look	5	6	13
Love	4	3	11
Mean	2	1	4
Notice	0	0	1
Prefer	0	0	0
Pretend	1	0	4
Promise	0	0	0
Remember	3	3	9

Realize	0	0	0
Recognize	0	0	0
Remind	0	0	0
Say	8	8	17
See	11	10	20
Show	2	7	4
Tell	6	7	12
Think	8	3	13
Understand	0	0	0
Watch	12	11	12
Want	9	13	21
Wish	3	0	3
Wonder	0	0	0

Research Question 3: MSV with Required CS

Group differences (p=<.001) were revealed in FPC use for CHL-CI and CHL-HA when compared to CNH, but not when compared to each other (p=.654). No differences were seen in WFC or WNFC use, p=.061 and .478. It should be noted that WFC and WNFC structures were rarely used across all three groups.

Table 3.6 Complex Syntax Use

Variable	CHL-CI (n=23) M (SD)	CHL-HA (n=22) M (SD)	CNH (n=28) M (SD)	p
FPC Correct	0.83 (1.03)	0.55 (0.74)	2.50 (2.25)	<.001 *CNH-CI:* .003 *CNH-HA: <.001* *CI-HA*: .654
FPC Error	0.04 (0.21)	0.05 (0.21)	0.07 (0.26)	
FPC Percent Correct	96.97 (10.04)	90.91 (30.15)	97.73 (7.79)	
WFC Correct	0.26 (0.69)	0.77 (1.01)	1.29 (2.16)	.061
WFC Error	0.17 (0.39)	0.09 (0.43)	0.04 (0.19)	
WFC Percent Correct	50 (53.45)	90.91 (30.15)	93.33 (25.82)	

WNFC Correct	0.17 (0.65)	0.23 (0.53)	0.46 (1.26)	.478
WNFC Error	<.001 (<.001)	<.001 (<.001)	<.001 (<.001)	
WNFC Percent Correct	100 (<.001)	100 (<.001)	100 (<.001)	

A follow-up regression model was conducted to determine how FPC use compared to overall MSV use in the sample. 7.9% of the unique variance was explained by group while an additional 32.7% is explained by MSV use in the entire sample.

Table 3.7 Regression Model for MSV in Sample

Model	R^2 Adjusted	Predictor Variables	B	SE B	β	t	p
1	.236						
		Group	-1.811	.375	-.497	-4.825	<.001
2	.479						
		Group	-0.858	.351	-0.235	-2.446	.017
		MS in sample	.0.97	.017	.561	5.831	<.001

Table 3.8 Regression Model for MSV in Simple

Model	R^2 Adjusted	Predictor Variables	B	SE B	β	t	p
1	.236						
		Group	-1.811	.375	-.497	-4.825	<.001
2	.233						
		Group	-1.770	.379	-.486	-4.671	<.001
		MS in Simple	.029	.034	.089	.856	.395

Chapter 4: Discussion

The purpose of this study was to analyze MSV usage between CHL and CNH as well as to analyze differences between CHL-CI and CHL-HA. These skills were hypothesized to be significantly different due to general weakness in vocabulary and complex syntax in CHL.

General CS Findings

Within the given language sample, CHL produced a comparable number of utterances compared to their age-matched, normal hearing peers. Within these utterances, CHL in this study were significantly different than CNH in terms of CS attempts, correct CS attempts and CS density; however, the two CHL groups were not different than each other. These findings were similar to Werfel et al. (2021).

Frequency of MSV Use

Our data revealed that MSV use is reduced in CHL-CI and CHL-HA in the given sample compared to CNH. This difference appears to come specifically from use of MSV in CS. CHL did not differ from CNH when using MSV in simple syntax. Therefore, it may not be that these words do not exist in their lexicon, the depth of knowledge for this vocabulary may not be sufficient to be used in CS. This idea is supported by de Villiers and de Villiers (2000) who reported that CHL have difficulty processing the meaning of MSV.

Use of MSV in CNH varied from simple utterances such as “Last time you didn’t say your doggie’s name” to complex utterances such as “I had cake because I love cake and it’s my favorite thing in the world” and “Dogs at friend’s house because my mommy said I want to go buy a new one but I wanna keep those dogs”.

CHL-CI demonstrated fewer complex productions than CNH which included “I don’t know”, “I just telling you” and “I love it”. Complex utterances included phrases such as “I don’t know what that is” and “I like to watch PawPatrol”. There was also one participant who used no MSV.

CHL-HA demonstrated fewer complex productions, as well. Examples of simple utterances include “I don’t know”, “Guess what” and “Look at him”. Complex utterances include “I don’t know how to play that thing” and “I hope there’s one that’s Frozenfour”. There was also one participant who used no MSV.

Lexical Diversity in MSV

Not only did our data reveal that CHL used a few total number of MSV, but it also revealed that they used less diversity of verbs within our analysis list. Words like *know, like, say, see, watch and want* were used frequently across all groups. Higher level words such as *consider, discover, prefer, promise, realize, recognize, remind, understand and wonder* were not used in any group. Verbs that were used less frequently were generally used the most by the CNH group. These results suggest that vocabulary could a crucial role in MSV use.

Expressive vocabulary was significantly correlated (p=.008) to total MSV in the sample only for the CHL-CI group. On average, this group also used the least diversity in MSV (M=4.74). This correlation may identify the need for a word to be within our lexicon before it is used, suggesting that vocabulary drives MSV use rather than knowledge of CS.

Use of MSV in Required CS

We wanted to further explore MSV use by investigating how these three groups used MSV in a required CS context. First, we analyzed how these groups differed in their use of full propositional, Wh- finite and Wh- nonfinite clauses. CNH produced significantly more correct FPC phrases than CHL-CI and CHL-HA. These results are similar to Werfel et al. (2021) who found that CHL performed below their age- and language-matched peers when using this specific structure. No differences were found in WNFC or WFC clauses; however, these clauses were rarely used by either of the three groups. Across all comparisons for use of MSV in CS, CHL-CI and CHL-HA were significantly different compared to CNH but not from each other. These findings were surprising considering that the degree of hearing loss was significantly different between groups.

Clinical Implications

Our findings revealed group differences regarding MSV that could be applicable for goals in therapy or in the classroom. As a whole, CHL preformed similarly as a group regardless of hearing device. Therefore, when working with these groups of children, clinicians should treat them equally and not assume that more access to natural sound without amplification results in higher language skills. These group differences in MSV use may also offer potential goals or target vocabulary to use in therapy. CHL experience vocabulary deficits as a whole and learn best through explicit instruction (Lund & Douglas, 2016). These trends would suggest that working with MSV in therapy could be beneficial since these verbs cannot be observed and, therefore, not easily acquired through indirect exposure.

Limitations

This study offers a snapshot of MSV use in CHL and CNH. At this given testing timepoint, MSV knowledge may still be emerging thus not offering a complete view of group differences. More testing may be warranted at a later timepoint to see if there are changes in group performance. Furthermore, this study offers a limited sample for each of the three groups. Repeating these analyses with more participants is required before any definite conclusions can be drawn.

Future Directions

We expect that future research can explore more variables related to MSV. First, we could conduct the study with older participants to see how MSV production changes with vocabulary growth. We could also monitor these groups across time to see if these differences remain constant. The current study looked at a wide range of MSV, but future studies could narrow this exploration to see how specific verbs develop over time or how their use changes within complex syntax. Finally, knowing that CHL utilize fewer MSV, we can explore or develop an evidence-based instruction to discover how to best teach these verb concepts.

Conclusions

The purpose of this study was to explore MSV production and analyze differences in the frequency of use, lexical diversity and production within required CS structures for CHL and CNH. Results indicate that CHL use significantly fewer MSV as a whole. These two groups also used significantly fewer MSV in required contexts compared to CNH. Finally, there is less lexical diversity of these verbs compared to CNH. The CHL-CI and CHL-HA groups differed significantly from CNH on all of these measures, but never from each other. Additional correlations show that expressive vocabulary is significantly tied to MSV use for the CHL-CI group. These results suggest that vocabulary drives use of MSV rather than syntax.

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Appendix A: Mental State Verb Reference List

Table A.1 Mental State Verbs and Utterance Examples

Mental state verb	***FPC Example***	***WFC Example***	***WNFC Example***
Ask	He asked if I could go.	He asked where I went.	He asked Mary where to go.
Believe	I believe that he is correct.	I believe what you are saying.	N/A
Consider	I considered that she was right.	He considered what she was saying.	He considered what to say to her.
Decide	He decided she was joking.	She decided whether he was lying.	He decided to go with her.
Discovered	He discovered that the shell was actually a shark tooth.	He discovered where the sharks lived and hunted.	He discovered who to search for at the beach.
Figure (out)	I figure that she will grow up.	I figured out when she would return.	I figured out when to leave tomorrow.
Find	I found out that we went to school together.	I found out where she goes to school.	I found out where to go.
Finish	N/A	I finished what the sentence she was about to say.	N/A
Forget*	I forgot that you were coming.	I forgot what you brought.	I forgot when to call you today.
Guess*	The boy guessed that the movie would be scary.	The girl guessed who stole the diamond ring.	I guessed where to put the gift.
Hate	I hate that she cancelled our plans.	I hate who she brought to the party.	N/A
Hear*	She heard that the team won the game.	He heard what they were talking about.	She heard when to reserve her tickets.

Hope	I hope that you come.	N/A	N/A
Know*	Lily knows that you aren't coming.	He knows who bought the gift.	Lily knows who to send the letter to.
Like*	I like that you came today.	I like who you brought to the party.	N/A
Look*	N/A	Look what I did	N/A
Love*	I love that you joined us.	She loves when you use that joke.	N/A
Mean*	I mean that you are wrong.	N/A	N/A
Notice	She noticed that he left early.	I noticed what she was wearing.	I noticed what she put in the bag.
Prefer	(I'd prefer that he comes.)	N/A	N/A
Pretend*	Jake pretends that he went to school there.	N/A	Jake pretends where to go.
Promise	She promised that she was honest.	N/A	N/A
Remember*	I remembered that you came to see me.	He remembered where the baby dropped her doll.	He remembered where to meet on Monday.
Realize	She realized that she forgot her lunch.	I realized where the class went.	He realized how to solve the problem.
Recognize	I recognize that girl over there.	She recognizes what she did was wrong.	He recognized how to solve the puzzle.
Remind	My mom reminded me that I should say please.	Zach reminded me who was coming to dinner.	Nina reminded Alex what to say during the speech.
Say	Megan says that he stole her seat.	Bob said what she was doing last night.	Molly said what to bring to the party.
See*	I see that you like animals.	He saw what you were doing.	She saw where to go.
Show	She showed you that the fan was still working.	He showed the man where they were going.	He showed him where to go.
Tell	I told you that you were messy.	He told her what they were doing.	She told me what to do.

Think*	I think that he forgot.	N/A	(I think what to do)
Understand*	He understands that she can't go.	She understands what they enjoy.	He understands how to solve the problem.
Watch	She watched that they left on time.	Molly watched what they played.	Bill watched where to go.
Want*	N/A	I want what you described to me.	N/A
Wish	I wish that you could come.	N/A	N/A
Wonder	I wonder if they are coming.	I wonder where they went.	She wondered what to do.

*denotes verbs also listed in (Bretherton & Beeghly, 1982)