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Investigating the Effect of Graphic Advance Organizers on the Reading Comprehension on Secondary-Age Students with Autism Spectrum Disorder

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Investigating the Effect of Graphic Advance Organizers on the Reading Comprehension of Secondary-Age Students with Autism Spectrum Disorder

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Reading comprehension interventions that target students with autism spectrum disorder (ASD) have traditionally included explicit instruction in the delivery of the intervention in order to compensate for the well-documented executive function difficulties experienced by many individuals within this population. A handful of single-case studies (*n*=9) within this literature have used supplementary graphic organizers (GOs), as one component of a larger treatment package, to successfully help students with ASD comprehend text more readily. The independent effect of a GO on the reading comprehension of individuals with ASD therefore remains untested. In this dissertation study, which employed single-case research methodology, five secondary students with ASD completed a reading comprehension intervention that featured graphic advance organizers (GAOs) with limited pre-training or instructional support provided by the implementer. Results indicated that some participants may be able to effectively use GAOs independently to increase their comprehension of expository texts. Findings, limitations, and implications are presented.

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CHAPTER 1: INTRODUCTION

As reading for understanding is an essential skill for most kinds of learning (Klingner, Vaughn, & Boardman, 2015; Solis et al., 2011) and for functioning independently in adult society (Chiang & Lin, 2007; Levy & Perry, 2011), deficits in reading comprehension in individuals with autism spectrum disorder (ASD) are an issue of particular note and concern for both researchers and teachers who work with this population. Many readers with ASD struggle to integrate and synthesize information from disparate sources within a higher-level text in order to abstract its main concepts, thus limiting their ability to "read for understanding" (Happe & Frith, 2006; O'Connor & Klein, 2004). The reading ability of many individuals with ASD might be best summarized by the statement: "It is possible to understand the meaning of a word or a sentence and still not understand the message the entire text conveys" (Randi, Newman, & Grigorenko, 2010, p. 893).

Graphic organizers (GOs) would appear to be a useful supplemental visual aid to help individuals with ASD develop stronger reading comprehension as well as increase their ability to understand the gist of ideas presented in expository reading texts (Carnahan & Williamson, 2013; Gately, 2008). Using a computationally efficient "visual argument", GOs help readers abstract the main ideas of a text by using relative spatial location to coordinate relationships between key concepts, which then serves as a pre-existing knowledge structure to assimilate new information from a text (Robinson, Corliss, Bush, Bera, & Tomberlin, 2003; Simmons, Griffin, & Kameenui, 1988). Believed to cater to the visually-mediated cognitive style used by many individuals with ASD (Kana, Keller, Cherkassky, Minshew, & Just; Samson et al., 2012; Stringfield, Luscre, & Gast, 2011), these supplementary visual aids are a recommended visual support for children with ASD in special education classrooms (Chiang & Lin, 2007; Gately, 2008).

A number of studies have found that GOs help individuals with learning disabilities and reading difficulties understand key concepts within a text (Dexter & Hughes, 2011; Kim, Vaughn, Wanzek, & Wei, 2004). A handful of studies have investigated the utility of GOs in helping individuals with ASD improve their reading comprehension (n=9). However, two factors explain why the effect of GOs on the reading comprehension of individuals with ASD remains obscure. First, each of these studies has delivered GOs to participants in an intervention that features explicit instruction or aspects of explicit instruction, rendering the independent effect of the GOs themselves impossible to determine. Second, each of these studies has delivered GOs to participants as one component of a larger treatment package, (delivered either mid-stream or at the conclusion of a reading session), also rendering the effect of the GOs impossible to isolate.

Therefore, in order to determine whether GOs themselves have an intrinsic utility for promoting reading comprehension in individuals with ASD, studies are needed to investigate the effect of GOs without the potential facilitative effect of additional instructional components. A 2004 research synthesis on GOs and their effects on the reading comprehension of students with learning disabilities (LDs; Kim et al.) similarly called for research to "clarify whether students' use of graphic organizers independently is an effective strategy to enhance their reading comprehension" (p. 116).

As argued above, the only way to determine the effect of an instructional tool, such as a GO, would be to investigate the effect of its use independent of other concomitantly administered reading aids on individuals within the targeted group. A second more practical reason therefore exists for determining the independent effect of GOs on the reading comprehension of students with ASD. Students with ASD typically require considerable resources from teachers, support staff, and the school itself (Fleury et al., 2014; Kucharczyk et al., 2015). If a GO could be used by students with ASD independently – or semi-independently – with limited instructional support, it would be a tremendous boon to both classroom teachers who teach content-area subjects to individuals within this population as well as to the individuals themselves. This may especially be the case as students with milder variants of ASD are increasingly placed into inclusive, mainstream classrooms that have limited resources and do not provide the additional instructional support found in special education classrooms (Ashburner, Ziviani, & Rodger, 2010; Symes, & Humphrey, 2011).

Motivated by both these experimental and practical rationales, this dissertation research study sought to investigate, using expository texts, the independent effect of GOs on the reading comprehension of students with ASD. A suggestion for "future research" provided by O'Connor and Klein (2004) in their own study exploring strategies for facilitating the reading comprehension of students with ASD provided a compelling argument for how GOs might be presented in such a study:

> …instructors could provide students with an advance organizer in the form of an abstract of the passage, which might activate prior knowledge while preventing students from "getting on the wrong track"…This indicates that graphic advance organizers should be investigated as a means of activating relevant prior knowledge before reading (p. 125).

As a result, a “graphic advance organizer” (GAO) was chosen to investigate the independent effect of using a GO, without the benefit of prompting or explicit instruction, on the reading comprehension of students with ASD. Researcher-developed “Wh-” GOs, which represented three to four pieces of key “who”, “what”, “what do” “where”, and “when” information from within a presented text, were used as the main organizing feature of presented GOs that were intended to provide a brief abstract of the text. Wh-comprehension questions have previously served in reading comprehension interventions for students with ASD as the organizing feature of GOs used for recording participant responses (i.e., Bethune & Wood, 2013; Reutebuch, El Zein, Kim, Weinberg, & Vaughn, 2015; Solis, El Zein, Vaughn, McCulley, & Falcomata, 2016). Presented GOs in the present study did *not* seek to provide *additional* background knowledge from outside the text that had the potential to obfuscate textual mental representations for readers with ASD (Wahlberg & Magliano, 2004). Rather, by providing an *abstract* across Wh-categories, each GO sought to strengthen global *intra*-textual inferences within presented passages that would promote text cohesion and bridge potential comprehension gaps.

The format of the GOs used in the present study followed recommendations provided by Dexter and Hughes (2011) in their review of GO research for students with LD: Each GO included a superordinate concept, several coordinate concepts, and brief descriptions of each coordinate concept. (A more thorough description is provided in Chapter 3.) In the present study, the GO was presented solely before the introduction of the text in order to eliminate the possible confounding effects of temporal placement (i.e., use of the GO during or after text presentation) on any observed gains in reading comprehension.

An alternating treatment single-case design with an initial baseline phase was chosen for its quick utility: It allows a comparison between treatments to be made more quickly than with a traditional A-B design, further allowing experimental control to be potentially established more quickly within a study (Gast & Ledford, 2009; Zhan & Ottenbacher, 2001.) As a comparison condition to the GAO treatment, Wh- questions were verbally posed to participants early on during the reading of a presented text and briefly discussed with the implementer, who was the author of this present dissertation, in order to help participants contextualize the information within the given passage. Wh- questions were chosen to serve as the sole feature of the comparison condition in order to create a comparison condition that could be administered in roughly the same amount of time as the GAO condition. As noted above, Wh- questions have previously been used as a portion of a treatment condition. Posing Wh- questions to students during the reading of a text is furthermore one recommended strategy for improving students' reading comprehension (National Reading Panel, 2000). A "conceptual cloze procedure" (El Zein, 2014), where key words of the reading were deleted for the participant to fill-in after the completion of each reading, was likewise used for its quick utility as a dependent measure of reading comprehension performance.

Expository texts from the Read Naturally series (Ihnot, Mastoff, Gavin, & Hendrickson, 2001) were used as reading materials. Texts that were non-social in nature were chosen in order to eliminate the possible confounding effect of participants' difficulty understanding the mental states of characters, which is a well-documented deficit in individuals with ASD (Baron-Cohen, 1989; Happe, 1994). The students who were chosen to participate in this study were middle-school and high-school students diagnosed with an ASD condition who had capable reading fluency skills. Middle-school and high school students were chosen for inclusion in this study over their younger counterparts for two reasons. Students with ASD in middle-school and high-school are expected to consume considerably more content-area material than children in lower grades (Gajria, Jitendra, Sood, & Sacks, 2007; Solis et al., 2012) and are therefore in greater need of instructional support that could potentially improve their reading comprehension. Second, older students are more capable of functioning independently than their younger counterparts, and therefore are more likely to be capable of using a GO independently.

The following questions were addressed:

1. To what degree (if any) do (a) graphic advance organizers with "Wh-" question information (GAO) and (b) a comparison condition of instructional prompting of "Wh-" questions (PR), promote reading comprehension?
2. If either treatment promotes reading comprehension, does (a) graphic organizers with "Wh-" question information (GAO) *or* (b) a comparison condition of instructional prompting of "Wh-" questions (PR), promote reading comprehension more effectively?

CHAPTER 2: REVIEW OF THE LITERATURE

Autism Spectrum Disorder (ASD)

ASD is a pervasive developmental disorder characterized by persistent deficits in social communication, social interaction, and the exhibition of restrictive, repetitive patterns of behavior (American Psychiatric Association, 2013). Deficits in developing appropriate inferences, understanding complex semantics, and comprehending the mental states of others are also well-documented (Baron-Cohen, 1989; Happe, 2006; Loukusa & Moilenan, 2009.) The syndrome includes individuals exhibiting a wide spectrum of cognitive profiles (Charman et al., 2011; Guerts, de Vries & van den Bergh, 2014; Rane et al., 2015) ranging from non-verbal individuals (IQ <70) with high-support needs who frequently require lifetime assistive-support to highly verbal "high-functioning" individuals with average or above-average IQs who in a minority of cases are able to lead largely independent lives in adulthood (Gray et al., 2014; Levy & Perry, 2011).

While the neurobiological basis of ASD is well-established (Philip et al., 2012; Rane et al., 2015; Valk, Di Martino, Milham, & Bernhardt, 2015), a number of genetic risk factors for developing the syndrome have been identified, but remain poorly understood (Krishnan et al., 2016; Minshew & Williams, 2007). In an effort to encapsulate these findings, a number of cognitive and neuro-cognitive theories of ASD have been proposed, but thus far have only successfully described particular characteristics or symptoms of the syndrome, rather than describing – or better yet explaining – the syndrome as a whole (Burnette et al., 2005; Charman et al., 2011; Pellicano, 2010b). Four of these theories, described later in this chapter, variously posit a deficit in forming mental representations (Happe, 1989; Happe & Frith, 2006), executive functioning (Ozonoff, Rogers, & Pennington, 1991), mental state attribution (Baron-Cohen, 1989), and brain connectivity (Just, Cherkassky, Keller, & Minshew, 2004; Just, Keller, Malave, Kana, & Varma, 2012) as main contributors to the symptomology associated with ASD. Overall, although great progress has been made in understanding ASD over the last 15-20 years, particularly through the use of functional magnetic resonance imaging technology (Just et al., 2012; Philip et al., 2012) and gene sequencing technology (Krishnan et al., 2016; O'Roak et al., 2012), a comprehensive theory explaining the overall etiology of ASD (Rane et al., 2015) and the genetic, developmental, and neural etiologies that likely contribute to this complex, mutifaceted, and heterogeneous syndrome (Bailey & Parr, 2003; Dawson et al., 2002), remain somewhat elusive.

The Brain in ASD

What the field of research in ASD lacks in a unifying theory of the syndrome, it partially makes up with an impressive body of descriptive neuroscientific data. Over the last two decades research has identified numerous differences in anatomy, functional activity, and connectivity (i.e., synchronization of activity) between the average neurotypical (NT) brain and brain of an individual with ASD as described briefly below:

- Anatomy: Differences between the average ASD and NT brain have been found in *anatomical micro-architecture* (i.e., neurons and small collections of cortical neurons known as mini-columns) using "diffusor tensor imaging (DTI)" (e.g., Alexander et al., 2007; Barnea-Goraly et al., 2004; Shukla, Keehn, & Müller, 2011) and "post-mortem studies" (e.g., Bailey et al., 1998; Kemper & Bauman, 2002; Palmen, van Engeland, Hof, & Schmitz, 2004); and in *anatomical macro-architecture* (i.e., regions of neurons) using “magnetic resonance imaging (MRI)” (e.g., Hardan et al., 2006; Minshew & Williams, 2007; Müller et al., 2011).

- Functional activity: Differences between the average ASD and NT brain have been found in *functional activity* (i.e., activity in localized regions) using “positron emission topography (PET)” (e.g., Happe et al., 1997; Pagani et al., 2012; Zilbovicius et al., 2000) and “functional magnetic resonance imaging (fMRI)” (e.g., Gomot et al., 2006; Hadjikhani et al., 2017; Koshino et al., 2005)
- Functional connectivity: Differences between the average ASD and NT brain have been found in *functional connectivity* (i.e., synchronization of neural activity within and between regions) using “electroencephalography (EEG)” (e.g., Coben, Clarke, Hudspeth, & Barry, 2008; Murias, Webb, Greenson, & Dawson, 2007; Peters et al., 2013), “magnetoencephalography (MEG)” (e.g., Cardy, Flagg, Roberts, Brian, & Roberts, 2005; Kikuchi, Yoshimura, Mutou, & Minabe, 2016; Lewine et al., 1999), and “fMRI” (e.g., Chanel et al., 2016; Kana et al., 2015; Williams et al., 2013).

Although reviews and meta-analyses of brain imaging studies in ASD (i.e., Philip et al., 2012; Rane et al., 2016; Valk, Di Martino, Milham, & Bernhardt, 2015) report that the great majority of studies in the published literature reveal differences in anatomy, functional activity, and functional connectivity between the average ASD and NT brain, some studies within this literature were limited by their focus on narrow regions of interest (ROIs), as well as their use of primarily males with high-functioning ASD as experimental group participants (Philip et al., 2012). Despite these limitations, one general theme emerges in this literature: On average, through multiple sources of analysis, the anatomy and functioning of the brain in an individual with ASD is different from that of an NT individual.

The overall story of brain development in ASD from infancy to adulthood is a fascinating one that largely informs our current understanding of the syndrome as one of local anatomical and functional over-connectivity within specific cortical regions contrasting with long-range under-connectivity between distal cortical regions, as gauged by anatomical and functional analyses (Philip et al., 2012). Early brain development in ASD is typically characterized by brain overgrowth in many cortical regions, (particularly the frontal cortex, but usually excluding the occipital cortex), producing on average larger brain volume compared to NT peers (Dickstein et al., 2013; Minshew & Williams, 2007), possibly due to accelerated genesis of neurons, dendrites, and synapses, (i.e., gray matter), along with their connecting myelinated axons (i.e., white matter; Courchesne et al., 2007; Courchesne, Campbell, & Solso, 2011). White matter in children with ASD, which is largely responsible for promoting effective inter-cortical communication, has also been shown to have weakened structural integrity (Courchesne et al., 2007; Wolff et al., 2012). Subsequently, this early brain overgrowth is typically followed by premature arrest of brain development as an individual progresses toward adulthood (Courchesne, Campbell, & Solso, 2011; Redcay & Courchesne, 2005), possibly the result of over-pruning of gray and white matter in order to compensate for accelerated early overgrowth (Courchesne et al, 2007, 2011). Abnormalities associated with neural glial cells may also play a role during development in the construction of these atypical neural networks (Just et al., 2012). The result of this altered neurodevelopmental trajectory – one that is not yet well-understood (Courchesne et al.

2007, 2011) – is an adult with ASD whose brain, on average, has similar gross anatomy (i.e., brain volume and weight) to an NT adult, but with a different anatomical and functional architecture (Philip et al., 2012; Rane et al., 2016; Valk et al., 2015).

Beyond research documenting the altered distributed brain network in ASD, additional research focusing on narrower topics has found differential activity between the average NT and ASD brain in a host of regions during compromised performance on a variety of social, cognitive, and linguistic tasks. As reported in Philip et al.'s meta-analysis (2012), these results include reduced or sometimes absent activity in cortical and sub-cortical (i.e., amygdala, thalamus, and hippocampus) regions of the brain implicated in emotional processing, language comprehension, facial recognition, social cognition, motor coordination, sensory integration, and a number of sub-skills captured under the umbrella of "executive functioning". Other regions, such as the occipital cortex, appear to be hyper-functional, ostensibly contributing to the remarkable visual memory found in some individuals within this population.

Theories of Cognition in ASD

Weak Central Coherence Theory. One theory of ASD, termed Weak Central Coherence Theory (WCC), posits that individuals with ASD do not display the NT bias for processing information globally and holistically. In contrast, WCC theory contends, individuals with ASD display a bias for processing cognitive, perceptual, auditory, and linguistic information in a piecemeal fashion at the expense of establishing higher-level meaning (Frith, 1989; Happe & Frith, 2006). In simpler terms, "weak central coherence" can be defined as "not seeing the trees for the forest" (Happe & Booth, 2008) or "failing to see the bigger picture" (Happe & Frith, 2006). Poor mean performance of individuals with ASD on central coherence tasks compared to individuals with attention-deficit hyperactivity disorder (Booth, Charlton, Hughes, & Happe, 2003; Booth & Happe, 2010) and intellectual disability (Snowling & Frith, 1986) suggests that this processing bias is specific to the ASD cognitive phenotype rather than a byproduct of weak executive functioning or compromised intellectual ability.

The specific cause(s) of weak central coherence in ASD is not well-understood, but this processing bias is thought by some to exist somewhat independently of – while also possibly contributing to – the theory of mind and social functioning deficits that are hallmarks of the syndrome (Jarrold, Butler, Cottington, & Jiminez, 2000; Pellicano, 2010b). WCC has been found in children and adults across the spectrum of ASD – regardless of performance on IQ tests or social cognition tasks – although existing along a continuum between individuals within this population (Happe, 1997; Happe & Frith, 2006; Joliffe & Baron-Cohen, 1999). Rather than a deficit, per se, some have interpreted WCC as a "cognitive style" (e.g., Happe, 1999) that prioritizes local over global processing, leading in some cases to remarkable capability in certain visuospatial and memory tasks (Jolliffe & Baron-Cohen, 1999; Shah & Frith, 1993).

This compromised ability to integrate pieces of information into coherent wholes has been reported most consistently in ASD on tasks that rely heavily on the processing of local visual features (i.e., embedded figure task, block design task), where individuals with ASD have been shown to repeatedly *outperform* NT individuals by significant margins (Cohen's $d > 1.3$; Pellicano, 2010b), and in tasks that rely heavily on the processing of holistic semantic features (e.g., listening comprehension and reading comprehension tasks), where performance of participants with ASD is often highly compromised and characterized by an overly literal, conceptually weak interpretation of content developed utilizing poorly drawn or incorrect inferences (Happe & Frith, 2006; Jolliffe & Baron Cohen, 1999; Loukusa & Moilenan, 2009). In contrast, some studies investigating visual global precedence (e.g., Mottron, Burack, Stauder, & Robaey, 1999) and visual illusions (e.g., Ropar & Mitchell, 1999) have found that individuals within this population perform similarly to NT individuals, suggesting WCC may be domain-specific rather than an "all-encompassing information processing bias" (Martin & MacDonald, 2004, p. 314). Although thematically similar to the neural systems-level theory of ASD known as Underconnectivity Theory, which posits ASD is mainly the product of poorly coordinated neural circuitry, a plausible neural model of WCC does not currently exist (Just et al., 2004, 2012).

Executive Function Theory. Executive Function theory (EF; Ozonoff, Rogers & Pennington, 1991) proposes that certain deficits in executive control account for the symptoms observed in ASD. Although present almost universally in ASD, levels of executive dysfunction vary considerably between affected individuals (Geurts, de Vries, & van den Bergh, 2014; Johnston, Madden, Bramham, & Russell, 2011; Pellicano, 2010b). A 2014 review of executive functioning theory in ASD found that deficits in the areas of working memory, inhibition, cognitive flexibility, and planning in both children and adults have been most consistently reported in the experimental literature (Geurts et al). EF deficits have been found to affect performance on a variety of everyday tasks, including linguistic functioning and reading comprehension (Locascio, Mahone, Eason, & Cutting, 2010; Sesma, Mahone, Levine, Eason, & Cutting, 2009). Despite well-documented EF deficits found in ASD, executive dysfunction has been disputed as a defining feature or cause of ASD since executive functioning deficits are present in several other syndromes (Pennington & Ozonoff, 1996; Sergeant, Geurts, & Oosterlaan, 2002).

Unlike WCC theory, EF theory has progressively gained support in the neuroscience literature. Reduced synchronization between frontal and posterior regions of the cortex has been observed in ASD on a variety of tasks measuring executive functioning sub-skills (e.g., Agam, Huang, & Sekuler, 2010; Kleinhans, Müller, Cohen, & Courchesne, 2007; Koshino et al., 2005), including three studies involving reading comprehension tasks (i.e., Just et al., 2004; Kana et al., 2006; Mason, Williams, Kana, Minshew, & Just, 2008). Overall findings have illustrated, on average, weaker inter-regional brain coordination in individuals with ASD during EF tasks – sometimes additionally accompanied by weaker or slower task performance – compared to NT individuals.

In addition to these general findings of reduced frontal-posterior connectivity, both under- and over-activation specifically of pre-frontal circuitry, which is responsible for sub-serving many EF functions, has been found in ASD during EF task performance (e.g., Gilbert, Bird, Brindley, Frith, & Burgess, 2008; Schmitz et al., 2006; Shafritz, Dichter, Baranek, & Belger, 2008). While findings of pre-frontal *under-activation* during EF tasks might be partially explained by the compensatory recruitment of nearby additional cortical regions (Guerts et al., 2014), and findings of pre-frontal *over-activation* during EF tasks might be partially explained by an isolated, hyper-connected pre-frontal region "talking to itself" (Courchesne & Pierce, 2005), the specific reasons for these contrasting findings are currently not entirely clear.

Theory of Mind Hypothesis. In contrast to WCC and EF theories, which posit domain-general deficits in ASD, the Theory of Mind (ToM) hypothesis (Baron-Cohen, 1989) posits a specific deficit in the domain of social cognition, i.e., the compromised ability to represent and understand the mental states of other people. Further distinguishing ToM from these other two theories, ToM deficits found in ASD can be clearly tied to one of the three major criteria of the ASD diagnostic triad: the social and communication deficits that serve as a hallmark of the syndrome (Tanguay, Robertson, & Derrick, 1998). A 2014 review of ToM abilities in ASD (Kimbi) found that across age ranges, verbal abilities, and IQs, the majority of studies demonstrated that individuals with ASD exhibited some level of ToM impairment. While many high-functioning adults with ASD were found to have passed *explicit* tests of ToM that children with ASD frequently failed, they often struggled with *implicit* tests of ToM that their NT peers were able to capably perform. Weak ToM is additionally thought to contribute to poor comprehension of narrative text, which requires the reader to represent the mental states of characters (El Zein et al., 2014; Mason et al., 2008).

Complementing the neuroscience research on executive functioning in ASD, yet other neuroscience research addresses ToM in ASD. According to a 2012 meta-analysis of brain imaging results in ASD (i.e., Philip et al.), deficits in social cognition, including ToM, are one of the most replicated findings in the ASD neuroscience literature. Compromised performance on tasks involving facial recognition, understanding false beliefs, and representing the mental states of others were typically accompanied by hypo-activation of cortical regions that are known to sub-serve the performance of these tasks in NT peers. A 2012 review of connectivity findings in ASD (i.e., Just et al.) reported that poor functional connectivity between these regions was additionally thought to play a role in the relatively poor mental state attribution found in individuals within this population. Some evidence additionally suggests individuals with ASD do not typically activate the same cortical mid-line structures as NT individuals during ToM tasks that involve self-referential processing (Moran, Qureshi, Lee, Weinberg, & Gabrieli, 2007).

Cognitive research investigating the relationship between WCC, EF, and ToM theories in ASD has typically focused on WCC-ToM and EF-ToM relationships. It has been hampered, however, by a paucity of longitudinal studies capable of elucidating dynamic relationships between these domains that could potentially emerge over the course of development (Pellicano, 2010b; Pellicano, Maybery, Durkin, & Maley, 2006). In the one longitudinal study investigating these relationships by Pellicano (2010b), results from a battery of tests frequently employed to respectively evaluate central coherence, executive function, or theory of mind found that both central coherence and executive function performance independently predicted theory of mind performance in children with ASD three year later. These results suggested that central coherence and executive functioning in individuals with ASD independently serve as important precursors to a well-developed understanding of other people's beliefs, intentions, and motivations.

As WCC and EF theories have been criticized for applying their respective constructs of deficit too broadly, ToM has been criticized for applying its own construct too narrowly (Pellicano, 2010b; Tager-Flusberg, 2007). Questions furthermore remain over whether ToM performance in ASD is largely mediated by linguistic ability instead of characteristics unique to ASD (Abbeduto, Short-Meyerson, Benson, & Dolish, 2004;

Happe, 1997), as well as to whether reduced interest in social stimuli or diminished social exposure in children with ASD play an important role in the development of weak ToM (Chevallier, Kohls, Troiani, Brodkin, & Schultz, 2012; Philip et al., 2012).

Underconnectivity Theory. Developed from findings reporting altered anatomical and functional connectivity in the brain in ASD (e.g., Just et al., 2004; Kana et al., 2006; Mason et al., 2008), Underconnectivity Theory (UT; Just et al., 2004, 2012) is a cognitive/neural theory and computational model positing that ASD is mainly the product of a disruption in the functioning of inter-regional connective circuitry, particularly between frontal and posterior cortical regions. However, the ability to perform lower-level processing tasks – ones that are not mediated by a coordinated network of cortical areas – remain intact or enhanced in ASD (Just et al., 2004, 2012).

Findings on connectivity in ASD generally support UT. Philip et al.'s (2012) meta-analysis found that weak synchronization – and therefore data transfer – was found in individuals with ASD in 18 of the 20 control groups studies that were surveyed. Poor connectivity was not reported to be task specific. Instead, it was a common theme appearing in a variety of tasks interrogating executive functioning, language comprehension, reading comprehension, and emotional processing, whose successful performance relies on the coordination of distributed cortical regions.

UT aims to explain and fully encompass the theoretical frameworks and findings proposed by WCC, EF, ToM, along with several other cognitive and neural theories of ASD etiology (Just et al., 2012). At least one published paper (i.e., Markram & Markram, 2010), however, has questioned whether this domain-general theory fully captures the full breadth of findings on ASD. Furthermore, a 2014 review of studies in

ASD that investigated the volume and integrity of white matter (i.e., Hoppenbrouwers, Vandermosten, & Boets), which is largely responsible for ensuring coordinated functioning of cortical regions, noted that few studies had investigated short-range anatomical connectivity in regions of the brain, thereby providing an incomplete picture of connectivity findings in ASD.

Influence of ASD Cognitive Theories and Findings on Present Study. The four above-described theories of cognition provided a theoretical rationale for pursuing, as described herein, a cognition-based approach to reading comprehension intervention research in ASD. Although none of these theories provides, on its own, a definitive account of the origins of ASD and its multiple manifestations, each theory with the exception of WCC is supported by a robust literature of converging findings from the fields of cognitive psychology and cognitive neuroscience that describes the relative strengths and weaknesses of the general ASD cognitive phenotype.

Reading Comprehension (RC) in ASD

As briefly described in Chapter 1, "reading for understanding" is especially challenging for many individuals along the autism spectrum (Randi et al., 2010). By most accounts, reading profiles of most individuals within this population demonstrate intact decoding abilities and basic grammar skills standing in contrast to deficient semantics for complex written material (Huemer & Mann, 2010; McIntyre et al., 2017; Nation, Clarke, Wright, & Williams, 2006). Difficulties understanding pragmatic language, developing appropriate inferences, and integrating information in context have also been reported (Happe & Frith, 2006; Huemer & Mann, 2010; Loukusa & Moilanen, 2011).

In what is arguably the most comprehensive and detailed meta-analysis reported to date, Brown, Oram-Cardy, and Johnson (2013) reviewed the decoding skills (i.e., “reading accuracy of non-words, single words, sentences, and/or passages as well as reading rate”), semantic knowledge (i.e., “receptive vocabulary using pictures or orally presented words”), and reading comprehension (i.e., “response accuracy, response times, eye-tracking measures, and/or recall scores [in response to reading material]” of participants with ASD across 36 reading comprehension studies. Their analysis revealed that participants with ASD displayed similar decoding abilities (Hedges g = -0.09), deficits in semantic knowledge of moderate effect size (g = -0.48), and deficits in reading comprehension of large effect size (g = -0.7) compared to NT peers. Decoding skills and semantic knowledge were determined to be reliable predictors of reading comprehension in ASD. The authors noted, however, that their data also suggested “some individuals or groups of individuals with [ASD] have strengths in both semantic knowledge and decoding, and that such individuals may have commensurately strong reading comprehension skills” (p. 9). Brown et al. attributed variability in findings between individuals with ASD to the well-documented heterogeneity of cognitive and reading profiles found between individuals within this population. In another analysis, Huemer and Mann (2010) – who examined intake data from 384 participants with ASD – reported a similar profile of decoding strengths and reading comprehension weaknesses.

Brown et al. (2013) also meta-analyzed the performance of individuals with ASD on decoding and comprehension skills of social and non-social texts. They found that individuals along the spectrum were better at comprehending non-social than social texts. This was not surprising given the well-established finding that many individuals with

ASD are poor at interpreting social cues and compromised in their ability to understand the intentions, motivations, and emotions of others (Baron-Cohen, 1989; Happe & Frith, 2006; Loukusa & Moilanen, 2009).

Three additional control group studies not included in reading comprehension reviews have interrogated the neural correlates of reading comprehension in ASD. Just et al. (2004) found that, on average, individuals in the ASD participant group activated a region of the brain involved in processing single-word meaning (i.e., a sub-section of Wernicke's area) more than those in the NT participant group, and a portion of the brain involved in integrative processing of syntactic and semantic content (i.e., a sub-section of Broca's area) less than those in the NT participant group. The ASD group additionally showed lower levels of functional connectivity between several language-implicated regions of the brain and performed more poorly on the behavioral task. The researchers concluded the ASD group was likely compromised in their ability to integrate the syntactic and semantic content of presented sentences.

Kana et al. (2006) found that, in contrast to NT participants, those with ASD tended to recruit occipital and parietal regions of the brain involved in visual processing during the presentation of *both* high and low imagery sentences, suggesting they were relying preferentially on visual imagery – or a "visual thinking strategy" – to comprehend sentence content. Lower functional connectivity was also found, on average, in participants with ASD compared to their NT counterparts in brain regions traditionally involved in language processing. Although no difference was found between groups in behavioral results, the brain-imaging results suggested the ASD group experienced difficulty integrating spatial thinking with language during the reading of presented sentences. Without reporting behavioral findings, Mason et al. (2008) found lower functional connectivity and recruitment of pre-frontal and temporal regions of the brain associated with social processing in the ASD group on a task involving narrative text.

In total, these neuroscience results suggest that reduced activity and connectivity between regions of the brain responsible for the integrative processing of syntactic and semantic content in sentences, accompanied by a preference for lexical over thematic processing, contribute to compromised reading comprehension in many individuals with ASD. A brain imaging meta-analysis of visual functioning in ASD by Samson, Mottron, Soulieres, & Zeffiro (2012) that found individuals with ASD typically demonstrate an overreliance on visual imagery in the processing of words and sentences underscores the robustness of Kana et al.'s (2006) finding, and further suggests that many individuals with ASD use mental imagery as a compensatory strategy for comprehension during receptive language tasks.

Outside of neuroscience results seen above, WCC, EF, or ToM theories have often been used to explain compromised reading comprehension in ASD that has been reported on behavioral measures. For instance, WCC has been used to explain poor performance of ASD compared to NT groups on the "homograph task", in which the correct pronunciation of a target word with a double meaning can only be determined using surrounding sentence context (e.g., Happe, 1997; Mottron, Burack, Stauder & Robaey, 2003; Snowling & Frith, 1986). The theory has also been used to explain poor reading comprehension of paragraph- and passage-length text (e.g., Frith & Snowling, 1983; Jolliffe & Baron-Cohen, 1999). EF theory, in turn, has been used to explain how poor skill sets in planning, sequencing, and monitoring compromise the ability of individuals with ASD to develop coherent mental representations of text (e.g., Calhoun, 2006; Hala, Pexman, & Glenwright, 2007; Russell, 1997), while ToM has been invoked to explain difficulty individuals with ASD have imputing the mental states of characters represented in narrative stories (e.g., Happe, 1994; Le Sourn-Bissaoui, Caillies, Gierski, & Motte, 2011).

Simple View of Reading. In addition to these above theories that have been invoked to explain the observed relative weaknesses of individuals with ASD in reading and language comprehension, two theories have been traditionally used in the area of special education to explain how reading comprehension occurs. The first theory, termed the "Simple View of Reading" (SVR; Hoover & Gough, 1990), posits that reading comprehension is the product of two equally weighted dissociable skills: decoding and linguistic comprehension. Their testable hypothesis formulates this theory in a simple equation: R (reading) = D (decoding) x L (linguistic comprehension). The theory has gained support from several studies that used NT (e.g., Tilstra, McMaster, Van den Broek, Kendeou, & Rapp, 2009) and LD (e.g., Catts, Adlof, & Weismer, 2006) school-age readers, which have investigated the variance within each of these two components (i.e., D vs. L) in participants and the respective contributions of each component to explaining overall reading comprehension performance.

The model, however, has been criticized as providing "neither a full theory of reading nor a blueprint for instruction" (Kirby & Savage, 2008, p. 75). Hoover and Gough (1990) admit as much in writing "The task remains to define components underlying decoding and linguistic comprehension" (p. 151). Failing to capture the complexities of the comprehension process under the umbrella of "linguistic comprehension", SVR unfortunately overlooks what researchers in the field of discourse comprehension have long argued: At its most elementary level, linguistic comprehension of a text consists of information from the text, information that is related to the text, and intra- and extra-textual inferences that are developed to fill-in the text's missing pieces in order to form mental representations of the text that facilitate its comprehension for the reader (e.g., Gernsbacher, Varner, & Faust, 1990; Kintsch & Van Dijk, 1978; MacNamara & Magliano, 2009).

Construction-Integration Model. In contrast, the second theory (Kintsch, 1988) and model (Kintsch, 1998) of reading comprehension, termed the Construction-Integration Model (CI; Kintsch, 1988, 1998), recognizes the basic assumptions of discourse comprehension research, though has arguably received less attention than SVR in the academic field of Special Education. It proposes that text comprehension is comprised of three representational levels: a "surface structure" that represents the words, phrases and syntactic structures used in a text, a "textbase of propositions" that represents the basic relationships between ideas within the text, and a "situation model" that represents concepts from outside the text used to contextualize information from the propositional textbase. Each of these levels, in turn, include further sub-structure. According to CI, comprehension of a text emerges to the extent the reader is able to accurately represent information at each of these three levels in mental representations of the text (Kintsch, 1988, 1998; McNamara & Magliano, 2009). Deeper comprehension occurs when mental representations from the propositional textbase are capably integrated with relevant background knowledge from the situation model (McNamara & Magliano, 2009; Williamson, Carnahan, & Jacobs, 2012). A number of studies have investigated these levels of representation, how they potentially interact, and how deeper reading comprehension that allows for complex problem solving demands not simply the recall of mental representations but the integration of mental representations into the reader's knowledge base (e.g., Britton & Gülgöz, 1991; Mannes & Kintsch, 1987; McNamara, Kintsch, Songer, & Kintsch, 1996).

Some of CI model's most interesting findings may be on the relationship between text coherence – the degree to which a text provides explicit and clear relationships between concepts – and background knowledge in contributing to NT readers' comprehension. For instance, Mannes and Kintsch (1987) found that text previews that were disorganized produced poor immediate factual recall of the main text but improved performance on delayed probes of deeper text comprehension that ostensibly drew from a reader's situation model. Another study investigating the differential impact of text organization on comprehension determined that in contrast to readers with *poor* background knowledge who benefited most from well-organized text with clear relationships drawn between concepts (i.e., strong coherence), readers with *strong* background knowledge benefited most from poorly-organized text with weak relationships drawn between concepts (i.e., weak coherence; Beck, McKeown, Sinatra, & Loxterman, 1991). In the one experimental study that investigated how CI manifests in ASD, Wahlberg and Magliano (2004) found that unlike NT participants, participants with ASD did not typically benefit from a written primer of background knowledge that resolved ambiguities in a disorganized main text, thereby producing an inaccurate situation model of the main text for readers with ASD. Although CI is currently the most widely accepted model of reading comprehension (McNamara & Magliano, 2009;

Williamson et al., 2012), it is but one of several testable models of comprehension in the field of discourse comprehension. Among other criticisms, detractors have argued the theory does not adequately explain how propositions from the textbase are formed and relate to each other (McNamara & Magliano, 2009).

In what may one day be considered seminal work in the area of reading comprehension research for individuals with ASD, Williamson et al. (2012) drew from both cognitive theories of ASD (i.e., WCC, EF, ToM) and Kintsch's CI comprehension theory (1988) to create reading comprehension profiles for children with high-functioning autism based on how different groups of readers interacted with text. Using a "constructivist grounded theory" approach that also included administering reading comprehension probes to participants, the researchers reported that readers fit into one of three groups of comprehenders, who in turn were each further divided into "high" and "low" comprehenders. The first group, "text-bound comprehenders", were limited to comprehending text within the propositional textbase. Outside of relationships explicitly drawn within the text, their understanding of the text was poor, and their situation model either non-existent or inaccurate. As predicted by WCC, low comprehenders in this group were prone to pay too much attention to textual details, to draw inaccurate text-based inferences, and to draw inaccurate global inferences that would have required the development of a strong situation model. The second group, "strategic comprehenders", had both an intact textbase model and situational model. They "(a) connect[ed] what was already known by the reader with the text, (b) asked[ed] questions during the reading, and (c) construct[ed] visual images" (p. 461). Low comprehenders in this group, however, were drawn to expressing thoughts unrelated to the text (i.e., EF) and had difficulty interpreting characters' motives (i.e., ToM). The third group, "imaginative comprehenders", created compelling but inaccurate situation models from inaccurate text bases. Low comprehenders in this group, unsurprisingly, had incomplete recall of the text (i.e., WCC).

Influence of RC Theories and Findings on Present Study. Published studies have yet to explore the facilitative effects of GOs through the theoretical lenses of WCC, EF, or CI theories. Nonetheless, WCC and EF theories of cognition in ASD, along with the CI theory of reading comprehension, were influential in providing a theoretical rationale in the present study for investigating the effect of GAOs on the reading comprehension of individuals with ASD.

WCC posits that individuals with ASD do not place written information in a holistic context, but instead perceive this information in a piecemeal fashion, thereby producing impoverished or incomplete mental representations of the text (Happe & Frith, 2006). Theoretically, it appeared plausible to the present investigator that by presenting a summary of accompanying passages (i.e., an abstract), a GAO might be capable of assisting readers with processing and contextualizing information from the passage that followed, i.e., enabling them to screen information from the passage for relevance, to focus attention on salient points, and to place these points in a holistic context presented by the GO.

Unlike WCC, EF is not a theory of knowledge representation. It does not embody antecedent or consequent mental representations in its stream of processes (i.e., working memory, inhibition, cognitive flexibility, and planning) that are compromised in many individuals with ASD (Guerts et al., 2014). Nevertheless, the practical implications of

EF theory appeared to the present investigator to be similar to those of WCC when applied theoretically to a GAO. Ideally, a GAO assists in partially compensating for relatively weak executive functioning processes in individuals with ASD, doing so by directing attention toward salient points of an accompanying passage. If functioning as intended, this hones the reader's ability to focus and process contextually similar material within the passage that follows.

CI theory, for its part, also influenced the development of the present dissertation study. Although research using a CI framework has only begun to investigate reading comprehension in ASD (i.e., Wahlberg & Magliano, 2004; Williamson et al., 2013), this theory shares a basic similarity with the ASD-specific WCC theory: Both emphasize the integrative nature of knowledge representation in producing conceptual understanding. However, through a comparatively richer epistemology, CI creates a distinction between *types* of mental representations that are formed as a product of the reading comprehension process, doing so by distinguishing between representations of the text (i.e., the propositional textbase) and representations of what the text is about that include the reader's background knowledge and experience (i.e., the situation model), both of which contribute to a reader's understanding of the text. As explored in greater depth in Chapter 5, it appeared to the present investigator that a GAO used in the present study might be capable of providing both *intra*-textual and *extra*-textual inferences that would strengthen the propositional textbase for participants with ASD.

CI theory additionally provides a rich model for understanding the reading comprehension process that the present investigator believed was central to informing any reading comprehension intervention, including the study presented in this dissertation. This made the theory highly influential in the development of the dissertation manuscript. Moreover, the theory of reading comprehension profiles for students with ASD by Williamson et al. (2013), as discussed above in Chapter 2, is largely informed by the CI model. As discussed in Chapter 5, Williamson et al.'s (2013) work proved to be important for understanding the different types of reading profiles participants in the present study may have used when interacting with texts that were presented to them.

Reading Comprehension Interventions (RCIs) in ASD

Reading comprehension interventions (RCIs) for individuals with ASD have been found to improve reading comprehension scores for students from 3rd grade through high-school (El-Zein, Solis, Vaughn, & McClulley, 2014). Explicit instruction methods or strategies have largely been used in the delivery of these interventions. Studies have typically employed single-case design, in which repeated measurements of a behavior are taken from an individual over the course of one or more administered treatments in studies where participants are able to serve as their own control subjects (Kennedy, 2005). Reviews of this literature have indicated that the majority of studies reported an improvement in participant reading comprehension on researcher-designed probes administered to participants (i.e., Chiang & Lin, 2007; El Zein et al., 2014; Whalon, Al Otabia, & Delano, 2008). Two studies conducted since the publication of El Zein et al. (2014) have shown reading comprehension improvement in experimental group studies that used standardized dependent measures.

The most recent and arguably most comprehensive review of RCIs for individuals with ASD, El-Zein et al. (2014) evaluated nine single-case studies and three group studies that were published between 1988 and 2012. The researchers found that the majority of studies employed strategy instruction or explicit instruction using a variety of treatment conditions. These were question-and-answer relations, reciprocal questioning, pronoun identification, directed reading/thinking, peer tutoring, graphic organizers, cooperative learning, and a computerized Book Builder program. The majority of studies employed narrative text as participant reading material. Researcher-designed reading comprehension probes were typically used to assess reading comprehension performance. None of the included studies investigated whether students could capably transfer reading comprehension strategies learned in the intervention to other texts (i.e., far-transfer tasks), or whether reading comprehension gains made during the intervention were maintained post-intervention for longer than several maintenance sessions.

El-Zein et al (2014) reported improved performance of participants with ASD on reading comprehension probes in 11 of the 12 surveyed studies, primarily illustrated through the percentage of non-overlapping data (PND) results that are often used to evaluate the efficacy of single-case studies. Certainty of evidence was rated as "inconclusive" for four studies, "suggestive" for five studies, and "conclusive" for three studies. The researchers concluded that this review provided a preliminary body of evidence to support explicit instruction as an effective means to improve the reading comprehension of students with ASD. WCC, EF, and ToM theories, they noted, provided "a strong rationale for the development of specific reading interventions for students with ASD" (p. 16), though few researchers took into account these theoretical frameworks in developing RCIs.

Although El-Zein et al. (2014) remains the most recent comprehensive review of RCIs in ASD, over a dozen additional RCIs for individuals with ASD have been published since 2012. The majority of these by-and-large effective studies have used single-case methodology. In contrast to a previous trend to use primarily narrative text as a reading material (El-Zein et al., 2014), several studies in recent years (i.e., Carnahan et al., 2016; Carnahan & Williamson, 2013; Reutebuch et al., 2015; Schenning et al., 2013; Zakas et al. 2013) have successfully improved reading comprehension performance using expository text. Several of these studies, discussed in greater detail in the next section, have furthermore used GOs as an aid in the delivery of an effective treatment package.

Two recent studies (i.e., Murdaugh, Deshpande, & Kana, 2016; Murdaugh, Maximo, & Kana, 2015) represent the first RCIs for individuals with ASD that used experimental group designs. These studies conducted by Murdaugh, Kana and colleagues tested the effect of the Verbalizing for Language Comprehension and Thinking (V/V) portion of the Lindamood-Bell reading curriculum on three groups of children (ages 8-13): an experimental group of children with ASD, a control group of children with ASD, and a control group of NT children. In Murdaugh, Maximo, and Kana (2015), participants in the ASD experimental group underwent sessions that focused on developing visual and verbal comprehension for four hours per day, five days per week, for ten weeks. In contrast to the other two included groups that did not demonstrate reading comprehension gains, results in the ASD experimental group showed post-test improvement on the Gray Oral Reading Test – 4th edition (GORT-4; Wiederholt & Bryant, 2001). This improvement in reading comprehension was accompanied by increased functional connectivity between regions of the brain that typically sub-serve language and reading comprehension in NT individuals, along with increased activity in occipital-parietal regions of the brain that sub-serve visual imagery. Increased functional connectivity that implicated Broca's and Wernicke's language areas in the experimental ASD group were furthermore independently correlated with gains in reading comprehension, independent of IQ scores. A similar study by Murdaugh, Deshpande, and Kana (2016) found similar results. Neither study, however, administered maintenance probes. The researchers in both studies suggested that reading comprehension gains reported in the ASD experimental group were facilitated by the dual-coding of sentential content in verbal and visual modalities, which Paivio (1990) famously posited as the dominant format of receptive learning in human cognition.

Influence of RCI Research on Present Study. The above-cited studies, all of which included explicit instructions or elements of explicit instruction in the delivery of the treatment package, helped establish an evidentiary rationale for exploring whether an effective RCI could be implemented *without* the use of this traditional instructional support. Experimental design of the present line of inquiry was also influenced and supported by a 2011 review of GO studies for students with LD (i.e., Dexter & Hughes), which suggested that interventions promoting learner independence were associated with strong maintenance effects.

Graphic Organizers

Graphic organizers are adjunct visual aids that help readers abstract the main concepts from reading material (Dexter & Hughes, 2010; Kim et al., 2004; Robinson et al., 2003). Using what has been called a "computationally efficient" visual argument (e.g., Robinson & Molina, 2002), GO's "use spatial arrangements and wording that graphically organize key conceptual relationships" (Simmons et al., 1988, p. 15). Intended to facilitate the comprehension of content-area material, these instructional tools come in several forms: cognitive maps, semantic maps, story maps, Venn diagrams, or framed outlines (Kim et al., 2004).

Originally called "structured overviews", GOs arose as an attempt to translate Ausubel's (1960, 1968) cognitive theory of "meaningful reception" into practice. Ausubel had argued that learning occurred when new knowledge was assimilated into existing knowledge structures. Thus, he proposed what was called an "advance organizer": an introductory written passage that highlighted central ideas from a main text. Presented before the main text's introduction, the advance organizer was intended to serve as a schema to incorporate new information from the text that followed. The structured overviews that arose from Ausubel's cognitive learning tool, which later become known as "graphic advance organizers", related content that might be placed in an advance organizer within a visual-spatial format. The first study using this new type of supplementary visual aid for learning took place in the late 1960s (Griffin, Malone, & Kameenui, 1995; Robinson, 1998).

Since the introduction of advance graphic organizers, numerous GO studies have delivered these instructional tools to participants in studies with a variety of study characteristics. Studies have varied by GO creator (i.e., researcher, teacher, student, or collaborative), type of GO used (examples seen above), type of text accompanying the GO (i.e., narrative, expository, mixed), and the dependent measure used to assess task performance (i.e., standardized or researcher-created). The number of GOs presented in a study has also varied – depending in part on the length of the accompanying text – along with the length, total number, and frequency of sessions over which GO instruction has been provided. Participant groups have included lower-elementary up to college-age students (Dexter & Hughes, 2010; Robinson, 1998).

Several study characteristics have emerged – or alternatively trended – more recently in GO research that has targeted reading comprehension. Although early studies used GOs almost exclusively in the advanced position in response to Ausubel's early work, subsequent studies presented them during or after the presentation of text (Moore & Readance, 1984; Griffin et al., 1995). In the 1980s, researchers added a new participant group to their investigations in this area: students with learning disabilities (LDs; Dexter & Hughes, 2011.) Only later, in the late 2000s, did GO studies using participants with ASD began to emerge (El-Zein et al, 2014). These changes in the demographic that was targeted in GO studies were accompanied by shifts in experimental methodology. Compared to earlier studies targeting NT participants, studies using participants with LD and ASD more frequently aimed to utilize GOs as part of participants' active, generative learning experience (O'Donnell, Dansereau, & Hall, 2002; Stull & Meyer, 2007) by recording participant responses in empty or partially-filled GOs. Whereas studies using NT participants have not always used a form of explicit instruction (Robinson, 1998), studies using participants with LD (Dexter & Hughes, 2010) or ASD invariably have. In contrast to the quasi-experimental and experimental studies that were largely used for NT (Robinson, 1998) and LD (Dexter & Hughes, 2010) studies, single-case design was typically employed for GO studies using participants with ASD. GOs were furthermore delivered exclusively as part of a larger treatment package in studies that used participants from this latter population.

Perhaps unsurprisingly, given the great heterogeneity of study characteristics in GO studies, research in this area has not been particularly systematic. In a review and coding of over 80 GO studies that used NT, LD, or ASD participants conducted by the author of the present dissertation, (no recent review has covered more than one of these populations), the author found that although GO studies often yielded favorable and compelling outcomes, researchers often did not provide a clear rationale for the specific parameters (mentioned above) chosen for implementing GOs – sometimes not mentioning these parameters at all. Similar findings were reported by the author of the last published review of GO reading comprehension studies for NT participants (i.e., Robinson, 1998), who stated existing GO research was non-systematic, involved studies that often provided unclear descriptions of materials and procedures, lacked consistency concerning the format of GOs, and that "the guidelines used in constructing GOs have not been based on empirical evidence, but rather on the authors' intuition" (p. 85). In an earlier review of GO research for reading comprehension on NT and LD populations, Griffin and Tulbert (1985) levied similar criticism, claiming that studies had been “plagued by methodological confounds” (p. 84) leading to little progress over the previous two decades in determining how GOs should be effectively constructed and implemented. Despite a host of more recent GO studies reporting impressive outcomes, the same criticisms might be made of more recent research in this area.

Reviews themselves of GO research for NT or LD populations, (no such reviews currently exist for the ASD population), have had their own shortcomings. Although thoroughly and thoughtfully interrogating the effect of GOs on almost all of the parameters mentioned earlier, two crucial ones that also informed the design of this current dissertation study were overlooked. First, although temporal placement of GOs (i.e., before, during, or after text) has been reported to differentially impact reading comprehension (e.g., Robinson et al., 2003; Shaw, Nihalani, Mayrath, & Robinson, 2012; Simmons et al., 1988), recent reviews of GO research for NT or LD populations have not included measurements of effect size on this variable since Moore and Readence's (1984) review that investigated the effect of GOs on the reading comprehension of NT participants. Second, no reviews have reported effect sizes based on the completion status of GOs (i.e., unfilled, partially-filled, completed), which has also been shown to differentially impact learning outcomes (e.g., Katayama & Robinson, 2000; Robinson et al., 2006; Stull & Meyer, 2007.)

Determining what methods work best in the hands of various investigators within this literature is therefore not without its challenges. The remainder of this review does not attempt to resolve them. Rather than aiming to make sense of the entirety of this voluminous literature, the remainder of the results portion of this section emphasizes, when possible, GO studies for NT, LD, and ASD participants that helped inform the design of this dissertation's research study: studies that (a) utilized graphic advance organizers (b) implemented without the use of instructional prompting or explicit instruction (c) to measure the comprehension of expository text passages.

Assimilation Theory and Dual Coding Theory

GO research has generally shown that providing key information from a text in a visual-spatial format improves subsequent recall of the text's content (Moore & Readance, 1984; Dexter & Hughes, 2011). Among other theories, "Assimilation Theory" (Mayer 1979, 1983) and "Dual coding theory" (Clark & Paivio, 1991) have argued why this is the case. Building on the work of Ausubel, Mayer posited that Ausebel's advance organizers provide the reader with background knowledge that activates relevant pieces of information during the reading of an accompanying text. Two non-exclusive versions of this theory were offered by Mayer. In the "organizational hypothesis", which is similar to Ausebel's (1960, 1968) theory of meaningful reception, advance organizers activate a superordinate knowledge structure that assimilates and organizes subordinate information from the accompanying text into this existing schema. In the "quantitative hypothesis", the schema is relieved of its subsuming role (along with the theory's similarity to Ausubel's). Instead, the schema simply facilitates the activation and encoding of relevant information from the text, but this new information is not integrated into the existing schema (Mayer 1979, 1983). In their meta-analysis on the effect of GOs on the reading comprehension of students with learning disabilities (LDs), Dexter and Hughes (2011) endorsed the organizational hypothesis of Mayer's assimilation theory.

In contrast to the organizational hypothesis, which stresses the integrative feature of conceptual change, Dual Coding Theory (DCT) posits that knowledge building occurs through the dual-coding of information across two related but dissociable systems: a verbal system and a visual system, each of which draws from different cognitive resources (Paivio, 1986). By encoding information in both prose and visual-hierarchal formats, DCT contends that GOs produce an additive encoding effect of represented content. Simultaneously, working memory capacity for processing information from the GO is increased by distributing the encoding process across two parallel systems (Langan-Fox, Waycott, & Albert, 2000; Vekiri, 2002). Dual-coding of represented material in experimental studies has been found to be associated with improved text recall (Sadowski and Paivio, 2007).

Graphic Organizers with Neurotypical Participants

When studying NT individuals, GOs have been found to effectively promote the reading comprehension of elementary (e.g., Reutzel, 1986; Simmons et al., 1988; Tajika, Taniguchi, Yamamoto, & Mayer, 1988), high-school (e.g., Alverman, 1981; Bean, Singer, Sorter, & Frazee, 1986) and college (e.g., Darch, Carnine, & Kameenui, 1986; Hall, Dansereau, & Skaggs, 1992; Robinson et al., 2003) students on administered probes using expository text. Both student-constructed (e.g., Bean et. al. 1986; Darch et al., 1986; Long & Aldersley, 1984) and researcher-constructed (e.g., Robinson et al., 2003; Snouffer & Thistlewaite 1980; Tajika et al., 1988) GOs have been determined to effectively promote performance. Short-duration studies lasting a single session (e.g., Bean et al., 1986; Bernard, 1990; Robinson et. al., 2003) and long-duration studies consisting of multiple sessions (e.g., Alvermann, 1981; Darch & Gersten, 1986; Simmons et al., 1988) have both proven effective.

According to the last review of GO research for reading comprehension that included effect sizes (i.e., Moore & Readance, 1984), graphic post-organizers that were presented after the main text were associated with an average effect size of .57 – three-tenths of a standard deviation above the average effect size for GAOs. Previously unmentioned, however, in an evaluation of this research is that although the effect size for GAOs was computed using studies that implemented *completed* GAOs, the effect size for post-organizers was computed using studies that implemented both *completed* and *partially-completed* post-organizers. A fair comparison between completed advance and post-organizers therefore does not exist. This issue aside, GO research during the intervening decades has yet to clearly determine whether Moore and Readance's (1984) original claim about post-organizers remains reproducible due to a host of methodological issues in these studies (Robinson et al., 2003; Shaw et al., 2012).

For the purposes of the present literature review, seven studies were successfully located that (a) utilized advance graphic organizers (b) implemented without the use of instructional prompting or explicit instruction (c) to measure the comprehension of expository text passages. Participants in five out of seven studies benefited from the use of GAOs. Besides these results of mixed success, the variability across studies of both experimental designs and the age groups of included participants renders GAOs currently unlikely to qualify as an evidence-based practice for promoting reading comprehension (Odom et al., 2005).

Snouffer and Thistlethwaite (1980) investigated the effect of a single GAO on the reading comprehension of college freshmen reading physical science and history materials. A vocabulary pre-reading activity condition and control condition were used as comparisons. Participants from the GAO condition scored higher on a 20-question post-test administered immediately after the reading compared to participants from the other two conditions.

In a series of three control-group experiments, Alvermann and colleagues investigated the effect of GAOs on the reading comprehension of fourth graders using expository texts. Alvermann (1984) found students who received 14 days of pre-training for using a GAO were better able to identify main ideas from the accompanying text during the study than those who received 7 days of pre-training, who in turn performed better than a control group. A similar experiment by Alvermann and Boothby (1986) found that those who received 14 days of training performed better than those who received 7 days of training, but that the latter group performed equally well to the control group. Boothby and Alvermann (1984) did not include the same regiment of pre-training, but instead undertook a 13-week study. No differences were found between the GAO and control group after a 1-month delayed-recall test.

Tajika et al. (1988) investigated the effects of a pictorial advance GO on the reading comprehension of fifth graders using expository text. Their study included an additional experimental condition and a control condition. It consisted of four phases: pre-learning, learning, immediate recall, and a delayed recall test administered one week after the completion of the study. Participants from the "integrated pictorial advance GO" condition recalled significantly more "idea units" from the text on both immediate and delayed recall tests compared to participants in the other two conditions.

In what may be the most sophisticated study of GO temporal placement and reading-text interactions, Robinson et al. (2003) administered a series of three experiments to college students that investigated the optimal (a) temporal placement of graphic organizers (i.e., before or after text) (b) number of organizers presented at one time (i.e., in a single presentation or interspersed within text) and (c) length of text presented at one time (i.e., a few sentences, pages, or an entire text) for learning concept relations, learning concept applications, and free-recalling micro- and macro-propositions. The researchers found on multiple-choice and free-recall probes that participants who received several GAOs followed by the entire text benefited optimally. A study by Shaw et al. (2012) – that included Robinson as a co-author – investigated advanced vs. post-organizers, but found in contrast to the earlier study that those who received post-organizers outperformed those who received GAOs.

Several other studies were located that utilized GAOs for expository texts. These studies, however, did not clearly investigate the independent use of GAOs for one or more reasons. Studies either included a form of explicit instruction in the delivery of the GAO (i.e., Barron, 1970; Estes, Mills, & Barron, 1969; Weisberg, 1970), confounded the independent effect of the GAO by allowing participants to continue using this instructional aid during the reading of the main text (i.e., Alvermann, 1988; Elkin, 1980; Hall, 1977; Underhill, 2001), required participants to engage in additional learning activities during the GAO condition (i.e., Bernard, 1990), or a combination of these confounds (i.e., Alvermann, 1981; Simmons et al., 1988).

Graphic Organizers with Participants with Learning Disabilities (LDs)

Despite having distinct learning profiles from individuals with ASD (Goldstein, Beers, Siegel, & Minshew, 2001; Mayes & Calhoun 2008), individuals with LD have difficulties in the areas of drawing appropriate textual inferences, identifying main textual ideas, and identifying extraneous textual information (Dexter & Hughes, 2011; Kim et al., 2004) that are similar to those found in ASD (Happe & Frith, 2006; Loukusa & Moilenan, 2009). GOs are a recommended instruction tool for students with LD that have been found to effectively help students address or circumvent some of these deficits, and to improve the reading comprehension of elementary, middle-school, and high-school students with LD on administered probes. Both student-constructed and researcher-constructed GOs have been determined to effectively promote reading comprehension performance. Short and long duration studies have both yielded positive results (Dexter & Hughes, 2011; Kim et al., 2004). Although IQ has not been measured in literature reviews as a mediating factor in observed outcomes, students with lower verbal ability were reported to obtain greater benefit from GO interventions (Dexter & Hughes, 2011).

Surveying a total of 29 control-group and single-group studies, Kim et al. (2004) reviewed GOs and their effects on the reading comprehension of students with LD. They reported in their synthesis of research that both teacher- and researcher-implemented studies were found to be effective. Moreover, several specific types of graphic organizers were found to work well. Students with LD who used semantic organizers, cognitive maps, and framed outlines demonstrated higher scores on comprehension probes than did students in comparison groups, which were generally associated with medium to large effect sizes across studies. The researchers noted that their analysis demonstrated "effective outcomes at the elementary and secondary levels for the use of graphic organizers" (p. 114). They cautioned, however, that all studies yielding significant results used researcher-developed assessments that are generally associated with higher effect sizes than standardized probes, and stated that further research was needed to clarify whether students with LD could effectively use GOs independently.

Building on Kim et al.'s synthesis, Dexter and Hughes (2011) reviewed the effects of GOs on the reading comprehension and math learning of students with LD. Sixteen control group studies were included in their meta-analysis, which measured mean effect sizes on a variety of measures that compared GO to control group performance. Overall, GOs were found to be associated with large post-test (*ES* =.91) and medium maintenance (*ES* =.56) effect sizes. In addition to promoting factual recall, the researchers found GOs were useful for improving scores on another "near-transfer" task: performance on higher-level skills such as textual inferencing and the ability to relate textual concepts to each other (*ES* =.94). GOs were also found to facilitate performance in “far-transfer” tasks, where participants were quizzed on topics not directly covered in the reading material. This mean effect size, however, was considerably smaller (*ES* =.36.). In studies where maintenance probes were taken – between one and four weeks after the completion of the study – effects were far more durable for near-transfer tasks (*ES* =.63) than for far-transfer tasks, where the effect size was negligible (*ES* =.07).

Interestingly, Dexter and Hughes found that simpler GOs that could be used independently by participants were associated with the lowest post-test effect sizes, but the largest maintenance effect sizes, suggesting that the learning from these more "computationally efficient" GOs was less profound but more durable. The researchers also found that GOs were effective when used before, during, or after a reading task. However, they reported that all reviewed articles incorporated aspects of direct or explicit instruction. The inclusion of explicit instruction in the delivery of GOs would suggest that the independent effect of GOs – including GAOs – for students with LD has yet to be either investigated or determined.

Focusing specifically on GOs presented using a digital interface, Ciullo and Reutebuch (2013) reviewed five single-case and seven single group studies that evaluated the effect of computer-based GOs on the reading comprehension of students with LD. Studies with the highest effect sizes were reported to have been delivered in interventions that incorporated the principles for effective instruction outlined in Vaughn, Gersten, and Chard (2000): (a) small-group instruction (b), explicit instruction, (c) extended student practice with feedback and interaction, (d) gradual reduction of support, (e) content enhancement tools (e.g., graphic organizers), and (e) controlling task difficulty. The researchers additionally found that two studies comparing the facilitative effect of GOs presented by computer interface vs. paper text found an advantage for computer-presented GOs.

Graphic Organizers with Participants with ASD

GOs are a recommended tool for facilitating reading comprehension in children with ASD (Gately, 2008; National Autism Center, 2010) and are thought to appeal to the visually-mediated cognitive style of many individuals within this population (Kana et al., 2006; Samson et al., 2012; Stringfield, Luscre, & Gast, 2011.) Yet only in the last decade have researchers added GOs to their arsenal of instructional tools in RCI studies using this population. The initial results from nine peer-reviewed single-case studies – each of which included GOs as one element of a larger treatment package – have been positive. During treatment, the interventions have been found to increase participants' reading comprehension and ability to identify main ideas and themes from narrative and expository texts. However, none of these studies have investigated participant performance beyond several maintenance sessions or on far-transfer tasks.

Studies that included GOs have produced increased scores on reading probes for elementary (i.e., Bethune & Wood, 2013; Kelly & Whalon, 2008; Stringfield et al., 2011), middle-school (i.e., Carnahan & Williamson, 2013; Schenning, Knight, & Spooner, 2013; Solis et al., 2016; Zakas et al., 2013) and high-school (i.e., Carnahan, Williamson, Birri, Swoboda, & Snyder, 2016; Reutebuch et al., 2015) students. These studies have used GOs as adjunct visual displays that complemented text (i.e., Carnahan

& Williamson 2013; Whalon & Hanline, 2008), uncompleted or partially-completed organizers for recording participant responses (Bethune & Wood, 2013; Carnahan & Williamson, 2013; Reutebuch et al., 2015; Schenning et al., 2013; Solis et. al., 2016; Stringfield et al., 2013), or in both capacities (Zakas et al., 2013).

Three studies used narrative text (Bethune & Wood, 2013; Stringfield et al., 2013; Whalon & Hanline), five used expository text (Carnahan et al., 2016; Carnahan & Williamson, 2013; Reutebuch et al., 2015; Schenning et al., 2013; Zakas et al. 2013), and one used both (Solis et al., 2016) as a reading material for participants. The majority of studies delivered between 10 and 20 sessions of instruction. The majority of studies also facilitated the reading comprehension of participants who had high-support needs. None of the studies administered a GO in the advanced position. Even in studies where GOs were featured as a major organizing element of the intervention (i.e., Bethune & Wood, 2013; Schenning et al., 2013; Stringfield et al., 2011; Zakas et al., 2013), gauging the independent effect of the GO was confounded by a course of explicit instruction.

Whalon and Hanline (2008) used a multiple baseline design to investigate the ability of children with ASD (ages 7-8) to engage in reciprocal questioning with partners using “story cards” and a social skills curriculum. Story cards that accompanied the narrative text included key elements (e.g., setting, characters, events), accompanied by pictorial representations (e.g., faces of children for “characters”) and questions (e.g., “who are the characters in the story?”). Students were prompted during the intervention phase to generate questions. In addition to the story cards, participants used checklists as an instructional support. The incidence of generating questions was used as a proxy measure for reading comprehension performance. Two out of three participants registered gains in the number of questions that were generated in response to reading material.

Stringfield et al. (2011) used a multiple baseline design to evaluate the effect of a story map intervention on three 8-11 year olds with high-functioning autism. After reading narrative stories included in the study, participants were prompted to place responses within an empty story map that was used record key elements of the story (e.g., characters, time, place). Each participant demonstrated improved performance during intervention and maintenance phases on accuracy of story map completion and correct quiz responses.

Bethune and Wood (2013) used a delayed multiple baseline design to assess the ability of three 8-10 year old participants with ASD to respond to “Wh-comprehension” questions drawn from a narrative text. Using a “least to most prompting hierarchy” (i.e., independent, verbal, gesture, physical), each participant was prompted to place responses into unfilled GOs, which consisted of four columns with “Wh-” categories (i.e., Who?, What?, Where?, What doing?). The researchers found a positive association between the participants’ use of GOs and their competence in extracting and placing elements of the story into the appropriate Wh- categories.

Solis et al. (2016) delivered two single-case studies using alternating treatment designs to investigate the effect of question development, anaphoric cueing, and applied behavior analysis (ABA) on the reading comprehension and on-task behavior on a total of four participants (ages 10-13). A mixed set of narrative and expository texts were used as reading materials. In both studies, partially filled graphic organizers were used to help facilitate participants’ understanding of key elements of the reading material. All participants benefited from the treatment and recorded their highest reading comprehension scores during the alternating phase that included an ABA-implemented token economy of positive reinforcement.

Carnahan and Williamson (2013) used a multiple baseline reversal design to investigate the degree to which three middle school students with ASD were able to comprehend short expository science texts. Participants were measured on their ability to correctly answer comprehension questions and accurately complete an unfilled Venn diagram with relevant topic material. Results across participants indicated gains in reading comprehension that continued within a short maintenance phase. In a similarly designed study, Carnahan et al., (2016) used a researcher-completed "text structure organization guide" that identified key relationships (e.g., cause and effect) within the accompanying texts as part of a scripted intervention. The intervention was found to improve the reading comprehension performance of three high school students with ASD during intervention and maintenance phases.

Zakas et al. (2013) used a delayed multiple baseline design to investigate the effect of a GO intervention on the expository text comprehension of three 11-13 year olds with ASD. Prior to the beginning of the investigation, a "scripted story grammar approach", which utilized a series of prompts, was used to teach key concepts that were represented in the text. These concepts consisted of terms (e.g., detail, time, location, event), definitions of terms, and drawings of terms. Unfilled semantic organizers were used to interrogate student performance. In the intervention and maintenance phases of the investigation picture symbols were additionally used to complement the textual representation of material. These visuals were placed above key nouns (e.g., a rifle to represent “war”) and verbs (e.g., a picture of a man holding a white flag for “surrendered”) in an attempt to dually code key elements of the history text for participants. Each student demonstrated gains in performance on the reading comprehension measure during intervention and generalization phases.

Schenning et al. (2013) used a delayed multiple baseline design to investigate the effect of a guided course of structured inquiry that included the use of GOs on the reading comprehension of three students with ASD (ages 11-13). An adapted expository social studies text with similar characteristics to Zakas et al. (2013) was used as a reading material. Using a least-to-most prompting hierarchy, the implementers helped students identify key elements of the text through a series of questions, match these elements with the correct pictures representing these elements, and place the pictures in the correct sequential order in a GO. Students demonstrated improved performance on a probe that involved reproducing the GO during a second reading of the text. Recorded gains endured within the maintenance phase.

Lastly, Reutebuch et al. (2015) used a delayed multiple-baseline design to pilot the effect of an adapted version of a Collaborative Strategic Reading (Vaughn et al., 2013) intervention on the reading comprehension, challenging behavior, and social interactions of three high-school students with ASD. An unfilled graphic organizer with Wh- question stems was used as part of the treatment package to help participants summarize readings upon their completion. Reading comprehension scores increased on administered question probes during intervention and maintenance phases for all three participants. In addition, participants increased the incidence of initiating social contact with fellow group members during intervention phases while concurrently reducing incidence of challenging behavior.

In total, these GO-inclusive RCIs improved the reading comprehension performance of students with ASD on administered probes. This demonstrated that a GO or GOs can be used as one element of an effective treatment package that is delivered to participants using explicit instruction or elements of explicit instruction. Unfortunately, none of the included studies sheds light on the independent effect of a GO(s) – or GAO(s) – on reading comprehension. Furthermore, the effect of these interventions on long-term basal reading comprehension remains unexplored.

Influence of GO Theories and Research on the Present Study.

The "organizational hypothesis" of Mayer's assimilation theory (1979, 1983), which posits that an advanced organizer provides a schema integrating information from the text that follows, served as a basic theoretical rationale in the present study for exploring the potential facilitative effect of a GAO on the reading comprehension of students with ASD. Furthermore, with the exception of several studies in the NT literature, existing studies have not investigated the independent effect of GOs, but instead the synergistic effect of GOs paired with explicit instruction. This represented a specific gap in the literature, providing a rationale for pursuing the present study.

CHAPTER 3: METHOD

Overview

Single-case research design, which was employed in the present study, differs from traditional experimental group design studies by (a) focusing on the individual rather than the group as the unit of primary analysis (Kennedy, 2005), (b) allowing participants to serve as their own control group rather than including a group of participants that does not receive a treatment (Kennedy, 2005), and (c) establishing causal or functional relationships between an independent variable(s) and dependent variable(s) through measurements of performance between- and within-subjects rather than primarily between groups (Horner et al., 2005). Single-case studies typically include a baseline phase to establish the typical performance of a participant without the aid of a planned intervention. After experimental control – or a reliable trend of performance – is established for the participant in baseline phase, a treatment phase is then introduced, which includes one or more independent variables to be investigated (Horner et al., 2005).

Numerous designs for single-case design exist (Neuman & McCormick, 1995). Depending on the design, a baseline phase may be re-introduced (i.e., treatment withdrawal) in an attempt to further demonstrate the effect of the treatment, or two treatments may be alternated to compare their relative effects with one another. According to Horner et al. (2005), a functional relationship between the manipulation of the independent variable and change in the dependent variable is established in a study "when the design documents three demonstrations of the experimental effect at three different points in time within a single participant (within-subject replication), or across different participants (inter-subject replication; p. 168).

In the present study, an alternating-treatment design was used, following a delayed baseline phase, in order to investigate the effects of a (a) graphic advance organizer that includes Wh- question information (GAO) and (b) a comparison condition of instructional prompting of Wh- questions (PR), on the reading comprehension of participants. The investigator served as the interventionist and delivered one-on-one sessions with each of 6 student participants.

Research Questions

The following questions were addressed:

1. To what degree (if any) do (a) graphic advance organizers with "Wh-" question information (GAO) and (b) a comparison condition of instructional prompting of "Wh-" questions (PR), promote reading comprehension?
2. If either treatment promotes reading comprehension, does (a) graphic organizers with "Wh-" question information (GAO) *or* (b) a comparison condition of instructional prompting of "Wh-" questions (PR), promote reading comprehension more effectively?

Participant Selection and Setting

A total of six middle-school and high-school students, who attended a total of four different schools, participated in the study. Students were selected based on the following criteria:

(a) The student is in 6^{th}- 12^{th} grade;

(b) The student is classified by the school as an individual with ASD;

(c) The student has passage comprehension level of 2nd grade or above according to the Woodcock Johnson-III (Woodcock, McGrew, & Mather, 2001) sub-tests that are administered to each participant prior to the beginning of the intervention;

(d) The student has at least one goal or objective written in his/her Individualized Education Plan (IEP) that addresses reading comprehension;

(e) The student was willing to voluntarily sign an assent form stating his/her willingness in participating in the study. The parent or guardian of the student was willing to voluntarily sign a consent form stating his/her willingness for his/her child to be included in the study.

In the Spring study (Study 1A), the two students chosen to participate in the study (Albert and Samuel) attended a public middle-school in the central Texas area. In the Fall study (Study 1B), one participant attended a private middle school in the central Texas area (Hank), one attended a public middle-school in the central Texas area (Brad), and two attended a private charter high-school in the central Texas area (Sally and June). Each of these students participated in sessions in a school setting during school hours, with the exception of the two middle-school students in Study 1B (Brad and Hank), who participated in home sessions in the afternoon or early evening hours. The sixth student in the study (Sally) was unable to continue participating in the treatment phase and consequently dropped out of the study.

Academic Measures

The following sub-tests of the WJ-III (Woodcock et al., 2001) were administered by the present investigator/implementer to evaluate the initial reading level of each participant in Study 1A: Reading Fluency (#2), Passage Comprehension (#9), Editing (#16), and Academic Knowledge (#19). Only Reading Fluency (#2) and Passage Comprehension (#9) were administered to participants in Study 1B. These tests were used to help match each participant with the appropriate grade-level text, though for the purposes of the present study were of limited utility for doing so.

Participant Characteristics and Text Assignment

A summary of participant characteristics and their text assignment is provided below (Table 3.1) followed by a more detailed description of each participant's characteristics and text assignment.

Table 3.1. Summary of Participant Characteristics

Participant	Diagnosis	Age	Grade	WJ-III Reading Fluency	WJ-III Passage Comprehension	Grade Level Text Assigned
Albert	ASD	15	8^{th}	2.9	3.3	6
Samuel	AS	14	8^{th}	7.3	5.4	8
Hank	PDD-NOS	13	8^{th}	2.5	2.6	5
Brad	AU	13	7^{th}	2.8	4.5	7
Sally	PDD-NOS	15	10^{th}	4.8	5.8	8

Note: WJ-III=Woodcock Johnson III Tests of Achievement; ASD=Autism Spectrum Disorder; AS=Asperger syndrome; PDD-NOS=Pervasive Developmental Disorder-Not Otherwise Specified; AU=autism

Albert

Albert was a 15-year-old boy in the 8^{th} grade with a diagnosis of Autism Spectrum Disorder (ASD). This diagnosis had recently been determined by a Licensed Clinical Psychologist when Albert was a 15-year-old using the Autism Diagnostic

Observation Schedule (ADOS-2; Lord et al., 2012). He was reported in this clinical evaluation made available to the present investigator, (which contained considerably more psychometric data than any other participant), to have a limited ability to accurately interpret social cues. He was also reported to have trouble making friends with a tendency to lash out at peers in response to being taunted, but also in response to small perceived slights. Most fond of his "art class", he was reported to display little interest in learning or academics. In his free time, he was reported to enjoy playing video games and spending time with animals. One of his future goals was to become a zoologist.

Albert attended classes at his school in both mainstream classroom and special education settings. In interactions with the investigator, his facial expressions and prosody typically displayed a flat or muted affect – even when he was describing topics that he appeared to be excited about. Occasionally, he would describe problems he was having in school or at home – also delivered with his characteristic flat affect. Although he occasionally displayed a playful sense of humor, as a result of his flat delivery it was not always entirely apparent to the investigator when he was joking.

Testing of Albert's global cognitive ability on the Kaufman Assessment Battery for Children-2nd edition (KBIT-II; Kaufmann & Kaufman, 2006), administered when Albert was an 11-year old, placed him in the "very delayed range" (SS = 67). This score would qualify him as an individual with an Intellectual Disability. His visual-spatial abilities, in contrast, were listed in the "high average range".

More recent assessments in multiple clinical evaluations painted an uneven cognitive profile of generally intact executive function skills contrasted by highly compromised language skills. His scores on the Behavior Rating Inventory of Executive

Functioning (BRIEF; Gioia, Guy, Isquith, & Kenworthy, 1996) were mostly unremarkable. With the exception of a "clinically significant" inability to perform "Attentional Shift", which represents the ability to freely move from one to another activity, situation, or mode of thinking, his scores for other sub-skills captured under the umbrella of executive functioning including inhibition, initiation, working memory, planning/organization, and monitoring, were all reported to be in the "typical" range. His "metacognition index" and "global executive functioning" were likewise reported to be "typical".

In contrast, a recent evaluation on the Clinical Evaluation of Language Fundamentals (CELF-4; Semel, Wiig, & Secord, 2004), which evaluates language skills partially sub-served by many of the executive function skills listed above, placed his core language, receptive language, and expressive language scores each at or below the 1st percentile. These scores were interpreted by a Licensed Clinical Psychologist as demonstrating an overall rating of "severe impairment" for expressive and receptive language skills. Although his understanding of semantic relationships and ability to recall sentences were also recorded below the 1st percentile, in constrast he displayed an ability to assemble sentences in correct sequential order in the high average range (63rd percentile). This could suggest that although his ability to recall information he had previously heard or read was severely impaired, his ability to create an accurate mental model of the information he was currently reading was intact. Indeed, during the alternating treatment of Wh- questions, during which he answered three Wh- questions posed by the investigator early in the course of reading a presented text, he generally appeared to display an intact, though elementary understanding of the 6th grade texts he was reading.

Academically, it was noted in one of the recent reports that although math was his most difficult subject, reading was also a great challenge for him. One teacher reported that he took the meaning of class readings very literally and needed the underlying meaning of reading material to be explained to him. Academic performance may also have been negatively impacted by off-task behavior. An Applied Behavior Analysis (ABA) functional assessment noted he demonstrated a failure to complete tasks, left his seating area without permission, and often appeared withdrawn during class activities. In sub-tests of the WJ-III (Woodcock et al., 2001) administered by the present investigator, Albert gained grade equivalent (GE) scores of 2.9 for reading fluency, 3.3 for passage comprehension, 2.5 for editing, and 4.0 for academic knowledge.

Sessions for the present study were held in a resource room at his middle-school. Albert was initially assigned a GE 4.0 level text during pre-baseline phase, which was approximately one grade level above both his reading fluency (3.3) and passage comprehension (2.9) levels, as recorded during pre-testing. After his first session during the pre-baseline phase, he withdrew from the study but returned to participate in the study several weeks later. Using texts at both the 4.0 and 5.0 grade level produced highly variable baseline scores on reading comprehension (RC) probes, several of which yielded scores of 70% or above. A GE 6.0 level text was eventually determined to be most appropriate for his instructional reading level. Accordingly, his results listed in Chapter 4 only include data using GE 6.0 text.

Samuel

Samuel was a 14-year-old boy in the 8th grade with a diagnosis of Asperger Syndrome (AS). Under the previous diagnostic criteria for ASD conditions used in the Diagnostic and Statistical Manual – 4th Edition (DSM-IV; American Psychiatric Association, 1994), Asperger syndrome is a milder form of ASD that does not include pragmatic language impairment as a diagnostic criterion. The most recent reports of his cognitive and behavioral profile – administered when Samuel was a 9-year old – showed that this diagnosis was determined by a Licensed Specialist in School Psychology using data from (a) observations of Albert's behavior drawn from one-on-one meetings between Albert and the licensed specialist, (b) observations of Albert's behavior in the classroom made by the licensed specialist, (c) observations by classroom teachers and a school counselor, (d) parent reports, and (e) ratings on the Gilliam Asperger's Disorder Scale (GADS; Gilliam, 2001). Samuel's performance on a recently-administered standardized measure of global cognitive ability placed his intellectual functioning in the high average range (FSIQ=108) on the Wechsler Intelligence Scale for Children – 4th Edition (WISC-IV; Wechsler, 2004).

Clinical observations of Samuel's behavior as a 9-year old noted that he displayed an impairment in social reciprocity and in developing peer relationships. The evaluation stated that during testing with the examiner and when observed interacting with his peers, he rarely initiated conversation and sometimes engaged in "scripted conversation". The evaluation also stated that although teachers rated his ability to comply with teacher requests as "superior", his abilities to demonstrate self-control, adapt to new situations, and work cooperatively with others were rated as "poor". His parents stated he enjoyed playing by himself and watching TV shows about animals or infomercials, but had few friends.

These reports of Samuel as a 9-year-old, however, stood in contrast with the investigator's observations of Samuel as an extremely sociable, engaged, and intellectually curious 14-year-old. Towards the beginning of the intervention, he would often ask very relevant questions during the reading of the text, though stopped doing so after the investigator told him several times that unfortunately questions about ideas in the text could not be answered by the investigator. During sessions that included the prompting of Wh- questions, he generally appeared to show an intact understanding of the text. After readings, when time permitted, he would sometimes talk about his own knowledge, experience, and questions he had about the reading he had just completed. He also appeared to have a number of friends with whom he spent time after school and on weekends.

Samuel attended all mainstream classes at his middle-school. His social studies teacher described him to the investigator as a "strong student" and "one of his most eager learners." In sub-tests of the WJ-III (Woodcock et al., 2001) administered by the present investigator, Samuel recorded GE scores of 7.3 for reading fluency, 5.4 for passage comprehension, 3.9 for editing, and 5.1 for academic knowledge.

Sessions for the present study were held in a resource room at his middle-school. Samuel was initially assigned a GE 6.0 level text during pre-baseline phase, approximately half a grade above his passage comprehension level (5.4) and a 1.5 grade levels below his reading fluency level (7.3). Similar to Albert, his RC performance using his initially assigned grade level texts produced scores that were highly variable. He gained scores of 70% or above on several reading comprehension probes. A similar profile of performance was observed using grade 7.0 texts. A GE 8.0 text was eventually determined to be most appropriate for his instructional reading level. Accordingly, his results listed in Chapter 4 only include data using GE 8.0 text.

Hank

Hank was a 13-year-old boy in 8th grade with a diagnosis of Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS). Under the previous diagnosis of ASD conditions used in the DSM-IV (American Psychiatric Association, 1994), PDD-NOS was an appropriate diagnosis "when an individual fails to meet specific criteria for autistic disorder…but has similar difficulties in social interaction, and/or stereotyped behavior" (de Bruin, Ferdinand, Meester, Nijs, & Verheij, 2007). This diagnosis was made by a clinical psychologist when Hank was a 5-year-old using data from (a) ratings on the NEPSY: A Developmental Neuropsychological Assessment (Korkman, Kirk, & Kemp, 1998) and Vineland-II (Sparrow, Cicchetti, & Balla, 2005) neuropsychological evaluations, (b) clinical interviews, and (c) several questionnaires.

In these evaluations of Hank as a 5-year old, he was reported to have executive function difficulties that included focusing attention, shifting attention, initiating tasks, and inhibition. Problems with staying alert, "tuning in and out", and focusing on unimportant details were also found. In addition to providing inconsistent eye contact with others, he demonstrated a desire for "sameness" in his routines and a limited ability to engage in symbolic play. Other clinical observations included that he displayed difficulty following verbal directions, needed to be frequently redirected to a task, and was sometimes unresponsive to verbal prompts. Sometimes Hank would repeat directions out loud to himself that had been provided to him. Although these clinical observations were not inconsistent with those made by the present investigator, since these observations were drawn from diagnostic and neuropsychological assessments of Hank as a pre-school child, their relevance to Hank as a 13-year-old adolescent was not entirely clear.

Difficulties reported in social functioning and executive functioning as a 5-year-old contrasted with overall intellectual functioning reported to be in the high-average range (FSIQ=110) on the Universal Nonverbal Intelligence Test (UNIT; Bracken & McCallum, 1998). On UNIT sub-tests, Hank's reasoning, memory, and symbolic quotient were all reported to fall at the upper end of the average range. Specific aspects of his verbal and non-verbal memory, however, were significantly below average.

During face-to-face session, Hank presented to the investigator during sessions as a thoughtful, inquisitive, excitable, and extremely sociable 13-year-old, who often struggled to stay on-task. During the beginning of the intervention, he would often ask questions about the text, (sometimes relevant, sometimes irrelevant), though stopped doing so after the investigator told him several times that unfortunately questions about ideas in the text could not be answered by the investigator. During sessions that included the prompting of Wh- questions, Hank oftentimes did not appear to accurately comprehend content of the text and sometimes provided explanations that relied on small or irrelevant details from the passage. Hank would often talk to himself during the quizzes in what appeared to be an effort to facilitate his own thinking. In sub-tests of the WJ-III (Woodcock et al., 2001) administered by the present investigator, Hank recorded GE scores of 2.5 for reading fluency and 2.6 for passage comprehension.

Hank also exhibited an interesting preoccupation with rules and what he should or should not be doing at a given time. For instance, during one meeting, the investigator brought chips to eat and offered some to Hank. However, after it became apparent that the chips served as a distraction to Hank, the investigator asked him to stop eating them until the session had been completed. After the investigator returned to the testing room following a brief break between sessions, Hank admitted with great consternation and regret that he had “stolen several chips” from the investigator’s plate. In response the investigator replied that although it was generally considered rude to take other people’s food, in the future Hank could take the investigator’s food if the latter left the room but did not need to tell the investigator about it.

Sessions were held at the home of either Hank’s mother or father, both of whom lived in the central Texas area. Hank was initially assigned a GE 4.0 level text during pre-baseline phase, approximately one-and-a-half grade levels above both his passage comprehension (2.6) and reading fluency (2.5) levels, as recorded during pre-testing. He gained scores on RC probes of 70% and 80% on two passages using GE 4.0 text. A GE 5.0 level text was determined to be most appropriate for his instructional reading level. Accordingly, his results listed in Chapter 4 only include data using GE 5.0 text.

Brad

Brad was a 13-year-old boy in 8th grade who had been assigned the diagnosis of “autism” after previously receiving a diagnosis of PDD-NOS. The diagnosis of autism had been made approximately two years earlier by two Licensed Specialists in School Psychology using (a) the Gilliam Autism Rating Scale – 2nd edition (GARS-II; Gilliam, 1995), (b) the Behavior Assessment System for Children – 2nd edition (BASC-II;

(Sandoval & Echandia, 1995), (c) clinical interviews with Brad, his parents, and teachers, and (d) reports from school records.

His cognitive and behavioral report stated he had difficulty using pragmatic language skills and had a tendency to speak literally in conversation. He was also reported to avoid establishing eye contact with others and to become upset when routines were changed. Obeying the conventions of conversation, participating in group activities at school, and getting along with peers and teachers were all reported as areas where improvement was needed. When frustrated, it was reported that he frequently exhibited aggressive behavior that included breaking rules, disrupting other children's activities, and bullying them. On several occasions he had verbally threatened and assaulted peers and teachers.

On a recently administered Kaufman Assessment Battery for Children (KABC-II; Kaufman, 2004) he gained a Fluid-Crystallized Index (FCI) score – roughly equivalent to a full-scale IQ score - of 78, placing him in the "below average" range of global cognitive ability. Further KABC-II results reported he performed within the broadly "average" range on tasks measuring crystalized knowledge, fluid reasoning, visual-processing, long term retrieval, and auditory processing. These relative strengths were contrasted with difficulties in short-term memory that included tasks requiring him to exercise his rote memory. In sub-tests of the WJ-III (Woodcock et al., 2001) administered by the present investigator, Brad recorded GE scores of 2.8 for reading fluency and 4.5 for passage comprehension.

Although initially reluctant to participate in reading sessions with the investigator, he gradually warmed up to the idea. Overall, he came across as a thoughtful, engaged, 13-year old who enjoyed playing football and video games and spending time with friends. During the beginning of the intervention, he would often ask relevant questions during the reading of the text, though stopped doing so after the investigator told him several times that unfortunately questions about ideas in the text could not be answered by the investigator. In sessions with the investigator, he was generally highly focused, though occasionally would stop during the middle of a reading to offer a thought or piece of (often-humorous) commentary. During sessions that included the prompting of Wh-questions, he generally displayed what appeared to be an intact understanding of passages. The aggressive behaviors reported in clinical evaluations were not evident during these sessions. Social behaviors typically associated with ASD were also not clearly apparent to the investigator.

Although records indicated his vision was intact, he did display a tendency to skip over lines when he was reading the presented passages out loud, and sometimes needed to be prompted to return to reading text he had mistakenly glossed over. In both reading and writing tasks administered during the study, he also sometimes transposed, omitted, or mispronounced syllables of words – behaviors that are consistent with phonological processing disorders such as dyslexia (Gaab et al., 2007). Despite difficulties with reading, consistent with results on his KABC-II (Kaufman, 2005), his receptive language skills appeared to be reasonably strong. He reported to the investigator that he often watched YouTube videos to learn content-area material for homework instead of completing assigned reading material that ostensibly covered similar content.

Sessions for the present study were held in the home of Brad's parents. Brad was initially assigned a GE 5.0 text during pre-baseline phase, one-half of a grade level above his passage comprehension level (4.5) and approximately two grade levels above his reading fluency level (2.8), as recorded during pre-testing. He gained a score of 80% on a GE 5.0 text, and two scores of 70% on a GE 6.0 text. A GE 7.0 level text was determined to be most appropriate to target his instructional reading level. Accordingly, his results listed in Chapter 4 only include data using GE 7.0 text.

Sarah

Sarah was a 15-year-old girl in 10th grade who had been assigned the diagnosis of PDD-NOS with an intellectual disability by a Clinical Psychologist at the age of 8. The clinician noted that her auditory recall was seriously impaired but her visual recall was at or above age level and a relative memory strength. Recent performance on the WISC-IV (Wechsler, 2003) determined her global cognitive ability to be in the impaired range (FSIQ=68). On executive function tasks, her planning skills (DELF-4; Delis, Kaplan, & Kramer, 2001) and ability to follow directions (CELF-4; Semel, Wiig, and Secord, 2004) both fell in the moderately impaired range (2nd percentile). Language skills were generally reported to fall in the low-average to impaired ranges. In contrast, her ability to complete visual-perceptual tasks (WISC-IV; Wechsler, 2003) that tapped her ability for complex, nonverbal reasoning was assessed in the high-average range (75th percentile).

Sarah presented to the investigator as a quiet, thoughtful child. At times she displayed a wry sense of humor. She did not socially engage with the investigator very frequently, though appeared to have a number of friends she spent time with after school and during the weekends. During sessions of the present study that included the prompting of Wh- questions, she often displayed difficulty providing relevant explanations of what she had read.

Sessions were held with Sarah at her high-school, with the exception of the last several sessions, which were held at her parents' home. Sarah was initially assigned a GE 7.0 text during pre-baseline phase, approximately one grade level above her passage comprehension level (5.8) and approximately two grade levels above her reading fluency level (4.8), as recorded during pre-testing. She gained two scores of 80% on RC probes for the GE 7.0 text. A GE 8.0 level text was determined to be most appropriate to target her instructional reading level. Accordingly, her results listed in Chapter 4 only include data using GE 8.0 text.

June

June was a 16-year-old girl in the 10th grade who had been diagnosed with Asperger syndrome. Because she was unable to participate in either treatment condition, her results are not included in the analysis.

June was assigned a GE 8.0 level text, approximately two grade levels above her passage comprehension level (5.8), and approximately one-half a grade level below her reading fluency level (8.7), as recorded during pre-testing. A GE 8.0 text was used for the duration of baseline phase.

Design

The effects of the two independent variables (i.e., GAO using Wh- questions vs. verbal prompting of Wh- questions) were evaluated using an alternating treatment single-case design, which included a delayed baseline phase. Although an experiment that employs alternating treatments does not require the use of a baseline phase prior to the introduction of the alternating treatments, such a measurement of baseline performance is desirable when the effects of the alternating treatments are unclear or unproven (Herrera

& Kratochwill, 2005). The alternating treatments were counterbalanced across participants, in order to reduce sequencing and carryover effects (Barlow & Hayes, 1979).

In Study 1A, the alternating treatment was administered sequentially (i.e., A-B-A-B-A-B-A-B etc.), which is considered a generally acceptable practice (Kratochwill et al., 2010). However, semi-random sequencing of intervention sessions is considered more desirable, where more than two sessions of the same treatment condition do *not* occur back-to-back (e.g. A-B-A-B-B-A-A-B), to reduce potential carry-over effects between treatments (Kratochwill et al., 2010). Semi-random sequencing was therefore used for the Study 1B.

The implementation of baseline phase and intervention phases were made with the consultation of a faculty member on the investigator's dissertation committee. For each session, grade appropriate Read Naturally (Ihnot et al., 2012) texts were used for the investigation.

Dependent Variable

The dependent variable was a "conceptual cloze procedure " (El Zein, 2014), in which ten key words of the administered reading were deleted for the participant to fill in after the completion of each reading. A "conceptual cloze procedure" was chosen over a "random" cloze procedure that uses fixed-ratio deletions (i.e., every *nth* word). Although the random cloze controls for task difficulty more effectively, in principal, the conceptual cloze more capably targets content words for deletions that are more central to the understanding of a text (Bachman, 1985; Greene, 2001). Deletions targeted key nouns, verbs and adverbs, and were distributed roughly equally throughout each reading. Words that appeared on a GO used in the study were not targeted as cloze deletions. One point was granted to the participant for cloze completions that were either an (a) exact match to the original text or (b) semantically similar. Words that were semantically similar but syntactically inappropriate were also marked as correct. No credit was provided for semantically incorrect cloze completions or cloze deletions that were left blank by the participant. Scores were calculated for each cloze quiz as correct words/10.

Procedure

Baseline, GAO, and verbal prompting conditions were identical, except for the use of the GAO in the GAO treatment, and the use of Wh- questions posed to the participant in the verbal prompting treatment. The precise nature of the Wh- questions (represented either in the GO or used for verbal prompting) depended on the text being used. In both treatments, three questions were included using a combination of "who", "what", "where" and "what doing" questions, as has been used previously in Bethune and Wood (2013).

Baseline

a. The interventionist discussed with the student what the student knew about the given topic that was to be presented in the text (i.e., review of background knowledge).

b. The interventionist discussed any vocabulary with the student (presented at the top of each reading), with which the student might be unfamiliar (i.e., vocabulary preview).

c. The student read the passage orally to the interventionist.

d. During the oral reading, the student reviewed any unfamiliar vocabulary words from within the text that had not been reviewed in the earlier vocabulary preview.

e. After reading, the student completed the cloze procedure independently.

Graphic Advance Organizer

a The interventionist discussed with the student what the student knew about the given topic that was to be presented in the text (i.e., review of background knowledge).

b. The interventionist discussed any vocabulary with the student (presented at the top of each reading), with which the student might be unfamiliar (i.e., vocabulary preview).

c. Graphic organizer was introduced and orally read by the participant before being removed.

d. Student orally read the passage to the interventionist.

e. During the oral reading, the student reviewed any unfamiliar vocabulary words from within the text that had not been reviewed in the earlier vocabulary preview.

f. After reading, the student completed the cloze procedure independently.

Wh- Question Verbal Prompting

a. The interventionist discussed with the student what the student knew about the given topic that was to be presented in the text. (i.e., review of background knowledge).

b. The interventionist discussed any vocabulary with the student (presented at the top of each reading), with which the student might be unfamiliar (i.e., vocabulary preview).

c. The student orally read the passage to the interventionist.

d. Early in the reading, the student was prompted with three Wh- questions about the text.

e. During the oral reading, the student reviewed any unfamiliar vocabulary words from within the text that had not been reviewed in the earlier vocabulary preview.

f. After reading, the student completed the cloze procedure independently

Materials

Materials for each session were provided by the present investigator and included the following: (a) assigned texts for student reading from Read Naturally (Ilnot et al., 2012; an example can be found in "Appendix B") (b) accompanying graphic organizer (only in the GAO treatment condition; an example can be found in "Appendix A") (c) cloze procedure measure (Appendix C) (d) fidelity observation form for recording the fidelity of the intervention's implementation (Appendix D) (e) video camera for recording sessions (f) timer and (g) writing utensils.

In the present study, recommendation for creating GOs provided by Dexter and Hughes (2011, p.53) were considered:

> A well-made GO consists of a superordinate concept (e.g., main idea, topic) placed in an oval in the middle or top of the page. Coordinate concepts (e.g., categories representing related concepts) are placed in ovals surrounding or underneath the superordinate concepts. Coordinate concepts can include a variety of examples, functions, or characteristics of the superordinate concept. Finally, subordinate concepts (e.g., concepts representing the coordinate concept) are listed below each coordinate concept (Bos & Anders, 1990, 1992; Pearson & Johnson, 1978).

In the present study, the GO consisted of a superordinate concept (i.e., name of reading) placed in a box at the top of the page. Three coordinate concepts (i.e., three Wh-questions) were placed in ovals underneath the superordinate concept. Subordinate concepts beneath each coordinate concept briefly summarized information from the text. As described in Chapter 1, GOs used in the present study represented an abstract of the text (i.e., O'Connor & Klein, 2004) across subordinate concepts.

Sessions

For studies 1A and 1B, sessions were conducted 3-5 times per week, depending on the availability of participating students. For Study 1A, the intervention took place over the last six weeks of the Spring semester. For Study 1B, the intervention took place over an eight week period during the following Fall semester. Two passages were typically read (and their respective cloze procedures completed) by each participating student during each meeting. On a number of occasions, however, time only allowed for one reading and accompanying cloze procedure to be completed.

Data analysis

Data was analyzed in two ways. First, using Microsoft Excel, line graphs of each participant's data were created to measure reading comprehension performance, based on the student's cloze procedure scores. Lines were inserted to visually differentiate different phases of the study. This method allowed for the data for each student to be visually inspected. Visual inspection is a common method of analysis in single-case research (Kennedy, 2005). Second, the percentage of non-overlapping data (PND) was calculated for each participant on cloze procedure scores. Calculating PND requires an identification of the percentage of points that are above the highest point found in baseline. The interpretation of PND is as follows: (a) <90%=very effective (b) 70-90%=effective treatment (c) 50-70%=questionable treatment (d) below 50=ineffective (Scruggs, Mastropieri, 1988).

Fidelity of Implementation and Inter-Rater Agreement

A doctoral candidate, trained by the present investigator, from the Special Education Department at a tier-one university where the investigator was enrolled, scored 40% of each participant's videotaped sessions from Studies 1A and 1B for fidelity of the intervention's implementation. He also scored 40% of each participant's cloze procedures from Studies 1A and 1B to establish inter-rater agreement. Both the sessions and cloze procedures that were rated were randomly chosen by the doctoral candidate from an equally distributed number of baseline, GAO, and verbal prompting sessions.

The intervention was implemented with "high" procedural fidelity for participants (2.8/3.0; 93%) with an overall rating of "high quality" (6.7/7.0; 96%). Inter-rater agreement on the cloze procedures was 91%.

CHAPTER 4: RESULTS

Method of Interpretation

Results of the present single-case study, which employed a delayed multiple baseline design, were interpreted using visual analysis (Kennedy, 2005) and percentage of non-overlapping data (PND; Scruggs & Mastropieri, 1988). Interpretation of PND is as follows: (a) <90%=very effective (b) 70-90%=effective treatment (c) 50-70%=questionable treatment (d) below 50%=ineffective. These two evaluative tools were used to determine whether functional relationship(s) existed between two separate alternating treatments (i.e., GAO; prompting of Wh- questions), administered iteratively following an initial baseline phase, and improved reading comprehension of short expository texts, in six participants previously diagnosed with ASD.

Overall Results

Overall results from the study illustrated a variable treatment response by participants to the intervention (i.e., both treatment conditions), which was conducted in 2014 over the course of the spring (Albert and Samuel; Table 4.1; Figure 4.1) and fall (Hank, Brad, Sally, June; Table 4.1; Figure 4.2) semesters. A functional relationship was established between the introduction of both the graphic advance organizer (GAO) and "prompting of Wh- questions" (PR) treatments and higher mean response accuracy on reading comprehension (RC) probes for one participant (Samuel); a second participant's (Albert's) RC performance likely benefited from the increased instructional support provided during both of the alternating treatments; three other participants (Hank, Brad, and Sally), in contrast, did not demonstrate improved RC performance due to either treatment and were characterized as non-responders to the intervention. Due to extenuating circumstances, a sixth participant (June) only completed baseline phase, and the effect of both treatments on her RC performance was therefore unknown. Although June's results are discussed below, since she did not participate in the intervention phase her data is not included in the accompanying figures and table.

Table 4.1. *Mean Scores for Accuracy of Responding on Reading Comprehension Probes*

Participant	Baseline (%)	Graphic Advance Organizer (%)	Wh- Question Prompting (%)
Albert	40	69	57
Samuel	41	77	77
Hank	58	68	61
Brad	63	75	64
Sally	73	71	69

Figure 4.1. *Reading Comprehension Performance for Albert and Samuel (Study 1A)*

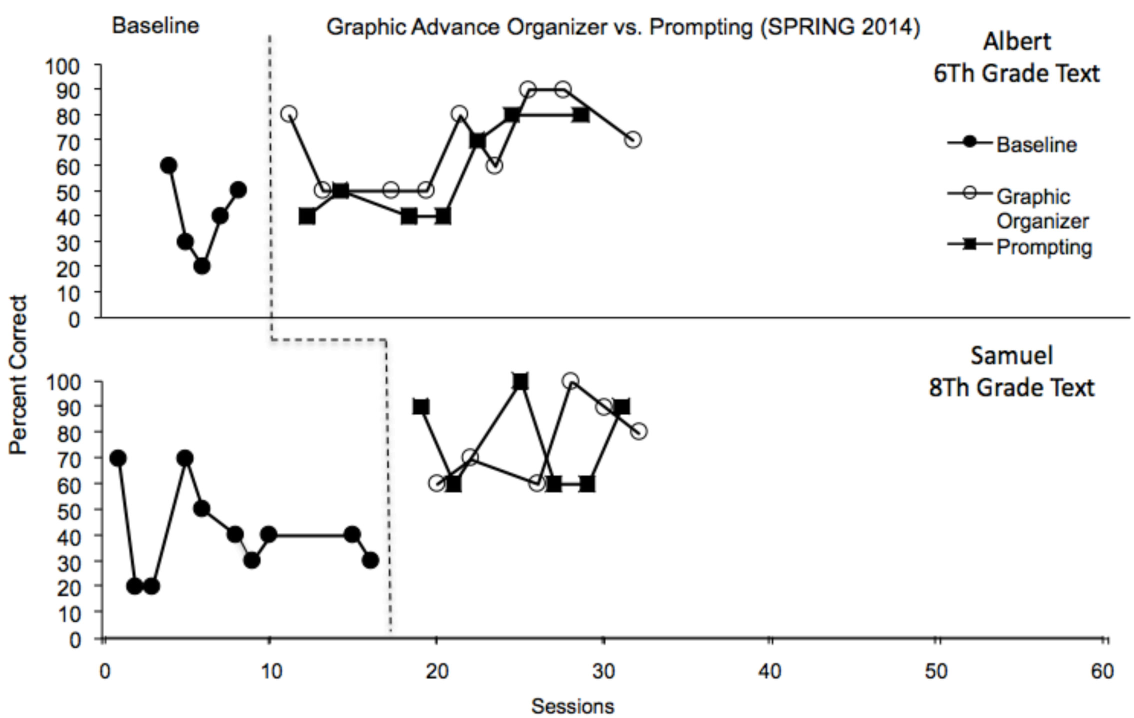
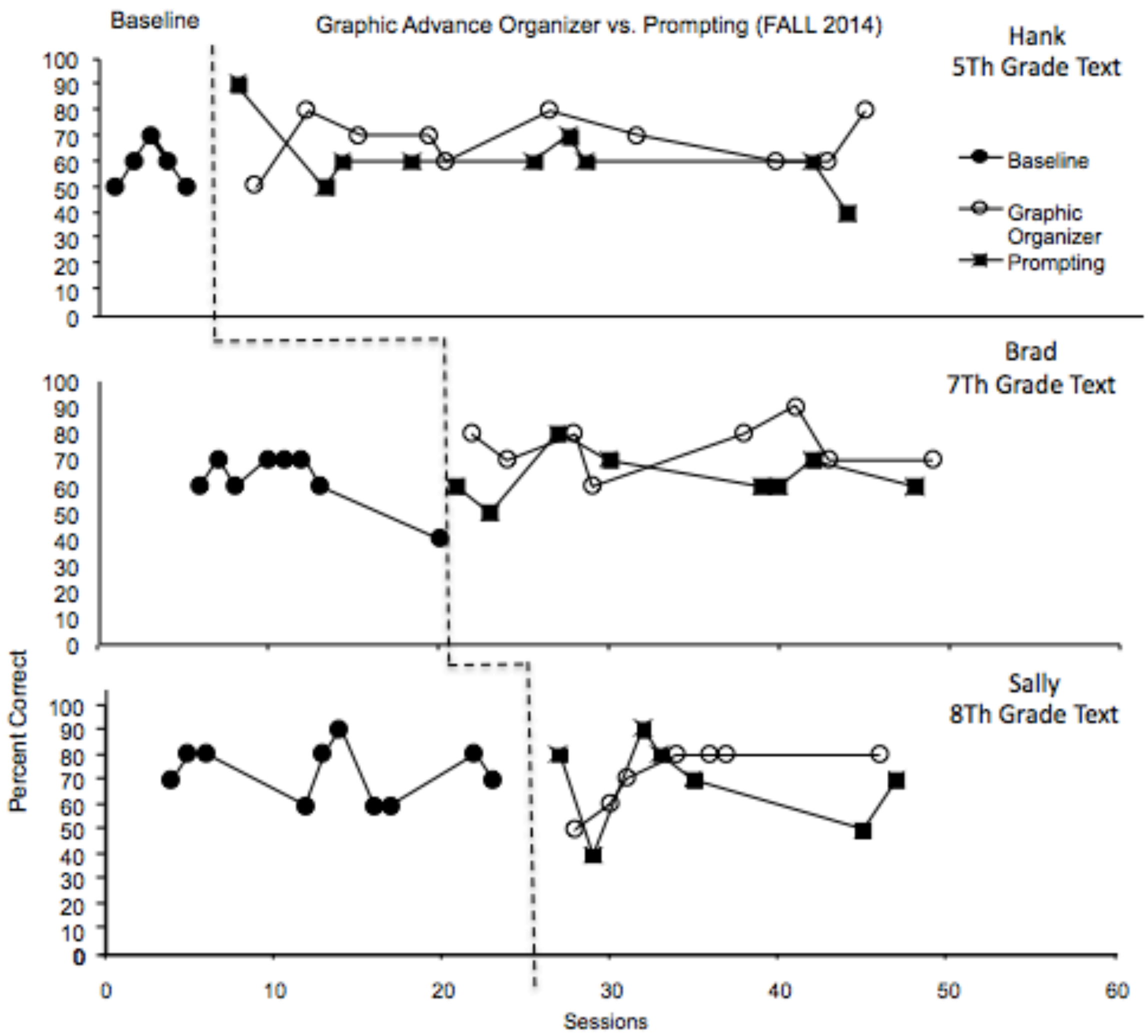


Figure 4.2. *Reading Comprehension Performance for Hank, Brad, and Sally (Study 1B)*



Individual Results

Albert

Baseline phase. During the five sessions that were conducted during baseline phase, Albert's scores ranged between 20% and 60% with a mean of 40%. An ascending trend of scores (i.e., 20%, 40%, and 50%) was observed over the course of his last three baseline sessions. As time restrictions did not allow further evaluation of baseline performance, intervention phase commenced upon the completion of his fifth baseline session.

Graphic Advance Organizer phase. During the nine sessions that composed the GO phase, comprehension scores ranged between 50% and 90% with a mean of 69%. After an initial RC score of 80% was recorded for the first GO session, performance decreased to 50% for each of the three following sessions. A generally ascending trend of scores between 60% and 90% was recorded for the remaining five sessions. As a result of an interruption to one session, two GO sessions followed each other consecutively.

Prompting of Wh- Questions Phase. Over seven PR treatment sessions, a range of scores on RC probes between 40% to 80% was recorded, with a slightly smaller mean score compared to the GO treatment, of 57%. After initial scores of 40% and 50% were observed during the first four prompting sessions, scores increased to 60% or 70% for the remaining three sessions, mirroring the upward trend of scores observed during the GO treatment.

General Results. Although the data was not entirely conclusive due to unsteady baseline performance on RC probes, Albert's increased mean level of response accuracy during the GO (29%) and PR treatments (17%) strongly suggested that both treatments improved his RC performance. Although no immediacy of effect on RC performance was present during the introduction of either GO or PR phases, positive shifts in the distributions of the ranges of scores compared to baseline, as well as ascending trends of performance during both treatments, were recorded during the study. Despite these noteworthy gains in scores during treatment phases, according to standards of PND, the

GO treatment was found to be questionably effective (PND=56%) and the PR treatment was found to be ineffective (PND=43%).

Samuel

Baseline phase. During the ten baseline sessions that were conducted during baseline phase, Samuel's scores on RC probes ranged between 20% and 70% with a mean of 41%. Over the course of his last five baseline sessions, a low, stable baseline was established with scores of either 30% of 40% recorded for each RC probe.

Graphic Advance Organizer Phase. During the six sessions that composed the GO phase, RC scores between 60% and 100% were observed with a mean of 77%. An immediate effect of the GO treatment was also observed: mean response accuracy of 30% or 40%, recorded during his last three baseline sessions, increased to 60% or 70% on RC probes during his initial three GO sessions. Higher scores, which ranged from 80% to 100%, were recorded during his last three sessions.

Prompting of Wh- Questions Phase. Over six PR treatment sessions, an identical range of RC scores to GO phase of 60% to 100% was recorded with an identical mean of 77%. The PR treatment produced an immediate effect with scores between 60% and 100% recorded during the initial three PR sessions. Performance within this range was variable across sessions.

General Results. The two interventions were equally effective for Samuel: both produced an increase in RC performance over baseline of 36%. This increase was accompanied by an immediate effect of the GO and PR treatments. A positive shift in the distribution of the range of scores compared to baseline also emerged during both treatment phases. Performance within both of these ranges was variable. As a result of two high outlying RC scores of 70% during baseline, PND for both treatments was 50%, rendering both treatments questionably effective.

Hank

Baseline Phase. During the five sessions that were conducted during baseline phase, Hank's scores on RC probes ranged between 50% and 70% with a mean of 58%. An ascending trend of scores during the first three baseline sessions (i.e. 50%, 60%, 70%) was followed by a descending trend of scores during the remaining two baseline sessions (i.e. 60%, 50%.)

Graphic Advance Organizer Phase. During the ten sessions that composed the GO phase, RC scores between 50% and 80% were observed with a mean of 68%. Scores were variable within this range, and did not reveal any particular trends in the data. With the exception of three scores of 80%, the remaining fell between the baseline range of scores of 50%-70%.

Prompting of Wh- Questions Phase. Over nine PR treatment sessions, a range of RC scores between 40% and 90% were recorded with a mean of 61%. With the exception of the first (90%) and last (40%) RC scores observed during PR phase, RC performance formed a discernible trend: scores with an identical range to baseline of 50% to 70%.

General Results. Neither intervention was shown to improve Hank's RC performance. He gained mean RC scores 10% and 3% above baseline for the GO and PR treatments respectively. These marginal gains in mean RC performance observed during both of the treatments, when coupled with a lack of other positive trends in the data during treatment phases, did not provide sufficient evidence to demonstrate that either treatment improved his RC performance. If indeed either treatment produced a positive effect on RC performance, the effect was likely very small. PND was 30% and 10% for the GO and PR treatments respectively.

Brad

Baseline Phase. During the seven sessions that were conducted during baseline phase, Brad's scores on RC probes ranged between 40% and 70% with a mean of 63%. Brad produced an immediate steady baseline performance: scores of either 60% or 70% on each of the administered RC probes, with the exception of his last baseline session, where a score of 40% was recorded.

Graphic Advance Organizer Phase. During the eight sessions that composed the GO phase, scores on RC probes ranged between 60% and 90% with a mean of 75%. Scores were variable across these sessions, but revealed both a slight increase in his mean response accuracy compared to baseline performance and an upward shift in the distribution of the range of scores over baseline.

Prompting of Wh- Questions Phase. Over eight PR treatment sessions, a range of 50% to 80% percent accuracy was recorded on RC probes with a mean of 64%. Similar to scores observed during GO phase, scores were variable across sessions. Only one of these eight sessions produced a RC score (80%) above the range of 40%-70% recorded during baseline.

General Results. Neither intervention demonstrated improvement of Brad's RC performance. Brad gained mean scores 12% and 1% above baseline for the GO and PR interventions respectively. Neither of these minimal gains in mean RC scores or other trends in the data indicated that either intervention bolstered Brad's RC performance. If indeed either treatment was beneficial, the effect was likely minimal. PND for the GO and PR treatments was 50% and 12.5% respectively.

Sally

Baseline Phase. During the ten sessions that were conducted during baseline phase, Sally's scores on RC probes ranged between 60% to 90% with a mean of 73%. Performance within this range was variable across sessions and did not form any discernible trend.

Graphic Advance Organizer Phase. During the eight sessions that composed the GO phase, scores on RC probes ranged from 50% to 80% with a mean of 71%. An upward trend of scores (50%, 60%, 70%) was followed by four sessions during which 80% response accuracy was recorded on each RC probe. One of Sally's eight RC scores (40%) fell below the range of scores of 60%-90% recorded during baseline phase.

Prompting of Wh- Questions Phase. Over seven PR treatment sessions, a range of 40% to 90% was recorded on RC probes with a mean of 69%. Scores were variable across sessions and did not form a discernible pattern within this range. Two scores of 40% and 50% fell below the range recorded during baseline.

June

General Results. Although June completed baseline phase, she did not participate in either treatment phase provided in the study. After the conclusion of the fall semester, her availability was limited, causing her withdraw from the study. During June's twelve baseline sessions, she gained scores on RC probes that ranged from 60% to 100% with a mean of 79%. Several scores were recorded at or near ceiling levels: two scores at 90% response accuracy and two others at 100%. Given her very capable performance during baseline, a trend of improvement (but not drastic improvement) in other participants who were responsive to the treatments, and the role of ceiling effects, it appears unlikely that the data from either treatment phase would have demonstrated improvement to her RC performance had she completed the study.

Summary

Response to the intervention provided in the alternating treatment was variable across participants included in the present study. One participant (Samuel) demonstrated clear and immediate improvement on RC probes during both treatment conditions; a second participant (Albert) showed more gradual improvement of RC performance during both treatment conditions, following unstable baseline performance; other participants did not demonstrate responsiveness to the intervention. As explored in the following chapter, this variable treatment response was likely due to either (a) the well-documented cognitive heterogeneity found between individuals with ASD, which potentially impacted the ability of some participants included in the study to effectively utilize the instructional supports provided in the respective treatment conditions (b) compromised internal validity in the study, which potentially decreased the validity of results, or (c) a combination of both factors.

CHAPTER 5: DISCUSSION

Research Questions

The present research study sought to address two questions:

1. To what degree (if any) do (a) an advance graphic organizer (GAO) with "Wh-" question information and (b) a comparison condition of instructional prompting of "Wh-" questions (PR), promote reading comprehension?
2. If either treatment promotes reading comprehension, does (a) graphic organizers with "Wh-" question information (GAO) *or* (b) a comparison condition of instructional prompting of "Wh-" questions (PR), promote reading comprehension more effectively?

Even without considering threats to internal validity, (discussed in the "Limitations" section below), the responses to both questions are not entirely definitive. One participant clearly benefited from the GAO condition, a second may have, while three others were non-responsive. The mean accuracy improvement for the GAO condition was slightly higher than for the PR condition – but only if non-responsive participants were included in this analysis.

Question 1

Samuel demonstrated clear and immediate improvement in mean response accuracy on reading comprehension (RC) probes during both treatment conditions. A functional relationship was therefore established between the introduction of both the graphic advance organizer (GAO) and "prompting of Wh- questions" (PR) treatments and higher mean response accuracy on reading comprehension (RC) probes. Albert showed more gradual improvement to RC performance during both treatment conditions, following an initial period of unstable baseline performance. Due to time restrictions a continuation of baseline sessions was untenable. Similar to one or more participants from two other published single-case studies that have investigated reading comprehension interventions (RCIs) in ASD (i.e., Carnahan & Williamson, 2013; Carnahan et al., 2016), Albert finished baseline phase on an ascending trend line. Nonetheless, if the three scores he recorded at the conclusion of baseline phase (i.e., 20%,, 40%, 50%) represented the beginning of an ascending trend of performance, the validity of the 29% gain he recorded in mean response accuracy in the GAO condition is questionable.

The three other participants were non-responsive. The alternating treatment design of the present study did not allow for *within-participant* replications of the treatment effect to be demonstrated, which is one method of illustrating a functional relationship between the manipulation of an independent variable(s) and a dependent variable. More importantly, three *between-subject* replications of the treatment effect *were not* demonstrated in the present study. Therefore, a functional or causal relationship between the introduction of either independent variable (i.e., GAO or PR) and the dependent variable *was not* demonstrated (Horner et al., 2005).

Question 2

It remains unclear whether the treatment of interest – the GAO treatment – was more effective at promoting reading comprehension than the prompting of Wh-questions. Samuel performed equally well during both treatment conditions: He gained 36 percentage points over baseline for a mean response accuracy rates 77%. If Albert's scores were representative of his true performance, he improved slightly more over his average baseline performance (40%) on the GAO condition (69%) compared to the PR condition (57%). Although surely not approaching statistical significance as gauged by a *t* test, an analysis that includes non-responders shows that all five participants performed at least as well if not better on the GAO condition compared to the PR condition (i.e., mean improvement in accuracy = 0%-11% differential), suggesting the GAO treatment may have had a slightly greater effect facilitating reading comprehension.

Variable Treatment Response

Across-Participants Variability

The heterogeneity of participant characteristics across participants on several parameters may have made some participants more susceptible to the GAO treatment than others. Participants varied in the severity of their ASD diagnosis. Three participants (Albert, Hank, Sally) had been previously diagnosed with milder variants of ASD (i.e., Asperger syndrome or PDD-NOS) that are associated with higher verbal ability and do not include “pragmatic language difficulties” as a pre-requisite for diagnosis. In contrast, two participants (Albert, Brad) were diagnosed with more severe forms of ASD (i.e., autism or Autism Spectrum Disorder) that are associated with lower verbal ability and include this deficit in language pragmatics. Although not all testing of participants’ global cognitive functioning had been administered recently, participants also varied on this measurement. Two participants were reported to have global cognitive functioning in the “high average” range (Samuel, Hank), one in the “borderline impaired or delayed” range (Brad), and two in the “impaired or delayed” range (Albert, Sally). Participants also varied considerably on their reading fluency (GE range = 2.5 – 7.3) and reading comprehension (GE range = 2.6 – 5.8) levels in testing administered by the investigator, but did not demonstrate the well-documented within-participant differential between higher reading fluency and lower reading comprehension found in many individuals with ASD (Brown et al., 2013). It is not clear whether the facilitative effect of GOs differentially impacts individuals with ASD specifically on parameters discussed above: (a) diagnosis, (b) global cognitive ability, (c) reading fluency or (d) reading comprehension level. However, lower verbal ability, which interacts with several of these parameters, has been associated with a greater facilitative effect from GOs (Dexter & Hughes, 2011).

Participants also varied on their level of executive functioning. The two participants who appeared to benefit from the intervention either scored within the "typical" range on recently administered executive functioning sub-tests (Albert), or did not have difficulties with executive functioning noted in previous testing results (Samuel). In contrast, the two participants who were non-responders (Hank, Sarah) had well-documented histories of executive function deficits recorded in previous testing. Another non-responder, Brad, did not have executive function difficulties noted in his file, but during sessions with the investigator sometimes transposed, omitted, or mispronounced syllables of words – behaviors that are consistent with phonological processing disorders such as dyslexia (Gaab et al., 2007). These maladaptive decoding behaviors displayed by Brad do not necessarily suggest his cognitive profile included an executive functioning deficit; instead they are more compatible with the possibility that other factors unrelated to reading comprehension may have affected his ability to benefit from the GAO treatment.

Within-Participant Variability

Considerable variability in reading comprehension performance was also recorded for individual participants. Although experimental control was established in baseline phase for all participants with the possible exception of Albert, baseline phase scores for several participants were variable. This trend of uneven reading comprehension performance continued for several participants during treatment phases. At least three possible factors might explain this within-participant variability that relate either to the type of instruction that was provided in the intervention or to the potential variability in the difficulty of the texts that were used for the intervention.

First, unlike a number of published RCI studies of students with ASD, the present study did not seek targeted responses during treatment phases, which has the potential to produce higher and steadier performance during these phases. RCIs that relied heavily on explicit instruction, including a system of least-to-most prompting (i.e. Bethune & Wood, 2013; Zakas et al., 2013), sometimes "guide" participants toward the correct answer on researcher-designed comprehension probes and also provide participants with multiple opportunities to submit the correct answer. Such courses of instruction may therefore unintentionally inflate mean participant accuracy rates on reading comprehension probes during treatment phases, producing higher and more stable trends of performance. In contrast, no such prompting was provided in the current study. With the exception of the treatments themselves (i.e., GAO or verbal prompting of Wh- questions), the only additional instructional support that was provided during the oral reading of the text was the review of unfamiliar vocabulary words. In an attempt to control across treatment conditions for task difficulty, participants were not even provided with answers to questions they posed to the investigator about the text during or after its reading. Consequently, variability in response accuracy rates from individual participants in the current study may partially be the result of natural variability in performance that was not bolstered or stabilized by instructional support.

Second, without the inclusion of a stronger instructional scaffolding provided by the investigator, the reading level of text assigned to participants may have been too difficult. As a result, participants may have provided a disproportionate number of "guesses" on their reading comprehension probes that could have contributed to unsteady performance. Participants were originally targeted with reading materials that were rated to be between one-half to one grade above their grade equivalent (GE) passage comprehension score (WJ-III; Woodcock et al., 2001). However, in order to produce performance that was (a) steady and (b) not at or near the performance ceiling of the cloze procedure (i.e. 10/10), the texts that were eventually used for each participant in baseline phase were between two and 2.5 grades above GE passage comprehension scores.

Third, variability in text difficulty may have contributed to variability in accuracy on the reading comprehension probes. The "Read Naturally" expository texts that were chosen for the present study were developed for increasing oral reading fluency (Hasbrouck, Ihnot, & Rogers, 1999), not for improving reading comprehension. High positive correlations between reading fluency and reading comprehension are well-established (Hasbrouck & Tindal, 2006; Fuchs, Fuchs, Hosp, & Jenkins, 2001). However, such results may indicate that individuals gain these two dissociable skills in roughly equal measure, not that reading texts themselves have highly correlated fluency and comprehension levels. Studies of individuals with ASD, who often have capable reading fluency skills coexisting with weak reading comprehension skills (Nation et al., 2006; Brown et al., 2013), strongly suggest that the fluency level of a text is not necessarily a strong indicator of its reading comprehension level. It would appear furthermore unlikely that the Read Naturally grade level passages – 24 of which are included for each grade level – are necessarily written to the same comprehension level simply because they are written to the same fluency level. For example, is the text passage "Tornadoes", which describes how dry air, moist air, and water vapor collaborate to create a spiraling vortex, written at the same reading comprehension level as the text of "King Henry VIII", which describes how the king's beheading of wives, discomfort with Roman Catholicism, and formation of the Church of England, ushered in the Protestant Reformation? Both texts are taken from the Grade 7.0 text book of readings, but that on its own hardly establishes their relative levels of comprehensibility. Additionally, passages from the 7.0 book of readings on historical monuments (e.g., "The Leaning Tower of Pisa", "The Mexican Pyramids"), historical events (e.g., "The Tangshan Earthquake", "China's Ancient Buried Army"), a historical figure (e.g., "King Henry VIII"), and the science behind natural phenomena (e.g., "Earthquakes", "Radiation") recruit different amounts and different kinds of background knowledge, which clearly must differentially impact the understanding of text (Kintsch, 1988; MacNamara & Magliano, 2009). Stated differently, it's difficult to imagine these potential differences in reading comprehension level and background knowledge recruitment required for understanding passages, which were purportedly written to the same grade level, would not be reflected in variable rates of accuracy on reading comprehension probes.

An Executive Function and Construction-Integration Account of Results

The present study provides only scant data for formulating a robust hypothesis that explains precisely why the present study produced the observations described here. Besides including only five participants from which to draw conclusions, the intervention itself provided only a bare minimum of instructional support and interaction between the investigator and each participant. This light course of instruction sought to minimize variability in the treatments (i.e., GO vs. PR) that could potentially contribute to reading comprehension performance, but provided few opportunities to understand precisely how participants conceptualized the reading material. The cloze procedure, which involved filling in blanks for deleted words, similarly did not provide much of a window into the cognitive processing of each participant. In fact, the single greatest opportunity for the investigator to gain a sense of how the participant conceptualized the passage material occurred when participants answered Wh- questions during the comparison condition in the alternating treatment. In order to control for the length of the sessions across the two treatments, however, these interactions were rather brief, once again limiting the investigator's ability to gauge participant conceptualization of the material.

Despite this paucity of observational data, there is a plausible – albeit parsimonious – account that explains why both interventions may have worked for some participants but not for others. It draws on both performance data and clinical records of participants. While participants varied considerably across a number of parameters, including reading comprehension ability and global cognitive ability (as discussed in greater detail earlier), based on available data the best predictor of whether the treatments were effective for individual participants appears to be their level of executive functioning ability. Albert and Samuel, who each appeared to have benefited from both treatments, each appeared to have intact executive function skills. In contrast, Hank and Sarah did not, whereas Brad appeared to have additional reading difficulties related to word decoding that interfered with his reading comprehension.

Albert's uneven cognitive profile is particularly striking. Despite impoverished receptive language scores recorded below the 1st percentile on the CELF-4 (Semel et al., 2004) and overall global cognitive ability in the "very delayed" range (KBIT-II; Kaufman, 2001), Albert demonstrated executive function sub-skills in the "typical" range for all but one of the Behavior Rating Inventory of Executive Function (BRIEF's; Gioia et al., 1996) sub-tests. (A more detailed clinical description is provided in Chapter 3.) On one of the only CELF-4 sub-tests that significantly recruits executive functioning processes, Albert displayed an ability in the "high average" range to assemble disorganized sentences in correct sequential order (63rd percentile.) Besides intact executive function skills, his reading comprehension performance in the GO treatment, which was slightly stronger than in the PR condition, may have been further buoyed by relatively strong visual-spatial abilities that had been recorded in the "high average" range. Relatively low verbal ability, which differentially benefits students with LD in promoting GO-facilitated reading comprehension (Dexter & Hughes), may have also contributed to stronger performance during this treatment.

Albert exhibited a "literal interpretation" of speech and prose according to one of his teachers, consistent with the investigator's own observations. As such, he may have fit Williamson et al.'s (2013) reading profile of a "Text Bound Comprehender" with

“Low Comprehension”. Individuals with this particular reading profile do not necessary create a “situation model” that draws on background knowledge and experience to inform their meaning of the text (Williamson et al., 2013). An alternative, plausible explanation would suggest that his improvement in cloze procedure accuracy during the treatments was the product of intact retrieval memory. However, this second interpretation was not supported by results of the CELF-4 assessment (Semel et al., 2004), which showed performance for his recall of sentences in the 0.1 percentile.

Samuel’s cognitive profile was quite different in most respects from Albert’s. His global cognitive ability measured on the WISC-IV assessment (Wechsler, 2004) was reported to be in the high average range (FSIQ=108). In addition to the fact that an assessment of his cognitive profile was gauged by psychometric data that was older than Albert’s, the conclusion that he had intact executive function skills was not supported by positive evidence in his clinical file indicating that his executive functioning skills were intact. Instead, this conclusion was supported by a lack of any indication in his clinical file that he had executive functioning difficulties, by the investigator’s observation of Samuel’s behavior, and by the impression provided by the teacher of his mainstream social studies class that he was a strong student.

Samuel’s tendency to ask strategic questions about the reading and to provide thoughtful and full answers to Wh- questions, which sometimes incorporated his background knowledge, suggested he might be a “Strategic Comprehender” with “High Comprehension” (Williamson et al., 2011). With the possible exception of Brad, Albert was likely in many respects the most “neurotypical” of the six children (including June who only underwent baseline phase) participating in the study. Alternatively, his improved mean accuracy rate for both treatment conditions over baseline phase may not have derived from intact executive functioning skills – or at least it derived from *more* than his intact executive functioning skills. Instead, his overall success might be attributed to the fact that, compared to his peers in the study, he may have had an elevated ability to assemble more intact mental representations of presented texts that served, in turn, as solid foundations for utilizing the treatments to improve his reading comprehension.

With only five students participating in the baseline and treatment phases, this present work does not demonstrate how important intact executive functioning skills actually are to being able to effectively utilize the treatments that were implemented. No studies, in fact, have examined the relationship between executive functioning performance of individuals with ASD and performance on a RCI – let alone one that includes GOs or the answering of Wh- questions. And yet an educated guess would suggest that executive functioning skills were critical to effectively utilizing the study's treatments. Both treatments clearly implicate the ability to direct attention and working memory to relevant content and away from irrelevant content, just as reading comprehension in general requires (Sesma et al., 2009; Locascio et al., 2010). It would seem therefore that intact executive functioning skills helped facilitate the creation of accurate mental representations of treatment-generated content for Samuel and Albert, which in turn facilitated their understanding of accompanying texts.

It remains unclear, however, precisely how participants who ostensibly benefited from this study were actually able to do so. According to the Construction-Integration model (CI; Kintsch, 1988), along with more recent work using CI theory (Wahlberg &

Magliano, 2004; Williamson et al., 2013), at least two non-exclusive models hypothetically would exist for explaining how “treatment-generated mental representations” (TGMRs) from the GAO or PR treatments would interact with the “propositional textbase”, to promote reading comprehension in successful readers of the present study.

One model can be called the “TGMR Textbase Model”, while the other the “TGMR Situation Model.” Both models necessarily include a propositional textbase, which consists of propositions that represent basic relationships between ideas within the text (Kintsch, 1988). Readers extract the propositional textbase from propositions – the basic “idea units” of a text and how they relate to each other – and continually draw inferences between sentences (micro-propositions) and passages (macro-propositions) in order to maintain text coherence (Perfetti & Frishkoff, 2008).

Although both models necessarily include a propositional textbase, only the TGMR Situation Model includes a “situation model,” which facilitates reading comprehension but is not a necessary precursor for it (Wahlberg & Magliano, 2004). The situation model is the reader’s understanding of “what the text is about” and includes the reader’s background knowledge and experiences. It also provides extra-textual inferences used to contextualize information from the propositional textbase (MacNamara & Magliano, 2009). In contrast to the propositional textbase, the situation model is comprised of non-propositional and nonverbal information. It may also include modality-specific representations (e.g. visual-spatial) as well as semantic representations (Perfetti & Frishkoff, 2008).

During the general reading comprehension process – when specific instructional aides are *not* provided – the processes associated with the propositional textbase and situation models continually interact with one another in order to provide the reader with a moment-by-moment comprehension of the text. An intervention, such as the one provided in the current study, contributes an additional variable to the mix: "treatment generated mental representations" (TGMRs). In a treatment such as the GAO provided in the current study, TGMRs may play a primary role by providing a superordinate knowledge structure that integrates information from the reading passage (Mannes & Kintsch, 1987). At least in NT participants, during an intervention TGMRs can *contribute* and enrich the situation model – that is, at least, the point of any intervention that aims to improve reading comprehension – and may serve as a subsuming knowledge structure from within the situation model (MacNamara & Magliano, 2009). Not all individuals with ASD, however, are believed to produce situation models in order to understand text (Wahlberg & Magliano, 2004; Williamson et al., 2013).

This first hypothetical model of results in the present study – the "TGMR Textbase Model" – states that the propositional textbase for a given reading subsumed the treatment-generated mental representation (TGMRs), and that in successful participants, TGMRs served to increase *intra*-textual cohesion of the propositional textbase (hereafter referred to as the textbase). This first account assumes that text comprehension did not develop or rely on the creation of a situation model that would have been capable of providing *extra*-textual inferences to increase the cohesion of propositions within the textbase. This model is a more plausible explanation for the PR treatment, where the introduction of the text – and ostensibly the formation of a textbase – preceded the introduction of Wh- questions that were asked early during the reading of the passage.

In the second hypothetical model – the "TGMR Situation Model" – that favors Mayer's (1979, 1983) "organizational hypothesis" of assimilation for GOs, TGMRs facilitated the creation of a situation model. TGMRs then served as a superordinate knowledge structure from within the situation model for organizing an understanding of what the text was about. The use of TGMRs to develop a situation model is most plausible for the GO treatment, where the introduction of the treatment – and ostensibly formation of TGMRs – preceded the introduction of the text. In contrast, in the PR treatment, where the textbase preceded the answering of Wh- questions, mental representation produced by the textbase instead of those produced by the treatment may have served as the superordinate knowledge structure from within the situation model.

However, in the TGMR Situation Model, TGMRs could have actually served as the subsuming knowledge structure for both treatments, not simply the GAO treatment. Even though the text was introduced before the treatment in the PR condition, the engagement of participants in an active, generative learning process (O'Donnell, Dansereau, & Hall, 2002; Stull & Meyer, 2007) during the answering of Wh- questions may have encouraged participants to utilize TGMRs generated from the treatment as a superordinate knowledge structure.

Stated differently, if participants created situation models of the text, it appears for *both* treatments that the treatment-generated mental representations (TGMRs) rather than the propositional textbase may have served as the superordinate knowledge structure contributing to the situation model. But the reasons for why this may be the case may differ in the two treatments. In the GAO condition, TGMRs may have been superordinate because of their temporal placement (i.e., before the introduction of the text), whereas in the PR condition TGMRs may have been superordinate because participants were engaging in active, generative learning during the treatment. The fact that the PR treatment was a verbal exercise and GAO treatment was a visual-spatial exercise may have also influenced how TGMRs from each condition were utilized.

The operation of TGMRs could furthermore be differentially impacted by (a) reader and (b) reading passage. For instance, if Albert were indeed a "Text Bound Reader" with low comprehension, he may have been unable to leverage TGMRs to create and contribute to a situation model. By default he would have integrated TGMR's into the textbase, as Williamson et al.'s (2013) model would predict. (Presumably Albert utilized TGMRs in some way, since his performance ostensibly improved as a result of the treatments.) In contrast, as a "Strategic Reader" who had strong background knowledge about a number of passages that were included in the study, Samuel might have automatically created a situation model – one that may or may not have shown a preference based on treatment condition for utilizing TGMRs or the textbase in contributing to the situation model. Furthermore, when reading passages where he commanded a high level of background knowledge, TGMRs and the textbase would have presumably contributed less to Albert's situation model than when he was reading passages where he knew little about the topic.

Limitations

The present work has a number of limitations that relate to the study's experimental design, implementation, dependent measure, participant pool, materials, and social validity.

Experimental Design

The experimental design may have promoted carry-over effects in performance because the two treatments were so similar to one another. Furthermore, the treatment was administered in sequential order (i.e. A-B-A-B-A-B-A-B etc.) in Study 1A and in semi-random order (e.g. A-B-A-B-B-A-A-B) in Study 1B. Although semi-random sequencing of intervention sessions is considered more desirable in order to reduce potential carry-over effects, both are considered acceptable practice (Kratochwill et al., 2010). Using both sequencing methods in a single study, however, potentially reduces the study's treatment fidelity. Additionally, answering the research questions in a single-case instead of group study reduced the potential generalizability of results.

Implementation

The investigator did not demonstrate a clear baseline trend for one of the participants who ostensibly benefited from the treatment. The validity of the reading comprehension gains he recorded are therefore questionable. This intervention also included an unusually high number of sessions. Including pre-baseline sessions used to establish steady participant performance, each of five participants who completed the intervention read passages and completed cloze procedures for approximately 30 readings. As a result, it is possible that some participants may have become less motivated and attentive to reading materials with increasing numbers of sessions. It is also possible that the high number of sessions administered to each participant represented a “learning burden” or created a “washout effect”. Lower motivation, learning burden, or washout could have contributed to lower scores for participants – particularly toward the end of the intervention.

The study was furthermore implemented during two different time periods during adjacent fall and spring semesters, which potentially compromised the integrity of the delayed multiple baseline design of this alternating treatment study. The intervention was additionally implemented in several settings, which had the potential to differentially impact outcomes: a public school (Albert and Samuel), a private school (Sally and June), and three different homes (Hank and Brad)[1]

Dependent Measure

The cloze procedure, which deleted important content words distributed throughout the text (El Zein, 2014), may not have appropriately controlled for difficulty (Bachman, 1985; Greene, 2001). Variable difficulty on this dependent measure could have contributed to the high within-participant variability of cloze scores that characterized the performance of several participants. Additionally, the cloze procedure does not test participants’ inferencing ability and critical thinking skills as capably as other measures of reading comprehension (Bos, & Tarnai, 1999). As a result, participants may have recorded higher scores on passages that were ostensibly above their actual reading comprehension level than if a more difficult dependent measure had been employed.

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[1] The implementation of Hank’s sessions was split across his mother’s and father’s homes

Participant Pool

As discussed earlier in this chapter, heterogeneity in participant characteristics including global cognitive ability, reading comprehension level, and executive functioning level may have increased the variability of observed outcomes. The fact that several participants had deficits in one or more of these areas could have potentially compromised the ability of the present study to show a treatment effect.

Materials

As discussed earlier in this chapter, potential variability in the reading comprehension level of texts that were assigned to a particular grade level (and therefore to a particular participant) may have contributed to within-subject variability in scores on the dependent measure. Differences in the amount and kind of background knowledge recruited for texts may have also contributed to this variability in scores. Additionally, although guidelines suggested by Dexter & Hughes (2011) and O'Connor and Klein (2004) were adopted for constructing and implementing the GOs, it is possible the GOs constructed by the investigator did not all provide "abstracts" of accompanying passages that were of equal quality, which could have also impacted participant scores.

Social Validity

The present study would have benefited from the administration of a "social validity" assessment to participants (Horner et al., 2005), which would have measured the practical importance that each participant assigned to the intervention as a whole and to each of the two treatments (i.e., GAO and PR). A social validity assessment would have also likely been useful for developing a theory of how TGMRs operated for participants as discussed in the previous sub-section.

Experimental and Classroom Implications

RCIs that target children with ASD have traditionally emphasized the use of instructional prompting in the delivery of the treatment package (El Zein et. al., 2014) in order to compensate for the well-documented executive function difficulties faced by many individuals within this population (Russell, 1997, Calhoun, 2006). The perceived necessity of using a course of explicit instruction to address reading comprehension deficits in individuals with ASD has also affected the design of studies that employed GOs (Knight et. al, 2013). The current study may provide preliminary experimental evidence demonstrating that, in contrast to this conventional wisdom, explicit instruction is not always necessary in GO studies. A sub-group of participants with ASD may be more self-directed learners than previously thought. Further verification of the GAOs treatment response would suggest that adjunct visual aids can be successfully delivered as one element of larger treatment package, without the benefit of an implementer's prompting, in order to improve the reading comprehension of a sub-set of students with ASD: those who have sufficient executive function skills to effectively utilize GAOs as a tool or prosthesis that orients their conceptualization and organization of content from the accompanying passages.

If proven effective, GAOs *by themselves* would be an invaluable tool for both students with ASD and their teachers. Teachers can produce the simple GAOs that were used in this study with minimal time and effort. GAOs furthermore require only limited supervision for their successful implementation. These visual supports would therefore be a simple, easy, unobtrusive way for teachers to help students with ASD gain better access to the information presented within expository text. In individuals with LD, GOs that encourage independent use have furthermore been found to produce higher effect sizes in maintenance probes than GOs that require more instructional support (Dexter & Hughes, 2011.) Teachers may additionally wish to consider leveraging computer technology to present GOs, which has been shown to potentially provide an enhanced facilitative effect to readers with LD (Ciullo & Reutebuch, 2013). Were GAOs to be adopted as an effective classroom practice, they would offer potential benefits beyond improved academic outcomes such as the increased peer acceptance that is associated with it (Flook, Repetti, & Ullman 2005) in order to combat the loneliness and isolation experienced by many students with an ASD condition (Chamberlain, Kasari, & Rotheram-Fuller, 2007).

Future Directions

Researchers may wish to design future studies employing GOs in order to determine whether GAOs can be effectively utilized independently by individuals with ASD – or a subset of individuals within this population – for promoting stronger reading comprehension. Dexter and Hughes (2011) found that simpler GOs that promoted independent use by students with LDs were associated with the lowest post-test effect sizes *but* highest maintenance effect sizes. This suggests that, in principle, independent use of these learning tools promotes durable longer-term gains in reading comprehension. Researchers might therefore wish to investigate the effect of GOs on individuals with ASD without the scaffolding of explicit instruction that typically orients the delivery of GOs in RCIs.

Several improvements to the experimental design of the present study could be made. Leveraging the science of Applied Behavior Analysis (ABA) would likely be helpful in promoting both reading comprehension and the on-task behavior this activity requires (Solis et al., 2016). Studies may also wish to include a more sensitive dependent measure of reading comprehension that interrogates critical thinking skills more effectively than a cloze procedure. It would also likely be useful for such assessments to include a far-transfer (also known as "generalization") task that includes either researcher-generated questions or a standardized (also known as "norm-referenced") assessment. Employing such a measurement would help determine whether reading comprehension strategies used by participants in the intervention could be applied to new and novel contexts. Maintenance probes that included far-transfer tasks could also be administered in order to determine whether reading comprehension gains observed during the intervention were truly durable and thereby contributed to stronger long-term reading comprehension performance.

Through maintenance probes, future studies may furthermore wish to investigate a main question not addressed by the present study: What happens to reading comprehension after the GAO is removed? If improved reading comprehension performance were to be maintained in a future study long after GAO removal, this could suggest that readers were creating and utilizing their own "mental graphic organizers" to orient ideas represented in the text and comprehend reading passages. A brain imaging study that included a maintenance brain scan, (administered in addition to pre-test and post-test brain scans), would likely help provide an answer to this question. Future studies may wish to address these questions using single-case design in order to further determine their independent utility. However, since the GAO treatment from the present intervention required minimal instructional support from the investigator and could be easily implemented in a classroom, future studies may wish to employ an experimental group design, which would help provide a more substantial evidence-base (Odom et al., 2005) for or against using GAOs with individuals with ASD. GAOs could also be used in classroom studies as part of a multi-element design, which are generally associated with better learning outcomes in students with LD (Vaughn et al., 2000), although such an approach would not help determine their independent utility.

Nonetheless, in the end, there does not appear to be a compelling need to further investigate the utility of independently used GAOs with individuals with ASD. A number of studies demonstrating far more compelling results are found in El Zein et als. (2014) review of RCIs for students with ASD in addition to two successful randomized-control studies by Murdaugh and colleagues (2015, 2016) that used the Lindamood Bell reading curriculum. Although the visually-mediated cognitive style used by many individuals with ASD (Samson et al., 2012) suggests that individuals within this population may particularly benefit from their use, the findings from Dexter and Hughes' (2011) meta-analysis of graphic organizer studies for students with LD would seem to suggest GOs' facilitative effect would be unlikely to produce durable reading comprehension gains for students with ASD: Far-transfer maintenance effects they described for reading comprehension were negligible (*ES*=.07). What this means is that individuals with LD in GO treatment conditions maintained, on average, the same basal reading comprehension performance as control group participants – anywhere from one week to one month post-treatment.

This finding highlights what should arguably be of greater concern than the efficacy of GO treatments for researchers who investigate RCIs with individuals with

ASD: Most of these studies do not investigate far-transfer and maintenance effects (El Zein et al., 2014) that would help determine whether a given intervention actually improved the everyday reading comprehension of participants (Gajria et al., 2007). El-Zein et al. (2014) furthermore reported most of the studies included in their synthesis used researcher-developed dependent measures that, as they wrote, are "consistently associated with larger effect sizes and may be less valid and reliable than standardized forms of assessment" (p. 1308). Additionally, unlike standardized measures, researcher-developed ones do not allow for cross-study comparisons of performance (Gajria et al., 2007).

It's not entirely clear whether this paucity of data on long-term reading outcomes is specific to the burgeoning field of RCI research targeting individuals with ASD, or alternatively applies more generally to the subsuming field of RCI research in special education, in which dozens if not hundreds of RCI studies have been conducted over the last 30 years. Although the field of special education has developed many impressive interventions that have helped many children who struggle with reading comprehension obtain significant immediate benefits, it would appear that the latter scenario is more likely. Despite reporting impressive immediate reading comprehension outcomes, Edmonds and colleagues (2009) noted the following in a synthesis of results from reading interventions that targeted struggling readers in grades 6-12:

> The moderate and large effects on training and near-transfer measures did not frequently generalize to measures of broader, more general comprehension. It appears that comprehension and multicomponent interventions can result in students' becoming more proficient in applying learned strategies and learning taught content, but they often do not result in readers who use the strategies independently and flexibly in novel contexts (p. 293).

Due to the narrow focus and strict inclusion criteria of the Edmonds et al. synthesis, only 13 treatment-comparison interventions were included. But in this rich description, the researchers articulated a theme that resonates with the quantitative results reported in reviews that evaluated larger numbers of RCI studies. Berkeley, Scruggs, and Mastropieri (2010) conducted a meta-analysis of RCIs for students with LD that included a total of 40 quasi-experimental and experimental studies and nearly 2,000 participants. Despite recording impressive treatment (*ES*=.69), maintenance (*ES*=.69), and far-transfer (*ES*=.75) effect sizes that approached what are considered large effect sizes (i.e., *ES*=.80; Cohen, 1988), no instances of far-transfer standardized assessments were reported. Only one instance of a standardized assessment maintenance test (*ES*=.22) was reported. Gajria et als. (2007) synthesis investigating RCIs, which targeted expository text comprehension for students with LD, reported similar findings of impressive performance on researcher-developed measures contrasted with a paucity of data on standardized assessments.

More than the question of whether a particular intervention, such as a GAO, is effective for promoting reading comprehension of students with ASD or LD, special education RCI research should arguably be more concerned with the question of the long-term effects of RCIs on basal reading comprehension. In addition to adhering to the well-established practices used in special education research that control for studies' internal validity, which have been developed by some of the leading minds in the field (e.g., Horner et al., 2005; Odom et al., 2005), special education research may wish to place additional emphasis on establishing the external validity of studies by considering the following question in the development of future RCIs posed by the investigator of the present study:

> Does the intervention produce meaningful effect sizes on far-transfer maintenance assessments that include both standardized and researcher-developed measures?

There is a simple rationale for including both standardized and researcher-developed assessments. Standardized measures provide potentially more reliable and valid assessments (El Zein et al., 2014) that also allow for cross-study comparisons (Garja et al., 2007). However, unlike researcher-developed assessments, they often provide little qualitative data that can be used to gain a more nuanced portrait of participants' cognitive and reading profiles (Williamson et al., 2013). Maintenance effects, which are typically assessed anywhere from one week to one-month post-intervention (e.g., Dexter & Hughes, 2011), would arguably provide even more useful data if comprehension probes were administered several months or even a year post-intervention.

Besides the will and funding to pursue research that incorporates some of these observations – which by necessity require a control group or control participants to control for maturation effects – the field of special education may wish to consider whether other fields of research have the potential to make worthwhile contributions to this endeavor. Two fields deserve special mention here, the first of which is discourse comprehension. Discourse comprehension studies the act of interpreting a written or spoken message that integrates incoming information into the memory or knowledge structure of the interpreter (McNamara & Magliano, 2009).

Taking a page from Williamson et al. (2013), who drew on research in the field of discourse comprehension (i.e., Construction-Integration Model; Kintsch, 1988) in the creation of reading comprehension profiles for students with high-functioning ASD, the field of discourse comprehension could potentially help researchers develop interventions that promote deeper reading comprehension and more durable, long-term outcomes. There is an essential idea endorsed by many researchers in the field of discourse comprehension that may augment the positive outcomes of less-developed RCIs – one that the academic field of Special Education has rarely discussed: Readers who are able to integrate new information into their existing knowledge base – which in Kintsch's CI model is similar to a situation model – generally engage in deeper critical thinking that promotes deeper comprehension than do readers who merely *activate* and *encode* new information but do not integrate it into their existing knowledge base (e.g., Kintsch, 1988; Wahlberg & Magliano, 2004).

Over the last several decades, researchers in discourse comprehension have investigated the question of how to promote knowledge integration in reading comprehension through various studies that have probed how variables such as local text cohesion (i.e., the degree to which micro-propositions are well organized and conceptually overlap in adjacent sentences), global text cohesion (i.e., the degree to which macro-propositions are well-organized and conceptually overlap across passages or an entire text), local and global intra-textual inferences (i.e., short or long distance inferences that draw on information from within the text), and extra-textual inferences (i.e., inferences that draw on background knowledge and experience to increase a text's local or global cohesion) can be modulated to effect the degree to which readers develop well-formulated representations of expository and narrative texts (McNamara & Magliano, 2009). Few RCI researchers in special education have considered the differential effect of these variables in constructing interventions – let alone the general question of how to promote integration of content from a reading passage into an existing knowledge base.

The field of discourse comprehension, however, has been largely limited by a focus on describing reading comprehension processes in NT individuals. Unlike researchers in the field of special education, in general discourse comprehension researchers are not skilled special educators who have the knowledge and experience to develop and implement interventions that target individuals with LD, ASD, or other disabilities. Perhaps both fields have something to learn from one another.

The second field that is likely to benefit RCIs in special education is cognitive neuroscience. Thus far, a meta-analysis of visual processing in ASD (i.e., Samson et al., 2012) and two fMRI brain imaging studies investigating the neural correlates of reading comprehension for expository text in ASD (i.e., Just et al., 2004; Kana et al., 2006) suggest that the default mode of linguistic comprehension for many individuals with ASD does not promote a holistic understanding of a text and its features. Instead, individuals with ASD typically display an overreliance on visual imagery (i.e., involving sub-sections of the occipital-parietal cortices) and the processing of single words (i.e., involving a sub-section of Wernicke's area) that includes weak recruitment of *networks* responsible for integrating single words (i.e., Wernicke's-mediated network) with syntactic and semantic content (i.e., Broca's-mediated network) during the reading comprehension process. Brain imaging results from Murdaugh et al. (2015, 2016) indicated that reading comprehension gains on a standardized measure were achieved through a combination of engaging traditional networks of the brain used by NT individuals and engaging compensatory visual processing strategies that are a traditional strength of many individuals with ASD.

Currently, researchers conducting RCI studies of individuals with ASD do not know whether participants are leveraging both visual areas and language networks in the brain, which can function together to promote a deeper understanding of higher-level text (i.e., Murdaugh et al., 2015, 2016), or primarily visual areas that, on their own, would afford only shallow comprehension of higher-level texts (i.e., Just et al., 2004; Kana et al., 2006). Arguably, researchers would greatly benefit from this knowledge. Indeed, in the field of dyslexia research, where reading fluency studies that leverage brain imaging technology have been conducted for the last 15 years (Temple et al., 2003), brain imaging technology has shown promise for the *predictive* information it provides for learning outcomes. A study that measured structural (DTI) and functional (fMRI) properties of the brain in children with dyslexia more accurately predicted future gains in reading fluency than state-of-the-art behavioral measures (Hoeft et al., 2011). It is not difficult to imagine that a decade from now, RCI studies that further interrogate visual and language processing in readers with ASD could provide similar predictive measures of future reading comprehension gains if researchers honed their sites on accomplishing such a goal.

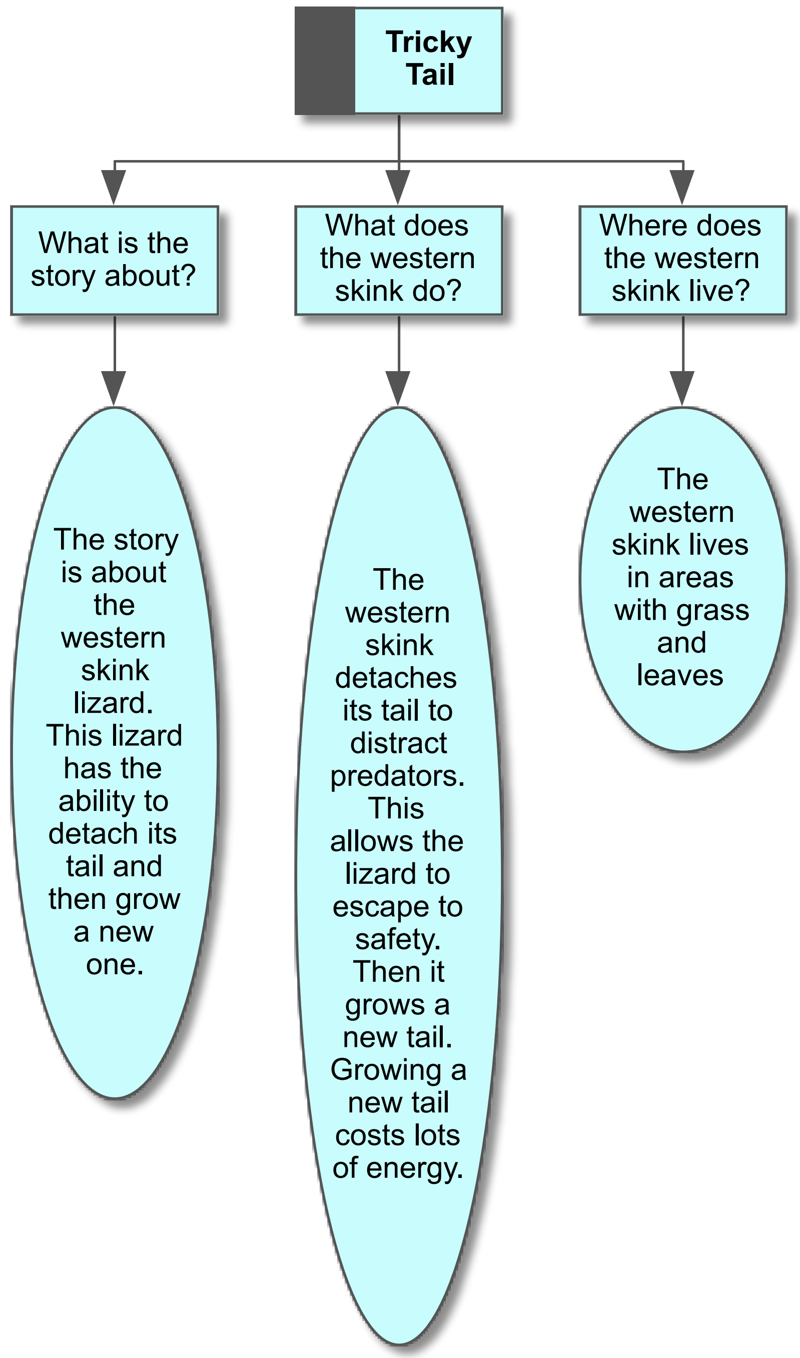
The above methodological considerations, which together advocate for the adoption of a more inter-disciplinary approach in developing RCIs that aim to produce more durable far-transfer and maintenance effects, does not suggest that traditional research and interventions in special education should be abandoned. Instead, these ideas suggest that RCI research should place a greater emphasis on long-term outcomes –

particularly an intervention's effect on basal reading comprehension performance – and that the contributions of other fields may serve to augment and enrich existing evidence-based practices in special education research. If indeed independently used GAOs are an effective strategy for promoting reading comprehension in some students with ASD, such an approach could potentially provide invaluable insight into how and why GAOs work with individuals within this population and for whom they work best.

APPENDICES

APPENDIX A

Sample Graphic Advance Organizer (GAO) for *Read Naturally* reading (Grade 6.0 Text)



APPENDIX B

Sample Text from *Read Naturally* (Grade 6.0 Text)

Tricky Tail

Story 11, Tracks 1–4

regenerate
Regenerate means to grow back again or to produce anew.

appendage
An appendage is a body part that is connected to the main body or head of an animal.

distracts
Distracts means draws someone's attention away from something.

detached
Detached means no longer connected.

Birds of prey circle above, and snakes **slither** though the grass and leaves on the ground. These and other predators might be in search of a meal. Surrounded by such threats, it's not surprising that the western skink tries to keep out of sight. Still, this lizard does **expose** itself **periodically**. It spends time **basking** in the warmth of the sun and **pursuing** the insects and spiders that make up its **diet**. Fortunately for the skink, remaining hidden isn't its **sole** means of protecting itself.

A fully grown western skink measures **approximately** seven inches from tip to tip. More than half of that length is its tail. It is this long tail, which is bright blue when the skink is young, that can help it escape danger. If a predator attacks its tail, the skink simply lets the **appendage** go. Even after the tail has left the skink's body, it continues to help its owner get away. For a short time, it wiggles about **vigorously**. While the **detached** tail **distracts** the predator, the skink can often **scurry** to safety.

The skink doesn't go without a tail for the rest of its life. Another tail will grow to replace the **discarded** one. Though the new tail may be a similar size, it will not be an exact **duplicate** of the original. The inside will consist of **cartilage** rather than hard bones, and even if the skink's tail had still had a bright blue **hue** when it fell off, the new one will not.

The western skink is not the only lizard that can **autotomize** and **regenerate** its tail. Many skinks and other lizards have this ability too. This trick can save a lizard's life, but it is not without **drawbacks**. For one thing, generally a tail only breaks off with such ease from an original—not regenerated—part of the tail, which limits how frequently this method of **eluding** enemies can succeed. Plus, when leaving its tail behind, the lizard loses a lot of energy stored as fat. In addition, it must **expend** even more energy to grow a **replacement**. In some cases, the tail provides the means to **recoup** some of that fat. A lizard may return to where it dropped its tail after the danger has passed. If the predator hasn't eaten the tail, the lizard may make a meal of it!

words read ________ - errors ________ = ________ cold score ________ ________ ________ ________ ________ ________

words read ________ - errors ________ = ________ hot score ________ expression goal ________ ________ date passed

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Sequenced Level 6.0
Story 11, Tricky Tail

APPENDIX C

Sample Cloze Procedure for *Read Naturally* Text (Grade 6.0)

Tricky Tail (6.0)

Birds of prey circle above, and snakes slither through the grass and leaves on the ground. These and other predators might be in search of a meal. Surrounded by such threats, it's not surprising that the western skink tries to keep out of sight. Still, this lizard does ______________________ itself periodically. It spends time basking in the warmth of the sun and pursuing the insects and spiders that make up its diet. Fortunately, for the skink, remaining ________________________ isn't its sole means of protecting itself.

A fully grown western skink measure approximately seven inches from tip to tip. More than half of that length is in its tail. It is this long tail, which is bright blue when the skink is young, that can help it ____________________ danger. If a predator attacks its tail, the skink simply lets the appendage go. Even after the tail has left the skink's body, it continues to help its owner get away. For a short time, it ________________ about vigorously. While the detached tail distracts the predator, the skink can often scurry away to safety.

The skink doesn't go without a tail for the rest of its life. Another tail will grow to _______________________ the discarded one. Though the new tail may be a similar size, it will not be an exact _____________________ of the original. The inside will consist of cartilage rather than hard bones, and even if the skink's tail had still had a bright blue hue when it fell off, the new one will not.

The western skink is not the only lizard that can autotomize and regenerate its tail. Many skinks and other ________________________ have this ability too. This trick can save a lizard's life, but it is not without ________________________. For one thing, generally a tail only breaks off with such ease from an original – not regenerated – part of the tail, which limits how __________________________ this method of eluding enemies can succeed. Plus, when leaving its tail behind, the lizard loses a lot of energy stored as ___________________________. In addition, it must expend even more energy to grow a replacement. In some cases, the tail provides the means to recoup some of that fat. A lizard may return to where it dropped its tail after the danger has passed. If the predator hasn't eaten the tail, the lizard may make a meal of it!

APPENDIX D

Procedural Fidelity Form

<u>Fidelity Form for Intervention (GRAPHIC ORGANIZER CONDITION)</u>

Student______________________

Date of Session:___________________

Observation #:_____

Condition (Record as Baseline, Prompting or Graphic Organizer): ___________________________

Reading (Provide the name of the reading): ____

Please use this single form to rate only one of the three conditions (either Baseline, Prompting, or Graphic Organizer as presented on pages 2-4). The "overall rating" that you assign to the intervention (p. 5) takes into account whichever condition you rated.

<u>Procedural Fidelity</u>

Graphic Organizer Condition ONLY:

Rate the fidelity with which the Graphic Organizer phase was implemented

3 High	2 Mid	1 Low	NO
All 5 features observed	One to two features are missing	Three to four features missing	No components observed (all five features missing)

☐ Teacher builds background knowledge or connects to student's prior knowledge before reading
☐ Teacher pre-teaches key vocabulary words before reading
☐ Teacher prompts student to review graphic organizer prior to reading***
☐ Teacher prompts student to orally read the passage.
☐ Teacher reviews additional vocabulary words that the student is unfamiliar with during read aloud.

Score for GO phase: _______________

*** = This feature is additional to baseline

Overall Rating:

Overall, I consider this teacher's implementation to be:	*Highest Quality*				*Less than Adequate*		
	7	6	5	4	3	2	1

High quality (6-7): The student engages actively in reading activities. The teacher implements the intervention and provides explanation and feedback that is appropriate to the student's needs.

Average quality (3-5): The students understands what he is supposed to do, yet he lacks a high level of engagement in the reading activity. The student may quickly deviate off task if not closely monitored. The teacher provides explanations and feedback that may be lacking in some areas, such as tailoring feedback to meet the specific needs of the student, pacing the session, and providing reading materials that are at an appropriate level. The teacher may provide inconsistent or incorrect information about one or more strategy. The teacher omits a strategy that should be present.

Low quality (1-2): The student is not engaged and is not proficient at using the strategies. The teacher does not provide the needed explanation and feedback. The teacher may note be able to create a positive work environment.

Appendix E

Student Assent Form

Assent for Participation in Research

Title: Investigating the Effects of Prompting and Graphic Organizers on Secondary Students with Autism Spectrum Disorder

NOTE:

Introduction

Hi, my name is Aron Weinberg and I am a tutor at The University of Texas at Austin. You have been asked to be in a research study about reading. This study was explained to your mother/father/parents/guardian and she/he/they said that you could be in it if you want to. I am doing this study to look at whether certain teaching methods help students, such as yourself, improve their reading.

What am I going to be asked to do?

If you agree to be in this study, you will be asked to take some testing to look at your reading level. Then, we'll be doing some reading. At first, I'll just let you read on your own. Then, I'll be helping you read through the passages. At the end of each time we work together, you'll fill out a short exercise that looks at what you have learned.

This study will take 8-12 weeks. If you participate, we'll be working together 2-4 times per week. Each session will take 30-40 minutes, except for the first one which will take about an hour. Two other students are participating in the study.

Our sessions will be video recorded. This is so someone else can watch the videos and look at how I'm teaching. The IRB (the group who approved this study) may look at these study records at any time.

What are the risks involved in this study?

There are no foreseeable risks to participating in this study.

Do I have to participate?

No, participation is voluntary. You should only be in the study if you want to. You can even decide you want to be in the study now, and change your mind later. No one will be upset.

If you would like to participate, just sign at the end of this letter and give it to your mother/father/guarian. You will receive a copy of this form so if you want to you can look at it later.

Will I get anything to participate?

You will not receive any type of payment participating in this study.

Who will know about my participation in this research study?

The records of this study will be kept private. Your responses may be used for a future study by me or or other researchers.

Whom to contact with questions about the study?

Prior, during or after your participation you can contact me, Aron Weinberg, at 617-510-5912 or at aron.weinberg at utexas.edu for any questions or if you feel that you have been harmed.

Signature

Writing your name on this page means that the page was read by or to you and that you agree to be in the study. If you have any questions before, after or during the study, please feel free to ask me. If you decide to quit the study, all you have to do is tell me.

________________________________ Signature of Participant

____________________ Date

Appendix F

Parental Consent Form

Parental Permission for Children Participation in Research

Title: Investigating the Effects of Prompting and Graphic Organizers on Secondary Students with Autism Spectrum Disorder

Introduction

The purpose of this form is to provide you (as the parent of a prospective research study participant) information that may affect your decision as to whether or not to let your child participate in this research study. The person performing the research will describe the study to you and answer all your questions. Read the information below and ask any questions you might have before deciding whether or not to give your permission for your child to take part. If you decide to let your child be involved in this study, this form will be used to record your permission.

Purpose of the Study

If you agree, your child will be asked to participate in a research study about improving reading comprehension using instructional supports. The purpose of this study is to see if the use of instructional prompting and graphic organizers can improve the reading of students with ASD.

What is my child going to be asked to do?

If you allow your child to participate in this study, they will be asked to:

- Have their reading level be evaluated. This testing will occur in one session of 50-60 minutes previous to the beginning of the intervention.
- Work with me (Aron Weinberg) for the duration of the intervention. During this time, your child and I will read texts and I will use prompts to help him/her learn the ideas in the text. A visual aid called a graphic organizer will also be used. The graphic organizer will summarize the main points of the text. Students with ASD have benefitted by using prompts and graphic organizers in various studies in the U.S.
- At the end of each session, your child will complete a short reading comprehension exercise.

This study will take: 8-12 weeks. Sessions will occur 2-4 times per week. Each session (with the exception of the first session for assessing reading level) will last 30-40 minutes. Two other children will participate in the study.

Sessions with your child will be video recorded. This allows a trained research assistant to rate how well I implement the reading program.

What are the risks involved in this study?

There are no foreseeable risks to participating in this study.

What are the possible benefits of this study?

The possible benefits of participation are that your child may experience increased reading comprehension and a stronger ability to understand the main points of a text.

Does my child have to participate?

No, your child's participation in this study is voluntary. Your child may decline to participate or to withdraw from participation at any time. Withdrawal or refusing to participate will not affect his/her relationship with The University of Texas at Austin in anyway. You can agree to allow your child to be in the study now and change your mind later without any penalty.

What if my child does not want to participate?

In addition to your permission, your child must agree to participate in the study. If you child does not want to participate he/she will not be included in the study and there will be no penalty. If your child initially agrees to be in the study they can change their mind later without any penalty.

Will there be any compensation?

Neither you nor your child will receive any type of payment participating in this study.

How will your child's privacy and confidentiality be protected if s/he participates in this research study?

Your child's privacy and the confidentiality of his/her data will be protected by me. Only myself and the other members of the research team will have access to data from the study.

If it becomes necessary for the Institutional Review Board to review the study records, information that can be linked to your child will be protected to the extent permitted by law. Your child's research records will not be released without your consent unless required by law or a court order. The data resulting from your child's participation may be made available to other researchers in the future for research purposes not detailed within this consent form. In these cases, the data will contain no identifying information that could associate it with your child, or with your child's participation in any study.

If you choose to participate in this study, your child will be video recorded. Any recordings will be stored securely and only the research team will have access to the recordings. Recordings will be kept for a period of five years and then erased.

Whom to contact with questions about the study?

Prior, during or after your participation, you can contact me, Aron Weinberg, at 617.510.5912 or at aron.weinberg at utexas.edu for any questions or if you feel that you or your child has been harmed. This study has been reviewed and approved by The University Institutional Review Board and the study number is _____________.

Whom to contact with questions concerning your rights as a research participant?

For questions about your rights or any dissatisfaction with any part of this study, you can contact, anonymously if you wish, the Institutional Review Board by phone at (512) 471-8871 or email at orsc@uts.cc.utexas.edu.

Signature

You are making a decision about allowing your child to participate in this study. Your signature below indicates that you have read the information provided above and have decided to allow them to participate in the study. If you later decide that you wish to withdraw your permission for your child to participate in the study you may discontinue his or her participation at any time. You will be given a copy of this document.

____
Printed Name of Child

_______________________________ ________________
Signature of Parent(s) or Legal Guardian Date

_______________________________ ________________
Signature of Investigator Date

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Vita

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