NON-WORD REPETITION AND VOCABULARY

IN ADOLESCENTS WHO ARE BLIND

by

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DEDICATION

This thesis is dedicated to all of the students with whom I have had the privilege of working. You have inspired me to keep learning, to follow my dreams, and to seek answers in the hope of improving the fields communication and education for future generations.

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LIST OF ABBREVIATIONS

Abbreviation	Description
ASD	Autism Spectrum Disorders
ID	Intellectual disability
ED	emotional disturbance
ADHD	attention deficit/hyperactivity disorder
LD	learning disabled
GT	gifted and talented
PPVT	Peabody Picture Vocabulary Test
TSBVI	Texas School for the Blind and Visually Impaired
SES	socio-economic status
CTOPP-2	Comprehensive Test of Phonological Processing - 2nd edition
TOAL-4	Test of Adolescent and Adult Language - 4th edition
CLD	culturally and linguistically diverse
ERP	event-related potentials

ABSTRACT

When compared with their sighted peers, prior research on individuals who are blind has indicated strong working memory, as measured by digit span tests, and phonological memory, as measured by non-word repetition tasks. However, research related to vocabulary skills is limited and often contradictory. Some indicates that those who are blind have poor vocabulary skills, perhaps due to missing visual information, while others demonstrate the potential for individuals to use vocabulary correctly despite a lack of visual input. What is known is that sighted individuals who perform well on digit span and non-word repetition tests have strong vocabulary skills. This would imply that individuals who are blind should have at least comparable vocabulary abilities but this has not yet been considered. This study compared the working memory, phonological memory, and vocabulary skills of adolescents who are blind with those who are sighted. Prior research focused on elementary-aged students, so this study expands results to a new age-group. Results indicate that there are no group difference between working and phonological memory skills and no group difference between vocabulary skills of those who are blind and sighted, with the exception of spoken analogy skills.

1. REVIEW OF LITERATURE

In individuals who have vision, working memory, phonological memory, and vocabulary are tightly linked together. While working memory and phonological memory skills between individuals who are blind and individuals who have vision have been compared, there is little research directly comparing the vocabulary skills of these two groups of individuals. As a result, it is unclear if the memory and vocabulary connection is true for those who are blind as well. The following presents literature on individuals who are blind, their working memory skills, their phonological memory skills, and their language and vocabulary development, leading directly to the study questions: are the skills of adolescents who are blind different from those who are sighted in the areas of memory and vocabulary? If yes, do the differences follow prior research? If no, why is there no difference?

Visual Impairment and Congenital Blindness: A Definition and Rationale

The phrase "visually impaired" is an umbrella term that has many different definitions, depending on the context in which it is being used. Functionally, a person who is visually impaired has sight that cannot be fully-corrected even with the use of glasses or contacts, leading to difficulties seeing distance or print in books, difficulty functioning in bright or dim environments, reduced visual fields where one cannot see in all directions without turning the head, and/or color blindness (Huebner, 2000). The legal definition states that a person with a visual impairment has vision that is 20/200 or less corrected in the better eye or a visual field of 20 degrees or less (Huebner, 2000). This definition, often referred to as "legal blindness", is used to qualify for Social Security and other government funding, though does not show the fullest extent of what it can mean to be visually impaired.

For the purposes of this study, however, the educational definition will be used. To qualify for educational services as a student with a visual impairment, a student's vision must be so impacted that it affects his or her education, causing specialized services to be needed in order for the child to access general education curriculum (Huebner, 2000).

Within this umbrella term of visual impairment is a group of individuals with blindness. That is, these individuals have no vision, except perhaps light perception, which is the ability to see shadows or the presence or absence of light (Huebner, 2000). A further subgroup is the group of individuals with congenital blindness which will be the population of interest in this study. To be considered congenitally blind, an individual must be born without his or her vision, though this definition often includes those individuals who lose their sight before age one. As Huebner states, "Students who never experienced vision or do not have visual memory learn differently...They rely totally on senses other than vision to learn" (2000, p. 58). When considering language development, in particular, turning one is an important milestone as children generally produce their first meaningful word around this time; thus, any vision s/he has can affect language production greatly even at such a young age.

Furthermore, research has shown that individuals who have "late-blindness" or even some remaining vision perform similarly to those who are fully-sighted. Wan, Wood, Reutens, and Wilson (2010) investigated this by comparing individuals with congenital blindness to those who became blind after the age of one. They found a significant difference in the auditory abilities between those with congenital blindness and all others, but no difference between those who became blind after age one and the sighted individuals.

Working Memory and the Digit Span Test

In considering the effects of vision loss on functioning, researcher have compared development, memory, and other abilities of those who are blind and those who are sighted. In particular, comparisons of the working memory abilities of individuals who are blind and those who are sighted have been investigated. Working memory can be defined as "an active system for holding and manipulating information over brief periods of time during the course of ongoing cognitive activities" (Withagen, Kappers, Vervloed, Knoors, & Verhoeven, 2013, p. 2162). That is, working memory is one's ability to remember and use information for a short period of time, such as when performing mental math calculations.

One test that is often used to evaluate a person's working memory ability is the digit span task. Included in many intelligence tests, the digit span task requires individuals to listen to ever-increasing lists of numbers and repeat them back in order (Mason & Hull, 1995; Withagen et al., 2013). Another variation asks individuals to listen to a list of numbers and then repeat them back in reverse order. An advantage to these tests is that they have no visual component, meaning that those who are blind can easily participate in the same way as their sighted peers, without accommodations.

When comparing the results of these two groups, research has been consistent: those who are blind perform better on digit span tests than their sighted peers (Mason & Hull, 1995; Rokem & Ahissar, 2009; Smits & Mommers, 1976; Withagen et al., 2013). These studies have included comparisons between groups of children, groups of adults, and even a longitudinal study that followed a group of individuals for 20 years (Withagen et al., 2013). Those who are blind out-perform those with sight by recalling significantly more digits in digit span forward tasks.

To further test working memory, beyond just digit span, Withagen et al. (2013) compared the skills of children who were blind with their sighted peers and found that those who were blind had superior performance on such tasks as repeating lists of 15 unrelated words, learning names of new objects, a listening span task using sentences, and a digit span backward task. Their hypothesis was that children who are blind train themselves to be better at listening, experience brain reorganization, and have improved processing of sequential auditory information as this is how they experience life.

Pring (1988) also investigated the working memory skills of these two groups, comparing memory and manipulation of lists of provided words and words that were created by the participants themselves. It was found that those who are blind have better memory for the lists of provided words, while those who are sighted remembered more of the words they made-up. It was hypothesized that the act of creating words is helpful for the sighted, as they formulate mental pictures to facilitate recall; for those who are blind, however, lack of vision makes this type of imagery challenging, so it is easier for them to use their skills in serial recall and retrieval to remember lists. Again, individuals who are blind were better able to use working memory skills for memorizing lists of given information, though remembering invented information was not a strength.

Phonological Memory and the Non-Word Repetition Task

Research has also shown that individuals who are blind have superior phonological memory skills when compared with those of sighted people (Raz, Striem, Pundak, Orlov, & Zohary, 2007; Rokem & Ahissar, 2008; Swanson & Luxenberg, 2009). Phonological memory is considered a component of working memory and can be defined as the "temporary storage of verbal information...[wherein] items are held within a phonological store of limited duration, and the items are maintained within the store via the process of articulation" (Swanson & Luxenberg, 2009, p. 281).

To test phonological memory, a non-word repetition task is often used. To execute this task, a "non-word" for the given language, in this case English, is said and the listener must repeat it accurately. For example, one might hear the word "naib" or "chinoitowb" (Dollaghan & Campbell, 1998, p. 1138). Words have an ever-increasing number of syllables and become more challenging as the test proceeds. As with the digit span test, this task has no visual component, allowing for ease of participation for all individuals.

The connection between non-word repetition and phonological memory for the English language has been well-documented (Gathercole, Willis, Baddeley, & Emslie, 1994). Gathercole (1995) wrote that, since a non-word is made-up and no one has heard it, an individual has to use their phonological memory to hold the "word" in his or her memory for long enough to be able to repeat it back. If an individual is able to recall longer strings of meaningless syllables, then his or her phonological memory must be good. Gathercole and Baddeley (1990) also found that being able to accurately complete this task requires "accurate encoding and storage of the phonological sequence in the absence of support by lexical processes" (p. 451). It doesn't matter how good other abilities are; non-word repetition skills are based solely on one's phonological processing ability as the words are unlike any others one has heard.

Rokem and Ahissar (2008) found that adults who were blind performed significantly better than sighted peers when remembering groups of non-words, which they referred to as pseudowords in their work. They compared skills of 16 adults with congenital blindness and 16 adults with vision. Both groups averaged around 32 years old. Rokem and Ahissar (2008) investigated tone and frequency discrimination, as well as digit span and recall of strings of two-syllable non-words. Individuals who were blind performed statistically better on digit span forward tasks and recalling longer group of non-words than their sighted peers. Raz, Striem, Pundak, Orlov, and Zohary (2007) found that, when presented with a list of 20 words, the individuals who were blind remembered significantly more of the words. In addition, they were better able to remember the words in order, and to remember longer strings of words, tapping a combination of their phonological and working memory skills.

Swanson and Luxenberg (2009) completed two studies with the same group of 17 children who were blind and 19 who were sighted to determine if there was a difference between the groups in terms of short term memory and working memory. All participants took an intelligence test. Short-term memory tasks included a test wherein students were asked to repeat back sentences of increasing length and complexity; another which required repetition of lists of unrelated words; and a digit forward and backward exam. Working memory tests included a task that required repeating back addresses after interfering questions were asked; verbal word association activities; and paragraph recall. The results showed that children who were blind outperformed their sighted peers on any short-term memory task involving the "phonological loop," or phonological memory, but did not perform better on those that were considered working memory tasks. They attributed short-term memory success to the superior auditory processing skills of those who are blind relative to those who were sighted, while they demonstrated equivalent skills on the working memory tasks. Interestingly, Swanson and Luxenberg (2009) categorized digit span as a short-term memory task, instead of working memory task, and thus, their results corroborate the general understanding of memory skills of those who are blind.

Explaining These Enhanced Memory Skills

Many explanations have been suggested as to why memory seems to be a strength of those who are blind, but, generally, researchers accept the superior working and phonological memory skills of individuals who are blind. In fact, using event-related potentials (ERPs), Röder, Rösler, and Neville (2001) showed differences in brain activation when presenting auditory memory tasks to individuals with congenital blindness versus those with sight. They found similar areas of activation but increased efficiency in the working patterns in the brains of those with blindness. Individuals with congenital blindness had superior memory performance, faster speech processing, and more efficient encoding of information. The researchers surmised that this is due to their reliance on the auditory sense for acquiring information from the world and that the brain's neuroplasticity makes it able to adapt to this need for auditory efficiency and improve memory. This argument was echoed by Hertrich, Dietrich, and Ackermann (2013) who described the brain as being able to interpret timing cues of acoustic information more quickly, thus allowing individuals who are blind to be able to process auditory stimuli more quickly and efficiently than their sighted peers. It is believed that this enhanced processing and encoding allows individuals who are blind to be able to interpret faster speech and to remember slower speech more efficiently and effectively.

Occelli, Lacy, Stephens, Merabet, and Sathian (2017), however, argued that it is not enhanced verbal memory, but rather enhanced verbal ability that allows for the consistent success of individuals who are blind on these tasks. They found that individuals who were blind outperformed their sighted peers on verbal memory tasks but not on spatial memory tasks. They took this to indicate that memory is not an overall strength of those who are blind, leading to questions of whether verbal strengths were a result of improved skills in retrieval or encoding.

Raz et al. (2007) proposed that the consistently superior scores on digit span and non-word repetition tasks reported for people who are blind is due to an overall state of "superior serial memory" (p. 1229). In addition to gathering information from the world using their hearing, individuals who are blind do everything in a sequence, from traveling, to getting dressed, to finding an item in a room. Their lives are a list of steps, as otherwise it would be challenging to remember where one is or where something is located. In this way, they have a lot of practice with not just remembering, but remembering things in a sequence. As a result, their brains are used to recalling lists of information, in order, and being able to process this information quickly and accurately, simply for survival, a theory that was reiterated by Mason and Hull (1995). Individuals with sight rely on visual cues instead, rarely having to memorize lists but instead focusing on other properties of items to remember them. As a result, recalling lists of digits or random syllables is more challenging for those with sight.

Early Language and Vocabulary Development of Children who are Blind

The language development of individuals who are blind has long been a topic of interest for researchers. Without vision, those who are blind are at a disadvantage for learning many skills, from how to find a specific person in a crowded room, to what a building looks like, to being able to quickly and correctly pair words with objects. As a result, individuals who are blind need to learn these skills in a different way, which can, potentially, impact their language and vocabulary.

Mulford (1988) undertook the daunting task of attempting to describe the language development of children who are blind. In particular, 16 children – 9 male and 7 female – were followed over a period of time from infancy in order to compare their results with prior research on children who are blind and with previously completed research on children with vision. Mulford (1988), along with Perez-Pereira and Conti-Ramsden (2012), noted the difficulty in finding children who were "just blind,” as "a majority of young blind children...are in fact multihandicapped. The etiology of their visual impairment is frequently maternal rubella or some other prenatal influence having a severe impact on multiple aspects of fetal development" (p. 297). As of 2012, one of the leading causes of childhood blindness in the developed world is Retinopathy of Prematurity, which is a result of being born prematurely (Kong, Fry, Al-Samarraie, Glibert, & Steinkuller, 2012). Like the babies with rubella described by Mulford (1998), prematurity and low birth-weight are often accompanied by many lifelong disorders and challenges, such as developmental delays, speech and language disorders, ASDs, and/or other learning disabilities. In essence, individuals who are blind may have difficulty with vocabulary development, because they have other developmental disorders (Perez-Pereira & Conti-Ramsden, 2012). However, given the superior performance on working memory tasks, it is logical to believe that vocabulary should also have superior results.

Prior research, conducted by Norris, Spaulding, and Brodie (1957), as cited in Mulford (1988), revealed a delay of 8-12 months in the use of one and two words by individuals who were blind. Yet, in their own sample, Mulford (1988) found no statistical difference between toddlers who were blind and their sighted peers in reaching these milestones. They found differences in the early vocabulary of these two groups, noting that those who were blind used more action words while those who were sighted used more nouns. It was also found that those who were blind, when using nouns, typically named furniture items and foods, while those who were sighted were more likely to label animals and food.

Furthermore, Mulford (1988) noted the importance of responsive caregiving in the development of language for those who are blind. While all children's language and vocabulary are best fostered in a nurturing and highly verbal environment (Hart & Risley, 1995), it may be especially important for those who are blind as they do not get the same incidental information as their sighted peers do from their environment. Mulford (1988) found that babies who were interacted with more and who had responsive parents used first words earlier and more spontaneously, while those with less responsive parents had delays in language development. Further investigation found that, as the children aged, mothers of those who were blind used more commands, as well as repetitions of these commands, to elicit speech or actions, while mothers of those with vision used a wider range of sentence types, as well as descriptive words. Perhaps, as a result, the children who were blind were found to have delays in syntax, use of morphemes, and vocabulary. Mulford (1988) concluded, saying that as these children aged, they continued to exhibit delays especially in the areas of semantic relations, correct usage of referents, and correct vocabulary usage, especially with relation to visual terms.

Vocabulary Skills and Tests of Vocabulary

With early language development showing this lag, it is not surprising that research regarding language skills, and vocabulary skills in particular, has such mixed results. Perez-Pereira and Conti-Ramsden (2012) described the work of researchers from the 1950s through the 1980s that focused on vocabulary deficits in students who are blind. For example, Cutsforth's (1951) seminal research demonstrated that children with congenital blindness used visual terms, ranging from colors to abstract size concepts, with which they had no direct experience. His conclusions, which continue to influence beliefs today, were that these individuals lacked complete definitions of vocabulary, because they used words that they could not understand due to their physical limitations. For Cutsforth, it wasn't enough for a child to say, "The grass is green" or "Atoms are microscopic". To him, a child who is blind could not possibly understand the true concepts behind these words and thus their vocabulary must be meaningless.

However, Perez-Pereira and Conti-Ramsden (2012) also cited other researchers, such as Landau and Gleitman (1985), who reported that the blind do have a conceptual understanding of more words than previously thought. Testing by Landau and Gleitman (1985) revealed that vocabulary for children who are blind, especially at later ages, was comparable to that of their sighted peers. Landau and Gleitman (1985) surmised that vocabulary development is not based solely on direct experience, but rather on the semantics and syntax of sentences in which a new word is presented. In this way, individuals who are blind should learn vocabulary similarly to their sighted peers as they can still hear language to decode it.

Jaworska-Biskup (2011), similar to Cutsforth (1951), found that individuals who are blind often lack visually-based concepts (i.e., of size, color, etc.) and, at age 10, can be up to two years behind their sighted peers in concept development. However, unlike Cutsforth (1951), Jaworska-Biskup (2011) reported that individuals who are blind demonstrated the understanding that color, like the familiar concepts of size and weight, is an inherent trait of an object. For example, a person who is blind can use adapted rulers and scales to measure the length of a room or the weight of a book, which would help in building the idea of how tall a mountain or skyscraper is, even if the individual cannot see these entities. In this way, Jaworska-Biskup (2011) suggested there could be a middle ground of the two theories of vocabulary learning, showing the importance of vision as well as syntax, in expanding one's knowledge of definitions.

Yet, based on their research, Perez-Pereira and Conti-Ramsden (2012) determined that the cognitive development of children who are blind is delayed during early childhood due to the lack of vision. By not being able to see, they cannot easily make connections between items in the world around them or develop an understanding of the objects in their world. Building concepts takes longer for children who are blind than their sighted peers. However, when language is further developed, whether due to natural development or interactions with others, conceptual understanding can increase, and the cognitive disparity can be decreased. Perez-Pereira and Conti-Ramsden (2012) note that the vocabulary skills of children who are blind become "proficient," but they may never reach that of their sighted peers, simply due to these early years of delayed conceptual understanding. While individual differences exist and some individuals may take an active role in learning more about words and their meanings, resulting in a strengthening of their vocabulary skills, for others, this lack of concepts may be the reason for any deficits in vocabulary.

Still, it is hard to generalize from any of these previous research studies, as most studies included just one to five individuals. Furthermore, there are multiple methodological issues in studying the population of children who are blind. First, the population of those with blindness and/or visual impairments ranges in visual ability. Second, response behavior can be subject to interpretation, particularly in very young children. Third, definitions of "first words" have not remained consistent throughout the decades. Fourth, different theories of language development may have affected interpretation of data. Fifth, the inclusion of individuals with multiple disabilities is inevitable (Perez-Pereira & Conti-Ramsden, 2012). This makes it difficult to know whether any vocabulary differences noted between children who are blind and those who are sighted are due to visual impairment alone, or potentially to another aspect of the individual's situation, or to some combination of factors. Measuring the vocabulary skills of those who are blind is not easily done.

A further complication, in considering the vocabulary of individuals who are blind, is the question of how that vocabulary is measured. Typically, picture naming tasks, such as the Peabody Picture Vocabulary Test - 4th Edition (PPVT-IV; Dunn & Dunn, 2007), are used to test knowledge of words. Unfortunately, this assesses only one type of vocabulary – labeling of objects, verbs, and adjectives - and does not demonstrate deeper understanding of vocabulary. However, Perez-Pereira and Conti-Ramsden (2012) explain that for other, more abstract ideas, there is no way to ensure that any two people, blind or otherwise, have the exact same understanding of a word. What the word "freedom" means to one person may be completely different from someone else, depending on their experiences. Does this signify that only one person understands the meaning of the word?

Furthermore, the PPVT, as a picture naming task, is not designed to be accessible to those who are blind, which the authors acknowledge. In a classroom, teachers can create individualized assessment tasks or portfolio assessments based on what they have taught and, in this way, gauge a student's learning of important concepts and words (Shanahan, 2013). However, when considering a test of general vocabulary, this is not feasible. As Vervloed, Loijens, and Waller (2014) noted, when individuals who are blind are asked to give definitions of words, beyond simply labeling the presented item, vocabulary deficits are easily noticed. To further complicate the issue, Morash and McKerracher (2017) evaluated various standardized tests to determine their reliability when given to individuals who are blind, and they reported that the vocabulary tests were the least reliable, potentially raising doubt for the usage of any easily-accessible assessment.

Vocabulary can be assessed via reading comprehension or solely verbal means. Curtis (1987) described the many types of vocabulary tests that are available, depending on the types of results that are desired. Curtis noted that vocabulary knowledge can be divided into "synonyms, explanations, uses, descriptions, and demonstrations," (p. 45) wherein using a word is considered to show a concrete understanding of the definition while giving synonyms shows a deeper, more abstract comprehension of the whole word. It is important to consider these levels of vocabulary knowledge when assessing and comparing the skills of individuals and groups.

In addition to reflecting on the type of vocabulary knowledge desire, the type of words is another consideration. Linders (1998; as cited in Vervloed et al., 2014) studied the vocabulary of those who are blind extensively and determined the words that individuals often struggled to understand could be divided into three common categories. Unfortunately, these categories are challenging to describe to an individual who is blind and, therefore, even more problematic for the individual to learn. One of Linders' categories was "far-away words," (p. 434) which includes things that one cannot directly interact with, that are too large, too fragile, too small, or too dangerous, including animals. As such, individuals can have a book-learned definition for these words, but it is more difficult to have full-understanding of these terms. A second category was "close-by words," (p. 434) which consists of words that must be experienced in non-visual ways, such as "cold" or "sleep." The last category of challenging words is described as "abstract words," (p. 434) which includes words that have to be learned via language and syntax. These include prepositions, such as "between," and conjunctions, such as "because," which cannot be explored or touched, and are not objects. These categories present a way to organize the words that are used daily, but also those that are presented on assessments, and demonstrate the range of vocabulary that can present difficulty for individuals who are blind. It would not be surprising, then, if these individuals did not perform well on evaluations where such terms were commonly used.

Non-Word Repetition, Phonological Memory, and Vocabulary

Elshout-Mohr and van Daalen-Kapteijns (1987) described the cognitive processes involved in learning word meanings, writing that the

"disposition of a "limited working memory", for instance, is a feature that is psychologically dependent on the kind of materials that are processed. Although a person might be expert in managing the limitations of working memory while processing symbolic information, the person could, at the same time, be a novice in managing these limitations in processing semantic information. The problems created differ in nature, and the skill required to solve these problems differs accordingly" (p. 54).

They explain that, in order to learn the meaning of a word, one must participate in three simultaneous tasks. First are cognitive processes, followed by understanding the "unit" of the word, described as a word's one meaning despite being used in many contexts (ex. "great Wall of China" versus "great job"). The last is "semantic modality", which they defined as the different contexts from which the unit meaning is created. Using these processes can be challenging and requires manipulation, synthesis, and more than just strict memorization. In other words, it is possible that individuals may excel at working memory in some instances, such as in the repetition of digits or non-words, but then struggle with word meanings, due to the nature of the processing requirements.

However, Gathercole, Service, Hitch, Adams, and Martin (1999) reported that research findings show that "Children with good phonological memory skills have been consistently found to have greater vocabulary knowledge in their native language than other children with poorer memory function" (p. 65-66). Gathercole (2006) wrote, "The ability to repeat multisyllabic nonwords...probably represents the most effective predictor of language learning ability that is currently known" (p. 513). While not known for sure, the hypothesis is that, in having better phonological and short-term memories, these individuals are then able to transfer these skills into creating long-term storage of words, thus building their vocabulary.

Gathercole, et al. (1999) completed a study on typically-developing four-year-old children to test this hypothesis. In their study, they used non-word repetition, digit span, and vocabulary tests to establish if this link between memory and vocabulary exists. As predicted, results indicated that all phonological memory tests were correlated with vocabulary tests. Children who were around five-years-old and those who were about 13-years-old were then assessed to see if this correlation changed with age, using age-appropriate phonological memory and vocabulary tasks. Again, it was found that, for both age groups, there was still a high correlation between memory and vocabulary skills. These results confirmed a study by Gathercole et al. (1994), which found that digit span and non-word repetition were correlated with vocabulary for four, five, and eight year olds, though the strength of the correlation at eight was not as strong.

If these results hold true for individuals who have sight, it stands to reason that individuals who are blind should also perform well on tests of vocabulary. With research consistently showing that their performance on digit span and non-word repetition tasks exceeds that of their sighted peers, their performance on vocabulary tasks should show a similar trend.

However, there is a gap in the knowledge of how phonological and working memory skills correlate with vocabulary skills for those who are blind. While memory tasks have been compared between these two groups, little is known about the direct comparison between the vocabulary skills of those who are blind and those who are sighted. The mixed results on the development of vocabulary skills of the blind imply that those who are blind may not follow the same pattern as their sighted peers in that having better memory skills may not result in better vocabulary.

Population

Throughout the literature, it became apparent that prior research has focused on either children or adults. Digit span and non-word repetition tasks have been used to show the current skills of children and to predict future performance, while these assessments have been to compare the skills of different adult populations. There is little to no available research about adolescents. For purposes of this study, adolescents will be used and will include those who are aged 12 years to 19 years.

Gathercole and Baddeley (1990) believed that non-word repetition could not be used with adolescents and adults as they considered it an easy task with little room for error. However, to combat this, materials were chosen that were created for this age group so that the non-words would not be easily repeated by all participants. This study looks at whether this task can be relevant for these populations, despite these beliefs.

Research Questions

Given these gaps in knowledge, the purpose of this study is to delve deeper into the relationships between skills in digit span, non-word repetition, and vocabulary to evaluate whether there is a difference in abilities between those adolescents who are blind and those who are sighted. The following research questions will be addressed:

1. Do middle and high school students with congenital blindness achieve significantly different scaled scores on digit span tests that assess working memory than students who are sighted?

2. Do middle and high school students with congenital blindness achieve significantly different scaled scores on non-word repetition tests that assess phonological memory than

students who are sighted?

3. Do middle and high school students with congenital blindness achieve significantly different scaled scores on spoken tests of vocabulary knowledge (e.g., Word Opposites, Word Derivations, Spoken Analogies) than students who are sighted?

2. METHODS

Participants

Included in this study were six students who are congenitally blind and 6 same-aged peers who are sighted. Participants who are congenitally blind were recruited from the Texas School for the Blind and Visually Impaired (TSBVI) and were attending middle or high school there. Any student who voluntarily asked for forms and who received parental consent was considered. Inclusion criteria required that students be congenitally blind or have vision loss that occurred before the age of one, with, at most, light perception and be between the ages of 12 and 19 years old. Participants could be either gender, from any racial/ethnic group, and any level of family socioeconomic status (SES). Teachers at TSBVI assisted in identifying eligible students, collecting consent forms, and informally assessing students' ability to participate in a 50-minute set of assessments.

Sighted peers were recruited from a convenience sample of middle and high school students known to the researchers. Sighted peers were recruited from specific age, gender, race/ethnicity, and SES levels to match the participants who were blind. All students, sighted and blind, were given a parent survey about home language usage. They were also asked about parental education to determine SES for each student to match for these factors, using the Hollingshead Four-Factor Index (Hollingshead, 1975). See Table 1 "Study Participants" following the Methods section for more information regarding the individuals in this study and Table 2 “Hollingshead Results” for the Hollingshead Four-Factor Index scores for these same participants.

As can be seen, the group of students who were blind consisted of two female and four male students, while the students who were sighted included one female and five males. The average age of participants for the group of students with blindness was 15.69 years and for the group of sighted students was 15.51 years. Of the six students who were blind, five reported receiving speech and language treatment services at some point in their lives, as opposed to just one of the six for those with vision.

Materials

Researchers used several instruments to conduct this study. Consent and assent forms were required for all families and participants. Parents were also given a researcher-created survey containing questions about their child's first and, if applicable, second language-usage and history of speech and language therapy, as well as parental education and employment. Students participated in a short researcher-created interview about their age, vision, and speech and language therapy history.

In addition, the Comprehensive Test of Phonological Processing - 2nd edition (CTOPP-2; Waggner, Torgesen, Rashotte, & Pearson, 2013) was used to assess phonological and working memory skills. The CTOPP-2 is a standardized, norm-referenced test that is used to evaluate phonological-processing skills, especially with respect to reading. It can be used with individuals who are four years old to 24 years 11 months, thus including the population of interest for this study. Assessments look at reading skills from the bottom-up, evaluating phonological awareness (sounds and how they go together), phonological memory (the ability to remember and manipulate sounds), and rapid naming (the ability to quickly and easily access information - such as letter sounds or number names - from memory).

Specifically, for this study, phonological memory was of interest, so the subtests

Memory for Digits, to test working memory skills, and Non-Word Repetition, to test phonological memory skills, were given. Memory for digits has 28 items which were presented via an audio-recording; a number was spoken and the participant was asked to repeat back the digits heard in the order they were heard. Testing was discontinued when the participant missed three sets of digits in a row. Non-Word Repetition consisted of 30 items of increasing difficulty; students listened to an audio-recording of the invented word and repeated back what they heard. All sounds had to be said correctly for the word to be correct. Again, testing was discontinued when there were three errors in a row. These two subtests were chosen to confirm results from previous research. The adolescent age group is part of the norming sample for the CTOPP-2 (Waggner, Torgesen, Rashotte, & Pearson, 2013) and thus the lists from this assessment were used. Also, these tests were easily and consistently presented for both those who are blind and those who are sighted.

In addition, three subtests from the Test of Adolescent and Adult Language-4th Edition (TOAL-4; Hammill, Brown, Larsen, & Wiederholt, 2007) were given to assess the participants' vocabulary skills: Word Opposites, Word Derivations, and Spoken Analogies. The TOAL-4 is an assessment that can be used for individuals who are 12 years old to 24 years, 11 months old. This directly addresses the adolescent population in question for this study and is one of the reasons it was chosen. The TOAL-4 is an assessment of written and spoken language abilities. Included are subtests that address the language components of grammar, semantics, and graphology. The term grammar refers to the act of putting words together to create correct phrases and sentences, as well as manipulating words by adding prefixes and suffixes, while semantics refers to word meaning.

For this study, spoken language was chosen as the measurement of vocabulary ability as it does not require access to visual information. The subtests administered required only listening, thus no accommodations were necessary for the students who were blind. For the Word Opposites subtest, the examiner read a word and the participant was asked to give a word that meant the opposite. For the Word Derivations subtest, participants were given a word and two sentences. Using a cloze sentence format, the participant was required to manipulate the given word to form a grammatically correct sentence. The Spoken Analogies subtest required the participant to complete cloze sentences using analogies that included knowledge of definitions or manipulation of prefixes and suffixes. Each subtest was discontinued when three in a row were missed. These subtests were chosen due to their ease of presentation to both groups, the range of skills addressed, and the ability to complete all tests orally. Visual tasks were not used due to the need for accommodations which would have changed the required test administration guidelines. Writing tasks were not used given the researcher's knowledge that many individuals attend the school for the blind to learn to write braille. As a result, potential errors in writing may not have reflected vocabulary errors but rather writing errors. To avoid any confusion, these tasks were not used.

For both assessments, individuals from culturally and linguistically diverse (CLD) backgrounds were included in the norming samples, which was beneficial as the study sample included individuals from many CLD populations. When considering individuals with congenital blindness, Morash and McKerracher (2017) advocated for the usage of verbal memory tests that are normed on sighted populations and concluded that results can be compared to the norming sample but must be interpreted with caution, despite believing them to be a valid tool. As previously noted, they found vocabulary tests to be the least reliable. The TOAL-4 was not part of their evaluation, though, so, this assessment was used, though its results will also be interpreted with caution. It is the case that individuals who are blind were not members of the norming sample for either of these assessments. However, for ease of interpretation, raw scores for both groups were converted to scaled scores. Both tests have means of ten and standard deviations of three for all subtests given.

Testing Environment

Students from the TSBVI were tested on their school campus. The superintendent and principal granted permission for the researchers to use school facilities for this study. Various classrooms and offices were used, as available, and were chosen for their privacy, quiet environment, and ease of access. Sighted peers were tested in the participants' homes or public locations, such as private rooms at the local library. While these were not as quiet as desired, this allowed for assurance of safety of the students and ease of participation for students and their families.

Procedure

Students who are congenitally blind were informed of the study and volunteered to participate as they desired. They were then given consent forms and surveys for their parents to answer, which they then returned to the front office at the school to be returned to the researchers. Students 18 years or older signed their own consent forms but were still required to have their parents complete the survey. Participants were then scheduled to complete the assessment process. Sighted peers were recruited directly by the researchers, matching for demographic characteristics to the best of their abilities. Consent and survey forms were given and returned. Scheduling of sessions was made at the convenience of the families.

Each session began with the student signing an assent form to confirm his or her agreement to participate. Students were asked if they were comfortable with being audio-recorded for research purposes. The researcher then asked the questions on the researcher-created interview. Next, the subtests from the CTOPP-2 were completed, followed by the subtests from the TOAL-4. The testing procedure lasted between 30 and 50 minutes per participant.

Reliability

The primary researcher calculated raw and scaled scores for all assessments given. One assessment from each group, sighted and blind, was chosen at random, and then a third was chosen at random from the remaining tests. A second researcher recalculated raw and scaled scores for these assessments, with 25% of tests being evaluated for reliability. Reliability of scoring for all subtests was 100%.

Data Analysis

Following data collection, raw scores were calculated. Using the manuals for the CTOPP-2 and TOAL-4, standard scores were then calculated for each participant. Means and standard deviations were calculated for the students who were blind and the students who were sighted for each subtest that was given. T-tests and Mann Whitney U-tests were then performed for the mean group scores of each subtest to determine if there was a difference in one particular test: Digit Span, Non-Word Repetition Task, Word Opposites, Word Derivations, and Word Analogies.

Table 1. Study Participants

Students who are blind	#1	#2	#3
Age	16 years	18 years, 2 months,	14 years, 11 months
Gender	Female	Male	Male
Ethnicity	Hispanic	Hispanic	African American
Language(s)	English Limited Spanish	English only	English only
Maternal Education	Some college	Unknown - lives with great-grandma	College graduate
Paternal Education	College graduate	Unknown	High school graduate
Visual Impairment	Yes - light perception	Yes - color/light perception in right eye	Yes - light perception
Speech Therapy	No	Yes - when younger	Yes

Students who are blind	#7	#8	#9
Age	17 years, 1 month	13 years, 11 months	14 years
Gender	Male	Female	Male
Ethnicity	Hispanic	African American	Hispanic
Language(s)	English and Spanish	English only	English and Spanish
Maternal Education	High school graduate	No response	Less than 7th grade
Paternal Education	Unknown	No response	Unknown
Visual Impairment	Yes - light perception and sees shadows	Yes - light perception only	Yes - light perception only
Speech Therapy	Yes – diagnosed expressive and receptive lang. disorder	Uncertain	Yes - when younger

Table 1. Study Participants Continued.

Students with sight	#4	#5	#6
Age	16 years, 1 month	13 years, 6 months	16 years, 10 months
Gender	Male	Male	Male
Ethnicity	Caucasian	African American	African American
Language(s)	English only	English only	English only
Maternal Education	Graduate school	Graduate school	Graduate school
Paternal Education	Graduate school	Graduate school	Graduate school
Visual Impairment	No	No	No
Speech Therapy	No	Yes	No

Students with sight	#10	#11	#12
Age	14 years, 2 months	13 years, 5 months	19 years, 1 month
Gender	Female	Female	Male
Ethnicity	Caucasian	Hispanic	Hispanic
Language(s)	English	English and Spanish	English and Spanish
Maternal Education	Some college	Less than 7th grade	Some college
Paternal Education	Some college	Less than 7th grade	College graduate
Visual Impairment	No	No	No
Speech Therapy	No	No	No

Table 2. Hollingshead Results

Students who are blind	Maternal Education	Maternal Job	Paternal Education	Paternal Job	Total	Total Maternal Only
1	5	7	6	8	26	12
2	5	0	0	0	5	5
3	6	1	4	0	11	7
7	4	1	0	0	5	5
8	None given					
9	1	1	0	0	2	2
				Average:	**9.8**	**6.2**

Students with sight	Maternal Education	Maternal Job	Paternal Education	Paternal Job	Total	Total Maternal Only
4	7	9	7	9	32	16
5	7	9	7	9	32	16
6	7	9	7	9	32	16
10	5	4	5	6	20	9
11	1	4	1	4	10	5
12	5	7	6	7	25	12
				Average	**25.17**	**12.33**

3. RESULTS

Group Results

Please refer to Tables 3 and 4 after the Results section for the means, standard deviations, and t-test results for the two groups of students. Refer to Figures 1 and 2 after the Results section for graphical representations of this information.

As can be seen in the tables and figures, there was no significant difference found between the groups for any memory tests, nor for Word Opposites and Word Derivations. However, there was a statistically significant difference between groups for Spoken Analogies.

To confirm the results of the t-tests, Mann-Whitney U tests were also performed. This test does not assume normal distribution of results, which is quite possible given the mixed nature of the populations studied. The U-values can be found in Table 5, following the results section, but confirm t-Test results. Only the test of Spoken Analogies showed a difference of statistical significance

Question 1 Results: 1. Do middle and high school students with congenital blindness achieve significantly different scaled scores on digit span tests that assess working memory than students who are sighted? There was no significant difference found in terms of digit span test scores between the two groups

Question 2 Results: 2. Do middle and high school students with congenital blindness achieve significantly different scaled scores on non-word repetition tests that assess phonological memory than students who are sighted? There was no significant difference found in terms of non-word repetition test scores between the two groups.

Question 3 Results: 3. Do middle and high school students with congenital blindness achieve significantly different scaled scores on spoken tests of vocabulary knowledge (e.g., Word Opposites, Word Derivations, Spoken Analogies) than students who are sighted? For Word Opposites and Word Derivations, no significant difference was found. However, the difference between groups for Spoken Analogies was found to be statistically significant. The students with sight scored significantly higher on this subtest than did the students who were blind.

Individual Results

Group results, while the subject of the research questions, do not fully explain the skills of the individuals who were assessed for this study. Each student has his or her own skills that contribute to the group averages but that may or may not follow the trend of the group and the patterns of previous research. Individual results are included to show the range of abilities that contributed to the group results, as this information may lead to future investigation and demonstrates the importance of caution when drawing conclusions.

Individual Results: Students who were Blind

Participant one. When compared to the standardized scores, participant one scored in the average range for non-word repetition task and digit span. For the vocabulary tasks, participant one scored in the average range for Word Opposites and Word Derivations, but was below the average range for Spoken Analogies. It should be noted that, prior to this study, participant one had never heard of analogies before, and the examples on the TOAL-4 were the participant's first exposures.

Participant two. Participant two showed scored above average on memory for digits and average for non-word repetition. He scored above average on Word Opposites and

Word Derivations. His score on Spoken Analogies was in the average range. When interviewing this student, he noted that he loves to read and write.

Participant three. Participant three scored in the average range for both memory tasks. Scores on vocabulary tasks ranged from average on Word Opposites to below average for both Word Derivations and Spoken Analogies.

Participant seven. Participant seven scored in the above average range for memory for digits and average for non-word repetition. His scores were below the average range for Word Opposites, Word Derivations, and Spoken Analogies.

Participant eight. Participant eight scored above average on the digit span task and was in the average range for non-word repetition. Participant eight scored below average on all vocabulary tasks.

Participant nine. Participant nine scored in the average range on the digit span task and below the average range on non-word repetition. Scores on Word Opposites and Word Analogies were below the average range, and the score on Word Derivations was in the average range.

Individual Results: Students with Vision

Participant four. Participant four scored below the average range on both memory subtests. He scored in the average range for all vocabulary subtests. range.

Participant five. Participant five scored below the average range on both the digit span task and non-word repetition task. He scored in the average range for Spoke Analogies and above the average range for both Word Opposites and Word Derivations.

Participant six. Participant six scored above the average range on the digit span task. Scores on the non-word repetition task and all vocabulary subtests were in the average range.

Participant ten. Participant ten scored below the average range on the two memory subtests and Word Derivations. She scored in the average range for Word Opposites and Spoken Analogies.

Participant eleven. Participant eleven scored in the average range for the digit span task, non-word repetition task, and Spoken Analogies. Scores for Word Opposites and Word Derivations were below the average range.

Participant twelve. Participant twelve scored in the average range on the digit span subtest and below the average range for the non-word repetition task. For vocabulary, participant twelve scored below the average range on Word Opposites and Word Derivations and in the average range for Spoken Analogies.

Overall, the argument that students who are blind have poorer vocabulary skills did not hold true for the participants in this study. It would seem that they are able, at least by adolescence, to demonstrate vocabulary skills that are commensurate with their sighted peers.

Table 3. Results: Memory

	Memory for Digits	Non-Word Repetition
Mean Blind	11.33	8.833
Standard Dev. Blind	3.44	3.19
Mean Sighted	8.833	7
Standard Dev. Sighted	3.87	3.1
t-Test result	1.1822	1.0101
Significant?	No	No

*All t-Tests were performed at $\alpha = 0.05$.

Table 4. Results: Vocabulary

	Word Opposites	Word Derivations	Spoken Analogies
Mean Blind	7.5	7.667	6.167
Standard Dev. Blind	3.56	3.01	2.967
Mean Sighted	8.33	8	10.5
Standard Dev. Sighted	2.88	2.89	2.7
t-Test result	-0.4458	-0.1954	**-4.4588**
Significant?	No	No	**YES**

*All t-Tests were performed at $\alpha = 0.05$. Critical value for determining significance changes for each subtest given.

Table 5. U-Value Results

Test	U- value	Significant?
Memory for Digits	9.5	No
Non-Word Repetition	11.5	No
Word Opposites	14	No
Word Derivations	16.5	No
Spoken Analogies	**1.5**	**YES**

*All U-Tests were performed at $\alpha = 0.05$. For all, U is significant if < 5.

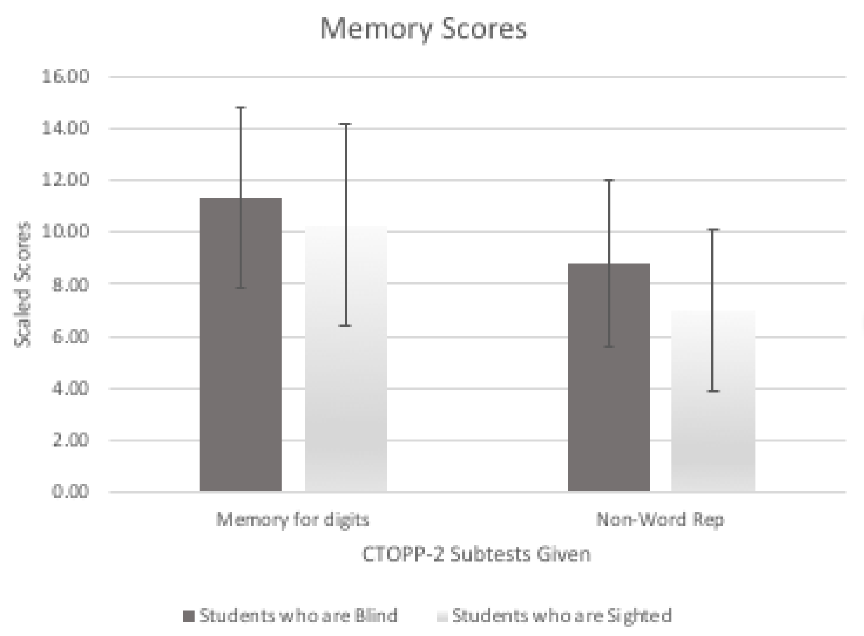

Figure 1. Means and standard deviations from digit span and non-word rep. tasks.

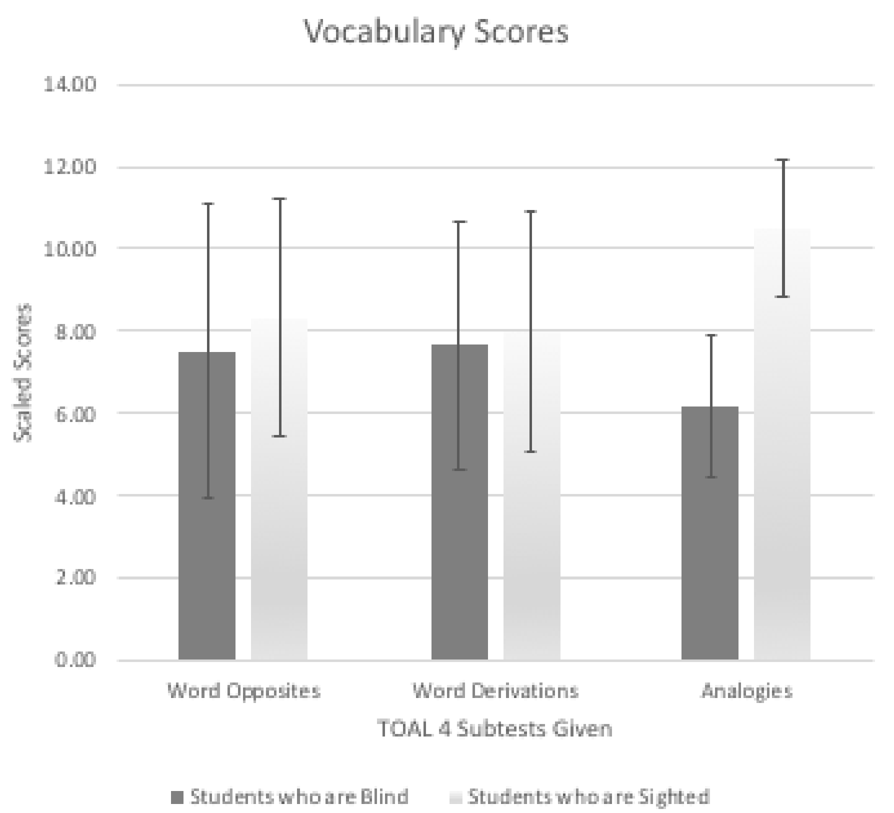

Figure 2. Means and standard deviations for vocabulary tests.

4. DISCUSSION

In this study, there was no statistically significant difference between groups for the digit span task or the non-work repetition task. There was also no statistically significant difference between groups for the vocabulary tests of word opposites and word derivations. However, a statistically significant difference was found between the groups on the test of spoken analogies, wherein the group of students who are sighted scored higher than the group of students who are blind.

The data from this study contradict the results of previous researchers. In this study, adolescents who are congenitally blind scored similarly to their sighted peers on digit-span and non-word repetition tasks. This result was surprising given the depth and breadth of research which would suggest that students who are blind often perform better than students who are sighted. However, in looking closely at the data, it is important to note that the results trend towards a difference. Students who are blind had higher scores than students with sight, thought the difference did not reach statistical significance. It is possible that this finding is a result of the small sample size in this study.

Students with vision struggled, in particular, with non-word repetition tasks. While the results do not indicate a significant difference, they were much more distracted by the "words" themselves. Several students in this group had difficulty completing the task as they were laughing at the phonemes presented, rather than trying to remember them. It is possible that, had they been better able to focus on the task at hand, their performance may have been better.

Results from the vocabulary assessments, however, were mixed, which echoes the results of previous research. Individuals who are blind scored at a similar level as their sighted peers for two out of the three tests, which raises the question of why the analogies test yielded different results. Several of the students had never been introduced to analogies before, but there were individuals from both groups for whom this was true. Therefore, it seems unlikely that it was the format alone caused the difference. It may be that the words were more abstract or that making the connection between different words is a more challenging task. Some questions that were frequently missed referred to aspects of objects that are visual in nature, such as parts of an animal or locations on a map. These would be more difficult for a person who is blind to know unless it was memorized from a textbook or conversation. A person with sight, however, could have seen these items, even incidentally, and been more easily able to correctly answer the questions.

When analyzing the common errors on the analogy assessments, the words missed by those who are blind can be easily divided into three common categories that have been previously described by Linders (1998; as cited in Vervloed, Loijens, & Waller, 2014). For example, in the category of "far-away words," students often struggled with the words "peninsula," "flake" (referring to snow), and "feather," as well as the idea of continents and the countries in them. These are items that are difficult or impossible to touch, whether because of their size or because a bird rarely stands still to be examined, while an individual with sight can see them, whether in person or in a book. The second category of "close-by words," which consists of words that must be experienced in non-visual ways, however, were not missed by those who were blind. For the last category of "abstract words," which have to be learned via language and syntax, there are some terms that were consistently missed by the students who were blind. These included the idea of "masculine" versus "feminine," as well as category words like "reptile" and "amphibian." While the latter can be physically explored, the word itself describes a class and is not an object. When breaking the assessment items down in this manner, it can be seen why the students who were blind may have struggled with some of the items.

For the other two assessments, errors made by students from both groups were fairly similar. In fact, the greatest challenge seemed to be in finding the one correct word that was required by the test to gain credit. Many students from both groups demonstrated knowledge, for example, of what the opposite of a given word was, but were unable to provide the one expected term defined as "correct" by the test. However, as the results demonstrate, as both groups struggled with this, these challenges were fairly equal for both groups and did not lead to a difference in their performance overall.

Given the closeness of the group's scores on two out of the three vocabulary assessments, it seems unlikely that Morash and McKerracher's (2017) concerns about reliability of vocabulary tests played any role in the score differential for analogies. However, it would be important to continue testing individuals to search for consistency, while considering Morash and McKerracher's (2017) concerns that the lower results may be due to a lack of test reliability, rather than to weaker skills. While the TOAL-4 (Hammill, Brown, Larsen, & Wiederholt, 2007) seems to show an accurate picture of the skills of the students in the study, the chance for irregularities points to the need to evaluate using many tools, not just one easy-to-give assessment, when making referrals and determining eligibilities of students for speech therapy.

Despite not being statistically significant, the scores for vocabulary for those who were blind were, overall, lower than their sighted peers. However, the lack of significance is commensurate with the work of Landau and Gleitman (1985), as cited in Perez-Pereira and Conti-Ramsden (2012). In this study, students demonstrated the ability to use words, even words with visual aspects, at a level similar to their peers, and, as Jaworska-Biskup (2011) found, the two-year differential found in childhood was no longer apparent by adolescence. Interestingly, the highest scores for both word opposites and word derivatives were achieved by a student who was blind. This demonstrates that in every group there are individual differences. Similarly, a student with vision and a student who was blind both achieved identical above-average scores on the memory tests. In every group, there will be individual students who do not follow the trend and who do better, or worse, depending on their own circumstances, motivation, upbringing, and other personal factors.

Perez-Pereira and Conti-Ramsden (2012) noted that, depending on the person and his/her environment in childhood, language may actually be the motivator and key piece to development of other skills, rather than a deficit. For participant two**,** his love of reading and writing since childhood may have been responsible for developing his advanced vocabulary skills. His interests and environment may have led to his relatively higher scores on the assessments, and despite vision loss, he accurately learned the meanings of words via syntax, as Elshout-Mohr and van Daalen- Kapteijns (1987) believed was possible (as cited in Perez-Pereira & Conti-Ramsden, 2012).

Though Gathercole (2006) and Gathercole et al. (1999) claimed that better non-word repetition and digit span scores predicted better vocabulary test scores, this was not found to be consistent for the participants in this study. For example, participant number six scored in above average and average ranges for memory, but was average for vocabulary while participant five scored below average for memory but above average for two out of three vocabulary tests. It seems that their memory scores did not correlate with their vocabulary scores in any way. Instead it would be seem that the argument put forth by Elshout-Mohr and van Daalen-Kapteijns (1987) may hold true for this study's participants. Rather than showing a consistency in the strength or weakness of processes across the tests, it is possible there are different processes at work when completing memory and vocabulary tasks that allow individuals to excel in one area but not the other.

Finally, it would seem that language and age were not a factor in the results in differences between groups. There was no statistical difference in the ages of the two groups, as the students who were blind averaged 15.69 years and the students who were sighted averaged 15.51 years. There were also the same number of students who were native bilinguals in each group. It was noted, though, that students who were bilingual tended to score better on tests of memory than they did on tests of vocabulary. However, depending on their exposure to English, it is possible that the language of examination is what made the difference, rather than their vocabulary abilities.

Two obvious differences between the characteristics of the groups can be seen. The first was that there were more students who were blind who were receiving or had received speech and language services. While the exact reasons for their eligibilities are unknown, four of the students described working on categorization skills, as well as prefixes and suffixes. These are directly related to vocabulary skills, raising the question of whether their skills were at the level of their sighted peers because of therapy or in spite of therapy. The other is related to their SES. As the Hollingshead Four-Factor analysis showed (Hollingshead, 1975), students who were blind were from households with significantly lower SES scores, averaging 9.8, often being raised by single parents who had fewer years of education and lower occupational rankings, while students with vision were from two-parent households which averaged 25.17 on the index. As Hart and Risley (1995) noted, young children from homes with lower SES have lower vocabularies. Differences in SES This could have affected vocabulary scores, rather than, or even in addition to, any visual impairment. This is an area that would need to be controlled for in future studies to evaluate what role SES plays and what role vision plays in vocabulary development for these individuals.

5. CONCLUSION

Summary and Implications

The purpose of this study was to compare the working memory, phonological memory, and vocabulary skills of adolescents who are blind with their sighted peers. It was found that, unlike in prior research, there was no statistically significant difference between adolescents who are blind and their sighted peers on digit span and non-word repetition tasks in this small sample. There was also no statistically significant difference between the groups on word opposites and word derivation vocabulary assessments, but there was a significant difference for spoken analogies. As a group, students with vision had higher scores on this test.

While memory was not statistically different, average scores were higher for students who were blind. Knowing that students who are blind may have strong memory skills is something that teachers and other professionals can use in training and teaching. In regards to vocabulary, based on this study, there is no reason to expect that students who are blind will necessarily have below average skills. Knowing this, educators and other service providers, such as speech-language pathologists, occupational therapists, physical therapists, and psychologists, should expect to see typical vocabulary skills from their students who are blind.

From looking at these results, it is important that referrals and eligibility determinations are made with caution. Based on this study, the lack of difference implies that students who are blind should not receive more referrals for vocabulary difficulties than their sighted peers. Any perceived deficits should be viewed with caution and evaluated with a variety of assessments, not just a single standardized test, to ensure that the students have the opportunity to demonstrate their skills. It maybe that any apparently weaker skills need only be addressed via the teacher of the visually impaired, without needing another diagnosis and services from a speech-language pathologist.

Limitations

This study has several limitations. The small sample size means that generalization to all individuals who are blind is inadvisable. Sighted individuals were not perfectly matched with those who were blind, though researchers attempted to match demographics to the best of their abilities. In recruiting individuals, there were many factors that were not considered: did any participants have any other disorders, like autism spectrum disorders, a learning disability, ADHD, or cerebral palsy? As Mulford (1988), as well as Morash and McKerracher (2017), noted, it is challenging to find individuals who are blind who do not have co-morbid diagnoses due to the etiologies of blindness. Therefore, some score discrepancies may be due to other disability conditions or disorders, rather than to blindness itself.

While information was collected about receipt of speech and language services, it is not known why students were receiving services. There was also no data collected as to how long students had been receiving services, what goals had been addressed, and what progress had been made. Without this information, it is difficult to know if success on the assessments was due to intervention that had previously been provided from speech-language pathologists, from working with teachers of the visually impaired on concept development, or from development and incidental learning that would have occurred anyway.

Furthermore, while basic background information was gathered, there was no full interview to discuss the upbringing of each participant. It is well-documented that vocabulary breadth and depth relies greatly on the interactions one receives from birth, which is tied closely to SES and maternal education (Hart & Risley, 1995). By not matching peer groups exactly for these factors, it is possible that some differences between the groups was due to these factors, rather than to blindness itself. There are many personality factors that could also affect the results of this study, from confidence to motivation to preference for language tasks to general happiness in life. Some students were very motivated to participate in the study, thinking about answers before responding and considering questions as they were asked. Others were quick to say, "I don't know" when this was offered as a possible choice when perhaps, had they thought about a question for a moment, they may have been able to answer it correctly. Any combination of these factors could have a tremendous effect on how any student learns vocabulary and/or performs on an assessment, and it is hard to control and match for all of these individual differences.

In addition, the environments where testing was conducted was not consistent. Students at the school for the blind were tested in offices or classrooms that were available, so they were typically quiet, without interference from talking by others. However, announcements were made, bells rang, and other distractions were present at times. Each session was not equal. It does raise the question of whether a group or an individual performed differently because of the environment in which he or she was tested. Some individuals were tested in their own homes; this may have increased comfort but also distractibility. Inconsistencies in environment could have resulted in test scores that were not consistent with their actual skills.

In considering distractibility, being blind means that auditory distractions are the only ones that need to be contended with, apart from physical comforts. However, an individual with sight has visual, as well as auditory, distractions. She or he can see the researcher making notes and may wonder what is being written. Any unrelated movement, item on the wall, or other such object in the room may become a distraction, depending on the individual. Not all testing environments were equal, and this is something that would need to be considered in the future.

Future Research

Given its limitations, repeating this study with a larger population will be very important. A larger group may clarify whether or not there is a significant difference between memory scores for this age group. Given the difference in analogy skills, research into this is important as well. What is it about analogies that is challenging for individuals who are blind? Is it the format or the content? This is something that is important to investigate to determine any needed remediation. In looking at vocabulary skills, it is also important to look at how referrals and eligibility for speech and language services are being determined for these students who are blind. Finding out more about how many students are being evaluated, how many receive services, and what assessments are used to make this determination will be important in evaluating whether these diagnoses are being made correctly. Given that the results of this small study indicated there was no difference in vocabulary overall, it is important to consider that vocabulary and associated language skills are not what is causing referrals. These are some areas to further investigate to be able to educate individuals who are blind so they can reach their full potential, whether this means receiving speech services, working with their teachers of the visually impaired, or parent training.

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