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Auditory Processing Deficits in Students With Autism and Research-based Instructional Strategies

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AUDITORY PROCESSING DEFICITS IN STUDENTS WITH AUTISM AND RESEARCH-BASED INSTRUCTIONAL STRATEGIES

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Abstract

The ability to accurately process and interpret auditory information, for individuals with autism spectrum disorder or ‘ASD’, is often difficult. Here we review behavioral, neurophysiological and imaging literature pertaining to this field with the aim of providing a comprehensive account of how auditory processing deficits impact individuals with ASD, in order to develop effective educational tools. Literature was sourced from peer-reviewed journals published over the last two decades which best represents research conducted in these areas. Findings show substantial evidence of atypical processing of auditory information in subjects with ASD at behavioral and neural levels. Abnormalities are diverse, ranging from atypical perception of various low-level perceptual features (i.e. pitch, loudness), to processing of more complex auditory information such as prosody. Trends across studies suggest that auditory processing impairments in individuals with ASD most likely present during processing complex auditory information and are more severe for speech than for non-speech stimuli. The interpretation of these findings, with respect to various cognitive accounts of ASD, is discussed and suggestions offered for further research.

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CHAPTER 1: INTRODUCTION

In the United States, there has been a dramatic increase in the number of students who qualify for special education services under the category of autism spectrum disorder. Recent data estimates that there are 378,000 students with autism being served under the Individuals with Disabilities Act (IDEA) (Carter, E. W., Harvey, M. N., Taylor, J. L., & Gotham, K., 2013). In December 2015, the Department of Education delivered the annual report issued to Congress. An analysis of the report showed that from 2008 to 2013, students with the diagnosis of autism increased from five percent to 8.2 percent. (Thirty-Seventh Annual Report to Congress, pg. 126) These students entered public schools with complex needs and a range of unique characteristics that challenged educators. The students' individual characteristics impacted their ability to process educational environment and function within a classroom.

When placed into a mainstream classroom environment with peers, special needs students must learn how to participate in a system that may not understand their unique learning needs. One area of difficulty for some students with autism is auditory processing. For these students, their disability interferes with their ability to accommodate verbal communication, complex language content and overall classroom expectations. This may be due to the environmental obstacles and instructional methods that they are being exposed to within the mainstream courses.

In the United States, education law ensures that all students are given a free and appropriate public education (FAPE). Special education law builds on this right but mandates that schools provide education to all students in the least restrictive environment, which holds schools responsible for supporting these students in mainstream classrooms. As schools continue to advance the integration of all students in the least restrictive environment, the need for programing for students with special needs within the mainstream classroom continues to evolve. A Department of Education report from 2015 showed that the percentage of school-age students served under the Individuals with Disabilities Education Act, who received instruction in a class with non-disabled peers 80 percent or more of their day, increased from 51.8 in 2004 to 62.1 percent in 2013 (Thirty-Seventh Annual Report to Congress, pg.47). The progression of inclusive education has allows students to receive initial instruction from content specialists while developing skills need to participate with same aged peers. As positive as the progression of inclusion has become, the complexity becomes exhaustive when teachers must meet the array of needs for students with autism and even more so when communication and auditory needs are impacted. Under the Individuals with Disabilities Education Act (IDEA), Title II of the Americans with Disabilities Act of 1990 (ADA) (Title II), and Section 504 of the Rehabilitation Act of 1973 (Section 504), schools are obligated to meet the communication needs of students (IDEA, Authority 20 U.S.C. 1401). Assistive technology, used in a broad term within the legislation, plays a key role in providing teachers a platform to support students. When legislation such as this is enacted, often times the reality of how schools will implement it is not always considered.

One needs to take a deeper look into how the classroom environment, including students' ability to process auditory information and instructional methods, impacts students educational success. In this paper, an analysis of research on aspects of auditory processing was completed in order to understand the impact on academic performance of students with autism in an inclusive setting. Due to the range of characteristics involved in auditory processing, I limited my research to five characteristics that impacted students in an inclusive classroom. Specific aspects of auditory process reviewed were; auditory figure ground, auditory discrimination, audiovisual integration, auditory memory and auditory integration in order to better understand the impact the disability had on student learning. Multiple instructional methods were also reviewed to identify possible instructional supports.

Students with autism and auditory processing needs have difficulty stabilizing their senses within the environmental complexities of classroom learning. Background noise in a classroom is constant with talking, papers moving, air systems blowing, computers humming, noise in the hallway, ect. All of these acoustic intrusions are processed and sorted unconsciously by the typical student. For a student with auditory processing needs, in order to identify the instructional information being provided, they must consciously sort through the intrusions to extract instructional content. Other students may struggle within the environment simply due to auditory sensitivity causing discomfort, limiting participation and learning.

Processing auditory information is a multifaceted task. A student must integrate two sensory processes, such as auditory and visual, in order to properly discriminate information being relayed. This process can often be difficult as students struggle to discriminate similar sounds or have limited abilities to use visual facial cues to infer meaning. A major key to learning is one's ability to process information into memory. When auditory memory is impacted, to transfer a lecture or any auditory information into the web of working memory is an arduous task. Verbal directions are often given with the expectation a student can process all the information, in order to complete a multi-step task in a timely fashion.

Traditional instruction is often provided in lecture form with student participation consisting of passive engagement such as note taking or completion of worksheets. Hands-on-learning activities, such as labs or work groups are often content specific and utilized less often in some content areas. Teachers need to be taught to incorporate diverse student learning styles into course instruction but these techniques are not always part of teacher development trainings.

As a special education teacher, I have seen firsthand the impact of academic success when students progress through a system that does not address their needs. This academic injustice is what lead me to research the auditory processing skills of students with autism in the mainstream environment. Consider this case. After multiple failed classes, a student with autism transitioned to high school. His academic skills were above average but his classroom performance was poor. He was often seen distracted in class and inattentive to the demands of the course. He missed assignments, failed tests, and in earlier years could be found crouched under his desk or table during class. His behaviors were looked at as reflections of non-compliance resulting in a behavior support plan. As part of his programing, a social skills class was added. During social skills class, he processed challenges that impacted his learning. He identified that the fan was too loud for him to concentrate on the teacher speaking. When he tried to do his work, he could not track what he was to do, so he did nothing. Until this point, no-one considered that the auditory instructional modality might be affecting his performance due to impaired ability to process the environment. I have collaborated with teachers using communication aids to better address students’ needs within their classes. I have seen teachers lose students in the throng as they implement lectures or class activities unaware of the student's sensory needs. Teachers move from class to class, teaching what they know in a one size fits all system, missing simple opportunities to modify assignments or class structures in order to better support learning for students with autism. Teachers don't avoid modifications and adjustments in teaching because they don't care. It happens because they don't know how. They are unaware. It is for these students, that I have written this paper-to identify the characteristics of auditory processing that pose the greatest impact to educational performance for students with autism. The goal is to provide educators with the initial strategies to support students within the classroom setting.

There are 378,000 students with autism being served under the Individuals with Disabilities Act (IDEA) in the United States (Carter et al., 2013). We need to ensure that these students are provided the educational services they deserve by equipping teachers with the resources they need to be effective.

Integrating students with special needs into the mainstream program is complicated, but it is beneficial for all when successful programming is executed. Creating an environment tailored to individual differences in a cohesive system allows students to develop understanding and empathy for others. As individuals with disabilities learn to advocate for themselves in order to enhance their education, teachers develop classes in a way that enriches the learning experience for all students. Rather than struggling in a labyrinth of the mainstream classroom, instructors and students can be successful with support and resources.

Definition of terms

Autism Spectrum Disorder- A spectrum of early onset neurodevelopmental disorders characterized by poor social reciprocity and communication, combined with repetitive and stereotyped patterns of behavior interests and activities. (Boets et al., 2015)

Auditory Processing- ability to listen, comprehend, and respond to information that we hear through auditory channels (Yalcinkaya, 2009)

Auditory Discrimination- discrimination of frequency, intensity and duration differences in sound (Jones,2009)

Auditory Figure-Ground- ability to perceive relevant auditory stimuli in the presence of background noise. (Hasbrouck ,1980)

Audiovisual Integration- receiving visual and acoustic information into intended articulatory gestures (Colin 2015)

CHAPTER 2: LITERATURE REVIEW

Auditory Figure Ground

Processing in Autism is linked to deficits in different aspects of the disability. Several hypotheses have been created around autism and the brain's ability to integrate auditory information within different types of stimuli. Groen, van Orsouw, Huurne, Swinkels, Van, Buitelaar, & Zwiers. (2009), wanted to know if participants with autism were affected similarly to the control group when presented auditory tasks affected by integration of stimuli. Through an auditory stimulation test in a controlled environment, stimuli were presented in four forms; pink noise, which is similar to concept of white noise or static, amplitude-modulated pink noise where integrated dips in sound created an increase in neurological demands of the listener, moving ripple, a sound that does not occur across all frequencies but is more difficult to separate due to is similarity to true speech. Finally, amplitude-modulated moving ripple. These stimuli integrated the dips that were present in the pink noise along with the amplitude adjustments and complexity of the moving ripple (Groen et. al., 2009, pg. 744-745). Subjects who participated in the autism group were all categorized as high functioning. Subjects were not given feedback but were initially told to ignore background noise.

An analysis of the results indicated only slight differentiation in abilities between subjects with autism and subjects in the control group. Groen et al (2009), suggested that due to difficulty converting auditory information into short term memory subjects with autism showed increased difficulty processing auditory information when it was presented with temporal dips stimuli, with slight divergence of ability amongst the two groups in regards to speech reception threshold, No significant difference in ability was noted between subjects with autism and the control group when spectral dips in ripple sound stimuli was presented. Results also indicated that subjects with autism had difficulty processing sound or stimuli with complex patterns and groupings of speech sounds.

Further research on the individual's ability to discern pertinent auditory stimuli while distorted with background noise was conducted by Jon Hasbrouck (1980). This study specifically looked at participant performance when presented with unilateral and bilateral ear occlusion. Hasbrouck selected 21 participants with auditory figure ground disorders, receiving services under the category of learning disabilities. Participant ages ranged from four years to 17 years. Stimulus tapes based on the standard Quiet and Noise Subtests of Goldman-Fristoe-Woodcock Test of Auditory Discrimination were used. A total of five tapes were used in random order. Participants were instructed with Goldman-Fristoe-Woodcock Test of Auditory Discrimination procedures. Participants responded by pointing to a picture following a verbally requested.

Data resulted in positive performance in all participants during quiet controls showing significant results versus those scores in all noise controls. Percentile data revealed a mean score of 11.76 percent when no occlusion was provided during noise controls. Scores below 25 percent resulted in a failing performance scale. When presented with occlusion, the data revealed that 19 out of 21 participants improved with a score needed to pass the assessment, 25 percent. Performance scores were evaluated by comparing the percentage of gain of skill with the best performance with ear occlusion versus no occlusion during noise controls. A 36.06 percent gain was reported. Researchers identified that the data suggested that participants' performance success was higher in all noise controls when occlusion was present. If occlusion systems, such as headphones, utilized within a location with extraneous noise, such as a classroom, performance scores are predicted to improve based on data.

Auditory Discrimination

In an initial study by Jones, Happe, Baird, Simonoff, Marsden, Tregay, Charman (2009), the correlation between auditory discrimination and auditory sensory behaviors in individuals with autism was evaluated. Participants in the study included individuals with autism, individuals diagnosed with an ICD-10 (ICD-10 is the 10th revision of the International Statistical Classification of Diseases and Related Health Problems) diagnoses, but were not identified under the autism label, and individuals identified as non-disabled. During the study, participants were administered a hearing screening to assess normal hearing levels. Auditory discrimination tasks requested that participants identify the frequency, intensity, and duration of a sound made by an image. In addition, individuals completed a self-report using the Adolescent/Adult Sensory Profile (AASP) to establish self-recognition data related to four auditory quadrants; low registration, sensation seeking, sensory sensitivity, and sensation avoiding.

The researchers noted that differences in auditory discrimination abilities were not significant between individuals with autism and the control group when assessing all tasks. Enhanced auditory discrimination within the frequency domain was noted, however, the quantity of individuals impacted in the autism and control groups was not significant, statistically. Discrimination between intensity and duration tasks resulted in similarly enhanced abilities within both groups, providing that a superiority of skill was not identified within the autism group. When reviewing self-reporting data, researchers identified that individuals with autism self-reported stimulation and sensory seeking behaviors during testing of duration and intensity, but less often reported during frequency. Researchers evaluated duration discrimination to show that individual's duration discrimination abilities were an illustration of behavior not a response to the stimuli. Duration data showed a manifestation of processing affected by the participants' abilities to maintain attention in order to perform successfully on tasks. The increased duration showed significant links to an increase in complexity of task.demands.

Looking deeper into the complexities of auditory stimuli that affect individuals with autism, Whitehouse and Bishop (2009) investigated an individual's ability to understand and orient to a human voice while being manipulated by auditory stimuli. The main focus of this study was to understand why individuals with autism showed difficulty orienting to typical speech sounds. The study evaluated 15 males, diagnosed with autism and able to comprehend simple conversational speech, along with 15 non-disabled individuals, four female, 11 males. The speech stimuli was clustered into blocks of speech stimuli of naturally sounding vowels, non-speech stimuli, and complex tones.

An analysis of Whitehouse and Bishop's (2009) data showed that both groups responded similarly to sound waves. However, individuals with autism had discrepant event-related-response (ERP) to speech when embedded in non-speech sounds. Participants with autism identified novel sounds, encompassed within nonspeech sounds waves. Atypical responses were reported when participants with autism were required to encode speech sounds but were not reported during non-speech sounds. When participants were requested to pay attention, fewer encoding deficits were identified. A key finding was the inability to control attention to speech sounds when non-speech sound was encompassed. Poor orientation was distinguished as a product of hyperattentive response to non-speech sounds, actively impeding an individual's response toward speech sounds.

Further research by Ceponiene, Lepist, Shestakova, Vanhala, Alku, Ntnen, & Yaguchi (2003) targeted individuals with autism and their ability to decipher speech sounds in non-speech sound combinations. Researchers investigated individuals with autism who had the ability to perceive sound while expressing difficulty in attending. Participants underwent sound testing with event-related potential (ERP). Data was retrieved when exposed to stimulus of a standard vowel and other synthesized natural sounding speech.

Individuals in participating groups showed similar results when simple and complex sounds were administered. Data disturbances in participants with autism were identified when vowel changes occurred. Researchers reported that disturbances in identifying speech sound specific deficits were more probable than sensory deficits to auditory input. Involuntary attention switches reported from the Pa3, an ERP component present after the stimulus, associated the function of the auditory stimulus impacted the subject's ability to orient to speech sounds. Ceponiene et al (2003), concluded that deficits in the area of auditory processing and orienting of vowels is coupled with the 'speechless' quality of the stimulus.

Donkers, Schipul, Baranek, Cleary, Willoughby, Evans, Belger (2015) extended the research of event-related potentials (ERP), correlating auditory responses to atypical sensory response patterns in children with autism. Researchers evaluated ERP data extracted from testing, clarifying the link between neural connections of auditory processing and its relationship with sensory response patterns of hyporesponsiveness, hyperresponsiveness, and sensory seeking. Participants completed developmental and sensory testing, diagnostic confirmation and an EEG session.

All subjects showed typical neural responses to auditory tones. Participants with autism showed decreased early sensory response while exposed to passive standard repeated tones. Individuals also demonstrated diminished attention during exposure to infrequent, novel, naturalistic sounds. Significantly weakened P3a response reported compromised orienting abilities for participants with autism, as this component is attention dependent. During the evaluation of data involving pitch and duration deviant tones, a weakened response indicated disrupted encoding of simple sensory information. Behavior characteristics during this testing showed more severe sensory seeking behavior correlation. When individuals showed increased response to standard tones, sensory seeking behaviors did not present. Hyperresponsiveness was noted when individuals P1 & N2 responses, which correlated with higher order thinking. A diminished behavioral response was observed when presented standard tones engaging a weakened P1 response with increased N2. Comprehensive results indicated inherent neural bases for typical characteristics of autism.

Audiovisual Integration

Mongillo, Irwin, Whalen, Klairman, Carter, & Schultz (2008) attempted to identify whether participants with autism deviated from same age peers without autism when utilizing visual information. If so, under what conditions did this occur? Conditions of this study required participants to complete six perceptual tasks: one exclusively visual task, Male/Female Classification, and five audiovisual tasks: McGurk, the gender, vowel, ball size and ball composition match/mismatch.

Data from the Mongillo et.al (2008) study supported the McGurk Effect, eliciting an inconsistent correlation between auditory and visual stimuli. Participants with autism performed notably worse than same age peers when presented tasks with human faces and voices. However, they performed with comparable scores on task with non-human stimuli. This data supported the characteristic in autism that individuals have limited social interactions yet remain hyper attentive to non-human stimuli. Researchers interpreted performance with non-human stimuli from both participant groups to conclude that task demands given with auditory stimuli from a cartoon character or objects may have positive performance results.

In an effort to provide more data on specific aspects of how visual cues impact the perception of speech, McGurk effect, Jarocci, Rombough, Yager, Weeks, Chua (2010) researched the impact visual conditions had on speech perception for children with autism. Twelve children with autism and 12 same-age, typically developing peers participated in a computer generated bimodal speech perception task. Participants were presented simple consonant-vowel sounds in three different forms: unimodal auditory, unimodal visual (lip reading), and bimodal. Auditory conditions provided the participants with a blank screen and male voice stating the following sounds: /ba/, /tha/, /va/, or /da/. During visual conditions, images were shown only displaying the mouth area of the face in order reduce the impact of other visual cues from the face. Participants finally received visual and auditory bimodal input at the same time.

Observational data indicated no notable variance during the unimodal auditory trials. When participants were evaluated on their ability to perform under unimodal visual conditions, students with autism displayed significantly discrepant scores, standard deviation of 23.79%, from peers. During bimodal conditions with matched auditory and visual input, both groups of participants performed similarly. Results stipulated that the use of visual supports, lip reading, during bimodal events provided less assistance on information processing than auditory input in students identified with ASD.

Colin, Radeau & Deltenre (2005) provided additional research using the McGurk Effect to identify how individual's cognitive and sensory functions affected audiovisual speech integration mechanisms. Researchers performed the experiment twice. Methods for the two experiments were identical except in the second experiment, participants were only assessed on one auditory intensity in a control condition and one in an audiovisual experimental condition. Experiment one consisted of 32 paid volunteer participants, ages 17-25. Experiment two consisted of 128 college students ages 17-35, participating while in an introductory Psychology class. Participants were seated in front of a screen sitting on a table. Above the screen sat a speaker producing the auditory output. Background noise was integrated and noted to top out at 30 decibels (dB). During auditory trials, the screen was turned to black. Auditory intensity fluctuated from 40 dB, 50 dB, 60 dB, and 70 dB between presentation blocks. Stimulus was introduced 12 times for each auditory condition and intensity. Each stimulus was repeated four times for a total of 24 trials. Audiovisual conditions were presented over eight trials with 12 repetitions each, totaling 48 trials. No examples were given but instruction was provided to participants they would hear meaningless syllables. Responses were given two ways, free response and multiple choice. During audiovisual sessions participants were directed to look at the screen.

An examination of the data included conditions of audiovisual and visual responses where no voicing confusion was present were considered illusory responses. Experiment one showed that the impact of multiple choice versus free response was significant. Multiple choice controls provided 28% more illusions than free response controls. Combinations of auditory velar input to visual bilabial presentations correlated with 22% more frequency than fusion presentations, auditory bilabial input to visual velar. Face size and intensity results were unremarkable. Due to results of intensity data, the researchers implemented experiment two in order to determine if results were partly due to the participants learning a strategy for the presentations. Experiment two showed multiple choice controls provided 21% more illusions than free response controls. Combinations of auditory velar input to visual bilabial presentations correlated with more frequency than fusion presentations, auditory bilabial input to visual velar. Intensity had more impact in experiment two. Notable data was retrieved from face size presentations, delivering 8% more illusions than small faces.

Auditory Memory

A review of Tsatsanis, Noens, Illmann, Pauls, Volkmar, Schultz & Klin (2011) study on the impact of organization and processing style on nonverbal memory was examined with the premise of information processing in mind. The researchers used the Rey Osterrieth Complex Figure (ROCF) Test to rate the participants' ability to replicate a complex line drawing. Participants were presented with the stimulus image and instructed to replicate the image by free hand drawing. The image was then removed and the subjects were asked to reproduce the image from memory. Finally, after an extended delay, the subjects were asked to reproduce the image again. The study's participants varied in age from six to forty-two years and were classified into three groups: individuals with autism, a clinical control group an dcfcd a non-impaired group.

The results indicated a significant developmental aspect. Participants in the younger group (ages six to fourteen) showed limited variation in ability or processing style compared to control groups, primarily viewing the task with a parts-oriented style. This was considered evident to processing supports due to age. Participants in the adolescent and adult groups (ages fourteen to forty-two) showed notably differentiated styles. Participants from the autism group were distinctly separate from both the control groups by approaching the task with a parts oriented processing. Control groups showed an ability to convert to a configuration approach to complete the task over time. Distinction in ability to successfully complete the figure with fewer errors was not identified between the control groups and the individuals with autism. Researchers suggested that these results indicated that the processing style of individuals with autism can be defined in two ways, “parts-to-parts” and “parts-to-whole”. When managing complex information, individuals with autism who processed information in the “parts-to-whole” style were able to manipulate smaller pieces of information in order to understand the full concept. Individuals who were unable to organize small pieces of information were observed producing fragmented figures, ultimately unable to identify the whole image. Researchers demonstrated that individuals may become overwhelmed in open ended situations and need support in order to apply newly learned information in functional situations.

Minshew and Goldstein (2001) looked deeper into the functional memory of individuals with autism and the impact on memory functions due to organizational strategies. The study participants included 52 individuals diagnosed with autism and 40 neuro-typical control group individuals. Participants ranged in age from 12-40 years old and were comparable in IQ and verbal scores. Hypothesis one examined incremental learning by employing paired- associate learning and short-term memory tasks. During the short-term memory tasks, participants were required to wait 10-20 seconds then repeat three words. Distractions employed by participants included counting backwards. Paired associate learning tasks were conducted using standard protocol verbal paired association methods. List of paired words were auditorily administered to participants. The first word was repeated and participants were required to pair it with another word. A delayed recall trial was conducted 30 minutes immediately following recall tasks. Hypothesis two investigated skill maintenance as the task requirements increased in complexity. Part a.) conducted visual protocol during completion of tasks comprised of three stylus mazes. Each maze had choice point elements that increased in quantity as the task developed. Part b.) utilized the Detroit Test of Learning Aptitude-Revised (DTLA-2) subtests for letter and word sequences along with the oral directions. Each sub test increased in complexity as the participant advanced. Hypothesis three investigated the effect of recall in delayed recall tasks when compared with immediate recall tasks. Data from the previous testing was evaluated for this hypothesis. The logical memory subtest of the Wechsler Memory Scale-Revised along with the Rey-Osterrieth Complex Figures (ROCF) assessment were conducted utilizing a delayed and immediate recall protocol.

Data was compared among group results to evaluate the results of the three hypotheses. Evidence of group effect during 10 vs. 20 second interval delays during short term memory trials and paired associate learning showed non significant effects. The learning trials reported that the group effects were notable but the data comparison to controls was not. Data on the subtests of the DTLA showed notable effects during letter and word sequencing along with the oral directions subtest for participants with autism. Letter sequencing had no notable effect for the group with autism. Delayed recall data investigating the third hypothesis established a significant effect in the autism group in short delay recall. Story recall reported notable effects for both groups. Analysis of the ROCF data reported that the main effect for the participants with autism was notable compared to the control group where data showed insignificant change.

Auditory Integration

Boets, Verhoeven, Wouters, & Steyaert (2014) explored deeper, the impact of low-level auditory spectral and temporal processing on participants with autism. They extended previous research by selecting participants with autism who also reported premature language delays. The study was conducted with 21 adolescents, ages 12-19, who had qualified under the category of autism. A control group was established with 21 typically developing adolescents, comparable in age range and equivalent boy/girl ratio to the autism group. Assessment of auditory processing was conducted using pure-tone hearing and seven psychological threshold tests. During presentation of stimulus, participants heard a progression of three sounds; one target and two reference stimuli. When stimulus was presented, participants saw a square appear on their computer screen. Participants had to select the stimulus that had a different auditory signature, the “odd” sound. Frequencies rotated from AM to FM as well as the duration of the silent gap was differentiated.

Researchers expected participants with autism to perform with prominent pitch processing skills. However, the data showed that participants with autism exhibited notably higher impairments in frequency discrimination sensitivity. These results were more robust during application of varying reference stimulus. Frequency discrimination and temporal measures of AM and FM detection as well as gap-in-noise detection data identified that participants with autism presented weaker performance. Significantly weak performance by participants with autism was also noted during 500 Hz frequency discrimination tasks. Slight, but inconsequential, differences were identified during gap-in noise testing. An analysis of the association between auditory processing abilities in participants with autism and the characteristics of autism revealed that auditory measures did not provide correlations. Frequency and gap-in-noise threshold provided notable correlations to autism traits.

Extending research on the effects traits of autism have on auditory integration, Prexman, Rostad, McMorris, Climie, Stowkowy and Glenwright (2010) studied how participants with high-functioning autism processed ironic language. Researchers selected three groups of children. Group one was made up of 18 children identified with high-functioning autism. Group two was comprised of 18 typically developing children selected by verbal ability matching to group one. Group three had 18 typically developing children selected as age matched peers. Participants watched 12 puppet shows. Each show was created to assess one of the following four types of irony: ironic criticism, literal criticism, literal compliment or ironic compliment. Scripted language was organized as to not use language to cue children to the correct answer. Scripts were prerecorded in order to ensure that vocabulary, intonations and other content-meaning inflections were provided during the show. A visual scale made of six faces, ranging from very serious to very funny was used to evaluate the speakers' humor. During the comprehension assessments, the participants used two different response measures. The six face scale and a "nice duck", "mean shark" object response. The duck and shark were physical objects with defining features that researchers pre-explained to children before the task. Irony comprehension comprised of participants being asked three questions after each show. The first question assessed whether the characters intent was mean or nice. The second question assessed the character's belief and elicited a positive or negative evaluation of the situation. The third question assessed the characters' humor. Did they intend to be "humorous" or "serious"? Data for response latencies and eye gaze was collected in three phases. Phase one data commenced when the speaker initiated communication. Phase two data commenced when the participant initiated movement toward a response. Phase three data was commenced when the participant started to select an answer.

Data related to the speaker's intent to be *nice* when they used different forms of compliments or to be *mean* when they used different forms of criticism revealed that all participants were competent with literal language. Response proficiency on literal compliments revealed no need for deeper investigation. The responses for all three groups were analyzed together, as data showed group scores to be commensurate with each other. After further examination of ironic criticism, scores for the group proved insignificant. Ironic compliments revealed that the verbally matched group performed with less precision than the age matched group. Corrections were made during the testing score review for ironic criticism, adjusting group effects from significant to marginal. Adjusted data revealed that the verbally matched group had lower accuracy. Scores in the area of *speakers belief* showed high performance for the group. Performance on *literal compliments* and *ironic criticism* did not show ample discrepancy so no further evaluation of skill was done. Literal criticism data showed a marginal shift in ability for the group. Notable results were identified in processing of ironic compliments. Participants in the age matched group performed with more accuracy than did children in the autism group or the verbally matched group. When interpreting humor, participants seldom identified the intent for ironic compliments correctly. Data was so discrepant, that researchers determined further analysis was not warranted. Literal compliment and literal criticism data evaluation revealed insignificant effect data for the group. The participant's ability to identify ironic criticism was significant. Participants in the autism group reported understanding of notably less humor when identified in ironic criticism than either of the control groups. Data was so discrepant that researchers determined further analysis was also not warranted for response latencies of ironic compliments. Data across the three phases only revealed notable data in phase one. Literal compliments and criticism revealed no notable results. Notably, data revealed that responses to ironic criticism commenced faster in the autism group than both control groups. In the final phases, the autism group was notably slower when answering incorrectly. During eye gaze data analysis, data showed that the autism group remained in phase one, looking at the duck, longer than the control groups. In the final phase, looking at the answer box, participants with autism used significantly less time than did the age matched group. Evaluation of error responses showed that participants with autism used a greater amount of time in later phases than did age-matched peers.

Language Processing

The impact of prosody on spoken and receptive language was investigated by McCann, Peppe, Gibbon, O'Hare & Rutherford (2007). Their research was conducted to expand knowledge of expressive communication hurdles that come into play due to prosody along with the impact of receptive language comprehension. Researchers selected 31 children diagnosed with high functioning autism, ages six- thirteen, and a control group comprised of 72 typically developing peers. Participants underwent assessments to evaluate receptive vocabulary, receptive grammar, expressive language, articulation/phonology, pragmatics, non-verbal ability, functional tasks and form tasks. The British Picture Vocabulary Scales- II, was used to evaluate receptive language and determine verbal mental age. When a single spoken word was given participants were to select the corresponding picture from a set of four choices. The Test of Receptive Grammar was used to evaluate auditory comprehension of syntax. Participants heard a sentence and were instructed to select the corresponding picture from a set of four choices. The Clinical Evaluation of Language Fundamentals-3UK evaluated expressive language by requiring participants to create a sentence using given words related to the displayed image. The Goldman-Fristoe-2 Test of Articulation required participants to state a single word in order to measure speech production skills. The Children's Communication Checklist evaluated the pragmatic facets of language. Participants were scored on 70 statements using a scale of 'does not apply', 'applies somewhat' or 'definitely applies'. The Raven's Progressive Matrices evaluated nonverbal cognitive skills via a pattern achievement test. Functional Tasks were conducted to analyze turn-end, effect, chunking, and focus skills of language. Form tasks evaluated auditory discrimination or imitation by listening to a recording simulated to be similar to a discussion being held in different room.

The data revealed that a majority of the participants' scores fell outside of the typical ranges on one or more assessments of language. Researchers reported that participants showed increased difficulty with expressive language tasks compared with receptive language tasks, but receptive skills had considerable relationship with prosody. No notable differences in abilities between the autism and control groups were designated in results on the receptive language tests, British Picture Vocabulary Scales-II and Test for Reception of Grammar. While evaluating expressive language, researchers compared scores on the Clinical Evaluation of Language Fundamentals-3UK, British Picture Vocabulary Scales-II and Test for Reception of Grammar.

The results proposed that expressive language is impacted at a greater level than receptive language due to significantly decreased scores on the Clinical Evaluation of Language Fundamentals-3UK compared to the other two assessments. Data differences were noted with regards to articulation deficits. The study showed that non-verbal and phonological abilities functioned independently. This data demonstrated that older participants with ASD had decreased receptive vocabulary and nonverbal abilities compared to the control group. Performance deficits in receptive functioning were found in the autism group on the Profiling Elements of Prosodic Systems in Children. Prosody scores showed no correlation with the phonology skills in participants.

Yalinkaya, Muluk and Sahin (2009) researched the impact that listening skills have on speaking, writing and reading abilities when auditory processing impacted performance. Participants were organized into two groups, 41 typically developing children in primary school and 26 children with auditory processing disorders. Researchers used the Observational Rating Scale in order to evaluate language operations. Qualitative data was collected from teachers and parents regarding the methods their children and students use to manipulate and interact with language and communication across the areas of listening, speaking, reading, and writing.

The data analysis showed no statistical difference in age between participating groups. Statistically remarkable differences were noted by the Observational Rating Scale across all areas; listening, speaking, reading and writing. Listening scores reported for the auditory processing disorder group were significantly decreased compared with controls with a standard deviation difference of -1.32. Speaking scores reported for the auditory processing disorder group were notably higher than the control group, with a standard deviation difference of +12.69.

Reading scores reported for the auditory processing disorder group were also notably higher than the control group, with a standard deviation difference of +2.85. Writing skills were reported for the auditory processing disorder group were notably higher than the control group, with a standard deviation difference of +3.17. During interpretation of the data, researchers linked data between areas. Data for participants with auditory processing disorders suggested notable deviations in listening and writing separately, but they showed a correlation with each other. Differences in speaking and writing were noted independently while they showed correlation between the two.

Instructional Supports

Stringfield, Luscre, and Gast (2011) studied the impact that a story mapping teaching technique had on readers' post reading test scores. The study was conducted with three male students, ages eight to eleven; all qualified for special education services under the category of autism. Participants were asked to read a passage aloud to determine oral reading accuracy. To assess comprehension, students retold the story from memory, then answered three to five short answer questions. The teacher instructed the students on the process of how to complete the story map and facilitated completion of the story map organizer during the first day of instruction. In follow up sessions, the students were not provided assistance with filling out the story map. After instruction, the participants were directed to complete the form using the recently read story. During the study, students read a passage and were instructed to complete their story map before completing the assessment. At the end, students read and were given the option to complete the story map or not before taking the assessment.

Story mapping assisted students in retaining story components in order to later evaluate their connection to the literature and answer assessment questions. The hypothesis was that skills students were taught to complete the story map impacted their cognitive processing while reading the passages. Students began to generalize this skill and independently fade the story maps as they mastered the assessments. According to the data, two of the three students were able to maintain improved assessment scores without use of the story map organizer. Stringfield et al (2011) hypothesized that the following three reasons may have impacted these results, but established that further research was needed to provide a definitive answer. One, the instructional intervention taught the process of looking back in the text for information and may have impacted the participants' ability to find information in text without the organizer. Two, students may have learned to visualize the story map as they read, not needing to physically complete it post reading. Finally, participants were instructed on ways to use the story map intervention assesses answers on assessment questions in order to identify incorrect answers.

Knight, Wood, Spooner, Browder, & O'Brien (2015) investigated the use of electronic text to support student comprehension of science content. Researchers identified that students with autism struggled to comprehend science content because they were unable to utilize substantial amounts of background knowledge along with challenges comprehending abstract and figurative language. Wood et al (2015) used the e-text system, Book Builder, an online resource, that provides a platform for individuals to author their own electronic book. The participants were four students, grades six through eight, who met criteria for alternative assessment standards and qualified for special education services under the autism category. Book Builder provided students support with defining unfamiliar vocabulary, visual supports (i.e, drawings and pictures) correlating with text information, text to speech options, modified text to reading level, summarizing supports (i.e, key facts list, concept map), and enrichment materials to assist with development of background knowledge.

Data showed that three of four participants improved performance when direct instruction was provided by the program coaches and vocabulary support systems. All participants' baseline scores showed low results, some steady, some irregular. During explicit instruction and when Book Builder supports were provided, three of four participants showed increased scores with a mean of four. Evaluation of maintenance stage data showed accelerated scores ranging from four to seven in two of four participants. Maintenance data was not collected on two of the participants due to time restrictions. Researchers warned results should be interpreted with caution due to data instability.

The use of systematic prompting during read-alouds was researched by Mims, Hudson & Browder (2012) to determine whether the modified system provided the least intrusive prompting method integrated into an inclusive classroom. The program supported students with moderate and severe disabilities. Researchers used grade-level biographies and evaluated text-dependent auditory comprehension. Intervention instruction was completed individually, with the student and intervention teacher meeting three times per week in addition to the 45 minute language arts lessons three times per week. Instruction focused on rules that assist in answering "Wh" questions (i.e., who, what, when, where, why) along with how to use a graphic organizer, T-chart, and answer sequencing questions (i.e., What came first?). Biographies were modified by the interventionist using adjusted vocabulary complexity and visual picture pairing to words.

Final data showed that all students who participated in the intervention had improved scores from baseline through maintenance, which was determined two weeks following the intervention. Growth throughout the intervention process was detailed using the mean scores of the four participants from baseline to final scores during the last intervention biography. Student 1 reported growth of 4.3, student 2 reported growth of 3.6, student 3 reported growth of 3.75, and student 4 reported growth of 6.1. Data also showed that three out of four students maintained growth from baseline scores when data was taken during the generalization phase. Student 1 maintained growth of 1.6, student 2 had a mean growth of -0.2, student 3 maintained growth of 0.75, and student 4 maintained growth of 2.3. After interviewing the teachers who participated in this study Mims et al (2012), that this intervention is a viable least intrusive accommodation to assist students with auditory comprehension.

Carnahan, Musti-Rao & Bailey (2009) investigated student engagement during group instruction using visual, interactive resources and music. Participants in this study consisted of six students receiving services under the category of autism (ASD) and one student receiving services under the category of other health impairment (OHI). Participants were significantly discrepant from their peers verbally and academically. Instruction was completed in a small group, special education setting. Instruction used teacher created and commercial produced books. Text was paired with interactive manipulatives (i.e. cut out shapes, small paper apples, cotton balls). During condition C, researchers incorporated music while reading to the group, allowing the story to be ready with a melodic rhythm. While the instructor read the story, students sat in a small circle and manipulated the pieces followed by teacher prompted comprehension questioning.

Data analysis showed significant increase in engagement across the groups. During instruction when the teacher only used interactive materials, engagement varied among participants, showing group mean of four percent increase. In phase C, instruction incorporated interactive materials and music stimulus. All participants showed increased engagement. Phase C had mean engagement growth of 28%. During the experimental trial, participants showed an engagement increase of 41% from baseline to phase C, using interactive books and music instruction.

The direct instruction model was compared to discrete trial teaching to determine the impact of language learning for students with autism. Flores and Ganz (2014) acquired 13 students with autism participating in extended school year (ESY) programing through their special education programs. Both Direct Instruction and Discrete Trial Teaching were facilitated by master's level teachers. Assessment materials and instructional content were provided through the Language for Learning program. During direct instruction, small groups of students sat with the teacher for 15 minute lessons. Instruction was lead by scripting, providing response prompting for individual and group responses. Instruction was repetitive and predictable for students. Incorrect responses were corrected by modeling the correct answer then asking the student to state the correct answers back. Discrete trial teaching was completed in a one-to-one model for 15 minutes per day. This system ranged from the lowest level prompting intervention to the greatest. Prompting was initiated by the teacher and followed with the student response. When students gave correct answers, they were awarded instant praise. In the event of an error, the teacher gave verbal prompts, followed by partial physical prompt, followed by verbal and full physical prompt when incorrect answers were sustained.

Researchers evaluated data to determine functional language interventions. The analysis provided evidence that the participants given direct instruction performed moderately higher on assessment growth compared to participants given discrete trial teaching. Participants in the direct instruction group had an average growth of 34% compared to the discrete trial group growth of 15%. Researchers noted that the other benefit of direct instruction. is that it was a system that allowed students to learn in a group model which replicated classroom instruction models closer than the discrete trial method.

Kamps, Barbetta, Leonard & Delquadri (1994) investigated the use of peer tutoring to improve reading and social skills. Students selected for the study were three boys, ages eight and nine, who received services under the autism category, and were enrolled in a mainstream class comprised of 14 peers. Reading fluency performance was recorded after peer tutoring sessions. Participants read a passage for two minutes while error data was collected. Comprehension was assessed based on five questions established by “Wh” (i.e. who, what, when, where, why) questions evolved from the two-minute passage read during reading fluency testing. Social interactions were monitored by observing participants with autism and their peers during unstructured time following tutoring groups. When students with autism initiated or responded to a conversational interaction, observers noted the opportunity. Duration and conversational exchanges were tracked to determine social interaction quality.

Researchers noted that data supported the hypothesis: class wide peer tutoring positively impacted student performance in reading fluency, comprehension and social interactions. Reading fluency data for participants with autism showed an improvement of 19, 31, and 12 correct words read while it also decreased the number of errors that occurred. Peer reading rates also improved by an average of 20 words per minute. Comprehension data showed a mean performance of 50% for two of the three students. The third student showed growth of 93%. Social interaction performance also showed significant growth. Participants moved from an average duration of 25-50 seconds during a five minute time span. After class-wide peer tutoring, the interaction duration increased to 138-203.

CHAPTER 3: METHODS

Project Details

The ability for individuals with autism spectrum disorder or 'ASD', to accurately process and interpret auditory information is often difficult. The increasing demographic of students qualifying for special education services under the autism category within public school systems emphasizes the need for additional educator supports. Educators receive limited training on the impact children with autism have within their classroom. Auditory processing deficits add to the complexities of an already challenging mainstream classroom. The goal of this project is to provide effective tools that allow educators to enhance instruction to assist learners with autism's distinct learning differences.

School districts, administrators and educators were my focused group for this project. Details are designed to be easily presented in a large scale presentation during staff development. It could also be used in small scale settings with individual teachers seeking professional development for their particular classroom and group of students.

The government has mandated that any student with a disability have access to technology, if necessary, in order to access instruction, as identified in the Americans with Disabilities Act, the Individuals with Disabilities Education Act, as well as the Rehabilitation Act, Section 504 (Legal Mandates for Assistive Technology, 2014). The following examples illustrate classroom accommodations for students. This project defined strategies with supported research that aid in data driven decision making. Details were provided to identify how these strategies can be incorporated into a classroom. Financial availability in a public school is often limited. In order to assist educators and administrators in identifying the feasibility of the strategy for use in their institution, pricing structures were provided.

Classroom Environment

The environment and organization of the classroom intensifies the effects of auditory processing deficits and stimulates the defining characteristics of autism. It is essential that educators learn to identify obstacles within their classroom and understand how those obstacles may affect learning for a student with autism. When an educator is tuned in to their classroom, they can facilitate environmental changes for individual students to enhance their learning experience.

Strategy 1:

Research: In order for a student to be successful in a classroom environment, the student must be able to extract salient information from the other acoustical factors (i.e. background noise, speaker listener distance, etc.). Students with autism show a weaker ability to discern pertinent auditory stimuli when distorted with background noise (Boets et al., 2014, Hasbrouch, 1980).

Classroom Application: Teachers can equip their classrooms with FM systems to accommodate student needs that detect instructional auditory output. The FM system provides direct auditory input from the instructor to the student through the use of a microphone with transmitter and earpiece receiver. By directing the signal directly to the students' auditory system, via earphones or speakers, instructors can assist students in discriminating necessary information from background intrusions.

Example Support: The Phonak EduLink system, is an FM system created to support students with auditory processing disorders, attention deficit hyperactivity disorders, and learning disabilities.

Cost: The cost ranges from $3,000 to $6,000 for a set.

Strategy 2:

Research: Jarocci et al., 2010, noted that use of visual supports such as lip reading during bimodal events, provided less benefit to information processing than auditory input in individuals with autism.

Classroom Application: Seating a student near the front of the room to have better visual of the instructor does not ensure improvement in understanding. Instructors can use multiple visual references to aid in understanding of auditory information while reducing the auditory focus of incorrect information. By doing so, instructors provide a system that delivers extended processing time and minimized irrelevant visual features. Visual cues also provide opportunities for students to become independent by reducing the amount of prompting required to complete tasks. Instructors should keep these supports simple so they do not become obstacles rather than supports.

Example Supports: Display calendars with timetables or schedules. Display cue cards (photos, symbols, or images) or checklists illustrating what the student is to do. Picto symbols from systems such as Boardmaker, provide templates and visuals developed to support students processing differences.

Cost: These strategies cost very little money and require more time to prepare and organize than financial obligation. Price estimated under $10. Boardmaker systems can range from $125- $799, depending on the applications you which to purchase.

Instruction

Strategy 3:

Research: When interpreting humor, individuals with autism seldom identify the intent for ironic compliments correctly. Studies also report that students understand notably less humor when identified in ironic criticism (Prexman et al., 2010).

Instructional Application: Instructors need to ensure the language they use is direct and clear. When instruction is given using figurative language, sarcasm or humor, students with autism can become confused and frustrated. Some types of vocabulary to be cognizant of would be, but not limited to, idioms, sarcasm, ironic language, figurative language. This type of language requires that the listener identify the literal interpretation of what was actually said. This ability to decipher meaning from language is shown to be difficult for students with autism (Prexman et al., 2010). Literal language with core vocabulary limits the amount of decoding of the intended instructional material. Students are able to use their time and energy to synthesize the content and develop a knowledge base for future learning.

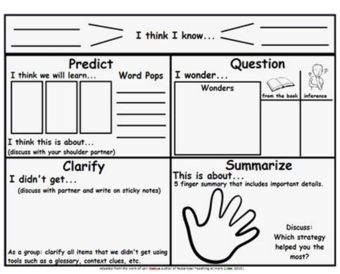
Cost: None

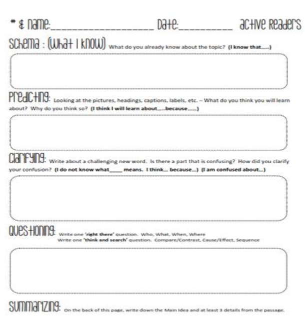
Strategy 4:

Research: Processing style can be defined in two ways, “parts-to-parts” and “parts-to-whole” (Tsatsanis, 2011). This style affects students ability to see the large picture. Students with autism sometimes perform tasks in fragmented ways, impacting non verbal memory skills. Individuals with autism show short memory recall deficits as the complexity of tasks increased compared to peer groups (Minshew, 2001).

Instructional Application: One method to support student learning is called Reciprocal Teaching. Students with autism need direct instruction on how to develop thought processes to critically process information. Reciprocal teaching provides a system for students to develop strategies that aids in comprehension. This intervention can be used across subject areas and can be supplemented with a visual cueing system to organize thought processes.

Example Supports:





(Figure 1)

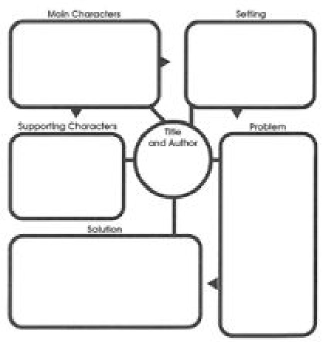
Cost: Dependent on training needs. Many graphic supports can be found online for free, come with programs already purchased by districts, or can be purchased in bundles for low cost to teachers and districts. Training needs for reciprocal teaching would increase the cost of this method but would ensure that staff can adequately provide the instructional system. Online samples are available as training aids for little to no cost.

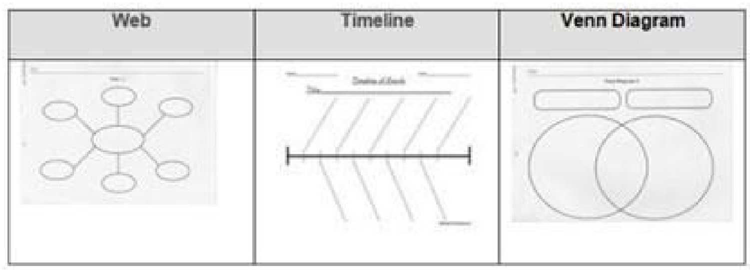
Strategy 5:

Research: Students use visual memory to support their auditory learning when visual organizers or supports are embedded into instruction. The use of story mapping assisted students in retaining story components in order to later evaluate their connections and answer assessment questions. (Stringfield, 2011)

Instructional Application: Instructors can use hands on materials to help students with autism organize information in order to process it effectively. Graphic organizers or story boards support visual process and decrease the energy students need to spend in order to process and remember information given auditorily. Instructors can complete an organizer along with the whole class during lectures, identifying key information and vocabulary, then place it in an organized format for later review. Graphic organizers can be used in small groups where students can use the titles and categories to engage with materials or text and develop conversation about what information is essential and needed for that topic. They can also be used as a wrap-up or study guide method. Students take what they know and develop visual template to mentally organize the information they have learned. Visual support engages a different information processing center of the brain than is needed to process auditorily and supports learners with auditory processing difficulties in a mainstream classroom.

Example Supports: The printable's pictured below provide graphic organizers for any subject (Figure 2). Online resources are also available (figure 3).





(Figure 2 & 3)

Cost: Dependent on training needs. Many graphic supports can be found online for free, come with programs already purchased by districts, or can be purchased in bundles for low cost to teachers and districts.

Strategy 6:

Research: Knight et al. (2015) identified that students with autism struggle with comprehension of science content due to needing substantial amounts of background knowledge along with the ability to comprehend abstract and figurative language. When provided with explicit instruction and Book Builder (etext) supports, participants showed increased performance scores.

Instructional Application: Instructors should look for programs that allow students to visually interact with the text. E-books that have features that allows student to select vocabulary and have it defined or an example given supports reduced background knowledge. Images that are interactive or text that highlights as it reads all assist students in tracking information as they read. Text to speech capabilities support students who may not be at grade level with reading. Some programs come with the option to modify the grade level of the text in order to support struggling learners. Summarizing features provide a recap of key content information and can be used in conjunction with graphic organizers. Enrichment materials assist with development of background knowledge. When teachers use curriculum that does not come with a pre packaged electronic program, resources are available for teachers to create their own electronic aids. School districts and teachers should be familiar with electronic text capabilities when making determinations for curriculum. Current curriculums often come with an electronic text and other support materials. Districts should consider these materials when budgeting for curriculum.

Example Supports: Extensions on systems like Google are available to provide above listed supports (ie. text-to-speech, notes taking, summarizing). Teacher made powerpoint or slides to correlate with lessons. E-text programs: http://www.bookbuilderonline.com/ http://www.flipbuilder.com/extension/textbook.html

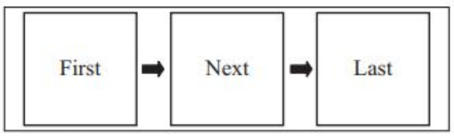
Cost: BookBuilder $55, 1 user, 12 month subscription. Programing/development time is high.

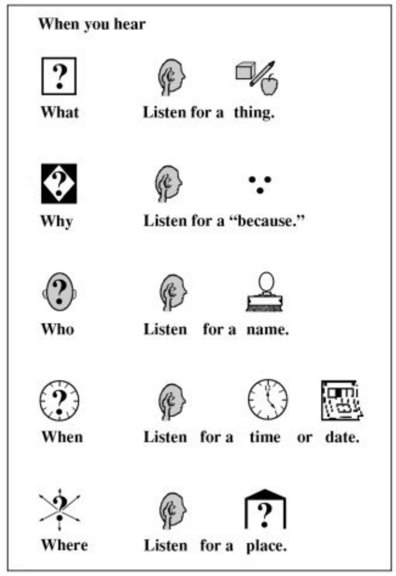
Strategy 7:

Research: The use of systematic prompting during read-alouds was researched by Mims et. al.(2012) to determine whether the modified system would provide the least intrusive prompting method to integrate into an inclusive classroom. The data received showed that all students who participated in the intervention had improved content retention scores from baseline to maintenance, which was determined two weeks after the intervention was finished.

Instructional Application: During Instruction, prompting is often used to elicit class engagement and assessment. The use of systematic prompting during read-alouds time has been found to be a non-intrusive support within an inclusive setting, as it provides a system for student comprehension growth. Instructors focus on rules to assist in answering "Wh" questions (i.e., who, what, when, where, why) along with how to use a graphic organizer, T-chart, to answer sequencing questions (i.e., What came first?). Instructors use clear language and provide direct answers and feedback to students. Instructors begin by talking through the system aloud to the class to introduce the thought process. As skills develop the teacher will begin to call on students and coach them through the questions and how to find the answer. Students are then given the opportunity to process the information on their own.

Example Supports: Two graphic organizers pictured below were created for use in Mims et al., 2012, study. The first graphic organizer (Figure 4) was similar to one used by peers to organize their responses to the sequence questions (i.e., What came first? Next? Last?) in the general education language arts class. The second was a T-chart graphic organizer with rules for answering "Wh" questions (Figure 5).





(Figure 4 & 5)

Strategy 8:

Research: During the experimental trial of Carnahan et al. (2009), student engagement during group instruction using visual, interactive resources and music was assessed. Participants engagement increased by 41% from baseline to phase C when the interactive books and music were part of the instruction.

Instructional Application: When working with students who are significantly discrepant from their peers verbally and academically, teachers can incorporate interactive materials and music to engage students. These books can be built into programing for augmentative communication or sensory integration. Teachers can sing songs as they play or read. They can provide physical movement opportunities for students by developing materials that can be placed within pages of text or that they can sit and manipulate in their hands as teachers read.

Example Supports: 

Cost: Dependent on materials cost or if items are purchased pre made and the quantity of items purchased. Estimated $10-$50

Strategy 9:

Research: The Flores and Ganz (2014) study showed that participants in the direct instruction group had an average growth of 34%. Researchers also noted other benefits for direct instruction as a system that allowed students to learn in a group model which replicated classroom instruction models.

Instructional Application: When looking at instructional delivery models, direct instruction provides many benefits to students and incorporates scripted delivery, providing ease of preparation for teachers. Direct instruction systems provide response prompting for individual and group responses that allows teachers to encourage whole group participation while also performing randomized comprehension assessments. Direct instruction methods are repetitive and predictable for students allowing them to focus on content rather than procedure. Incorrect responses are remediated by modeling the correct answer then asking the student to repeat the correct answers allowing for instant error correction and corrected practice.

Cost: $500-$5,000+, This strategy is one of the most expensive as it often is a structured curriculum that a district purchases. It also requires training for staff who are unfamiliar with the method which would be an added cost to districts.

Strategy 10:

Research: The peer tutoring model has shown positive results for teachers looking to increase reading fluency, comprehension skills, and social interaction skills of students with autism. The Kamps et al. (1994) study showed that classroom peer tutoring positively impacted student performance in reading fluency, comprehension and social interactions.

Instructional Application: Peers can be paired to read and work with students with autism in a cooperative setting. This encourages student engagement, positive reinforcement, and interactions between peers. Peers act as a positive model of skill for students to mimic. For example, a peer could read a passage then have the student with autism read the passage directly after, using the same reading techniques as the peer used. Teachers should preplan student groups to organize peer strengths with students with autism's struggling areas.

Cost: none

Sustainability

When I created the below leaflet, it was intended to be used as a double sided one page go to sheet for teachers when programing their classroom to support students with autism and auditory processing. Teachers do not have a lot of time to go through long powerpoint presentations to find details they previously heard, or have time to do research while preparing their classrooms for a new school year, new student, or new lesson. This leaflet is intended to give a quick snapshot to support the students, classroom, and instructional methods. Information within this leaflet identifies the character traits of autism and how those traits affect the classroom learning, and includes tools for teachers. This leaflet could be used as part of a teacher professional development program or as a resource for case managers to hand out as they meet with their students new teachers and discuss their students' needs. Limited funds are needed to duplicate this resource, making it sustainable for special education departments over the years. Items can also be modified to meet individual needs.

Tools for Teachers

Get to know your student!

Common Characteristics of Autism: Difficulty with social interactions and communication along with restric-

Skills and Strengths

- They have the ability to see the world from a different perspective and so bring a different insight
- Many people with autism are very logical and will play according to the rules
- Routines are learned quickly and firm. Students are highly motivated to repeat familiar routines
- Students are generally hard workers, excelling in tasks that require precision and accuracy rather than speed and judgment
- Able to use visual information meaningfully
- Able to pay attention to small details and keep up attention, when motivated

Social Interactions

- Difficulty recognizing feelings and thoughts of others
- Poor eye contact
- Difficulty maintaining personal space; physical intrusions on others
- Difficulty making or keeping friends
- Difficulty joining an activity and/or to be less involved in group activities
- Social naivete
- Difficulty understanding others' nonverbal communication
- Difficulty understanding jokes
- Misinterprets others' behaviors and social cues

Communication

- Limited understanding and use of nonverbal communication skills
- Odd production of speech
- Repetitive or idiosyncratic behavior
- Inability to initiate or maintain a conversation
- Not using finger to point or request
- Showing lack of spontaneous imitations or lack of varied imaginative play
- Absence or delay of spoken language
- Difficulty communicating feelings
- Students with ASD who can speak may say things that have no meaning or that seem out of context in conversations with others.

Restrictive , Repetitive, and stereotyped patterns of behavior, interest and activity

- Insistence on following routines or rituals
- Demonstrates distress or resistance to changes in activity
- Repetitive hand or finger mannerism, pacing, rocking, lunging/jumping
- Lack of true imaginative play
- Over-reaction or under-reaction to sensory stimuli
- Rigid or rule-bound thinking
- An intense, focused preoccupation with a limited range of play, interests, or conversation topics
- Echolalia

AUTISM AWARENESS

What you can do for these students in your class?

Classroom Environment

- Provide visual supports & routine: Post a schedule for the day/ class period. Give advanced notice of changes
- Create 'to do' lists and checklists for completing tasks or assignments
- Provide preferential seating
- Fewer verbal directions, pair with visuals, break-down multistep directions
- Reduce stimulation that allows the student to focus on relevant cues and information
- Provide organization and support transitions.
- Gain eye contact before speaking, but expect that a student might avert their eyes but still be listening.
- Communicate expectations with support staff to assist in classroom flow.
- Use peer tutoring
- Background noise support : use FM transmitter system.

Curriculum & Assignments

- Allow student to give verbal response , dictate to a staff or use technology when wanting to asses content knowledge. (writing is often a difficult skill)
- Testing modifications: Multiple choice, matching, test read, oral response, extra time
- Evaluate the extent the sudent's current skill set matche the demands of the activitiy.
- Identify key concepts for units and develop assignment /expectations around them.
- Use systematic prompting
- Create manipulatives to support student engagement
- Use Direct Instruction model
- Resources:

www.readingrockets.org/strategies/story_maps

Www.bookbuilderonline.com

Social / Communication

- Use "First, then..." language (Ex. "First do your bell work, then you can use the restroom.")
- Make sure you have students attention before giving directions.
- Assign groups rather than expecting students to engage in conversation to find a partner.
- During group activities define the student's role and responsibilities within the group.
- Allow wait time for responses.
- Proved choices to assist with difficult in word retrieval
- Provide practical feedback

Behaviors

- Maintain a calm, quiet, supportive attitude that communicates acceptance & confidence "You are ok. You will be able to handle this & I am here to help you."
- Ignore behavior but acknowledge the message and the student what to do right now to relax.
- Acknowledge the problem and the feeling, and clarify a simple, clear course of action.
- Reduce the demands
- Reinforce any effort or sign of self-control.
- Coupling statements - "You are reading a comic book, the direction is to work on your math worksheet."
- Allow student to have some control

CHAPTER 4: DISCUSSION AND CONCLUSION

Review of Thesis Question

This paper set out to identify how students with autism process auditory information in the classroom. Considerations included the environment of the classroom and ways the instructional methods currently being used impact students' educational success. In chapter two, an analysis was conducted from 20 peer-reviewed research studies that addressed characteristics of auditory processing that most commonly affect students with autism in the mainstream classroom. Specific topic areas reviewed included auditory figure ground, auditory discrimination, audiovisual integration, auditory memory and auditory integration. Data acquired from the literature studies provided the evidence based applications described in chapter three. These applications provided research based support ideas that will aid educators in programming for students with autism who display auditory processing issues within a mainstream classroom.

Importance of Understanding Auditory Processing in Autism in Schools

There are 378,000 students with autism being served under the Individuals with Disabilities Act (IDEA) in the United States (Carter et al., 2013). Diagnosis of students with autism increased from five percent to 8.2 percent from 2008 to 2013 (Department of Education, Pg. 126). With this increase we are also seeing the percentage of school age students, served under the Individuals with Disabilities Education Act, receive instruction in a class with non-disabled peers 80 percent or more of their day increasing from 51.8 in 2004 to 62.1 percent in 2013 (Department of Education, pg.47). This is an important topic because these students are entering public schools with complex needs and a range of characteristics that makes each of them unique complex learners. For these students, their disability impacts their ability to understand verbal communication, language content and impacts overall classroom performance due to environmental obstacles and instructional methods used within the mainstream courses. The statistics on inclusion of students in public schools, being serviced under the special education title of autism are alarming. When I considered the lack of formal education and training educators receive on best practices to support these students in their classes, I became even more concerned.

Summary of Main Points of Literature Review

The studies reviewed in chapter two have aided in developing a greater understanding of aspects of auditory processing in order to identify the effects within the classroom for students with autism. The complexity of the autism and auditory processing characteristics can cause significant impact within a mainstream classroom environment for many reasons. Research showed that students with autism had significant deficits and atypical responses when compared to control groups in all areas reviewed, auditory figure ground, auditory discrimination, audiovisual integration, auditory memory and auditory integration.

Emphasis on the impact of auditory figure ground difficulties was identified during research. Within the classroom environment, a student's ability to extract information from the other acoustical factors (ie. background noise, speaker listener distance, ect.) is imperative to their academic success. Individuals with autism show significant deficits with identifying verbal requests when presented in noise (Hasbrouck et al, 1980). As instructors provide verbal directions and information as a key teaching modality in a large group using lecture formatted instruction, it became clear that when a student was unable to work within the environment to detect the information, academic achievement suffered. Students with autism showed weaker ability to discern pertinent auditory stimuli while distorted with background noise (Boets et al., 2014). As students navigate the labyrinth of the classroom and auditory factors of mainstream education, characteristics of autism increase. They have skill discrepancies when identifying speech in non-speech sounds. Students with autism lack of ability to manage characteristics that impact their ability to fit into a social environment. This deficit also impacts their ability to learn. Poor orientation to speech was distinguished as a product of hyperattentive response to non-speech sounds, actively impeding individual's response toward speech sounds (Whitehouse & Bishop 2009). Neuro-typical students in a mainstream class are able to use multiple visual and auditory modalities in order to understand information presented by the teacher. Their ability to read body language and process context clues provide them with an advantage over their peers with autism. Individuals with autism used limited visual supports and lip reading during bimodal events which provided less assistance with information processing than auditory input (Jarocci et al., 2010).

When a student is able to identify the auditory information provided, they next need to process effectively. Individuals with autism show short memory recall deficits as the complexity of tasks increased when compared to peer groups (Minshew and Goldstein, 2001). Individuals with autism need support systems in order to manage their learning styles as they are impacted by the structure of mainstream teaching models. Matching students processing style can be done by teaching concepts with multiple modalities and descriptions in order to allow students with autism to learn. The processing style in individuals with autism can be defined in two ways, “parts-to-parts” and “parts-to-whole” (Tsatsanis et al., 2011). This style affects their ability to see the large picture. Sometimes performing tasks in fragmented ways, impacted nonverbal memory. A teacher needs to consider the language used while working with students with autism because student learning is fragmented. When interpreting humor, individuals with autism seldom identified the intent for ironic compliments correctly. They were also reported to understand notably less humor when identified in ironic criticism. Individuals with autism understand literal language but show discrepant communication skills compared to their non-disabled peers interpreting the intent of ironic language. (Prexman et al., 2010).

Insight Gained and Recommendations for Future Research

During my research, it became apparent that limited studies have been done on the characteristics of auditory processing specifically in students with autism. Even less research has been done on the impact of auditory processing deficits within a classroom. In order to facilitate a literature review with these limitations, I had to break down my focus. With areas of auditory processing segregated within the research, relevant and timely results were found in most areas. This led me to believe that research, as well as education has not reached a point where they have identified auditory processing difficulties for students with autism have not been identified as large-scale research topic yet. Professional development on autism for core content teachers, licensed outside of the area of special education, is limited. I was unable to find any systems in place that provide teachers instructional support in order to support students with autism who have impaired auditory processing skills.

More research needs to be done regarding the impact of auditory processing in students with autism, particularly within the classroom. This research could provide a training platform for teachers to improve student learning within an inclusive classroom. Findings could also provide special educators information on direct instruction needs for students with autism to aid them in being successful within their mainstream courses.

Summary

The number of students qualifying for special education services continues to grow across the country. Many students are being educated in inclusive education models. This provides students the opportunity to be included with their same age peers and active educational community members. Students with autism come into a classroom with qualities that are unique to them. Understanding the well-known phrase “when you meet one student with autism, you’ve met one student with autism” is key to success as a teacher. Each person with autism is an individual with characteristics unique to them. Many of these students do not enter a class knowing how to navigate the environment. As educators, we need to know our students and have an understanding of how best to educate each of them.

Setting up the classroom environment is just as important as implementing the instructional material when working with students with autism and auditory processing. The classroom is the initial factor that a student faces when beginning their education. Management and organization is key to providing students with autism the support they need to begin learning. Teachers need to understand the learning styles of the students in their classes and address their individual needs. Unless teachers understand their students on an individual level, they will not be equipped to tailor their instruction. Use of multimodal systems to reach each student's’ learning style will provide educational success.

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Appendix A

Figures From Methods Strategies

Figure 1: Reciprocal Teaching. (n.d.). Retrieved August 15, 2017, from http://comprehensionhart.weebly.com/reciprocal-teaching.html

Figure 2: Story Maps. (2015, May 11). Retrieved August 15, 2017, from http://www.readingrockets.org/strategies/story_maps

Figure 3*:* Graphic organizers. (n.d.). Retrieved August 15, 2017, from https://udltechtoolkit.wikispaces.com/Graphic organizers

Figure 4 & 5: Mims, P. J., Hudson, M. E., & Browder, D. M. (2012). Using read-alouds of grade-level biographies and systematic prompting to promote comprehension for students with moderate and severe developmental disabilities. *Focus on Autism and Other Developmental Disabilities, 27*(2), 67-80.

Appendix B

Tools for Teachers

Information used within chapter 3, Tools for Teachers, section are referenced from the following resources along with citations from this paper and my own knowledge and classroom experiences.

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