Dyslexia and Autistic Spectrum Disorder: Common Reading Difficulties, Common Solutions?
A Study Proposal

Presented to the S. Daniel Abraham Honors Program

in Partial Fulfillment of the

Requirements for Completion of the Program

Stern College for Women
Yeshiva University
May 7, 2019

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Introduction

Reading is a process of translating visual codes into meaningful language (Aaron, 1994), and is an extremely important foundation on which a child’s academic success is built. Reading skills in elementary school positively predict an individual’s academic and societal outcomes later in life (Hudson, Scheff, Tarsha & Cutting, 2018). It is estimated that approximately 7,000 children drop out of school every day (Miller, 2015), which number is attributed to students not having the literacy skills to keep up with school curricula (Kamil 2003; Snow & Biancarosa 2003). Approximately 8 million students from fourth grade through the end of high school require reading remediation. Burgess, Anthony & Lonigan (2000) note that when children struggle to read, they do not practice reading as much as typically developing children do. These children therefore do not gain the skills necessary to develop proper reading strategies, and or develop a negative association with reading. Proficient readers are less likely to drop out of school, and are, therefore, more likely to attend higher levels of education, which leads to successful careers.

Many individuals with autism spectrum disorders (ASD) experience trouble with reading, in both decoding and comprehension (Nation et al., 2006) as well as difficulties with executive dysfunction (Wang et al., 2017). Many individuals with dyslexia, a specific-language based learning disability, experience many of the same reading and executive-function struggles as individuals with ASD (Lyon et al., 2003). Flores & Ganz (2007; 2009) and Preventing Academic Failure (PAF), created some 40 years ago by Phyllis Bertin and Eileen Perlman, have demonstrated that when taught explicitly, in a clear and unambiguous manner, individuals with ASD and dyslexia can
gain the skills necessary to become effective readers (Shapiro, 1988). While these methods are similar in most of their aspects, they differ in one significant way: The PAF, which is used to help individuals with dyslexia employs a multi-sensory approach, including kinesthetic (movement-based) methods, in order to help those who are using it gain the necessary skills to become effective readers.

There is room for further research to investigate whether or not the PAF, specifically due to its multisensory approach, would be beneficial in helping children with ASD become effective readers. Since the struggles experienced by individuals with dyslexia are comparable to those with ASD, and the PAF has been demonstrated to help those with dyslexia become effective readers, perhaps it would be beneficial for those with ASD as well. Individuals with ASD often have sensory-integration difficulties (Leekam et al., 2017): Would the multisensory approach of the PAF be beneficial for these children’s decoding and comprehension? Would the multisensory approach help their general sensory-integration difficulties?

The scientific background of this paper will lead to a study designed to respond to these compelling questions.

**Scientific Background**

*Reading*

Many different factors contribute to an individual’s ability to read and understand reading effectively. Reading involves processes such as decoding, comprehension and other high level cognitive processes that are not specific to reading (Hudson et al., 2018), such as memory.
One way reading can be explained is the Simple View of Reading (SVR), which proposes two components: decoding and linguistic comprehension skills (Oliveira, Silva, Dias, Seabra & Macedo, 2014). Decoding is the conversion of symbols into sounds during reading; linguistic comprehension is understanding oral language (Gough & Tunmer, 1986). These tasks are extremely difficult for individuals who struggle with reading disorders. If an individual struggles with any of the basic skills necessary for reading and comprehension, it will be extremely difficult for him or her to succeed in becoming a proficient reader (Oliveira et al., 2014).

Burgess et al. (2000) researched the relationship amongst phonological sensitivity, an individual’s ability to recognize and work with the sound structure of spoken language; letter knowledge, and decoding abilities in preschool children. They assessed these children a year later in order to see if phonological awareness and letter sensitivity were predictors of decoding abilities. They found that the children who had strong phonological awareness and letter sensitivity in their last year of preschool had strong decoding skills as they entered elementary school.

Hogan, Catts & Little (2005) extended the research of Burgess et al. (2000) and sought to see at what age phonological awareness is most predictive of future decoding abilities. They confirmed that this skill is most predictive of whether children will be effective readers when a child is in the last year of preschool. This finding demonstrates that it is important for children to have phonological awareness even before they enter elementary school.

Burgess et al. (2000) and Hogan et al. (2005) suggest that phonological awareness and letter sensitivity are necessary for decoding properly, and that children who struggle in
these areas will have difficulty decoding. Since decoding is a critical aspect of reading with comprehension according to the SVR, children who so struggle would have difficulty with reading comprehension. Hogan et al. (2005) therefore point out that phonological awareness skill should be tested when evaluating a child for a learning disability.

**ASD**

Autism spectrum disorders (ASD) are a spectrum of neurodevelopmental disorders often characterized by executive dysfunction (Wang, Zhang, Liu, Cui, Wang, Shum, van Amelsvoort & Chan, 2017). Many individuals with ASD exhibit deficits in communication and social interaction and show repetitive patterns of behavior (Wang et al., 2017). Many scholars (Wang et al., 2017) believe that individuals with ASD do not have proper “Theory of Mind,” which makes it difficult for them to infer the mental states of others. Wang et al. (2017) explain the executive function deficits seen in individuals with ASD with the “weak central coherence theory,” which states that individuals with ASD are excellent at processing details but are unable to apply those details to greater global situations (Wang et al., 2017). The executive dysfunction theory accounts for the non-social features of ASD and states that most of the idiosyncrasies experienced by individuals with autism are due to executive dysfunction. Davidson, Kaushanskaya & Ellis-Weismer (2018) point out that many children with ASD experience trouble with reading comprehension, and current estimates range from 38-73 percent.
Children who have ASD show a range in reading abilities (Nation, Clarke, Wright & Williams, 2006). Some individuals with ASD show delays in both decoding and reading comprehension abilities; however, Flores & Ganz (2007) point out that yet others have hyperlexia, “an unusual preoccupation with letters and print, frequently developing precocious reading ability for age despite a lack of formal training” (Gabig, 2009, p. 67). Individuals with hyperlexia have advanced abilities in terms of word recognition, above what is expected for their age or grade-level, but not necessarily comprehension of content they are decoding at the word level.

Nation et al. (2006) conducted a study in which they investigated components of reading skills in children who have ASD. Researchers looked into word recognition, nonword decoding, text reading accuracy and reading comprehension abilities (all skills necessary in order to be an effective reader) in children who have ASD. Firth & Snowling (1983) reasoned that children with ASD may read words through techniques such as memorization, or may recognize words based on familiar patterns and shapes, as opposed to reading using phonological decoding. Individuals who read using phonological skills read words by sounding out letters and putting them together to form words. If it is true that children with ASD do not use phonological decoding skills when they read words, it can be assumed that they will struggle decoding nonwords, words that are “meaningless strings of letters that need to be decoded using letter-sound correspondence rules” (Nation et al., 2006, p. 917), since they only recognize words based on familiarity.

Additionally, previous research (Firth & Snowling, 1983) points out that even when children who have ASD show above average reading abilities, they often have trouble comprehending what they have read. While these children with ASD defy the typical way
of reading, via phonetic awareness, because they seem to have above average reading abilities, it is unclear if they comprehend at the word level or not.

Nation et al. (2006) investigated the levels of nonword reading in children with ASD, ages 6-15 years, as well as those children’s reading comprehension abilities. They used 90-minute long standardized tests, administered to children in a quiet room, and the children were allowed to take breaks when needed.

In terms of reading comprehension in children who showed accurate word reading scores, Nation et al. (2006) found that overall, children with ASD struggle to comprehend even though they correctly read words that were presented to them. Ten percent of the children with ASD had a comprehension score that was 2 standard deviations below their word accuracy score, and 24% of the children had comprehension scores that were 1-2 standard deviations below their accuracy score (Nation et al., 2006). The remaining 65% of children had comprehension and accuracy scores that were within 1 standard deviation of each other (Nation et al., 2006). Even though the majority of the children had scores that were within 1 standard deviation of each other, their comprehension score was lower than their accuracy score.

The researchers reasoned that the most interesting group to look at in terms of reading comprehension was the 20 children who showed adequate word accuracy skills, half of those children showed poor reading comprehension. Since they showed adequate reading skills, their reading comprehension struggles could not be due to inadequate decoding ability, and must be attributed to another factor.

Nation et al. (2006) used the task of decoding nonwords to determine whether or not children with ASD decode words using phonological skills or memory skills.
have high reading accuracy scores but low scores when decoding nonwords, it would be reasoned that the children rely on memory skills and not phonological skills to decode words. Nation et al (2006) found that most children in the group of 20 word-accurate children with ASD struggled to decode nonwords, demonstrating that children read words based on memorization and recognizing familiar patterns rather than using phonological skills.

Accordingly, Gabig (2009) found that children with ASD showed above-average abilities in identifying words when compared to children who are typically developing (TD); however, although children with ASD often display above-average decoding abilities, they often struggle comprehending words, leaving a discrepancy between their decoding abilities, which are high, and comprehension abilities, which are low (Flores & Ganz, 2007). Gabig (2009) also found that when compared to children who are TD, although children with ASD seemed to have typical word recognition abilities, they struggle when decoding non-words. This distinction can also perhaps be explained by the notion that children with ASD struggle when they are presented with something that is new to them, an idea discussed by Poljac, Simon, Ringlever, Kalcik, Groen, Buitelaar & Bekkering (2010). These researchers found that when children with ASD were not given specific directions as to what to do, they struggled to complete the task.

Flores & Ganz (2007) also point out that some children with ASD and with excellent word-accuracy struggle with reading comprehension. They explain this phenomenon by suggesting that these children struggle with connecting previous information to a current context (Flores & Ganz, 2009), a skill which is necessary to be able to comprehend a text.
Although children with ASD struggle when they are not given specific instructions, when they are given explicit directions, they are indeed able to switch tasks without difficulty (Poljac et al., 2010). In a study done to measure individuals’ ability to switch between tasks, Poljac et al. (2009) found that individuals with ASD did not struggle to switch tasks when they were given specific instructions and did not need to apply other generally known rules. Flores & Ganz (2007) therefore wondered if it would be beneficial to teach students with ASD to read explicitly in order to facilitate improved comprehension. They found that after being taught explicitly, children with ASD showed improved comprehension skills and maintained those improvements.

**Dyslexia**

Dyslexia is a specific language-based learning disorder that affects an individual’s ability to read (Lyon, Shaywitz & Shaywitz, 2003). Individuals who have dyslexia struggle with accurate or fluent word recognition and have poor spelling and decoding abilities. They struggle to decode and identify both real words and nonwords. It is believed that these difficulties come from a deficit in phonological awareness. Oliveira et al. (2014) found that children with dyslexia had deficits in word recognition coming from their struggle with phonological awareness. Phonological awareness and word recognition difficulties can lead individuals with dyslexia to struggle with reading comprehension. They read less than typically developing children, and therefore have impeded vocabulary growth and background knowledge (Lyon et al., 2003).

Lyon et al. (2003) point out that dyslexia has a neurobiological origin. Neurologist Dejernie (Lyon et al., 2003) notes that the parieto-temporal area of the brain is mostly
responsible for turning the visual perception of print into phonologic structures of 
language. Recent studies (Lyon et al., 2003) support Dejernie’s conjecture by using 
functional brain imaging to examine brain function during reading tasks. Functional 
magnetic resonance imaging (fMRI) and magnetoencephalography (MEG) are 
noninvasive brain imaging techniques and are therefore ideal for studying the brain while 
it is at work. Lyon et al. (2003) point out that functional brain imaging has shown that 
individuals who do not have reading impairments activate three areas of the brain while 
they are phonologically processing: (1) an anterior portion in the left inferior frontal 
system, (2) a dorsal parieto-temporal system, and (3) the ventral-occipito-temporal 
system. In contrast, it was found that individuals who have dyslexia show under 
activation in both posterior systems and increased activation in the inferior frontal gyrus. 
Additionally, Lyon et al. (2003) note that the parieto-temporal region is responsible for 
word analysis and focus on individual phonemes, while the occipito-temporal area is 
responsible for processing whole words and responds more rapidly than the parieto-
temporal region.

In summary, for an individual to read effectively, he or she must be able to understand 
that words can be broken down into phonemes and that letters in written words represent 
those sounds (Lyon et al., 2003). Lyon et al. (2003) have shown that this awareness is 
missing in individuals with dyslexia, which leads them to have difficulties reading and, 
concomitantly, comprehending effectively. Their struggle with the very basics of 
decoding for reading leads them to also struggle in more complex areas of reading such 
as fluency, comprehension, and vocabulary.
Executive Function and Working Memory

Executive function is an umbrella term that includes abilities such as “planning, initiation, shifting, working memory, problem solving, monitoring, and self-control” (Wang et al., 2017, p. 47). Working memory accounts for behavioral regulation, sustaining attention and abstract thinking (Wang et al., 2017), and includes the ability to simultaneously keep and manipulate old information in one’s mind while they are being given new information (Hudson et al., 2018). Working memory is, therefore, extremely important in everyday functioning (Wang et al., 2017).

Many researchers (for example, Hudson et al., 2018; Wang et al., 2017; Davidson et al., 2018) believe that executive function, and specifically working memory play a key role in an individual’s ability to read and comprehend effectively. Davidson et al. (2018) point out that there is a model of reading that further connects working memory and reading comprehension. The construction-integration (CI) model supports that when an individual reads, a mental representation of information is formed from the text that combines with relevant knowledge through cycles of integration and construction. Working memory plays a key role in this process as it holds the recently read information in order to integrate it with the other information that the individual is reading in order to comprehend it (Davidson et al., 2018). According to the CI model and other research (Hudson et al., 2018; Wang et al., 2017; Davidson et al., 2018), working memory and its effect on reading strategies are a key component in reading comprehension, and individuals who have working memory deficits would be expected to struggle when trying to comprehend effectively.
**Executive Function and Dyslexia**

Hudson et al. (2018) explain that reading is made up of many processes including decoding, listening comprehension and other non-specific processes, such as executive functioning. They explain executive functioning as a “collection of top-down control processes used when going on automatic or relying on instinct” (Hudson et al., 2018).

Additionally, Hudson et al. (2018) point out that it is possible for individuals to have ample decoding skills and have a deficit in reading comprehension, which is similar to what Nation et al. (2006) pointed out above regarding children with ASD who have hyperlexia, in that children who have hyperlexia are often times able to read and decode words extremely well but struggle to comprehend what they are reading. Hudson et al. (2018) classify this type of difficulty as a specific reading comprehension disorder, S-RCD. They posit that this discrepancy could be due to a deficit in executive function.

As described above, executive functions include tasks such as inhibition, task switching and working memory. Hudson et al. (2018) suggest that inhibition and task switching may be relevant to reading comprehension; in order to understand what one is reading, one must be able to properly inhibit their thoughts and switch between them to properly focus on relevant information while reading. Executive function tasks, especially working memory, are clearly applicable to reading because in order to be an effective reader, one must be able to keep previously read or understood material while adding in new information (Hudson et al., 2018).

Studies have shown that in order to comprehend properly, an intricate network that includes multiple areas of the brain must be working properly (Hudson et al., 2018).
Individuals who have dyslexia show a different anatomical makeup of these regions and specifically show a less asymmetrical makeup of language-related areas of the brain (Hudson et al., 2018). It has also been shown (Hudson et al., 2018) that through interventions, the reading skills of these individuals can be improved. Using MRI technology, Hudson et al. (2018) studied the brains of individuals with dyslexia, S-RCD, and those who are typically developing (TD), to see which areas of the brain are activated during reading, to pin-point where in the brain the deficits occur. They found that individuals with dyslexia differed from those with S-RCD and those who are TD in the occipitotemporal and supramarginal regions, both of which are areas that are associated with phonological and orthographic processing. Hudson et al. (2018) found that the S-RCD group did not differ from the TD group in these regions, supporting their hypothesis that the differences experienced by individuals with S-RCD lie in other brain functions. The researchers noticed, however, that individuals with S-RCD had more grey matter in the right frontal regions, areas that are associated with executive functioning, than did the TD group. This difference supports Hudson et al.’s (2018) premise that executive functioning plays a role in reading comprehension.

As was pointed out by Poljac et al. (2010), individuals who have dyslexia struggle with task switching, which demonstrates that these individuals already struggle with executive functioning. If reading comprehension, therefore, does in fact require executive function, as suggested by Hudson et al. (2018), that individuals with dyslexia struggle to comprehend what they read can be so explained.
Working Memory and ASD

Wang et al. (2017) posit that a major component of ASD is deficit in working memory; however, there is no conclusive agreement regarding working memory impairment in individuals with ASD. Wang et al. (2017), therefore, conducted a meta-analysis of 28 studies that investigated working memory impairments in individuals with ASD, which included 819 individuals with ASD and 875 controls.

Wang et al. (2017) found that there was a significant working memory impairment in individuals with ASD that was not associated with age or IQ, that individuals with ASD had significant impairments in both spatial and verbal working memory, and the impairments were significantly worse for spatial working memory. The researchers elaborate that individuals with ASD struggle to integrate details into larger global structures and meanings. Wang et al. (2017) describe that these details hinder working memory instead of enhancing it, which is the factor that results in greater impairments in spatial (visual) working memory.

Wang et al.’s (2017) meta-analysis also found that cognitive processing and cognitive load did not affect severity of the working memory impairment in people with ASD. This was evident from a study (Wang et al., 2017) that showed that impairments in working memory in individuals with ASD did not change from a low cognitive load to when the load was increased.

Wang et al. (2017) point out that deficits in working memory and executive function in general are most likely due to abnormalities in the brain structure of individuals with ASD. Structural abnormalities, such as enlarged brain weight and size (specifically in the frontal lobes), have often been found in children with ASD. Hyperconnectivity can result
in isolation of neural systems of the brain that are responsible for higher-level processes (such as executive function), and result in deficits in higher-level cognitive functions (Wang et al., 2017). Wang et al. (2017) note that results from their meta-analysis imply that working memory is identified as a potential therapeutic target when working with individuals with ASD.

Davidson et al. (2018) point out that word reading and oral language abilities predict reading comprehension abilities of children with ASD, however, working memory as a predictor of reading comprehension abilities in children with ASD has not been thoroughly investigated. They noted that previous research has been inconsistent, as some studies found that individuals with ASD showed intact working memory abilities (for example, Cui, Gao, Chen, Zou & Wang, 2010; Joseph, McGrath & Tager-Flusberg, 2005; Macizo, Soriano & Paredes, 2016; Williams, Goldstein, Caroenter & Minshew, 2005) whereas other studies found working memory deficits (for example, Gabig 2008; Hill, van Santen, Gorman, Langhorst & Fombonne, 2015) in individuals with ASD.

Working memory can be divided into verbal working memory and nonverbal working memory. Davidson et al. (2018) therefore sought to evaluate the function of working memory, and its different types, in connection with reading comprehension abilities in individuals with ASD.

Participants in the study by Davidson et al. (2018), included 19 individuals with ASD and 24 controls, of ages ranging from ages 8-14 years old. The group of children with ASD was comprised mostly of boys, while the control group was split more evenly between boys and girls. All individuals passed the pure-tone audiometry hearing test according to ASHA (American Speech-Language-Hearing Association) guidelines.
Davidson et al. (2018) evaluated participants’ nonverbal cognition, oral language, and reading abilities. Nonverbal cognition was assessed through the *Wechsler Intelligence Scale for Children- Fourth Edition*, vocabulary comprehension using the *Peabody Picture Vocabulary Test- Fourth Edition*, morphosyntactic comprehension through the *Test of Oral Language Development, Intermediate Version, Fourth Edition*. Reading abilities were assessed through the *Woodcock Reading Mastery Test, Third Edition*. The researchers looked at the subjects’ abilities to recognize real words and non-words and to read a short passage and identify information from the passage. Each participant was tested individually in a quiet room.

In order to evaluate working memory abilities, Davidson et al. (2018) used three N-back tests that evaluated different types of working memory. An N-back test is one in which images are shown repeatedly and an individual must identify when the image is the same as the one that was displayed “n” times ago. The researchers gave individuals a Shape Working Memory (WM) task, a non-linguistic task in which they were shown abstract shapes, an Object WM task, which is a linguistic task that showed individuals an image of an object that could easily be named, and a Word WM task, a linguistic task in which participants were shown a single word. Davidson et al. (2018) also used a 2-back test, and individuals were instructed to press a button when the image that they saw was the same as the one they saw two trials ago. The order in which the images were presented was random.

Davidson et al. (2018) found that the control group performed significantly better on all of the reading measures than did the group with ASD, including word reading, recognition, decoding and reading comprehension. They also found that the groups did
not differ significantly on the Shape, Object or Word WM tasks. The researchers noted that while word decoding was not significantly connected to reading comprehension in the control group, it was significantly connected in the group with ASD. They also found that while all three types of WM tasks were significantly and positively associated with reading comprehension, the Object WM task was most strongly related to reading comprehension (Davidson et al., 2018).

The fact that Davidson et al. (2018) found that the results of WM tasks of the two groups did not differ significantly is the polar opposite of what most of the previous literature suggested. Davidson et al. (2018) justified their results by explaining that when the group of individuals with ASD and the control group were well matched in terms of age, socioeconomic status, nonverbal cognition and oral language (as was in their study), verbal and nonverbal working memory would be “indistinguishable between the two groups” (Davidson et al., 2018, p. 3534).

Davidson et al. (2018) note that their finding that working memory did not differ between the group of individuals with ASD and the control group of typically developing children differ from previous studies for a number of reasons. First, their research only assessed working memory at the word level, whereas other studies tested beyond the word level. Second, said the authors, results may differ depending on what type of reading comprehension is measured. Davidson et al. (2018) used the Woodcock Reading Mastery Test, Third Edition (WRMT) to assess reading comprehension abilities, which does not require strong background knowledge or language, and does not assess inferencing. The WRMT places only minimal demands on an individual when assessing reading comprehension. It is possible, therefore, that individuals with ASD were able to
effectively comprehend as well as their typically developing peers because of the minimal demands and the lack of a requirement for inferencing (Davidson et al., 2018). Since Davidson et al. (2018) found that in certain cases working memory in individuals with ASD is “indistinguishable” (Davidson et al., 2018, p. 3534), from working memory in those who are typically developing, they suggest that this finding is open for further research to see if a change in teaching method, perhaps to explicit teaching or direct instruction (in cases where previous outside knowledge is not necessary for effective comprehension) would help the reading comprehension abilities of individuals with ASD.

**Explicit Teaching**

*Task Switching*

The ability to execute control over constant cognitive processes is essential in order to function in daily life. Poljac et al. (2010) noted that individuals with ASD and dyslexia both show problems with these types of cognitive control. Individuals with ASD commonly show deficits in planning and integrating new ideas and spontaneous behaviors (Poljac et al., 2010) whereas the struggles faced by individuals with dyslexia have been mostly linked to working memory and problems with shifting attention. Even though individuals with ASD and dyslexia struggle with different difficulties, all of their struggles are problems with executive function.

Poljac et al. (2010) delve into one area of executive function and focus specifically on cognitive flexibility. Cognitive flexibility is “the ability of the cognitive system to dynamically activate and modify cognitive processes in response to changing task demands and context factors” (Poljac et al., 2010, p. 402). The researchers therefore
studied individuals’ cognitive flexibility by examining their task-switching abilities as an expression of cognitive control.

Poljac et al.’s (2010) participants included 24 individuals with ASD, 25 individuals with dyslexia, and 27 individuals who acted as controls, ranging from ages 12 to 17 years old. The researchers presented participants with geometric figures that could be categorized either by shape or color.

Participants were given cues before each trial as to how they were to organize the objects. The directions were either to repeat the task (when the cue did not change the task) or to switch the task (when the cue changed the task). Directions were given explicitly and did not require the individuals to have prior knowledge of any rules. Poljac et al. (2010) were able to look at both the speed and accuracy of each individual’s ability to switch tasks. Poljac et al. (2010) found that children with dyslexia showed significantly more difficulty with repeating tasks and switching tasks than did children with ASD or the controls. The researchers posited that children with dyslexia most likely struggle implementing rules, such as knowing what is currently required and what task is irrelevant now. Additionally, the researchers reasoned that this difficulty could be due to deficits with working memory.

Poljac et al.’s (2010) results suggest that if it is true that children with dyslexia struggle because they are unable to differentiate which tasks are relevant to the task before them, there is room for further research to investigate how these children would react if the instructions they were given were even more specific and explicit than they were in the (2010) study.
Additionally, Poljac et al., (2010) found that the children with ASD showed similar task-switching abilities when compared to the controls. This can perhaps be explained by information mentioned above, that children with ASD mostly struggle when it comes to coming up with novel ideas or acting spontaneously (Poljac et al., 2010). In this (Poljac et al., 2010) study, the individuals with ASD were given explicit instructions regarding what was expected of them. Since individuals with ASD do not typically struggle (more than individuals who are typically developing) when the tasks they are expected to do are specified, they therefore showed results that were comparable to their typically developing peers. Poljac et al. (2010) point out that “clearly defined situations are the most optimal for children with autism” (Poljac et al., 2010, p. 412). This suggests that since individuals with ASD are successful when they are given explicit directions, there is room for further research to investigate if this method would relate to other cognitive functions, such as decoding and comprehension.

**Direct Instruction**

Flores & Ganz (2009) point out that it is extremely common for individuals with ASD to experience reading difficulties. Individuals with ASD often struggle to determine the correct homograph based on context clues and have a hard time connecting previous information they have read to a current text. Flores & Ganz (2009) explain that Direct Instruction has been used to improve reading comprehension in both general-and special-education classrooms.

The question they proposed for their study was whether or not direct instruction would improve reading comprehension skills in children with ASD.
Flores & Ganz (2009) used a Direct Instruction program, *Corrective Reading Thinking Basics: Comprehension level A* (Engelmann, Haddox, Hanner, & Osborn, 2002) in order to assess its effectiveness when taught to children with ASD. The participants in the study were four middle school-aged children, two of whom had ASD. One of the children with ASD had a score that was below average on the word and letter identification section, while the other child had a score that was within normal range. Both of the children had significantly below average performances on the passage comprehension section. They chose three areas to focus on: (1) picture analogies, (2) deduction, and (3) induction. As the children were able to comprehend information from each area, instructors lessened review of that area and introduced the next one. Flores & Ganz (2009) found that Direct Instruction greatly improved reading comprehension in the children with ASD. After Direct Instruction, the children’s scores grew from 0% correct to anywhere between 50-100% correct. The researchers also assessed the children six weeks after they had their last Direct Instruction. The children’s scores dropped, but were still higher than their baseline. They also found that the children followed the directions and did not get distracted from the task at hand. The study by Flores & Ganz (2009) demonstrates that Direct Instruction improves reading comprehension in children with ASD; however, as mentioned above, the comprehension scores of the children with ASD dropped six weeks after the children received Direct Instruction. This leaves room for further research to explore if this would be the case if the children were assessed as having typical levels of working memory, or if the scores would drop if they were taught one aspect of comprehension at a time instead of multiple ones, as had
been done in the study by Flores & Ganz (2009). Participants in the Flores & Ganz (2009) study only included two children who have ASD. Perhaps another study could assess the impact Direct Instruction on more children to see if these initial results would be applicable to a larger population of children with ASD.

**Explicit Instruction and ASD**

Braun, Austin & Ledbetter-Cho (2017) evaluated the effectiveness of explicit instruction for teaching reading comprehension skills to children with ASD. They explain that explicit teaching consists of lessons that have specific goals, with the aim that the child will be able to master separate but sequentially related learning objectives. General learning goals are broken down into specific objectives, with the expectation that since they are broken down, the students will be able to master without confusion. Another key aspect of explicit instruction is that teachers give students feedback after each step that they are working on to ensure that the teaching was effective (Braun et al., 2017).

Braun et al. (2017) recognized the research done by Flores & Ganz (2007; 2009) who had found that after explicit instruction, children with ASD showed improvements in their reading comprehension abilities. Braun et al. (2017), however, pointed out that while explicit instruction had been shown to be effective, further research is required because current research is limited by small sample sizes. They suggest that further research be done which includes larger sample sizes to ensure the validity of explicit instruction. Additionally, Braun et al. (2017) point out that further research should focus on whether or not recipients of explicit instruction maintain the progress that they have made long-term.
Braun et al. (2017) restate that explicit instruction is especially beneficial when working on teaching reading comprehension skills to children with ASD, as these children often struggle to comprehend due to deficits in executive functioning and difficulties bringing concepts together (Braun et al., 2017).

_Sensory Integration in ASD_

Many children with ASD present with varying sensitivities of sensory integration disorder, or SID. One approach posits that an individual’s sensory systems do not develop independently, but depend on pre-existing body senses and systems (Walting & Dietz, 2007). Therefore, when there are disruptions within these systems, sensory information is interfered with and individuals struggle to produce organized responses (Smith Roley, Mailloux, & Miller-Kuhaneck, 2007). This is the definition of sensory-integration difficulties and disorders.

This definition leads therapists to work with individuals with ASD presenting with symptoms of SID to engage in sensory experiences in meaningful contexts. This method supports an individual’s ability to properly execute daily functions that require sensory-integration (Smith Roley et al., 2007), as well as skills such as learning, reading, and math (Walting & Dietz, 2007).

Ayres & Tickle (1980) point out that children with ASD show a range of symptoms of disturbance in sensory processing, including includes atypical responses to auditory, visual, olfactory and tactile stimuli (Leekam, Nieto, Libby, Wing & Gould., 2017). Ayres & Tickle (1980) found sensory-integration therapeutic interventions to be beneficial for individuals with ASD, specifically This therapy was beneficial in decreasing “non-
engaging” behaviors, such as wandering and other unfocused actions, as well as increasing “engaging”, goal-directed behaviors (Avery & Tickle, 1980; Linderman & Stewart, 1999).

Inasmuch as it has been demonstrated that sensory-integration therapeutic interventions are beneficial for individuals with ASD, further research is compelled to explore whether a sensory-integrative approach could benefit children with ASD in learning skills such as decoding and reading comprehension.

*Direct Instruction and Dyslexia*

PAF, is an early grades intervention program designed to help children in kindergarten through third grade develop competent reading, spelling and handwriting. PAF has been demonstrated to be successful in more than 40 years of implementation in both public and private schools (Shapiro, 1988). The goal of PAF is to address reading failure in students who struggle or have diagnosed reading disabilities, including dyslexia. PAF utilizes multisensory instruction, including visual, auditory and kinesthetic strategies (including handwriting) in order to strengthen associations between sounds and letters and memory. The PAF curriculum applies direct instruction methods in order to ensure that the learners fully understand the skills that teachers are targeting.

The PAF curriculum starts with limited targets and builds on itself as the students grasp concepts. Teachers begin by instructing students regarding the simplest units of written language and phonological awareness, and only once children have mastered the simplest units do instructors move on to multisyllabic words (Shapiro, 1988). After multisyllabic word skills are mastered, teachers will move on to reading paragraphs with their students.
In order to ensure that students do not need outside knowledge in order to understand the paragraph, the text only consists of material and words that have been previously taught in PAF. The PAF also has methods and products that facilitate children to apply reading comprehension strategies.

PAF differs from other methods of teaching reading in that it is entirely explicit. PAF consists of explicit phonics lessons; children read aloud to their teachers, repetitions of readings and the texts children read consist only of previously taught material. PAF integrates spelling, reading and writing that children have been taught explicitly into one lesson. Sample lessons include review, introduction of new material, spelling dictation, reading and reinforcement (Shapiro, 1988).

PAF has been demonstrated to be an effective method when teaching students with dyslexia, as it teaches them the aspects of reading in an explicit and unambiguous way, and because teachers only move on to the more complex aspects of reading when the children have fully grasped what they have been previously taught (Shapiro, 1988).

As discussed above, working memory plays a key role in an individual’s ability to effectively decode and comprehend (Hudson et al., 2018; Wang et al., 2017). Working memory allows an individual to concurrently keep and use old information while they are being given new information. Since individuals with ASD and with dyslexia have deficits in working memory, they struggle to manipulate the information that they have previously learned and what they are currently learning. It is, therefore, most effective for these individuals to be taught in an unambiguous manner, which is done in explicit teaching (Braun et al., 2017).
Study Proposal

Scientific Background Recap

As the above literature demonstrates, children with ASD and children with dyslexia struggle with decoding and comprehension in similar ways. Both populations present with difficulties with executive function, specifically working memory (Wang et al., 2017; Hudson et al., 2018). Direct instruction and explicit teaching are methods in which children are taught to read in unambiguous ways. These teaching methods have been shown to be effective for both students with ASD and with dyslexia (Braun et al., 2017; Shapiro, 1988); however results for the children with ASD studied by Flores & Ganz (2009) regressed after six weeks.

The “Preventing Academic Failure” (PAF) is a method of explicit teaching that supports working memory and benefits individuals with dyslexia.

The PAF differs from the other direct instruction methods used to teach individuals with ASD in that it employs a multisensory approach. As discussed, children with ASD struggle with sensory integration (Ayres & Tickle, 1980). The difficulties that individuals with ASD face when integrating auditory and visual information could in fact be inhibiting their abilities to decode and comprehend effectively. Since the PAF employs a multi-sensory approach when teaching its learners how to read, this proposed study would investigate whether or not the PAF can be especially beneficial when teaching individuals with ASD.
Participants

The proposed study would consist of three groups of 10 girls and 10 boys in each. Two groups would have children with ASD, with mild-moderate sensory integration disorder (SID), and one group would have children with dyslexia. All participants would be the in first grade, a grade by which reading failure is often identified. The study would take place in a school consisting of children with dyslexia and ASD. Teachers instructing the children would have received the same training and support in being instructors of the PAF, and children would be taught in small groups, per PAF recommendations.

Method

All of the children would first be tested using the Funnix Reading placement tests, which can be used for children in grades K-6, in both decoding and comprehension. Their scores would be used as a baseline from which their results after using the PAF could be evaluated.

One group of children with ASD and the group of children with dyslexia would be taught using the PAF. The children would be instructed for one hour daily using the PAF for three months. At the end three months of implanting the PAF, children in both groups would be assessed, using the Funnix Reading placement tests, to see if they have made improvements in decoding and/or comprehension. After this initial evaluation, children would be assessed every three months (quarterly) for the remainder of the school year to see if they have been making improvements in decoding and comprehending. Additionally, children will
be tested after the summer following the first year of being taught using PAF in order to see if they have sustained any improvements that had been made after being taught with the PAF.

The third group, the group of children with ASD who were being taught using more typical direct instruction methods (such as those used by Flores & Ganz, 2009), would be taught and evaluated in the same way as the other two groups in the study. They would be similarly evaluated.

Results

Reading results of the two groups of children with ASD would be compared to see if the PAF is more effective, as effective, or less effective as the typical direct instruction methods used when teaching children with ASD in grade one. Would improved reading outcomes for children with ASD using the PAF last longer than those gained using traditional direct instruction methods? Flores & Ganz (2009) noted that those improvements diminished after six weeks. How would the group of children with ASD who were taught with the PAF compare to the group of children with dyslexia? Is PAF as beneficial for children with ASD in grade one with mild-moderate SID as it is for children with dyslexia in grade one? A statistical analysis would be applied and statistical significance assessed.

Possible Implications

Since children with ASD show a wide range of sensory-integration issues (Ayres & Tickle, 1980), it is possible that the PAF might help some children with ASD and SID
with reading development as well as improve their sensory-integration, while the multi-sensory nature of the program may overwhelm others. The children in this proposed study with ASD had mild-moderate SID; further research would be necessary in order to confirm whether or not the PAF benefits children with ASD and moderate-severe SID, both for reading and for sensory-integration and goal-directed behavior in general.

**Conclusion**

Reading is critically important for an individual to succeed throughout their lifetime (Hudson et al., 2018). Programs such as PAF and other direct instruction methods have been demonstrated to be beneficial to individuals with both ASD and with dyslexia become effective readers (Braun et al., 2017; Shapiro, 1988). If there are children with ASD who would benefit from a multi-sensory system such as PAF, it is crucial for research to establish the evidence of this benefit and for clinicians to utilize it.
Works Cited


