Cognitive profiles of students with hearing loss as a pathway for differentiated instruction

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ABSTRACT

Hearing loss can disrupt a child's cognitive abilities and academic growth in areas such as reading, writing, math, social studies, and sciences. Yet educational interventions to enhance the cognitive performance of students with hearing loss remain uncertain because researchers have not holistically mapped the cognitive profiles of this population. The goal of the study was to compare the cognitive profiles of elementary, middle, and high school students with hearing loss to determine typical patterns of cognition. The participants included diagnosticians in a targeted school district who responded to a survey about the cognitive profiles of students with hearing loss who received special education services under the Individuals with Disabilities Education Act. The study employed heat maps to visually chart the strengths and weaknesses of the sample and render the results accessible to general practitioners. The findings of this study revealed that almost all students in the population were functioning in the below-average to average range on all cognitive abilities. Patterns of performance indicated that if a student scored below average on one cognitive ability, they likely performed below average on the other cognitive abilities. The study indicates that interventions should be designed to address each student's individual profile.

Keywords: hearing loss, cognitive abilities, differentiated instruction

INTRODUCTION

Any degree of hearing loss can impact the development of a child's communication, language, social, and academic skills (Tabaquim et al., 2013). Cognitive assessments have revealed that students with mild to moderate hearing loss typically lag behind their hearing peers by one to four grade levels (ASHA, 2020). Even with technological advances, such as cochlear implants, students with hearing loss still struggle to reach grade-level proficiency in reading, math, science, and social studies (NCSER, 2011).

Many students with hearing loss require specialized instruction with modifications and are therefore referred to special-education services through the Individuals with Disabilities Education Act (IDEA, 2004). IDEA includes "hearing impairment" and "deafness" as two disabilities that qualify students for special education and related services. The regulations in Sec.300.8(c)(5) define a *hearing impairment* as "an impairment in hearing, whether permanent or fluctuating, that adversely affects a child's educational performance," and *deafness* as "a hearing impairment that is so severe that the child is impaired in processing linguistic information through hearing, with or without amplification, that adversely affects a child's educational performance" (IDEA, 2004). To better characterize the population with hearing loss and their cognitive abilities, this study will use the term *hearing loss* to reference deafness and auditory impairments. While students with hearing loss are served under the IDEA, their potential intelligence may be widely differentiated and is a matter of research debate. It remains unsettled in the literature what educational interventions may enhance the cognitive performance of students with hearing loss because researchers have not holistically mapped the cognitive profiles of this population.

The terms *intelligence* and *cognition* refer to the core skills the brain uses to think, read, learn, remember, reason, and pay attention. Researchers have proposed multiple models for understanding cognitive functioning. According to Vygotsky (1962), cognition changes the ways humans develop, while individual learning experiences shape intelligence. Vygotsky (1962) argued that the absence of one sense, such as hearing, should not impact intelligence since alternate avenues for learning can deliver cognitive stimuli. As explained by Sattlers (2008), Carroll's 2005 study segmented individual cognitive abilities into modes of intelligence that could be isolated using the Three Stratum Theory.

The primary cognitive abilities (known as Gs) that derive from Three Stratum Theory include: (G_c) crystallized intelligence, or verbal and language-based knowledge; (G_f) fluid intelligence, the ability to solve new problems through reasoning and problem-solving without relying on previously learned information; (G_{lr}) long-term memory, the ability to store and retrieve information for an extended period; (G_{sm}) short-term memory, the capacity to retain information for immediate use; (G_v) visual processing, the ability to visualize and understand spatial relationships among objects; and (G_s) processing speed, the time an individual takes to complete reading, writing, or mathematical tasks (Evans et al., 2002).

When studying the impact of hearing loss on cognition, researchers have typically analyzed individual cognitive abilities in relation to student academic performance. Regarding crystallized intelligence, Marschark and Hauser (2012), Lieu et al. (2013), Delage and Tuller (2007), and Akamatsu et al. (2008) all found that hearing loss had a significantly negative effect on verbal comprehension, perhaps due to delayed language acquisition in infancy (Botting et al., 2016; Marshall et al., 2015). Examining fluid intelligence, Traxler (2000), Rodríguez-Santos et al. (2014), and Bull with other coauthors (2005) found that students with hearing loss did not perform as well as their hearing peers on mathematical tasks, especially when making comparisons using symbols, such as greater-than or less-than. Students with hearing loss have also historically performed less adeptly than their hearing peers on long-term memory storage tasks when they were asked to remember unfamiliar words (Liben et al., 1979, McEvoy, 1999; Tweney et al., 1975), which could derive from difficulties utilizing abstract categories to organize data (Marschark & Everhart, 2013). Likewise, Marshall together with coauthors. (2015) and Arfé and coauthors (2015) uncovered deficits in short-term memory among a population of students with hearing loss, which negatively impacted reading, writing, and math proficiency and could be due to struggles with selective attention.

Regarding visual processing, it has been suggested by some that students with hearing loss would rely on sight-oriented stimulation as a way of adapting to auditory impairment. Indeed, Marschark and Hauser (2012) recommended offering a rich visual-language environment for students with hearing loss to facilitate their academic skills. However, Marschark et al. (2015, 2017) discovered that, as with the general academic population, students with hearing loss are not necessarily primarily visual learners (35.2% had difficulty with visual processing skills). Few studies have specifically measured general processing speed among students with hearing loss, but the studies available have shown that students with hearing loss typically take longer to provide answers to questions that require memory recall (Epstein et al., 1994; Marschark & Cornoldi, 1991).

While these studies, when taken together, suggest that students with hearing loss experience deficits in all cognitive abilities as compared to their hearing peers, no research has holistically covered the patterns of strengths and weaknesses in relation to all six cognitive abilities at once for this highly diverse hearing loss population (Reesman et al., 2014). These cognitive abilities, when assessed together, may be used to create a cognitive profile for students with hearing loss. Since educators who work with hearing-impaired students often lack an understanding of these cognitive profiles, gaps in academic outcomes and cognitive delays continue to dampen the academic advancement of this student population (Detterman & Thompson, 1997; Marschark & Knoors, 2012). Further, there is a limited body of research on the relationship between cognition and grade levels in students with hearing loss at the elementary, secondary, and high school levels.

AIM AND METHODS

Aim & significance

The purpose of the present study is to identify whether cognitive patterns exist in students with hearing loss across elementary, middle, and high-school grade levels. A better understanding of the cognitive profiles of students with hearing loss among these cohorts could lead to narrowing their achievement gaps by assisting service providers in planning individualized instruction for students with hearing loss, based on their cognitive strengths and weaknesses. It is essential to obtain information about the cognitive abilities of K–12 students to build differentiated curricula and classroom strategies that accurately reflect diverse learning profiles.

Method

Data were collected via a survey created by the author and sent to diagnosticians to obtain information about students with hearing loss between six–18 years of age who were enrolled in one of the 10 largest school districts in the United States, and who were who were served under the IDEA. Educational diagnosticians who were responsible for administering assessments in the selected school districts wrote full individual evaluations and interpreted assessment results. The diagnosticians consented to participate in the comparative study and provided the convenience sample electronically. Diagnosticians completed multiple surveys, one for each student with hearing loss on the campuses they supported and who met the established criteria. To be included in the study, the students needed to have a documented hearing loss had received services under IDEA, and had taken a standardized measure or test of cognitive abilities. In addition, they were required to have no other diagnosed disabilities besides hearing loss.

Diagnosticians provided a range of scores for each of the six cognitive abilities assessed using standardized cognitive tests. These tests measure crystallized intelligence, fluid intelligence, long-term storage and retrieval, short-term memory, visual processing, and processing speed. The variables derive from McGrew (2012), Carroll's (2005) three-strata model, and Cattell-Horn-Carroll's theory of intelligence (Flanagan & Dixon, 2014). Cognitive test results were classified into the following categories: (a) below average, (b) low average, (c) average, (d) high average, (e) above average, or (f) not administered. The district's Institutional Review Board (IRB) did not give permission for the diagnosticians to provide exact scores for the individual students. The range of scores is derived from the standardized tests used by the district (such as the Woodcock-Johnson test and many others that assess cognitive abilities). Diagnosticians filling out the surveys would click on the ranges of scores that are defined below.

Data Analysis

To examine the performance of each elementary, middle, and high-school student by cognitive ability, heat maps were generated for each student to reveal the presence or absence of cognitive patterns. A simple color code conveys student performance in a visually striking and immediately identifiable fashion, which can aid information processing for visual learners and general practitioners. On the heat maps, red indicates below-average scores (<85); orange indicates low-average scores (86–89); yellow indicates an average range (90–110); light green indicates a high average range (111–114), and dark green indicates above average range (115). Gray indicates a lack of score when the test was not administered. The red spots are *hot* zones or areas of weakness that need to be addressed for an individual student. On the other hand, the orange spots are *caution* zones, or areas of recommended intervention. The yellow spots are *average* zones, which mean that students are performing on par with their hearing peers and are fulfilling academic expectations for their age.

For ease of visual interpretation, the heat maps were split into two subgroups for each grade level (titled Group A and Group B). Group A included data for students who were administered the crystallized intelligence, long-term storage, and retrieval tests of cognitive abilities (i.e., in most cases, information on all six cognitive abilities was collected). Group B covered students who were not administered crystallized intelligence, long-term storage, and retrieval tests. This group generally includes information for four cognitive tests (i.e., fluid intelligence, short-term memory, visual processing, and processing speed).

The heat maps can be viewed either vertically or horizontally. A vertical review involves examining a column from the top down and provides information about the group of students as a whole on each cognitive ability. Conversely, a horizontal review allows for an examination of one individual student's cognitive abilities. The tables provide an overview of the status of a group of students on a particular test at a specific point in time. The heat maps spotlight student functionality as a whole and areas that require differentiation. Most importantly, the heat maps underscore the importance of treating each student as an individual and tailoring interventions accordingly.

RESULTS

The surveys were sent to 130 diagnosticians electronically. Ninety-three surveys were collected. Data were reported on 60 students (64.5%) at the elementary grade level (Grades K–6), 19 students (20.4%) in middle school (Grades 6–8), and 14 students (15.1%) in high school (Grades 9–12). Based on examination by grade level, the findings revealed that almost 70.52% of students in the sample (at any grade) were functioning in the below-average to average range on all cognitive abilities and potentially required interventions. The study also revealed that when a student performed in the below-average range on one cognitive ability, then they likely performed in the below-average or low-average range on other cognitive abilities.

Elementary School Students with Hearing Loss by Cognitive Ability

An examination of the heat map of elementary-school students in the study (Groups A & B) reveals that 69.44% students scored in the red, orange, and yellow zones, indicating that most of the elementary school students in this group performed in the below-average, low-average, or average range for various cognitive abilities (see Tables 1 and 2). On average across cognitive abilities, 32.2% of the elementary-school students performed in the low or below-average levels, 37.22% scored at the average level, and 7.22% scored high average or above average. The horizontal review indicates that if a student performed at the below-average (red) or low-average level (orange) for one cognitive ability, then the student likely performed at the below-average or low-average level for most cognitive abilities (i.e., the row is most likely red and orange across the cognitive abilities). Similarly, if the student performed at the average level (yellow), the student likely performed at the average level, one level above, or one level below on most cognitive abilities (i.e., the row is most likely yellow across the cognitive abilities with some orange or light green). In other words, the heat maps support previous findings that cognitive abilities work in tandem, such that one cognitive ability will likely influence each student's performance on other cognitive tasks (Arfé et al., 2015; Marshall et al., 2015). In addition, if a student performs in a particular range for one cognitive ability, for the most part, they perform only one level above or below that range for the other cognitive abilities.

It must be noted that the inclusion or exclusion of certain cognitive abilities was left to the discretion of educational diagnosticians (participants in the study) who had the necessary skills and knowledge to make assessment decisions that do not impact the performance outcomes for the cognitive abilities. That discretion is reflected in the heat maps. There is a strong possibility that elementary, middle and high-school students with hearing loss were not administered the crystallized intelligence and long-term storage and retrieval assessments because both assessments are verbally loaded and required adequate language skills to complete.

Middle School Students with Hearing Loss by Cognitive Ability

The heat maps of middle school students in Group A and Group B indicate that 75.45% of students scored in the red, yellow, and orange levels, which reflects the below-average, average, or low-average range of their various cognitive abilities (Table 3, Table 4). On average, 43.86% of middle school students scored in the low or below-average range, 36.59% scored in the average range, and 2.63% scored in the high or above-average range. As occurred with the elementary-school students, if middle-school students performed in a particular range for cognitive ability, they likely performed only one level above or below that range for the other cognitive abilities. The findings of the heat maps also suggest that cognitive abilities operate in tandem so that performance on one cognitive test reflects the students' other cognitive abilities.

Table 1. **Elementary School Students with Hearing Loss Tested on All Six Cognitive Abilities—Group A Heat Map**

Elementary School Students	Cognitive Abilities					
	Gc	Gf	Glr	Gsm	Gv	Gs
22	Below Average	Below Average	Below Average	Below Average	Below Average	Below Average
23	Below Average	Below Average	Below Average	Below Average	Below Average	Below Average
25	Below Average	Below Average	Below Average	Below Average	Below Average	Below Average
24	Below Average	Below Average	Below Average	Below Average	Average	Low Average
28	Below Average	Low Average	Low Average	Below Average	Below Average	Not Administered
26	Below Average	Low Average	Low Average	Below Average	Low Average	Below Average
27	Below Average	Low Average	Low Average	Below Average	Average	Below Average
29	Below Average	Low Average	Average	Average	Average	Average
21	Below Average	Average	Below Average	Below Average	Below Average	Not Administered
20	Below Average	Average	Below Average	Below Average	Average	Below Average
18	Below Average	Average	Below Average	Average	Below Average	Average
19	Below Average	Average	Average	Average	Average	Not Administered
15	Low Average	Below Average	Low Average	Average	Not Administered	Not Administered
17	Low Average	Low Average	Low Average	Low Average	Low Average	Average
16	Low Average	Low Average	Low Average	Average	Average	Low Average
11	Low Average	Average	Not Administered	Low Average	Average	Not Administered
14	Low Average	Average	Low Average	Below Average	Below Average	Below Average
12	Low Average	Average	Average	Low Average	Average	Low Average
13	Low Average	Average	Average	Average	Average	Average
10	Average	Low Average	Not Administered	Below Average	Below Average	Not Administered
8	Average	Low Average	Low Average	Low Average	Average	Low Average
9	Average	Low Average	Average	Average	Average	Average
7	Average	Average	Not Administered	Average	Average	Not Administered
2	Average	Average	Low Average	Below Average	Low Average	Average
3	Average	Average	Average	Average	Average	Average
4	Average	Average	Average	Average	Average	Average
5	Average	Average	Average	Average	Average	Average
6	Average	Average	Average	Average	Average	Average
1	High Average	Above Average	High Average	Average	Average	Average

Key

Above Average | High Average | Average | Low Average | Below Average | Not Administered

Note. Group A includes students tested on all six cognitive abilities. Gc = crystallized intelligence; Gf = fluid intelligence; Glr = long-term storage and retrieval; Gsm = short-term memory; Gv = visual processing; Gs = processing speed.

Table 2. **Elementary School Students with Hearing Loss Tested on Four or Fewer Cognitive Abilities—Group B Heat Map**

Elementary School Students	**Cognitive Abilities**			
	Gf	Gsm	Gv	Gs
50	Below Average	Low Average	High Average	Below Average
51	Below Average	Average	Below Average	Average
55	Low Average	Low Average	Below Average	Average
58	Low Average	Low Average	Average	Average
59	Low Average	Low Average	Average	Average
57	Low Average	High Average	Average	Average
56	Low Average	High Average	High Average	Average
30	Average	Not Administered	Not Administered	Average
36	Average	Not Administered	High Average	High Average
42	Average	Below Average	Average	Average
40	Average	Below Average	Average	High Average
34	Average	Low Average	Not Administered	Low Average
39	Average	Low Average	Low Average	Average
33	Average	Low Average	Average	Above Average
43	Average	Low Average	High Average	Average
31	Average	Average	Not Administered	Average
35	Average	Average	Below Average	Average
48	Average	Average	Low Average	Below Average
38	Average	Average	Low Average	High Average
32	Average	Average	Low Average	Average
44	Average	Average	Average	Low Average
41	Average	Average	Average	Average
47	Average	Average	Average	High Average
46	Average	Average	Average	Above Average
37	Average	Average	High Average	High Average
49	Average	Average	Above Average	Average
45	Average	High Average	Average	High Average
52	High Average	Not Administered	Not Administered	Not Administered
54	High Average	Average	Average	Low Average
53	High Average	Average	High Average	High Average
60	Above Average	Not Administered	Above Average	Not Administered

Key

Above Average | High Average | Average | Low Average | Below Average | Not Administered

Note. Group B includes all students tested on only four of six cognitive abilities. Gc and Glr tests were excluded. Gc = crystallized intelligence; Gf = fluid intelligence; Glr = long-term storage and retrieval; Gsm = short-term memory; Gv = visual processing; Gs = processing speed.

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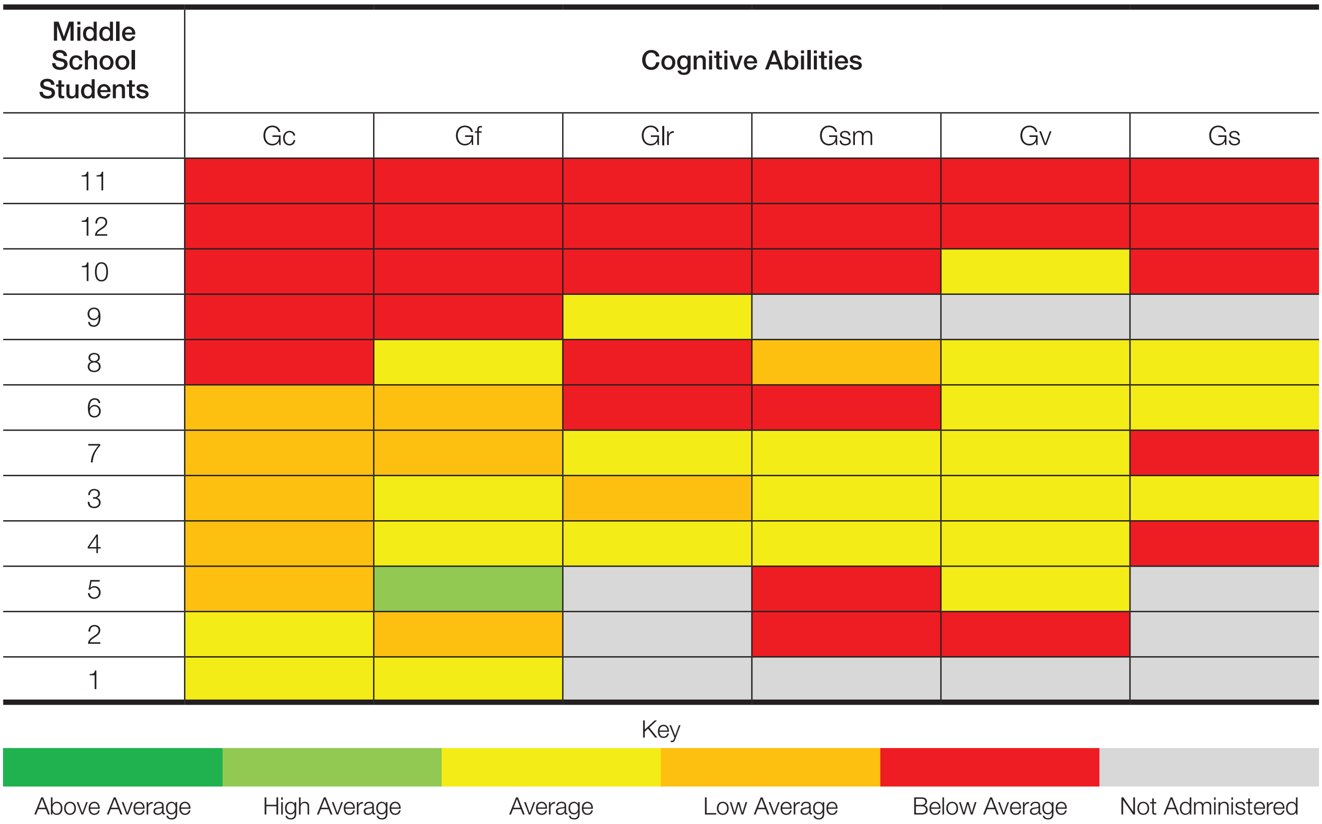
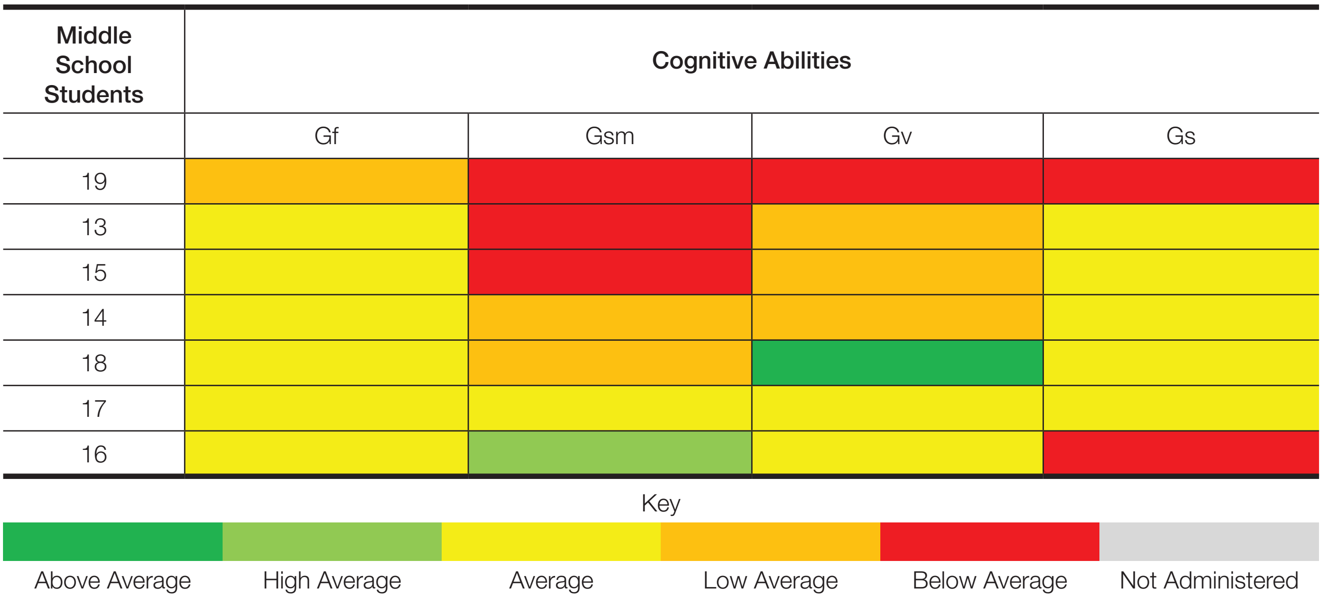
Table 3. **Middle School Students with Hearing Loss Tested on All Six Cognitive Abilities—Group A Heat Map**



Note. Group A includes students tested on all six cognitive abilities. Gc = crystallized intelligence; Gf = fluid intelligence; Glr = long-term storage and retrieval; Gsm = short-term memory; Gv = visual processing; Gs = processing speed.

Table 4. **Middle School Students with Hearing Loss Tested on Four Cognitive Abilities—Group B Heat Map**



Note. Group B includes all students tested on only four of six cognitive abilities. Gc and Glr tests were excluded. Gc = crystallized intelligence; Gf = fluid intelligence; Glr = long-term storage and retrieval; Gsm = short-term memory; Gv = visual processing; Gs = processing speed.

As noted for the elementary school students, there is a strong possibility that diagnosticians opted not to assess the crystallized-intelligence and long-term storage and retrieval among middle-school students since both assessments are require on language skills. There was a limited number of students (19) in the sample of middle-school students with hearing loss from which to generalize. However, the data indicate that the middle-school students in the sample had numerous cognitive weaknesses that need to be addressed in order to matriculate to high school.

High School Students with Hearing Loss by Cognitive Ability

An examination of the heat map of high school students in Group A and Group B indicates that 66.67% of students scored in the yellow, red, and orange zones

Table 5. **High School Students with Hearing Loss Tested on All Six Cognitive Abilities—Group A Heat Map**

High School Students	**Cognitive Abilities**					
	Gc	Gf	Glr	Gsm	Gv	Gs
10	Below Average	Below Average	Below Average	Below Average	Below Average	Below Average
11	Below Average	Below Average	Below Average	Below Average	Below Average	Below Average
12	Low Average	Low Average	Low Average	Low Average	Low Average	Low Average
13	Average	Average	Below Average	Low Average	Average	Average

Key

Above Average	High Average	Average	Low Average	Below Average	Not Administered

Note. Group A includes students tested on all six cognitive abilities. Gc = crystallized intelligence; Gf = fluid intelligence; Glr = long-term storage and retrieval; Gsm = short-term memory; Gv = visual processing; Gs = processing speed.

Table 6. **High School Students with Hearing Loss Tested on Four or Fewer Cognitive Abilities—Group B Heat Map**

High School Students	**Cognitive Abilities**			
	Gf	Gsm	Gv	Gs
14	Low Average	Average	Average	Below Average
13	Low Average	Above Average	Low Average	Low Average
4	Average	Below Average	Below Average	Average
9	Average	Average	Not Administered	Average
7	Average	Average	Low Average	Below Average
6	Average	Average	Average	Average
3	Average	Average	Average	Above Average
5	Average	Average	Above Average	Average
2	Average	High Average	Average	Average
1	Above Average	High Average	Above Average	Average

Key

Above Average	High Average	Average	Low Average	Below Average	Not Administered

Note. Group B includes all students tested on only four of six cognitive abilities. Gc and Glr tests were excluded. Gc = crystallized intelligence; Gf = fluid intelligence; Glr = long-term storage and retrieval; Gsm = short-term memory; Gv = visual processing; Gs = processing speed.

(Table 5, Table 6). Thirty-four percent of students performed in the below-average and low-average ranges, and 32.14% performed in the average range for various cognitive abilities, and 8.33% scored in the high average and above average ranges. At the individual level, if a student performed at the below-average, low-average, and average levels on one cognitive ability (red, orange, and yellow, respectively), then the student likely performed at the below-average, low-average, and average levels for the other cognitive abilities (i.e., the row is most likely red, orange, or yellow across the cognitive abilities). Similarly, if the student performed at the average level (yellow), the student likely performed at the average level or one or two levels above or below on most of the other cognitive abilities (i.e., the row is most likely yellow across the cognitive abilities with some orange, red, or green). There was a limited sample (14) of high school students in the study from which to generalize. However, within this sample, the findings suggest that students with hearing loss had several cognitive weaknesses that require remediation.

These results highlight the need for service providers to adjust instructions to meet individual needs in relation to each cognitive ability. The goal of educators working with students with hearing loss is to help them achieve their transition goals, whether those include graduating high school, matriculating to college, or getting a job. Based on the results of this study, some recommendations can be made to service providers to address the educational needs of their students with hearing loss.

DISCUSSION

About one-third of the students scored in the below-average range for fluid intelligence, visual processing, and processing speed. Half of the students scored in the below-average range for short-term memory. When examining the scores of the elementary-school students in the sample, students who performed in the below-average range on one cognitive ability tended to perform in the below-average range (plus or minus one range) for the other cognitive abilities. Similar patterns emerged among the middle and high-school students in the sample. Of the students who completed the crystallized-intelligence and long-term memory tests, 70% scored in the average range (high average, 5.6%; average, 43.5%; low average, 20.9%).

These findings support previous research indicating that— irrespective of their age, grade level, or type of hearing loss—students with hearing loss struggle with language development (Akamatsu et al., 2008; Delage & Tuller, 2007; Lieu et al., 2013) and with fluid-reasoning skills when working with mathematical concepts (Traxler, 2000). In terms of long-term storage and retrieval, there were no studies that specifically investigated this ability by age group. However, previous research has found that students with hearing loss diverged from their hearing peers in utilizing strategies to store and retrieve information (Marschark & Everhart, 2013; McEvoy et. al., 1999; Tweney et al., 1975). The discovery that half of the students with hearing loss at all grade levels performed in the below-to-low average range for short-term memory supports the hypotheses in the literature that memory ability is negatively affected by language proficiency (Arfé et al., 2015; Marshall et al., 2015). The finding that one-third of the students with hearing loss struggled in the area of visual processing skills confirms Marschark et al.'s (2015, 2017) assessment that students with hearing loss have no visual memory advantage over their peers. In terms of processing speed, there were no studies specifically aimed at students with hearing loss across different age groups. The current study found that one-third of the students in the sample with hearing loss performed in the below-average range for all grade levels in terms of processing speed.

The results of this study showed that two-thirds of students with hearing loss at all age groups scored in the below-average range in the area of long-term storage and retrieval. In addition, all the students in high school who were administered the test scored below average on long-term storage and retrieval skills. This tends to corroborate the documented finding that language and long-term storage and retrieval operate in tandem (Arfé et al., 2015; Marshall et al., 2015).

IMPLICATIONS FOR PRACTICE

The first key finding of the study is that any interventions for children with hearing loss need to include a language and communication component as part of a student's individualized education plan (IEP). The second key finding is that performance on cognitive abilities remained steady between grade levels. This means that service providers must consider students with hearing loss as a discrete group of students, and carefully personalize interventions and recommendations for them based on individual strengths and weaknesses.

The data also show that for some, cognitive abilities improve over time (e.g. high schoolers show better abilities) or decline (middle school students show less ability than elementary students). The factor at work here is most likely the nature of the interventions in the classroom. The data suggest that students who receive appropriate interventions improve in their cognitive abilities over time. However, the sample size is not sufficient to draw firm conclusions. Nonetheless, this suggestion points to the main message of this study: that special-education programs for deaf students need to be tailored to the specific cognitive issues faced by each student individually.

Such personalized recommendations may include (a) using repetition and rehearsal to improve short-term memory skills; (b) providing opportunities to revisit materials in multi-modal formats to appeal to various learning styles; (c) reviewing material with manipulatives like flashcards to improve vocabulary and math skills; (d) pre-teaching relevant vocabulary or background knowledge; (e) using games that expand existing knowledge; (f) establishing conversation clubs to promote linguistic proficiency; and (g) employing timed games, such as Boggle, Pictionary, and Beat the Clock to increase processing speed. These classroom activities may have the cumulative effect of building language, memory, processing, and mathematical reasoning skills to advance the cognitive performance of students with hearing loss.

LIMITATIONS

The primary limitation of this study was the small number of survey responses. Of the 93 surveys received from participants, 60 represented elementary school students, 19 represented middle school students, and 14 represented high school students, which means there were too few students in the middle and high school samples to draw generalizable conclusions about students in these age groups. At the time of the study, there were 378 students with hearing loss in the selected school district who may or may not have had secondary disability conditions. Generally speaking, if the number of responses was greater, then it would be possible to confidently extrapolate this data to the larger population of students with hearing loss. The researcher was also limited in precision by the privacy restrictions in place in school districts, which blocked access to demographic and assessment data. For example, the diagnosticians provided a range of scores for each ability instead of the actual scores. Having access to information about the type of communication methods that students in the study used would be instructive to differentiate between students whose primary method of communication was ASL versus those who communicate with other methods, such as speechreading.

CONCLUSIONS AND FUTURE RESEARCH

Cognitive abilities determine how well an individual learns. Therefore, understanding the cognitive profiles of children with hearing loss is critical for educators to plan evidence-based instruction, nurture cognitive advances, foster academic success, and prepare such students for college. This investigation revealed patterns of strengths and weaknesses in students with hearing loss for six cognitive abilities. The study uncovered the continued need for research and interventions to assist students with hearing loss in improving their cognitive development and language abilities.

Future research areas could uncover how memory and language influence one another in children with hearing loss, how and why language deficiency seems to interfere with many other cognitive abilities, why children with hearing loss are not preferentially visual learners, and why students with hearing loss seem to have slower response times on timed tasks than their hearing peers (perhaps a result of code-switching). A study that investigates the interaction between language ability and memory in terms of executive functioning in students with hearing loss could be worthwhile for assessing the root causes for assessed deficiencies. Finally, it would be instructive to test and measure the impact of differentiated instruction methodologies on the cognitive performance of students with hearing loss.

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