Lexical-Semantic Organization as Measured by Repeated Word Association in Children with Hearing Loss

by

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LEXICAL-SEMANTIC ORGANIZATION AS MEASURED BY REPEATED WORD ASSOCATION

IN CHILDREN WITH HEARING LOSS

A Thesis for the Degree

Master of Science

By

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Introduction

Receptive vocabulary scores in preschool-aged children are strong predictors of future academic and social success (Dollinger et al., 2008; Gertner et al., 1994; Rohde & Thompson, 2007; Ukrainetz, 2014). Learning words is not a simple task, however. Vocabulary must be adequately stored and organized to facilitate both effective retrieval of existing words and addition of novel words into the structured system (Lund, 2020). Thus, for children who struggle with receptive and expressive vocabulary, it is important to think not only about their vocabulary acquisition, but also storage and organization abilities or skills.

Vocabulary Outcomes for Normal Hearing Children

Typically developing children with normal hearing learn vocabulary through incidental learning, processing contextual linguistic input to infer and retain novel word meanings (Lund, 2020). Without explicitly learning strategies or receiving direct instruction, these children still grow proficient in learning new words quickly, only requiring as few as three exposures to learn new word-referent associations by the age of 18 months (Houston-Price et al., 2005). Initial word learning is likely only surface level. Learning the full meaning of a word must, at a minimum, consider the phonological components, orthographic display, multiple meanings, part of speech, and contextual evidence of the word. Therefore, learning the depth of words requires multiple exposures in context to store the word's multiple characteristics including semantic, syntactic, lexical, and phonological representations (Caramazza, 1997).

Lund (2020) outlined the pattern in which children with normal hearing acquire vocabulary through three distinct, but occasionally overlapping processes: triggering, configuration, and engagement. Proper functioning of all three processes allows individuals to increase the storage and depth of their lexical knowledge, including the development of novel semantic relationships, and to organize that information in a manner that allows for adequate retrieval. Triggering refers to the process of recognizing that a word is new and must be learned while simultaneously mapping the new word to its orthographic form (Hoover et al., 2010). The process of configuration involves recognizing the individual sounds in the word, the entire word form, and semantic representations from previously gained knowledge (Leach & Samuel, 2007). Engagement refers to the necessary interaction that must occur between the new word and the child's existing lexicon, facilitated by the organization of the lexicon. Engagement with the lexical organizational system must occur for a child to recognize semantic and taxonomic relations, phonological relations, and syntactic relations between words stored in the mental lexical and the novel word (Luce & Pisoni, 1998; Sheng & McGregor, 2010; Waxman & Gelman, 1986). Children must pass through all three processes to fully-learn a word's meaning.

Lexical-Semantic Organization in Children with Normal Hearing

A child's ability to recognize semantic and taxonomic relations, phonological relations, and syntactic relations, through the process of engagement, is an index of the maturity level of the lexical-semantic organization a child has in place. As a typically developing child's lexical-semantic organization develops, their systematic organizational patterns shift from relating words based on phonological properties to semantic properties (Cronin, 2002). Two types of semantic relations are present in lexical-semantic organization: thematic and taxonomic. Thematic relations describe words that coexist in the same schema (e.g., dog-bone) and taxonomic relations describe words that are hierarchically related (e.g., dog-animal). The shift in organizing semantic lexicon by thematic relations to taxonomic relations (the more mature organizational schema) occurs in middle childhood in typically developing children, resulting in an explosion of the child's vocabulary (Sheng et al., 2006). Even though this shift does not occur until middle childhood, typically developing children understand taxonomic organization at as early as three years of age (Waxman & Hatch, 1992).

In using taxonomic organization, a word association may be classified as superordinate, basic, or subordinate. For example, (Waxman & Hatch, 1992) used name possible taxonomic associations for the word dog as animal (superordinate), cat (basic), and golden retriever (subordinate). Typically developing children master superordinate relations, the broad category that a given target word is related to, around seven years of age (Di Giacomo et al., 2012; Lucariello et al., 1992).

Preschool-aged children with normal hearing also tend to demonstrate pure phonological relations between words through clang responses, alliterations (e.g., candy-can) or rhymes (e.g., dig-fig) to the stimuli word without semantic relations (Sheng & McGregor, 2010). As children with normal hearing continue schooling after kindergarten and their meaning-based organizational system continues to develop, the number of clang and unrelated responses to word stimuli decrease as the number of semantic responses increase (Cronin, 2002; Sheng, 2007).

A parallel shift from syntagmatic sequencing, responding to a stimulus word following a pattern of word from most frequently used with the stimulus word (e.g., cold-outside), to paradigmatic sequencing, responding to stimulus word following the same grammatical form class of stimulus word (e.g., cold-hot), occurs in middle childhood

(Nelson, 1977; Sheng & McGregor, 2010; Sheng et al., 2006). In contrast to the thematic-taxonomic relations which are mainly used to organize nouns, the syntagmatic-paradigmatic sequences are used to organize all parts of speech and are most observed in adjectives (Sheng et al., 2006). Similar to the thematic-taxonomic shift, as children with normal hearing continue schooling after kindergarten, the number of syntagmatic responses to word stimuli decreases as the number of paradigmatic responses increases (Lippman, 1971). In summary, typically developing children with normal hearing go through the complex process of learning a new word with relative ease.

Vocabulary Outcomes for Children with Hearing Loss

Distinct differences are present between vocabulary outcomes in children with and without hearing loss. Current literature reports a gap in the vocabulary knowledge of children with hearing loss and their peers with normal hearing (Lund, 2016; Lund & Dinsmoor, 2016; Peterson et al., 2010; von Ilberg et al., 2011). Due to United States Food & Drug Administration (FDA) regulations, the minimum age a child may receive cochlear implants, in the United States, is 9 months of age for children with bilateral profound sensorineural hearing loss. The minimum age was lowered from 12 months to 9 months in 2020. However, the minimum age for implantation when the participants for the present study were born was 12 months. Therefore, current participants with hearing loss falls at a minimum of one year behind in acquiring vocabulary knowledge in comparison to chronologically-age-matched peers. A child with hearing loss must learn vocabulary at a faster rate than normal hearing, age matched peers in order to “catch up” (Lund, 2016). Various studies have compared the vocabulary outcomes in children with hearing loss to chronologically-age-matched peers. The results proved children with hearing loss to be less proficient in word learning and to have smaller lexicons, as seen in both receptive and expressive naming abilities (Houston et al., 2005; Houston et al., 2012; Lund & Schuele, 2017).

Lund (2020) proposed that children with hearing loss may experience interruptions in one or all three of the subprocesses that normal hearing children predictably use to acquire vocabulary: triggering, configuration, engagement. Demonstrating difficulties in the process of triggering, children with cochlear implants failed to match the rate of normal hearing peers in pairing novel words to nameless pictures in a disambiguation task (Lederberg et al., 2000). Based on currently published literature, it is unclear if children with hearing loss demonstrate deficits in the configuration subprocess (Lund, 2020). It is important to consider the typical environments for word learning. Classrooms are the most common setting for implicit and explicit vocabulary learning for preschool children. Listening fatigue and listening effort, proven difficulties that are exhibited in individuals with hearing loss, tend to increase in severity in noisy environments (Hornsby et al., 2016). Because these difficulties increase in noisy settings, such as classrooms, they may contribute to potential difficulty in the configuration stage of word learning.

Lexical-Semantic Organization in Children with Hearing Loss

The process of engagement cannot optimally occur without the proper lexical-semantic organization of one's existing lexicon. To assess the possible difficulties that may occur at the engagement level of word learning in children with hearing loss, one must consider the known information on lexical organization in this population. A small number of studies have considered lexical organization of children with hearing loss in different ways. Children with hearing loss have demonstrated a reduced organization at the superordinate association level of taxonomic organization that is similar to vocabulary-matched peers, but lower than age-matched peers (Lund & Dinsmoor, 2016). These findings represent delayed development of complete taxonomic organization, the more mature organizational relation in comparison to thematic organization. Additional studies have found evidence of differences in lexical-semantic organization as children with hearing loss are consistently less likely to produce phonologically related responses to the prompted word in rhyming and verbal fluency tasks (Ground et al., 2014; Wechsler-Kashi et al., 2014). The literature referenced above indicates lexical-semantic organization in children with hearing loss that is similar to that of a younger, typically developing child as opposed to an age-matched peer. This delay in lexical-semantic organization is a determinant of deficits in the engagement process of word learning.

Current literature suggests there may be concurrent differences in lexical-semantic organization along with the delayed development of the organizational maturity of lexicon in children with hearing loss. Based on performances on analogy tasks, single word association tasks, and verbal fluency tasks in children and adults with cochlear implants, previous researchers have proposed that individuals with hearing loss use different lexical-semantic organization strategies than their hearing peers use (Kenett et al., 2013; Marschark et al., 2004). The organizational differences in children with hearing loss, as seen in their reduced ability to access semantic and phonological categories in relation to normal hearing peers, may be attributed to delays in categorical lexical development or a strong phonological relationship to semantic information (Wechsler-Kashi, 2010). Further research is needed to assess the specific taxonomic organizational differences in children with hearing loss for future guidance in appropriate and effective vocabulary intervention for this population.

Additionally, changes in lexical-semantic organization for children with hearing loss must be measured with a task that captures change in lexical organization strategies.

Repeated Word Association Task

To study the lexical-semantic organizational differences between children with and without hearing loss, the current status of organizational development must be measured in each population. A repeated word association task has been used to evaluate the differences in the storage and accessibility of semantic relationships between bilingual children and monolingual children and between typically developing children and children with specific language impairment (SLI; (Sheng & McGregor, 2010; Sheng et al., 2006)). In this task, each individual prompt was repeated multiple times and the individual produced a different single response each time. The repeated nature of the task not only assesses the storage of the lexicon, but also the accessibility of the semantically related words. In the Sheng and McGregor (2010) study, the lexical-semantic organization was assessed in each individual by recording the number of semantic, clang, and error responses. In the Sheng et al. (2006) study, organization was assessed by looking at the order of occurrence, frequency, and accessibility of paradigmatic responses which included synonyms, antonyms, coordinates, superordinates, or a direct negation of the prompt. In both studies, the typically developing children demonstrated an increase in semantically related responses and a decrease in phonologically related responses as age increased (Sheng & McGregor, 2010; Sheng et al., 2006). As demonstrated in these studies, and proposed in previous research, it is possible for the storage of semantic relationships to be comparable between groups while accessibility differs. This technique has not yet been applied to the understanding of lexical-semantic organization in children with hearing loss.

Purpose and Research Question

The current study aims to examine lexical-semantic organization in children with hearing loss in comparison to age-matched peers with normal hearing. Because semantic relations signal mature meaning-based organization, a majority of paradigmatic semantic responses on the repeated word association task will demonstrate the highest maturity of lexical-semantic organization. A majority of clang associations will demonstrate developing but delayed lexical-semantic organizational maturity. A majority of errored responses, including no responses, repetitions of the prompts, or responses bearing no relation to the stimuli, will demonstrate delayed lexical-semantic organizational maturity. If the children with hearing loss demonstrate more clang and error responses in relation to their normal hearing peers, it could be posited that children with hearing loss have differences in the development of lexical-semantic organization in comparison to age-matched peers with normal hearing. However, if the children with hearing loss demonstrate insignificant differences in the ratio of semantic to clang to error responses as their peers, it could be posited that the development of lexical-semantic organization is similar in children with and without hearing loss.

The purpose of the study is to compare the lexical-semantic organization between children with and without hearing loss. The following research questions were posed:

1. Do children with hearing loss (hearing aids or cochlear implants) show less evidence of a thematic-taxonomic shift during a repeated word association task than children with normal hearing?

2. Do children with hearing loss (hearing aids or cochlear implants) provide similar paradigmatic (rather than syntagmatic) responses as children with normal hearing in a repeated word association task?
3. Between age five and first grade, does the gap in the lexical semantic organizational maturity increase between children with hearing loss and children with normal hearing?

Method

All procedures in this study were approved by the University of South Carolina Institutional Review Board, with Texas Christian University in agreement.

Participants

A total of 109 children participated in the tasks analyzed for this study. All participants were part of the ongoing Early Language and Literacy Acquisition in Children with Hearing Loss (ELLA) Study (Werfel & Lund, 2015), which is a longitudinal study of children with hearing loss. Children who are part of the present study and analysis fell into two distinguishable groups, based on age. Group 1 consisted of participants who had not yet started Kindergarten and Group 2 consisted of participants who completed the 1st Grade. The families of children with hearing aids or cochlear implants reported their children were developing listening and spoken language skills, as opposed to the use of manual communication as the primary mode of communication.

Group One

Seventy-three participants were assigned to Group 1 based on age: 30 children with normal hearing (CNH), 22 children with hearing aids (HA), and 21 children with cochlear implants (CI). Participants were recruited through preschools and social media posts across the country. All children were enrolled in the ongoing ELLA study around 4 years of age and completed the measures for the current study around their 5th birthday, prior to beginning Kindergarten (CNH group *M*= 60.23 months, *SD*= 1.02 months; HA group = 60.45 months, *SD*= 1.23 months; CI group *M*= 60.43 months, *SD*= 1.00 months). Each participant came from English-speaking families, with the exception of one participant in the HA group (parent-rated primary language, Spanish; second language, English) and one participant in the CI group (parent-rated primary language, Arabic; second language, English). All participants were assessed with descriptive measures of overall language development, expressive language, and receptive language. Descriptive assessments for Group 1 included:

1. *Test of Early Language Development-3rd Edition (TELD-3*; (Hresko et al., 1999)) to measure each individual's expressive and receptive language abilities.
2. *Expressive One Word Picture Vocabulary Test- 4th Edition (EOWPVT-4; (Brownell, 2011))* to evaluate expressive vocabulary skills.
3. *Peabody Picture Vocabulary Test- 4th Edition (PPVT-4; (Dunn & Dunn, 2007))* to measure receptive vocabulary skills.
4. *Early Speech Perception Test* (*ESP*; (Geers & Moog, 2012)) to measure the effects of the amplification devices (hearing aids or cochlear implants) on each participant's speech perception ability.

For descriptive assessment measures for all Group 1 participants, see Table 1.

Group 1: Children with Normal Hearing

The children in the normal hearing group (n= 30) passed a screening for bilateral normal hearing status (e.g., pure tone thresholds of 20 dB HL or less in both ears at 1, 2, and 4 kHz). In a parent survey upon entry to the ELLA study, parents reported participant gender

(16 Female, 14 Male), ethnicity (26 Not Hispanic or Latino, 2 Hispanic or Latino, 2 Preferred Not to Respond), and race (24 White/Caucasian, 2 Black/African American, 4 Preferred Not to Respond or Identified as "Other"). Mother education was reported to be an average of 18.00 years (SD= 2.18). None of the participants were diagnosed with any disorder that may have affected speech or language skills at the time of testing.

Group 1: Hearing Aid Users

Participants in the hearing aid group (n= 22) met the following criteria: (a) a diagnosis of a bilateral hearing loss, (b) the use bilateral hearing aid amplification, and (c) and the family promoting the use of listening and spoken language. In a parent survey upon entry to the ELLA study, parents reported participant gender (6 Female, 16 Male), ethnicity (20 Not Hispanic or Latino, 2 Hispanic or Latino), and race (17 White/Caucasian, 3 Asian, 1 Black/African American, 1 Native Hawaiian or Other Pacific Islander). Mother education was reported to be an average of 16.98 years (SD= 1.80).

Twenty of the hearing aid group participants received a newborn hearing screening, of which seventeen of them failed. Nine of the participants had a mild to moderate hearing loss diagnosis, four had a moderate hearing loss diagnosis, seven had a moderately-severe hearing loss diagnosis, and two had a severe hearing loss diagnosis. The age of hearing loss diagnosis ranged from 0 months to 43 months of age (*M*= 10.85 months, *SD*= 15.91). The age of initial hearing aid amplification ranged from 2 months to 45 months of age (*M*= 13.84, *SD*= 14.13). Parents of the participants within the HA group reported the following potential causes of hearing loss: Stickler Syndrome, Genetic Causes, Connexin 26, BOR Syndrome, Binder's Syndrome, Usher's Syndrome, Lasix Prescription Drug, STRC Gene Mutation, and Chiari Malformation. The following additional diagnoses were present in the HA group:

Stickler Syndrome, Branchiootorenal (BOR) Syndrome, Non-Integrated Primitive Reflexes, and Spina Bifida. The participants wore a variety of hearing aids from manufacturers including Phontak (Phontak, Warrenville, IL), Oticon (Oticon, Somerset, NJ), and ReSound (ReSound GN, Bloomington, MN) brand hearing aids.

Group 1: Cochlear Implant Users

Participants in the cochlear implant group (n= 21) met the following criteria: (a) a diagnosis of a bilateral hearing loss, (b) the use of at least one cochlear implant device, (c) and the family prompting the use of listening and spoken language. In a parent survey upon entry to the ELLA study, parents reported participant Gender (11 Female, 10 Male), Ethnicity (all identified as not Hispanic or Latino), and Race (19 White/Caucasian, 1 Asian, 1 Black/African American). Mother education was reported to be an average of 17.48 years (SD= 2.14).

Twenty of the CI group participants received a newborn hearing screening, of which eighteen of them failed. Nine participants had a profound hearing loss diagnosis, eight participants had a severe to profound hearing loss diagnosis, three had a Severe hearing loss diagnosis, and one had a moderately-severe hearing loss diagnosis. The age of hearing loss diagnosis in the cochlear implant group ranged from 0 months to 36 months of age (M= 4.77 months, SD= 9.58). All of the participants received bilateral hearing aid amplification prior to cochlear implantation. The age of first ear amplification ranged from 6 months to 56 months of age (M= 27.64 months, SD=15.93) and the age of second ear amplification ranged from 16 month to 60 months (M= 29.68 months, SD= 18.19). Parents of the participants within the cochlear implant group reported the following potential causes of hearing loss: Auditory Nerve Neuropathology, Cytomegalovirus (CMV), Connexin 26, Pendred

Syndrome, Waardensburg Syndrome, Bacterial Meningitis, Mondini Dysplasia, Enlarged Vestibular Aqueduct Syndrome. The additional diagnosis of Agenesis of the Corpus Callosum was present in one participant in the CI group. The participants were implanted with a variety of cochlear implant brands including Cochlear (Cochlear Limited, Lone Tree, CO), Med-El (MED-EL, Durham, NC), and Advanced Bionics (Advanced Bionics Corporation, Los Angeles, CA).

Group Two

Thirty-six participants were assigned to Group 2 based on age: 16 children with normal hearing, 9 children with children with hearing aids, and 11 children with cochlear implants. All children were enrolled in the ongoing ELLA study around 4 years of age and completed the measures for the current study following the completion of 1st Grade (CNH group *M*= 85.19 months, *SD*= 4.76 months; HA group = 93.89 months, *SD*= 6.11 months; CI group *M*= 88.45 months, *SD*= 2.54months). Children with normal hearing were recruited from local community organizations in the southeastern United States. Children with hearing loss were specifically recruited from OPTION Schools, an international non-profit organization that provides listening and spoken language programs for children who are deaf and hard of hearing. All participants came from English-speaking families, with the exception of one participant in the HA group (primary language, Spanish; secondary language, English) and one participant in the CI group (primary language, Albanion; secondary language, English). All participants were assessed with descriptive measures of overall language development, expressive language, and receptive language. Descriptive assessments for Group 2 included:

1. *Clinical Evaluation of Language Fundamentals- 5th Edition (CELF-5*; (Wiig et al., 2013)) to measure each individual's expressive and receptive language abilities.
2. *Expressive One Word Picture Vocabulary Test- 4th Edition (EOWPVT-4; (Brownell, 2011))* to evaluate expressive vocabulary skills.
3. *Peabody Picture Vocabulary Test- 4th Edition (PPVT-4; (Dunn & Dunn, 2007))* to measure receptive vocabulary skills.
4. *Early Speech Perception Test* (*ESP*; (Geers & Moog, 2012)) to measure the effects of the amplification devices (hearing aids or cochlear implants) on each participant's speech perception ability.

For descriptive assessment measures for all Group 1 participants, see Table 1.

Group 2: Children with Normal Hearing

The participants in the normal hearing group (n= 16) passed a screening for bilateral normal hearing status (e.g., pure tone thresholds of 20 dB HL or less in both ears at 1, 2, and 4 kHz). In a parent survey upon entry to the ELLA study, parents reported participant gender (11 Female, 5 Male), ethnicity (15 Not Hispanic or Latino, 1 Hispanic or Latino), and race (14 White/Caucasian, 1 Asian, 1 Preferred Not to Respond). Mother education was reported to be an average of 17.25 years (SD= 2.65). None of the participants were diagnosed with any disorder that may have affected speech or language skills at the time of testing.

Group 2: Hearing Aid Users

Participants in the hearing aid group (n=9) met the following criteria: (a) a diagnosis of a bilateral hearing loss, (b) the use bilateral hearing aid amplification, and (c) and the family promoting the use of listening and spoken language. In a parent survey upon entry to the ELLA study, parents reported participant gender (6 Female, 3 Male), ethnicity (6 Not

Hispanic or Latino, 3 Hispanic or Latino), and race (7 White/Caucasian, 2 Black/African American). Mother education was reported to be an average of 17.22 years (SD= 3.11).

All hearing aid group participants received a newborn hearing screening, of which eight of them failed. Five had a mild to moderate hearing loss and four had moderate to severe hearing loss. he additional diagnosis of cerebral palsy was present in one participant in the HA group. The age of hearing loss diagnosis ranged from 0 months to 54 months of age (*M*= 17.33 months, *SD*= 20.17). The age of initial hearing aid amplificantion ranged from 4 months to 60 months (M= 22.33 months, *SD*= 18.90). T

Group 2: Cochlear Implant Users

Participants in the cochlear implant group (n=11) met the following criteria: (a) a diagnosis of a bilateral hearing loss, (b) the use of at least one cochlear implant device, (c) and the family prompting the use of listening and spoken language. In a parent survey upon entry to the ELLA study, parents reported participant gender (7 Female, 4 Male), ethnicity (2 Not Hispanic or Latino, 9 Hispanic or Latino), and race (10 White/Caucasian, 1 Preferred Not to Respond). Mother education was reported to be an average of 15.27 years (SD= 2.05).

All cochlear implant group participants received a newborn hearing screening, of which ten of them failed. Two participants had a severe to profound hearing loss and nine had a profound hearing loss. The age of hearing loss diagnosis in the cochlear implant group ranged from 0 months to 24 months of age (*M*= 4.57, SD=7.48). Three of the eleven children received at least one hearing aid prior to cochlear implantation. The age of first ear amplification ranged from 9 months to 36 months of age (*M*= 15.18, SD= 8.22) and the age of second ear amplification ranged from 10 months to 48 months of age (*M*= 25.09, SD= 21.81). Connexin 26 was reported to be the cause of hearing loss for three of the participants.

Parents of participants in this group did not report any additional diagnoses. Participants were implanted with Advanced Bionics (Advanced Bionics Corporation, Los Angeles, CA).

Data Collection:

All assessments were completed in the Speech and Hearing Centers at Texas Christian University (TCU), at the University of South Carolina (USC), in a participant's home, or in a local public library. These settings provided small rooms for the clinicians to carry out all necessary assessments in a quiet, one-on-one setting with limited distractions. PhD students and SLPs travelled around the country to administer all descriptive assessments (5-year-old groups: *PTONI, ARIZONA-3, TELD-3, ESP;* 7-year-old groups: *TONI, ARIZONA-3, CELF-5, ESP)* and the repeated word association task. These clinicians were trained beforehand, by the ELLA study primary investigators, on how to appropriately administer the task. Each repeated word association task administration was recorded with audio and video.

Test Stimuli:

The current study aimed to evaluate the status of lexical-semantic organization in children with hearing loss. The primary investigators adapted the repeated word association task from Sheng and McGregor (2010). The task included 24 stimuli words, 12 nouns (*Foot, Hat, Goat, Cow, Frog, Zipper, Broom, Pillow, Spoon, Desk, Kite, Turtle)* and 12 verbs (*Yawn, Kick, Cry, Hide, Eat, Count, Run, Sing, Read, Swim, Push, Squeeze*) that were presented to the children three different times within the same administration time. The examiner began the task with instructions to verbally produce a single word in response to the stimuli word. The instructions were read as follows:

"We are going to play a word game. I'm going to say a word and I want you to tell me the first word that comes to mind after you hear my word. Let's practice. If I said the word 'mom' a word you can tell me is 'dad', 'family', 'brother', or 'sister'. If I say the word 'birthday', a word you can tell me is 'cake', 'candles', 'presents', or 'ice cream'. Now you try some. I am going to say the same word three times, so you will try to tell me a new word each time."

To introduce the task, the examiner provided the participant with an example of a stimulus word (e.g., moon) and potential responses bearing thematic (e.g., sky) and taxonomic (e.g., Space) semantic relations to the stimulus word. The examiner administered a practice set with the words, "moon", "grass", and "cut", repeating each word three times to simulate the repeated nature of the task. If at any point a participant repeated a previous response, the examiner reminded the child to generate a new word or say, "I don't know". The examiner gave the participants 20 seconds per stimulus before counting silence as "No Response". The task took around 30 minutes for each child to complete. The clinicians administered one of the four forms (Form A, Form B, Form C, or Form D) to each participant. All forms contained the same twenty-four words in different orders of presentation.

Data Analysis:

Following each participant's completion of the repeated word association task, in tandem with the procedures from the Sheng and McGregor (2010) study, the participants' responses were coded into three categories: thematic relationship, taxonomic relationship, or not semantically related. The thematic relationship category encompassed responses that fell into the same schema as the stimuli, including function relations (e.g., hat-wear), descriptive relations (e.g., car-fast), causal relations (e.g., eat-full), part-whole relations (e.g., hand-finger), syntactic relations (e.g., stand-up), and location relations (e.g., kite-sky). The taxonomic relationship category encompassed hierarchically related responses, including superordinate relations (e.g., dog-animal), coordinate relations (e.g., dog-cat), and subordinate relations (e.g., dog-poodle). The not semantically related category included clang responses, such as alliteration or rhyme responses with no semantic relation to the stimuli, error responses, such as repetition of the stimulus, inflections, and real word responses with no semantic or phonotactic relations, and no response, such as unintelligible responses, nonsense words, and silent responses. Each participant response was then coded as either a syntagmatic sequence, a response that follows a different form class from the prompt, or a paradigmatic sequence, a response that follows the same form class of the prompt.

Coding Fidelity

To ensure reliability for the coding of the participant responses, the participant responses were coded by two individuals, per a code book created by the researcher. The coders had to achieve an inter-rater agreement of at least 80% for all coding categories prior to the commencement of the coding process. The individuals maintained reliability ratings of at least 80% throughout the coding process, with specific reliability ratings as follows: 86.40% for general thematic-taxonomic codes, 89.88% for specific thematic-taxonomic codes, and 90.80% for syntagmatic-paradigmatic codes. This percentage was calculated based on a point-by-point agreement formula (House et al., 1981). When coding discrepancies arose in the final analysis, the raters collectively reached an agreement.

Results

Effects of Amplification Type on Responses

Prior to answering the overall research questions, a *t*-test was completed to determine whether the performance of children with hearing aids significantly differed from children with cochlear implants. Tests compared performance of the two groups of amplification users across Group 1 and Group 2 for the following variables: Semantic Relations, Non-Semantic Relations, Errored Response, No Response, Clang Response, Thematic Response, Taxonomic Response, Syntagmatic Responses, Paradigmatic Response. The analysis yielded no significant differences between groups (*p*-value range= 0.57-0.958). Because the analysis yielded no significant difference in responses based on amplification devices, all proceeding data was analyzed comparing only two hearing statuses, children with normal hearing and children with hearing loss. For the descriptive performance of children across all variables, see Table 2.

Effects of Hearing Status on Responses

To analyze the similarities and differences of participant responses based on group (representative of age at testing) and on hearing status, repeated measures of analysis of variance were completed for each descriptive category of responses (Semantically Related vs. Non-Semantically Related Responses, Thematic vs. Taxonomic Responses, Syntagmatic vs. Paradigmatic Responses). Table 2 presents the numerical outcomes for each category.

Semantically Related vs. Non-Semantically Related Responses

Figure 1 shows the findings for group differences based on hearing status when evaluating semantic comparison. The analysis yielded an interaction effect of time and semantic comparison (F (1, 105) = 15.283), p = .000), but no significant interaction for the effect of time or hearing status. There were no three-way interaction effects of time, semantic comparison, and hearing status. In summary, all participants increased their number of semantically related responses to prompts between age 5 and the end of first grade and decreased their number of non-semantically related responses regardless of hearing status.

Types of Non-Semantically Related Responses

Recall that non-semantically related responses could be classified as an error, as no response to the prompt, or as a clang response. To evaluate the potential differences in the types of non-semantically related responses between groups, a univariate analysis of variance was completed with each type of response (errored, no response, clang) as the dependent variable. When evaluating the "errored" response type, the main effect of hearing status (F (1, 108) = 6.959, p = .010) was significant, as was the interaction effect of hearing status and time (F (1, 108) = 709.96, p= .030). The main effect of time was not significant. When analyzing the "no response" type, the analysis yielded a main effect of time (F (1, 108) = 8.849, p = .004). When evaluating the "clang" response type, no main effects were observed. These findings are demonstrated in Figure 2

Thematic vs. Taxonomic Responses

Figure 3 shows the findings for group differences based on hearing status when evaluating thematic and taxonomic responses. The analysis yielded a main effect of time (F (1, 105) = 274.26, p = .000) and an interaction effect of time and response type (F (1, 105) = 19.944, p = .000). Hearing status and the interaction effect of time and hearing status were not significant. In summary, all participants in Group 2 (post first-grade) responded with an increased number of both thematic responses and taxonomic responses; however, taxonomic responses did not grow as quickly as thematic responses. By first grade, there is not a difference in responses by hearing status.

Syntagmatic vs. Paradigmatic Responses

Figure 4 shows the findings for group differences based on hearing status when evaluating the sequence of responses (syntagmatic vs. paradigmatic). The analysis yielded a main effect of time (F (1, 105) = 31.12, p= .000) and the interaction effect of time and response type (F (1, 105) = 11.900, p = .001). Hearing status was not a significant main effect. In summary, all participants in Group 2 responded with an increased number of both syntagmatic and paradigmatic sequence responses regardless of hearing status.

Discussion

The overall purpose of this study was to evaluate and to compare the development of lexical storage and organization in children with normal hearing and in children with hearing loss. The findings suggest that although all children are growing in their vocabulary knowledge, retrieval, and organization, the proposed organizational shifts are not fully captured at the first-grade level by the Sheng and McGregor (2010) repeated word association task. The present data show trends that may indicate shifts in lexical-semantic organization for children with normal hearing and for children with hearing loss between age five and after first grade level and provides a starting point for additional in-depth study.

Shift from Phonological to Semantic Relations

This study provides evidence to support the existing developmental psychology literature's findings of systematic organizational shifts that occur as a child's lexicon increases. Cronin (2002) stated that typically developing children shift from relating words based on phonological properties to relating words based on semantic properties. Although time alone did not account for a change in the frequency of semantically related responses, time in combination with the type of response (semantically related or non-semantically related) resulted in an overall increase in semantically related responses and a decrease in non-semantically related responses in Group 2 (children post-first grade), regardless of hearing status. The present study adds data about children with hearing loss that was lacking in the extant research base: children with hearing loss who use spoken language also increase their semantically related responses and decreases non-semantically related responses as they get older.

A triple interaction effect between time, response type, and hearing status was not significant; however, a visual analysis of the data indicate that further study of these groups is merited. As shown in Figure 1, the children with hearing loss did not appear to reduce the frequency of non-semantically related responses as quickly as the children with normal hearing. Although this difference was not significant, it is important to note that the present study was cross-sectional; it is possible that individual differences in children across groups contributed to non-significant findings in this case. Further study is necessary to evaluate potential differences based on hearing status at a higher grade level which would further support the work of Wechsler-Kashi (2010) who found children with hearing loss to have a reduced ability to access semantic categories. Additionally, study of the same children over time would allow researchers to draw stronger conclusions about growth trends.

To further investigate the shift from phonological to semantic relations, the types of non-related responses (errored, no response, clang) were considered. Older (Group 2) participants with hearing loss had significantly fewer errored responses, which included responses that were a repetition of the stimulus, an inflection of the stimulus, or a real word with no relation to the stimulus word, in comparison to younger (Group 1) counterparts with hearing loss. At age 5, children with hearing loss had significantly more errored responses than children with normal hearing, but by the end of first grade, both groups had similarly low levels of errored responses. The older group 2 participants, regardless of hearing status, significantly reduced their occurrence of responses coded as “no response,” which were responses including repetition of a previous response, nonsense words, or silence for more than 20 seconds. Although no significant main effects emerged when assessing clang responses in Group 2 participants, the children with normal hearing almost entirely eliminated clang response, whereas the children with hearing loss continued to produce a considerable number of clang responses (an average of nine clang responses as compared to an average of three for children with normal hearing), which included initial alliteration and rhyming responses. Again, it appears that children with hearing loss may be slower to eliminate errored responses and perhaps for some children, clang responses. Further longitudinal study is merited to draw conclusions about maturation of responses for children with hearing loss over time.

Shift from Thematic to Taxonomic Relations

Sheng et al. (2006) found that typically developing children shift from organizing semantic lexicon by thematic relations (words that co-exist in the same schema) to taxonomic relations (words that are hierarchically related) in middle childhood. Group 2 participants, regardless of hearing status, significantly increased the frequency of their thematic responses, which corresponds with the concurrent increase in semantically related responses. Thematically related responses had a higher incidence as compared to taxonomic responses for all participants in Group 2, but taxonomically related responses were also higher in Group 2 participants with normal hearing than they were at age 5. The higher incidence in taxonomic responses may suggest that the children with normal hearing are preparing to make the organizational shift by the first-grade level. Although the current study's findings cannot state a significant trend towards taxonomic relations as compared to thematic responses at age five or in first grade, the results lay the framework for continued examination of the study's proceedings at an older age level.

Shift from Syntagmatic to Paradigmatic Sequencing

In addition to the proposed thematic-taxonomic relational shift in middle childhood, previous research proved a parallel syntagmatic-paradigmatic sequencing shift (Lippman, 1971; Nelson, 1977; Sheng & McGregor, 2010; Sheng et al., 2006). Group 2 participants, regardless of hearing status, numerically responded with more syntagmatic and paradigmatic sequences, which also reflects the overall higher frequency of semantically related responses in Group 2. Although all children seem to grow in syntagmatic sequencing response, the children with normal hearing seem to be growing faster in their syntagmatic sequencing abilities while all participants are slowly growing in paradigmatic sequencing abilities. This may be a reflection of the words used in the Sheng and McGregor (2010) task: the task includes no adjectives. A future study that also includes adjectives may better capture clearer trends towards a syntagmatic-paradigmatic shift.

Clinical Implications

The current study's findings contribute to the current body of literature suggesting a potential delayed emergence of lexical-semantic organization in children with hearing loss in comparison to peers with normal hearing. This difference is not clear in a repeated word association task between age five and after first grade in a cross-sectional sample. However, even given the limitations of the present study design, results suggest that children with hearing loss may be less efficient in producing semantically related responses and taxonomic responses than children with normal hearing. The largest evidence of a potential delay lies in the evaluation of the types of non-semantically related responses. When Group 2 participants with normal hearing responded with a non-semantically related word, the word was more likely to be classified as an "errored" response or "no response." These types of responses suggest a participant's disengagement with the task or insufficient lexical depth of the stimulus word to produce three distinct responses. On the contrary, when Group 2 participants with hearing loss responded with a non-semantically related word, the word may have been an "errored" response, "no response", or a "clang" response. The continued inclusion of clang responses, and even overall numerical increase in clang responses in Group 2 participants with hearing loss in comparison to Group 1 participants with hearing loss, suggests the potential of an organizational system that relies on phonological relations. Based on the outline from Cronin (2002) that the typical lexical-semantic organizational shift moves from phonological relations to semantic relations, the large remnant of clang responses in first grade children with hearing loss suggests delayed organizational development of the lexical system.

These findings further support the evidence from the hearing loss literature indicating school-age children with hearing loss have less mature lexical-semantic organizational systems than children with normal hearing (Kenett et al., 2013; Lund, 2020; Lund & Dinsmoor, 2016; Marschark et al., 2004; Wechsler-Kashi, 2010). Because vocabulary outcomes impact academic and societal success, as stated by Dollinger et al. (2008), these findings open avenues for future questions regarding language intervention for children with hearing loss. If literature suggests that children with hearing loss are delayed in their lexical-semantic organizational development and that several organizational shifts occur in middle childhood including phonological to semantic relations, thematic to taxonomic relations, and syntagmatic to paradigmatic sequences, then how should clinicians best facilitate organizational maturity? In addition, how large is the developmental "gap" between children with normal hearing and children with hearing loss in their lexical semantic organizational development?

Limitations & Future Directions

Limitations of the present study provide potential future research directions. First, the participants were recruited differently based on group resulting in demographics differences. Group 1 participants with hearing loss were recruited through social media outlets whereas Group 2 participants with hearing loss were recruited through OPTION Schools. The Group 1 participants encompassed a broader range of racial and ethnic demographics, as well as a larger number of diagnosable causes of hearing loss including syndromic and genetic conditions. Therefore, the Group 1 participants were likely a more representative sample of the hearing loss population across the United States. Children who successfully participate in OPTION schools tend to be well-resourced children without percentages of additional disabilities seen in the population with hearing loss at-large. They also tend to live near areas with aggressive and routine audiological services available for children with hearing loss (thus, the presence of an OPTION school). A more representative sample of children with hearing loss is likely to include children who cannot easily access high-quality services (Lund et al., 2021) . Second, the cross-sectional study design proved to be a limitation in directly assessing the developmental process across groups. Third, the age of the participants may not be representative of "middle childhood", as this terminology is a vague reference towards when organizational shifts should be expected. A future study should employ a longitudinal design, optimally including a diverse population sample as represented by the Group 1 participants and include task results in the third grade to explore the true developmental trajectory of lexical-semantic organization in children with hearing loss in comparison to peers with normal hearing.

Conclusions

Findings indicated that all children, regardless of hearing status, grow in their ability to produce semantically related responses between age five and at the end of first grade. This growth in turn facilitates an increase in thematic, taxonomic, syntagmatic, and paradigmatic responses. At first grade, the children with normal hearing provided responses to suggest that a shift from organizing words based on phonological relations to semantic relations had been accomplished (due to increase in semantically related responses, decrease in non-semantically related responses, and decrease in clang responses). Responses also suggested that these children are preparing to shift from organizing words based on thematic relations to taxonomic relations and from sequencing words based on syntagmatic to paradigmatic forms. Although the children with hearing loss had also grown in their abilities to produce all responses types, the remnants of phonologically related (clang) responses suggest that a complete organizational shift from phonological to semantic relations has not yet occurred at first grade. Thus, it is possible that the children with hearing loss experience delays in the development of lexical-semantic organization. A future study should employ a longitudinal study design with a representative sample of the extensive hearing loss population in the United States. In addition, a future study should evaluate the organizational gains of children in the third grade.

References

Brownell, R. (2011). *EOWPVT-4: Expressive one-word picture vocabulary test-fourth edition*.

Caramazza, A. (1997). How many levels of processing are there in lexical access? *Cognitive Neuropsychology, 14*(1), 177-208. https://doi.org/10.1080/026432997381664

Cronin, V. S. (2002). The syntagmatic-paradigmatic shift and reading development. *Journal of Child Language, 29*(1), 189-204. https://doi.org/10.1017/S0305000901004998

Di Giacomo, D., De Federicis, L. S., Pistelli, M., Fiorenzi, D., & Passafiume, D. (2012). Semantic associative relations and conceptual processing. *Cognitive Processing, 13*(1), 55-62. https://doi.org/10.1007/s10339-011-0399-7

Dollinger, S. J., Matyja, A. M., & Huber, J. L. (2008). Which factors best account for academic success: Those which college students can control or those they cannot? *Journal of Research in Personality, 42*(4), 872-885. https://doi.org/10.1016/j.jrp.2007.11.007

Dunn, L. M., & Dunn, D. M. (2007). *Peabody picture vocabulary test-fourth edition (PPVT-4)*.

Geers, A. E., & Moog, J. S. (2012). *Early Speech Perception Test*. Central Institute for the Deaf.

Gertner, B. L., Rice, M. L., & Hadley, P. A. (1994). Influence of communicative competence on peer preferences in a preschool classroom. *Journal of Speech, Language, and Hearing Research, 37*(4), 913-923. https://doi.org/10.1044/jshr.3704.913

Ground, W., Lund, E., Werfel, K. L., & Schuele, C. M. (2014). Auditory closure performance of preschool children with and without hearing loss. American Speech Language Hearing Association Convention, Orlando, FL.

Hoover, J. R., Storkel, H. L., & Hogan, T. P. (2010). A cross-sectional comparison of the effects of phonotactic probability and neighborhood density on word learning by preschool children. *Journal of Memory and Language, 63*(1), 100-116. https://doi.org/10.1016/j.jml.2010.02.003

Hornsby, B. W., Naylor, G., & Bess, F. H. (2016). A taxonomy of fatigue concepts and their relation to hearing loss. *Ear and Hearing, 37*(1), 136S-144S. https://doi.org/10.1097/AUD.0000000000000289

House, A. E., House, B. J., & Campbell, M. B. (1981). Measures of interobserver agreement: Calculation formulas and distribution effects. *Journal of Behavioral Assessment, 3*(1), 37-57. https://doi.org/10.1007/BF01321350

Houston, D. M., Carter, A. K., Pisoni, D. B., Kirk, K. I., & Ying, E. A. (2005). Word learning in children following cochlear implantation. *Volta Review, 105*(1), 41-72.

Houston, D. M., Stewart, J., Moberly, A., Hollich, G., & Miyamoto, R. T. (2012). Word learning in deaf children with cochlear implants: Effects of early auditory experience. *Developmental Science, 15*(3), 448-461. https://doi.org/10.1111/j.1467-7687.2012.01140.x

Houston-Price, C., Plunkett, K., & Harris, P. (2005). 'Word-learning wizardry' at 1;6. *Journal of Child Language, 32*(1), 174-189. https://doi.org/10.1017/s0305000904006610

Hresko, W. P., Reid, D. K., & Hammill, D. D. (1999). *Test of Early Language Development-Third Edition*. Western Psychological Services.

Kenett, Y. N., Wechsler-Kashi, D., Kenett, D. Y., Schwartz, R. G., Ben-Jacob, E., & Faust, M. (2013). Semantic organization in children with cochlear implants: Computational analysis of verbal fluency. *Frontiers in Psychology, 4*, 543. https://doi.org/10.3389/fpsyg.2013.00543

Leach, L., & Samuel, A. G. (2007). Lexical configuration and lexical engagement: When adults learn new words. *Cognitive Pscyhology, 55*(4), 306-353. https://doi.org/10.1016/cogpsych.2007.01.001

Lederberg, A. R., Prezbindowski, A. K., & Spencer, P. E. (2000). Word-learning skills of deaf preschoolers: The development of novel mapping and rapid word-learning strategies. *Child Development, 71*(6), 1571-1585. https://doi.org/10.1111/1467-8624.00249

Lippman, M. Z. (1971). Correlates of contrast word associations: Developmental trends. *Journal of Verbal Learning and Verbal Behavior, 10*, 392-399. https://doi.org/10.1016/S0022-5371(71)80038-5

Lucariello, J., Kyratzis, A., & Nelson, K. (1992). Taxonomic knowledge: What kind and when? *Child Development, 63*(4), 978-998. https://doi.org/10.2307/1131248

Luce, P. A., & Pisoni, D. B. (1998). Recognizing spoken words: The neighborhood activation model. *Ear and Hearing, 19*(1), 1-36. https://doi.org/10.1097/00003446-199802000-00001

Lund, E. (2016). Vocabulary knowledge of children with cochlear implants: A meta-analysis. *Journal of Deaf Studies and Deaf Education, 21*(2), 107-121. https://doi.org/10.1093/deafed/env060

Lund, E. (2020). Triggering, configuration, and engagement: Spoken-word learning processes in young children with hearing loss. In M. Marschark & H. Knoors (Eds.), *The Oxford Handbook of Deaf Studies in Learning and Cognition* (pp. 138-149). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780190054045.013.5

Lund, E., Brock, N., & Werfel, K. L. (2021). Location effects on spoken language and literacy for children who are DHH. *Journal of Deaf Studies and Deaf Education, 27*(1), 48-61. https://doi.org/10.1093/deafed/enab030

Lund, E., & Dinsmoor, J. (2016). Taxonomic knowledge of children with and without cochlear implants. *Language, Speech, and Hearing Services in Schools, 47*(3), 236-245. https://doi.org/10.1044/2016_LSHSS-15-0032

Lund, E., & Schuele, C. M. (2017). Word-learning performance of children with and without cochlear implants given synchronous and asynchronous cues. *Clinical Linguistics & Phonetics, 31*(10), 777-790. https://doi.org/10.1080/02699206.2017.1320587

Marschark, M., Convertino, C., McEvoy, C., & Masteller, A. (2004). Organization and use of the mental lexicon by deaf and hearing individuals. *American Annals of the Deaf, 149*(1), 51-61. https://doi.org/10.1353/aad.2004.0013

Nelson, K. (1977). The syntagmatic-paradigmatic shift revisited: A review of research and theory. *Psychological Bulletin, 84*(1), 93-116. https://doi.org/10.1037/0033-2909.84.1.93

Peterson, N. R., Pisoni, D. B., & Miyamoto, R. T. (2010). Cochlear implants and spoken language processing abilities: Review and assessment of the literature. *Restorative Neurology and Neuroscience, 28*(2), 237-250. https://doi.org/10.3233/RNN-2010-0535

Rohde, T. E., & Thompson, L. A. (2007). Predicting academic achievement with cognitive ability. *Intelligence, 35*(1), 83-92. https://doi.org/10.1016/j.intell.2006.05.004

Sheng, L. (2007). *Lexical access and semantic organization in children with specific language impairment* [Unpublished doctoral dissertation, Northwestern University]. Evanston, IL.

Sheng, L., & McGregor, K. K. (2010). Lexical-semantic organization in children with specific language impairment. *Journal of Speech, Language, and Hearing Research, 53*(1), 146-159. https://doi.org/10.1044/1092-4388(2009/08-0160)

Sheng, L., McGregor, K. K., & Marian, V. (2006). Lexical-semantic organization in bilingual children: Evidence from a repeated word association task. *Journal of Speech, Language, and Hearing Research, 49*(3), 572-587. https://doi.org/10.1044/1092-4388(2006/041)

Ukrainetz, T. A. (2014). *School-age language intervention: Evidence-based practices*. PRO-ED, Incorporated.

von Ilberg, C. A., Baumann, U., Kiefer, J., Tillein, J., & Adunka, O. F. (2011). Electric-acoustic stimulation of the auditory system: A review of the first decade. *Audiology and Neurotology, 16*, 1-30. https://doi.org/10.1159/000327765

Waxman, S. R., & Gelman, R. (1986). Preschoolers' use of superordinate relations in classification and language. *Cognitive Development, 1*(2), 139-156. https://doi.org/10.1016/S0885-2014(86)80016-8

Waxman, S. R., & Hatch, T. (1992). Beyond the basics: Preschool children label objects flexibly at multiple hierarchical levels. *Journal of Child Language, 19*(1), 153-166. https://doi.org/10/1017/s0305000900013672

Wechsler-Kashi, D. (2010). *Lexical processing during naming in children with cochlear implants* (Publication Number 3426894) [Doctoral disertation, The City University of New York]. ProQuest Dissertations Publishing.

Wechsler-Kashi, D., Schwartz, R. G., & Cleary, M. (2014). Picture naming and verbal fluency in children with cochlear implants. *Journal of Speech, Language, and Hearing Research, 57*(5), 1870-1882. https://doi.org/10.1044/2014_JSLHR-L-13-0321

Werfel, K. L., & Lund, E. (2015). *Early language and literacy acquisition in children with hearing loss* (1R01DC017173) [Grant].

Wiig, E. H., Semel, E., & Secord, W. A. (2013). *Clinicial Evaluation of Language Fundamentals- Fifth Edition (CELF-5)*. NCS Pearson.

Table 1

Table 1: Descriptive Assessment Measures by Hearing Status & Group

		Group 1	Group 2
Assessment	Hearing Status	M (SD)	M (SD)
TELD-3 Spoken Language	CNH	117.13 (9.30)	
Quotient Standard Score	HA	104.55 (20.66)	N/A
	CI	94.33 (18.68)	
EOWPVT-4 Standard Score	CNH	120.67 (11.42)	121.40 (12.43) *
	HA	110.50 (19.94) *	99.29 (17.66) *
	CI	103.11 (15.20) *	104.09 (11.95)
PPVT-4 Standard Score	CNH	112.40 (13.77)	109.80 (11.53) *
	HA	96.65 (17.11) *	95.57 (16.33) *
	CI	89.44 (13.35) *	95.91 (9.90)
ESP Category	CNH	4 (0.00)	4 (0.00)
	HA	3.91 (0.42)	4 (0.00) *
	CI	3.95 (0.21)	4 (0.00) *
CELF-5 Core Language	CNH		112.00 (13.46) *
Standard Score	HA	N/A	93.71 (11.15) *
	CI		95.00 (18.87) *

Note: M= Mean; SD= Standard Deviation; CNH= Children with Normal Hearing; HA= Hearing Aid User; CI= Cochlear Implant User* missing scores (Group 1- HA: 2 participants for *EOWPVT-4*, 3 participants for *PPVT-4*; CI group: 2 participants for *EOWPVT-4*, 3 participants for *PPVT-4* --- Group 2- CNH: 1 participant for *EOWPVT-4, PPVT-4, CELF-5;* HA: 2 participants for *EOWPVT-4, PPVT-4, CELF-5* and 1 participant for *ESP*; CI: 1 participant for *ESP*)

Table 2

Table 2: Descriptive Means of All Response Types by Hearing Status

Hearing Status	Group	Semantically Related	Non-Semantically Related	Errored	No Response	Clang	Thematic	Taxonomic	Syntagmatic	Paradigmatic
Normal Hearing	1 (N= 30)	33.600 (19.473)	38.400 (19.473)	10.967 (8.65)	18.700 (17.57)	8.733 (16.628)	27.067 (17.292)	6.533 (5.70)	17.867 (11.634)	15.733 (10.238)
	2 (N=16)	46.938 (11.410)	25.063 (11.410)	12.500 (8.287)	10.188 (8.175)	2.375 (3.384)	39.563 (10.807)	7.375 (5.864)	28.250 (8.606)	18.688 (7.078)
Hearing Aid Users	1 (N=22)	28.455 (15.963)	43.546 (15.963)	21.364 (14.773)	13.318 (9.214)	8.864 (11.175)	21.546 (13.233)	6.909 (6.286)	15.182 (9.215)	13.727 (8.881)
	2 (N=9)	39.333 (18.021)	32.667 (18.021)	16.778 (12.286)	7.556 (8.862)	8.333 (14.169)	33.111 (15.846)	6.222 (3.528)	22.222 (11.998)	17.111 (9.048)
Cochlear Implant Users	1 (N-21)	25.524 (16.816)	46.476 (16.816)	24.762 (17.178)	16.667 (14.637)	5.048 (10.888)	20.667 (13.912)	4.857 (3.941)	14.333 (10.086)	11.191 (9.015)
	2 (N=11)	43.182 (21.451)	28.818 (21.451)	11.000 (5.18)	8.091 (5.822)	9.727 (19.494)	37.818 (18.627)	5.364 (4.456)	27.818 (13.534)	15.364 (11.535)

Note: All values are reported as Mean (Standard Deviation); N= number of participants

Figure 1

Figure **1: Semantically vs. Non-Semantically Related Responses**

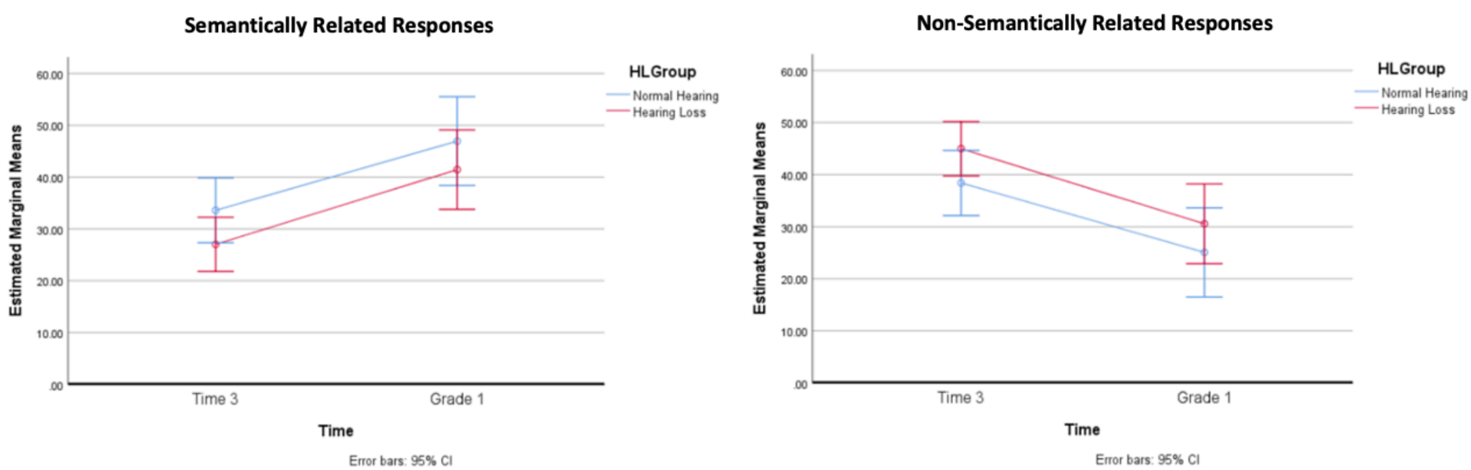


Figure 2

Figure 2: Non-Semantically Related Response

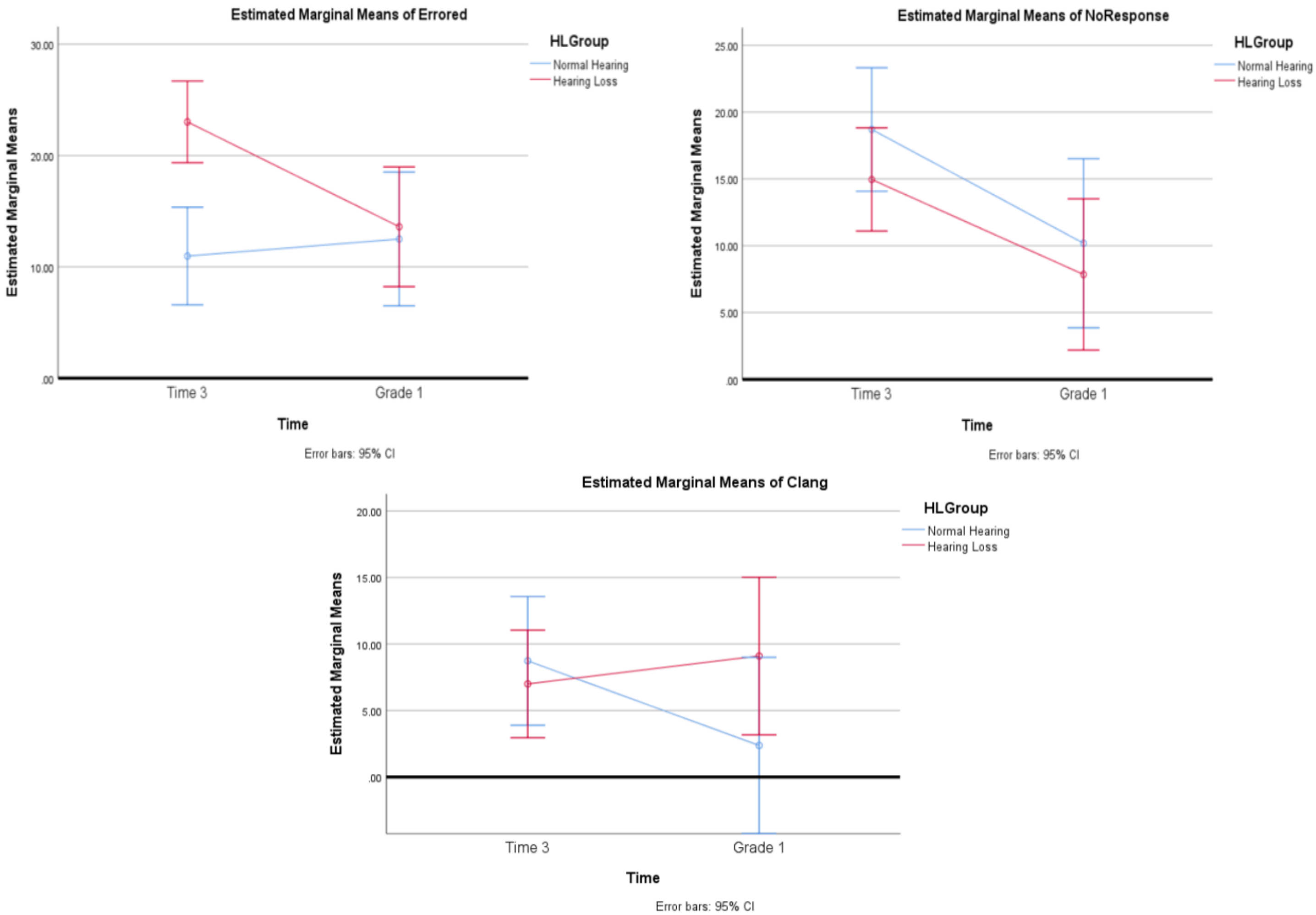
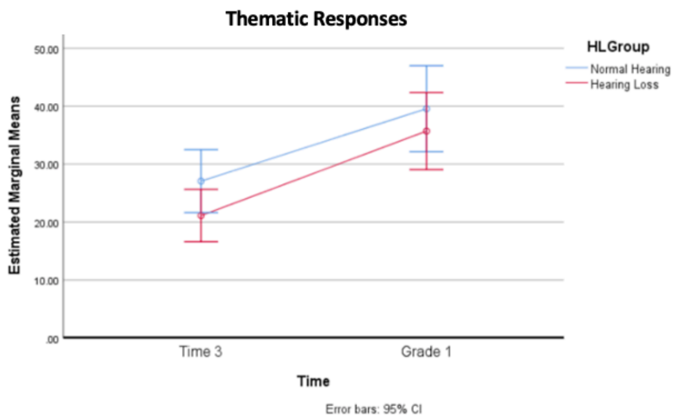


Figure 3

Figure 3: Thematic vs. Taxonomic Responses



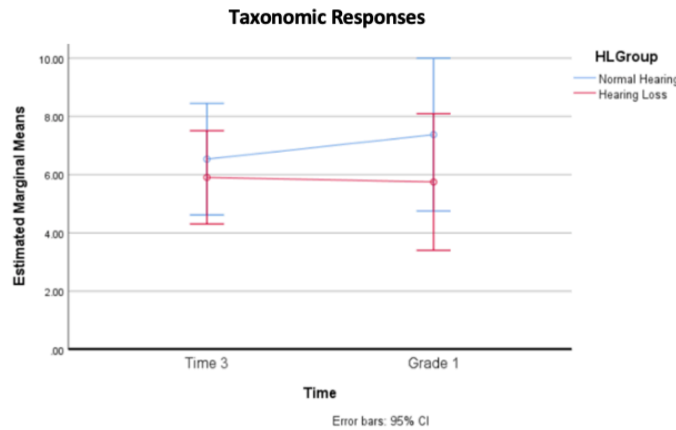
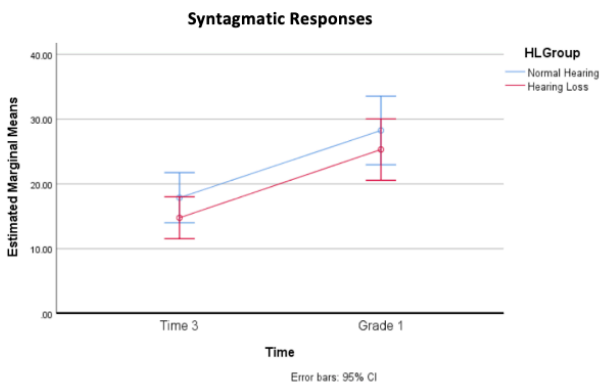
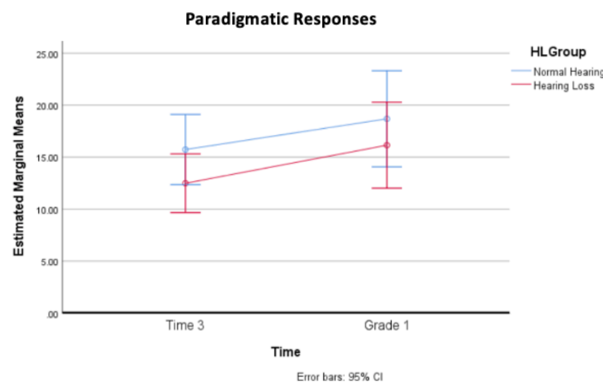


Figure 4

Figure 4: Syntagmatic vs. Paradigmatic Responses





APPENDIX

Coding Manual

Assessing Lexical-Semantic Organization in a Repeated Word Association Task

Texas Christian University

This manual will provide guidelines for coding responses in a repeated word association task. The purpose of coding these responses is to categorize the semantic relationships between the stimuli words and the responses, providing a description for the participants' current developmental status of lexical-semantic organization.

This work was informed by coding procedures described in (Sheng & McGregor, 2010; Sheng et al., 2006).

Coding Considerations

Level of Subjectivity: When coding each participant's responses, it is important to allow a level of your own subjectivity to play a role in determining the appropriate codes.

- Keep in mind the age level (5 years of age) of the participants when judging if the response is semantically related to the stimulus.
- Monitor the previous responses to facilitate your selection of the appropriate codes. For example, if the child has been producing all rhyming responses and the relationship you are evaluating is turtle-fertile, this would be considered a clang (X) response due to the child's pattern of rhyming responses.

Direction of Semantic Relations

- Most Thematic specific codes can be used regardless of the direction of the relationship, whether it is stimulus-response or response-stimulus.
  - For example, Yawn-Tired and Tired-Yawn would both be classified as a Causal relationship (CS).
- Syntactic relations may only be used in the stimulus-response format.
  - For example, Push-Swing would be classified as SYN, but Swing-Push would be classified as Function (F).
- All taxonomic relations must be classified based upon the stimulus-response relation.
  - For example, Cow-Calf would be classified as a Subordinate Relation (SUB) but Calf-Cow would be classified as a Superordinate Relation (SPR).

Choose the most appropriate code: There may be more than one code that could describe the type of semantic relationship between the two words but choose the one that most appropriately describes the relationship. Use your discretion when doing so.

Repetition of Response: If a child repeats the same response for the same stimulus (ex. "grass" in response to "goat" all three times), code the first response and code the following as Not Semantically Related (NSR) and No Response (NR).

Coding Procedures

Step 1: Establish if the participant's response bears any relation to the stimulus.

SEMANTIC RELATION: A response that bears relation to the stimulus is a word that has some level of a semantic relationship.

For responses that bear relation to the stimulus word, continue to **Step 2**.

NO SEMANTIC RELATION [NSR]: A response that does not bear relation to the stimulus can be classified into one of three categories.

1. Clang Response **[X]**: phonological relation to the word, typically by means of alliteration or rhyme, with no semantic relation to the prompt
    a. Alliteration Example: Bat-Bus
    b. Rhyme Example: Brain-Crane
        i. Nonword Rhyme Example: Goat-Loat
2. Error Response **[ER]**: presence of a verbal, real word response with no semantic or phonological relation to the prompt
    a. Error Response Examples
        i. Response= repetition of stimulus (ex. foot-foot)
        ii. Response= inflection (ex. foot-feet)
            1. Inflections may be…
                a. Plural forms of the stimulus
                b. Comparatives (ex. big-biggest)
                c. Tense changes of stimulus (ex. play-played)
        iii. Response= Real word with no relation (ex. foot-watch)
3. No Response **[NR]**
    a. No Response Examples
        i. Repetition of Response
        ii. Silence for more than 20 seconds following presentation of stimulus
        iii. Unintelligible Responses
        iv. Nonsense Words
            1. *Excluding nonsense words that rhyme with the prompt—code these as a Clang response*
        v. Nonsense Sounds

*Code all non-related responses with their specific classification code (X, ER, NR) **and the** NSR code.

Step 2: Determine if the participant's response bears a thematic or taxonomic relationship.

THEMATIC [TH]: A response that is thematically related to the stimulus is one that falls into the same schema. Thematic responses can be classified into one of the five categories.

1. Function Relations **[F]**: response describes the function of the object with a verb (describing the action of the object or an action commonly related to the object) or with a noun (describing the common correlates with the object)
    a. Examples: Hat-Wear, Dog-Bark, Student-Study, Spoon-Soup, Broom-Dirt, Read-Book, Eat-Broccoli, Read-Author
2. Descriptive Relations **[D]**: response describes characteristics of the stimulus
    a. Examples: Dog-Furry, Baby-Little, Car-Fast, Hat-Snow
3. Causal Relations **[CS]**: response completes a cause-and-effect relationship with the stimulus
    a. Examples: Lick-Wet, Eat-Full, Play-Sleepy, Yawn-Tired, Hide-Scared
4. Part-Whole Relations **[PW]**: response represents a portion of the stimulus, representing the complete object
    a. Examples: Dog-Tail, Hand-Finger, Book-Chapter, Turtle-Shell, Zipper-Jacket
    b. *Part whole relations, where the parts or members create the whole differ from the hierarchical, taxonomic relations where the sub concepts are simply examples of the broad concept.
    c. To classify as a part-whole relationship, as opposed to a taxonomic relation, the "part" must be something that <u>must</u> be present to compose the "whole".
5. Syntactic Relations **[SYN]**: response mirrors common word sequences that follow the stimuli
    a. Examples: Give-Back, Bounce-Ball, Stand-Up, Count-Seven
    b. **MUST** follow the direction of stimulus-response when classifying
6. Location **[L]:** response states the location where the object is typically found, or the action typically takes place
    a. Examples: Frog-Lilypad, Kite-Sky, Swim-Water, Hat-Head

TAXONOMIC [TAX]: A response that is taxonomically related are responses that are hierarchical. These relations should only occur when the response is an example of (SUB), broad category for the stimulus (SPR), or fall under the same broad category. Avoid trying to make the responses fall into the taxonomic category and only use TAX codes when the hierarchal relationship is obvious. Taxonomic responses can be classified into one of the three categories.

1. Superordinate Relations **[SPR]**: response describes the broader category that the stimulus fits into
    a. Example: Dog-Animal, Ice Cream-Dessert, Rain-Weather
2. Coordinate Relations **[CORE]**: response is a counterpart example that fits into the same category within the same broader category
    a. Example: Dog-Cat, Ice Cream-Cake, Rain-Snow
    b. Synonyms: House-Home, Jump-Hop, Small-Little
    c. Antonyms: Brother-Sister, Run-Walk, Happy-Sad
3. Subordinate Relations **[SUB]**: response provides an example of the broader category that the stimulus encompasses
    a. Example: Shoe- Boot, Dog- Poodle, Car-Jeep

*Code all responses with their specific classification code **AND** thematic [TH] or taxonomic [TAX] code.

For all responses that **Step 2** were completed for, continue to **Step 3.**

Step 3: Establish the sequence, if any, that the response exhibits.

SYNTAGMATIC SEQUENCE [SS]: A response that follows a different form class from the prompt. For example, if the stimulus is a noun, a syntagmatic sequence would be any semantically related verb, adjective, or adverb.

PARADIGMATIC SEQUENCE [PS]: A response that follows the same form class of the prompt. For example, if the stimulus is a noun, a paradigmatic sequence would be any semantically related noun.

ABSTRACT

LEXICAL-SEMANTIC ORGANIZATION AS MEASURED BY REPEATED WORD ASSOCIATION IN CHILDREN WITH HEARING LOSS

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Vocabulary knowledge drives academic and social success. Current literature suggests that children with hearing loss have poorer vocabulary organization in comparison to their peers with normal hearing. The current study aimed to evaluate and compare the development of lexical storage and organization.

Children fell into two groups based on age: children at age five and children in first grade. Participants were also divided based on hearing status (normal hearing, hearing aid users, or cochlear implant users).

Participants were asked to complete a repeated word association task, as outlined by Sheng and McGregor (2010).

The findings suggest that the proposed organizational shifts are not fully captured at the first-grade level by the repeated word association task. The present data show trends that may indicate shifts in children with normal hearing and in children with hearing loss between age five and after first grade level and provides a starting point for additional study.