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The Remediation of Episodic Memory Deficits in Children with Autism Spectrum Disorder: An Examination of the Efficacy of Cognitive Behavioral Therapy

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Author

Zielinski Deane, Kaycie

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The Remediation of Episodic Memory Deficits in Children with Autism Spectrum
Disorder: An Examination of the Efficacy of Cognitive Behavioral
Therapy

A dissertation submitted in partial satisfaction of the
requirements for the degree Doctor of Philosophy
in Education

by

Kaycie Leigh Deane

2016

ABSTRACT OF THE DISSERTATION

The Remediation of Episodic Memory Deficits in Children with Autism Spectrum

Disorder: An Examination of the Efficacy of Cognitive Behavioral

Therapy

by

Kaycie Leigh Deane

Doctor of Philosophy in Education

University of California, Los Angeles, 2015

Professor Jeffrey J. Wood, Chair

Autism Spectrum Disorder (ASD) is a development delay marked by impairment in social communication and behaviors, resulting in interpersonal relationship deficits (Bowler, Gaigg & Lind, 2011).   These social deficits persist throughout the individual's life (Crane & Goddard, 2008), thus it is important to explore various etiologies and interventions to remediate these struggles. One area that has been implicated as potentially contributing to social deficits in ASD is episodic memory (EM), or an individual's ability to re-experience themselves in a past event (Boucher & Bowler, 2008; Hare, Mellor & Azmi, 2006). There are two forms of EM, autobiographical in which the person was actively involved and non-autobiographical in which the person was an observer (Lind, 2010; Gilboa, 2004). Autobiographical EM is reliant on autonoetic awareness, or an understanding of one's personal experience (Wheeler et al., 1997) where non-autobiographical EM is reliant on theory of mind, or an understanding of other's experience (Baron-Cohen, 2000). To better understand EM deficits in children with ASD, this study sought to understand if these weaknesses could be remediated through the use of cognitive behavioral therapy (CBT) and what cognitive processes and additional factors might impact the outcome of treatment. Participants included 73 children (59 male) ages 6-13 with high functioning ASD. Participants were administered two types of EM measures, one that assessed short-term non-autobiographical EM and one that assessed long-term autobiographical EM, before and after participation in either a group or individual 32 week CBT intervention. Results

indicated that autobiographical EM functioning was impacted by participant's processing speed and narrative ability. Non-autobiographical EM functioning was influenced by participant age and the severity of their ASD symptoms. Findings also suggest that children who received individual therapy performed better on both measures after receiving treatment. Therefore, based on these outcomes it appears that EM functioning in children with ASD can be improved through the use of CBT. Future research should examine how this improvement impacts social functioning.

The dissertation of Kaycie Leigh Deane is approved.

Connie L. Kasari

Bruce L. Baker

Jennie Katherine Grammer

Jeffrey J. Wood, Committee Chair

University of California, Los Angeles

2016

To all children with autism:

May their limits be unknown

and their efforts be their own

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2005	B.A. Psychology Rider University Lawrenceville, NJ
2007	M.A. Psychology Pepperdine University Los Angeles, CA
2011-2012	UCLA Graduate Student Researcher, Graduate School of Education and Information Studies
2012	UCLA Graduate Summer Research Mentorship Fellow
2012-2015	UCLA Graduate Student Researcher, Semel Institute for Neuroscience and Human Behavior
2013	UCLA Graduate Summer Research Mentorship Fellow
2013-2016	UCLA University Fellowship
2014	Robert H. Levine Memorial Fellowship
2015-2016	UCLA Dissertation Year Fellowship

Selected Publications and Presentations

Fujii, C., Renno, P., McLeod, B.D., Lin, C.E., Decker, K., **Zielinski, K.** & Wood, J.J. (2013). Intensive Cognitive Behavioral Therapy for Anxiety Disorders in School-aged Children with Autism: A Preliminary Comparison with Treatment-as-Usual. *School Mental Health, 5*(1), 25-37.

Morrissey, A., Suchov, R., **Zielinski, K.**, Cornejo-Guevara, M. & Wood, J.J. (2015, April). *Empathy and Prosocial Responding in Children with Autism Spectrum Disorder.* Poster accepted to be presented at the Western Psychological Association Conference in Las Vegas, NV.

Zielinski, K., Whitham, S., Fujii, C., Renno, P., Storch, E., Lewin, A., Ehrenreich-May, J. & Wood, J.J. (2012, November). *Convergent and Concurrent Validity of the Columbia Impairment Scale for Youth with Autism Spectrum Disorders.* Poster presented at the Association for Behavioral and Cognitive Therapies conference in Washington, D.C.

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Zielinski, K., Wood, J. J., Renno, P., Whitham, S., & Sterling, L. (2014). Examining the Validity of the Columbia Impairment Scale for Assessing Level of Functioning in Youth with Autism Spectrum Disorder. *Journal of Child and Adolescent Psychopharmacology*, *24*(9), 509-512.

Chapter 1: Introduction

Autism Spectrum Disorder (ASD) is a developmental disorder that is marked by impairment in two main areas of functioning; social communication, and restricted or repetitive behaviors (American Psychiatric Association [APA], 2013). Within this heterogeneous spectrum disorder are varying levels of functioning. For example, individuals who present with less overall functional impairment and no cognitive impairment are often referred to as "high functioning" (Roth & Rezaie, 2011). While individuals with high functioning autism spectrum disorder may appear to have rather intact language and an absence of restricted and/or repetitive behaviors, they often experience impairment in other areas such as significant social deficits (Bowler, Gaigg & Lind, 2011). One area that has been identified as potentially contributing to the social deficits found in ASD is episodic memory (EM), or re-experiencing the 'self' in a past event either as an active participant or observer (Hare, Mellor & Azmi, 2006; Boucher & Bowler, 2008; Crane & Goddard, 2008; Crane, Lind & Bowler, 2012; Lind, impai2010; Lind & Bowler, 2008; Lind & Bowler, 2010).

General memory impairments, as they pertain to autism, were first noted and researched in the 1970's (Boucher, & Bowler, 2008; Hermelin, & O'Connor, 1970; O'Connor & Hermelin, 1978). Since that time, several research studies dedicated to better understanding memory have taken place. For example, in Tulving's (Tulving, 2002) influential information processing model, he identified that memory has at least two primary types, semantic, or factual memory, and episodic, or experiential memory (Stoettinger, Kaiser & Perner, 2009). Semantic Memory relies on noetic awareness, or knowing about the world, which is a more basic process, where EM relies on autonoetic

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awareness, or self-knowing (Wheeler, Stuss &Tulving, 1997). As Boucher and Mayes (2012) describe, many studies have found that often times in individuals with ASD, semantic memory appears intact while EM is impaired, citing that information related to emotion is at the greatest risk for memory deficits.

Episodic Memory as a whole can be broken into two distinct sub-categories: autobiographical in which the person is actively involved in the event (i.e., playing in a baseball game), and non-autobiographical in which one recalls learning about an event (i.e., reading about a baseball game; Lind, 2010). Both types are related to social functioning and therefore should be examined to determine the impact dysfunction in either area can have on individuals' interpersonal functioning. While the etiology of this deficit has yet to be determined, both areas of EM have been identified as impaired.

Bowler, Gaigg and Lind (2011) explain the origin of these general EM deficits as "impaired relational encoding" or an inability to combine the various aspects of an occurrence into a single coherent memory. It has also been hypothesized that EM deficits can be attributed to a lack of autonoetic awareness (Lind, 2010; Wheeler et al., 1997). Other potential contributing factors, such as deficits in the language required to share these events, have been cited as contributing to EM impairment (Klein, Chan & Loftus, 1999).

Cognitive Factors and EM

When considering all of the various elements that are involved in both the encoding and recall portion of a memory, it seems that the source of any potential deficit could be attributed to almost any cognitive process. The ASD literature suggests that perhaps there are no impairments to the episodic memory systems, but rather certain

confounds create the appearance of a deficit (Bowler et al., 2000).   Bowler and

colleagues (2007) found that individuals with ASD demonstrate a decreased use of

compensatory strategies to recall EM, which suggests that on a neural level, the

episodic memory system may be intact, but functions at a lesser capacity due to

potential impairments in cognitive processes. Therefore a careful examination of various

cognitive factors could provide some insight into the etiology of EM deficits in individuals

with ASD.

Personal Narratives and Episodic Memory

Numerous studies have found differences between the personal narrative ability

of typically developing individuals as compared to those with autism spectrum disorder

(ASD). Capps, Kehres and Sigman (1998) described some of these disparities; they

found that not only do children with ASD generally produce a comparatively diminished

amount of narratives than peers, but that the stories they do share lack in detail and are

often missing key components. Capps, Losh and Thurber (2000) noted differences in

expression of the stories down to missing details such as sound effects to provide

information and entertainment for the listener.

A defining deficit of ASD that is believed to impact personal narratives is an

overall weak central coherence, which is a decreased ability to understand the whole of

an event and rather focus on the details (Frith, 1989; Solomon, 2004). In addition to an

increased focus on small aspects of a situation, there is also an inability to connect

these pieces to form a comprehensive understanding. For example, Solomon (2004)

found that individuals with ASD tend to introduce a narrative in a manner similar to

typically developing peers, but struggle to stick to the initially introduced theme

supporting the weak central coherence theory. Introducing an idea is only one aspect of a narrative, but tying each piece of provided information to this theme requires the ability to understand the overall big picture or end goal of the story.

A central aspect that underlies each of the areas discussed is thematic continuity. Generally speaking, this is the way in which each aspect of the story relates back to the central theme and each statement builds off of the previous one (Solomon, 2004). Children with ASD have been found to make "proximally relevant" comments which are distally related to the general theme or topic but generally miss the purpose of the immediate point that is trying to be made (Solomon, 2004; Ochs & Solomon, 2008). Individuals with ASD have also been reported to insert information that is not at all related to the topic and then jump back to the general theme leaving the listener to make sense of the interjection, some of which may or may not be socially appropriate in the nature of the content (Ochs & Solomon, 2008).

Noted executive functioning deficits have also been implicated in adding to the overall presentation of disjointed personal narratives as told by individuals with ASD. Executive functions have been connected to many processes related to personal narratives including spontaneity as it pertains to adjusting the story so that the listener obtains full comprehension and the aforementioned struggle to stay on topic or add meaningful details that help reach a final outcome (Ochs & Solomon, 2008). Additionally, cognitive rigidity can make it difficult for an individual with ASD to shift from a particular point of interest and this factor combined with poor working memory may impact their ability to integrate social feedback from the listener into the manner in which they explain the story (Tager-Flusberg, Joseph & Folstein, 2001).

Losh and Capps (2003) examined the differences in personal narrative abilities between typically developing children and those with ASD. Interestingly, one area where the groups differed was on topic or theme. When asked to discuss a preferred activity the typically developing group discussed more interactive past-times such as sports where the ASD group discussed more isolated hobbies such as playing on the computer. Additionally, children with ASD were more likely to introduce irrelevant or off topic comments, which lead to an increased need for the assessor to query or prompt for overall theme clarification. The ASD group was also found to struggle with establishing clear causal relationships between different events within the story which impacted the listener's overall comprehension. Finally, lack of understanding of emotional knowledge was found to effect the number of references to the character's mental state when telling the story as well as using cues from the listener to provide additional information to ensure clarity.

In a follow-up study conducted by Losh and Capps (2006), they examined the ability of individuals with ASD to comprehend and express their personal experience in situations. It was found that when compared to typically developing individuals, those with ASD shared less about their personal experience in a narrative. Additionally, they struggled to determine causality between emotions experienced by themselves and others in the event and the reason for these feelings. Interestingly, individuals with ASD were better able to explain the cause of non-emotional components of the story than those directly linked to emotions. The authors hypothesized that this simplified understanding of emotions contributes to a lack of ability to analyze and reflect on personal experiences as well as the experiences of others. Thus, this diminished

understanding of emotions of self and others could contribute to the noted deficits in personal narratives observed in this population.

According to Colle and colleagues (2008), this lack of understanding regarding the listener's perspective has been found to have a relationship with Theory of Mind (ToM) deficits commonly associated with autism. Individuals with ASD generally do not adapt their communication style for the unique needs of each individual listener. This can lead to their narratives becoming either excessive in length and detail or lacking essential features for the listener to comprehend the story. Additionally, individuals with ASD often struggle to maintain one topic of conversation and introduce irrelevant details which interfere with comprehension rather than adding in details essential for the listener to understand the story. Overall, the role of ToM in personal narratives is to elaborate on details of an individual's experience and to monitor and preserve the listener's attention (Tartaro & Cassell, 2007; Capps, et al., 2000). However, the narratives of individuals with ASD often consist of irrelevant facts, deletion of details, or inclusion of excessive information with little to no reflection on the listener's understanding.

An additional confound adding to the quality of personal narratives in ASD is the execution of the story telling rather than the story itself. Goldman (2008) found that the basic mechanics of retelling a personal experience such as beginning, middle and end were present in individuals with ASD suggesting that they had been taught or inferred the basics of narrating an experience. However, what was lacking was the underlying purpose or goal of the story, as well as a clear identification of the key individuals and the resolution or outcome. There was also little reference to how the characters felt or

any connections drawn between emotions and actions lending these stories to contain little to no social meaning.

Capps, Losh, and Thurber (2000) attempted to examine most of these aspects discussed in one study that compared the narrative abilities of children with ASD to children with developmental delays and those who were typically developing. They found that the length of the story told by typically developing children was significantly longer than the other two groups. The syntax used by the ASD and developmentally delayed groups was also far less complex than that used by the typically developing group which is a critical component within narratives as it identifies the relationships between various components of the story. Similar to previous findings, the authors also noted less reference to causal relationships between character emotional states and actions within the story. There was evidence of attempts to engage the listener made by all three groups, however the techniques used by the developmentally delayed and ASD groups presented as much more scripted and less creative.

Considering all of the various areas implicated in contributing to personal narratives and observed as impaired in individuals with ASD, it can seem that remediation is not possible. However, Millward and colleagues (2000) point out that an intervention which focuses on helping an individual understand his/her role in a situation may improve their overall EM. With not only discussing social interactions while in session, but also having children practice sharing the events of social experiences outside of session (Wood et al., 2009), their ability to share coherent recollection of social events may also improve.

Verbal Ability

The complex language processes involved in retelling an event have been found to be impaired in individuals with ASD (Quill, 1997). In a study examining the role of language in memory recall conducted by Norbury and Bishop (2002), children with ASD were also found to have difficulty incorporating language with the encoding and recall of memories related to personal experiences. Despite the previous research that notes the extent of language deficits associated with ASD, the majority of episodic memory measures rely solely on verbal recall.

This finding also points to the potential for verbal ability to impact EM as deficits in the language required to share the events of a memory, have been cited as contributing to EM deficits (Klein et al., 1999). If an individual struggles not only to retain verbal components of an incident, but then also lacks the skill to express events within the experience, it seems that verbal ability could be a confound impacting EM performance. Therefore it is thought that examining EM convergence with verbal memory could point to confounds that may impact EM and broader areas of functioning.

Working Memory

The stability of the deficits within both types of EM points to the need to identify the factors that contribute to differences in memory encoding and recall. For example, the maturation of memory systems, most specifically in the frontal lobe has been implicated in EM development (Klein et al., 1999). Many previous studied have suggested that individuals with ASD demonstrate impaired working memory when compared to typically developing peers (Bennetto, Pennington & Rogers, 1996).

Specifically, two types of working memory, spatial and verbal, have been studied in individuals with ASD.

Previous research suggests that spatial working memory is often the most impaired type of working memory in individuals with ASD (Steele, Minshew, Luna & Sweeney, 2007). This type of memory, which is a crucial aspect of re-creating a scene or an event in detail, could contribute to these noted deficits related to recalling social situations (Williams, Goldstein & Minshew, 2005). In a study by Joseph, Steele, Meyer, and Tager-Flusberg (2005), it was found that individuals with ASD demonstrate decreased verbal working memory ability when compared to typically developing peers. It was concluded that this could impact EM in that language is the best strategy for self-monitoring sequences in a personally experienced or observed event. Without the ability to utilize working memory to mentally re-create a scene and/or verbally self-narrate the components of an event, meaning and understanding of the situation could be compromised.

Perceptual Reasoning

Perception, or recognition of patterns and nuanced features, has been found to be an area of strength for individuals with ASD (Mottron, Dawson, Soulieres, Hubert, & Burack, 2006). However, when verbal processes are required to complete a perceptual task those within this population have demonstrated decreased skills in this area, suggesting that language can impact perceptual performance (Joseph et al., 2005). Some studies have suggested that individuals with ASD struggle with translating visuals in their mind into verbal content that would allow them to more effectively share their ideas, while others have gone so far as to say that even when they could use verbal

abilities to mediate a situation, they tend to defer back to visual perceptual skills (Sahyoun, Soulières, Belliveau, Mottron, & Mody, 2009). On a neurological level, studies have found that during perceptual tasks the occipital areas of the brain related to visual processing are more activated than typically developing individuals who demonstrate a more equal activation of brain regions associated with both visual and semantic processing (Soulières et al., 2009).

It has been suggested that perceptual skills are an integral component of understanding one's own experiences as well as interpersonal interactions with others (Sahyoun et al., 2009). On tasks of social perception, individuals with ASD have demonstrated overall weakness, but particular impairment in areas related to understanding body language and facial expressions during a reciprocal interaction (Holdnack, Goldstein & Drozdick, 2011). In addition, previous studies showed that individuals with ASD exhibit decreased emotion perception as compared to typically developing individuals (Ozonoff, Pennington, & Rogers, 1990) Interestingly, this population has also been found to be better at identifying differences than similarities (Plaisted, 2001). This could impact EM functioning in that social interactions are often somewhat routine with similar events occurring across exchanges, but if individuals with ASD are attending to differences and are unable to pull from prior experience to guide their behavior, they will likely be unsuccessful. Additionally, difficulty with overall social and emotional perception could impact EM, or memory for social events.

Processing Speed

A basic conceptualization of processing speed is the proficiency and efficacy in which the brain processes information (Luna, Doll, Hegedus, Minshew, & Sweeney,

2007). When compared to individuals who are typically developing or those with ADHD and other clinical disorders, processing speed has been found to be most impaired in ASD (Calhoun & Mayes, 2005; Mayes & Calhoun, 2007). However, some studies have suggested that the actual neurological components involved in processing speed are intact, but present as impaired in specific situations (Scheuffgen, Happee, Anderson, & Frith, 2000). For example, the speed at which individuals with ASD process faces has been found to be delayed (McPartland, Dawson, Webb, Panagiotides & Carver, 2004).

It has been suggested that this decreased processing speed could add to the noted difficulty individuals with ASD demonstrate in social situations as they are generally unable to react in a socially appropriate manner within a proper amount of time (Faja, Webb, Merkle, Aylward & Dawson, 2009). Oliveras-Rentas and colleagues (2012) found a positive correlation between processing speed and communication ability in individuals with ASD suggesting some of the social deficits observed in this population could be related to the extended period of time required to process social interactions and determine appropriate responses. When examining the relationship between processing speed and memory it has been found that individuals with ASD demonstrate a delay in engaging memory systems crucial to guiding behavior (Luna et al., 2007). Delays in processing what is occurring in a social interaction, formulating an appropriate response, and retrieving memories to guide behavior could contribute to these noted deficits.

According to Bowler and colleagues (2007), on a neural level, the episodic memory system may be intact, but functions at a lesser capacity potentially due to additional neural systems that block retrieval or expression of a memory. If EM is

indeed intact, then other cognitive processes such as narrative ability, working memory, perceptual reasoning, verbal abilities and processing speed could impact EM so that while the system is intact, individuals with ASD still present externally with deficits. Interventions such as CBT, which focus on modifying thoughts in order to alter behaviors, could have a positive impact on social understanding and recall, thus improving EM (Millward et al., 2000). Additionally given the verbal demands associated with CBT, improvement in social communication could lead to improvements in EM (Klein et al., 1999).

Types of Episodic Memory

Autobiographical Episodic Memory

Autobiographical episodic memory refers to consciously re-experiencing the self in an event from a previous time, of which he/she was actively involved (Gilboa, 2004). However, the ability to recall a past personal experience depends on knowledge of one's own emotional, sensory, social and cultural experience in that given moment (Conway, 2001; Conway & Pleydell-Pearce, 2000). Ty1997). Prior research has highlighted the significant relationship between understanding one's self and autobiographical memory (Conway & Pleydell-Pearce, 2000). In order to obtain a full understanding and meaning of an event, beyond its' physical setting, it is imperative for an individual to understand the role that he/she plays within the occurrence.

However, individuals with ASD have been found to experience deficits in autonoetic awareness, thus impacting their episodic memory. This was demonstrated by Gardiner (2001), who found that when comparing individuals with ASD to a typical control group, the ASD group was better able to recognize previous stimuli (noetic

awareness) than to know they had experienced it (autonoetic). He hypothesized that individuals with ASD likely do not encode aspects of an experience, such as their role, in an integrative fashion, but rather store facts in an isolated and unrelated manner. Lind and Bowler (2008) attribute these deficits in autonoetic awareness to impairments in developmental processes such as lack of understanding of causal relationships, ability to mentally represent the self, and a fundamental breakdown in processing time periods.

Interestingly, Millward, Powell, Messer and Jordan (2000) found that when compared to children who are neurotypical or have learning disabilities, children with ASD demonstrate improved recall for events in which they were not an active participant, but rather an observer. By removing self-involvement from the retrieval process, thus removing the majority of the need for self-awareness or compensating for a lack of autonoetic awareness, individuals with ASD were able to better recall a situation. This points to a potentially critical deficit in regards to autobiographical episodic memory in that if one cannot understand and recall the role of the self within a situation, which is a large component of an event and involves many contextual clues, it is likely that the individual will not be able to obtain a clear understanding of the occurrence.

Non-Autobiographical Episodic Memory

Non-autobiographical episodic memory, or the recall of events in which one was an observer rather than an active participant relies on noetic awareness, or knowledge of the world (Wheeler et al., 1997). Noetic awareness is developed through observation, where an individual obtains an understanding of how the world works

based on examination and perception of surveyed experiences (Tulving, 1993). This type of awareness is generally related to semantic, or factual, memory, rather than episodic memory (Bowler, Gardiner, & Grice, 2000). However, in order to understand, and ultimately recall or learn from, an event in which one was not an active participant, they must have a basic understanding of social and cultural principles.

To understand observed social interactions, one must have "theory of Mind," which is an individual's ability to understand another's perspective (Baron-Cohen, 2000). It is well documented in the literature that individuals with ASD struggle with Theory of Mind as they have difficulty understanding another person's point of view and experience (Baron-Cohen, Leslie & Frith, 1985). For example, Happe (1994) found that when compared to a typically developing control group, individuals with ASD recalled more physical than emotional aspects of an observed story and struggled to identify mental states of the characters in the story. In other words, the ASD group was unable to use basic theory of mind applications to better understand and recall an observed social situation. Baron-Cohen and colleagues (1997) theorized that theory of mind is a main underlying component of socialization and communication. Lack of social awareness and communicative reciprocity are two well documented areas of weakness in ASD, both of which contribute to social cognizance and impact social functioning (Crane & Goddard, 2008).

Adding to the lack of clarity in comprehending an event, individuals with ASD have been found to struggle with source memory, or the concept of knowing versus remembering (Gardiner, 2001). This impacts memory recall in that the individual struggles to remember if he/she was an active participant or observer of the event, or if

he/she was told about the event. During an episodic memory assessment in which an individual is asked to recall an autobiographical memory, it is common for individuals with ASD to retell a memory of an event they viewed, such as a television show or movie, rather than an event of which they were a participant.   Lack of basic comprehension of an event, an inability to understand the experience of those involved, and confusion over one's role in the situation all likely contribute to the breakdown in non-autobiographical episodic memory.

Cognitive Behavioral Therapy and Episodic Memory

Cognitive Behavioral Therapy (CBT) has long been acknowledged as an effective treatment for a variety of diagnoses, but more recently has received attention for its use with individuals with ASD as it allows for simultaneous intervention in modifying an individual's thoughts, feelings, and behavior (Bauminger, 2007; Fujii et al., 2013; Sofronoff, Attwood, Hinton, & Levin, 2007; Wood et al., 2009). For example, Bauminger (2007) demonstrated the efficacy of CBT when used to improve social cognition and as a result, social interactions in children with ASD. Millward and colleagues (2000) suggested a cognitive intervention that is focused on improving the individual's experience of themselves and others in an event could help to remediate episodic memory deficits.

Common components of CBT include cognitive restructuring, affective training, emotion recognition, and parent education (Wood et al., 2009), with a focus on social awareness, reciprocal interchanges, and empathy. Tulving (1979) claimed that social awareness and understanding is a major component of episodic memory. Additionally, EM has been found to assist in several aspects of socialization such as social problem

solving, the initiation and maintenance of interpersonal relationships, and supplying information for social interactions and communication (Crane & Goddard, 2008). If the episodic memory deficits found in individuals with ASD are primarily due to deficits in social cognition, interpersonal communication or motivation, as opposed to memory encoding or retrieval per se, then by targeting social communication impairments through CBT, an improvement in EM should be observed post treatment.

As previously noted, a correlation between impaired theory of mind, or the ability to understand another person's perspective, and episodic memory functioning has been found in individuals with ASD (Bowler, Gardiner, & Grice, 2000). An impaired ability to understand another's experience could impact recall if there is a lack of understanding of the other's involved in the situation. When withdrawing the knowledge of one's own experience coupled with the experience of the other individuals involved in an event, the entire social context is removed. CBT has previously been used to help improve theory of mind skills for children with ASD. In a study by Sofronoff, Attwood, Hinton and Levin (2007), CBT was used to improve theory of mind deficits by teaching children with ASD to decrease rigidity in their thinking and ask others to explain their response if it was misunderstood. Bauminger (2002) used CBT to teach theory of mind skills to children on the spectrum by focusing on recognizing other's emotions during social interactions. A lack of understanding surrounding the social context would impair one's ability to call on past social experiences to use in current exchanges, thus impairing the individual's overall social skills. Therefore, improving theory of mind skills through the use of CBT could help improve noetic components of EM skills.

In autism, the impact of sympathetic hypo-arousal on memory formation remains unclear. Given the patterns of low social motivation seen in ASD, there is the possibility that these individuals experience particularly low levels of arousal as compared to typical peers when observing social events, leading to relative differences in the formation of social memories (Maras, Gaigg & Bowler, 2012). It is for this reason that integrating the child's interests, such as cartoon characters, into the delivery of CBT has been shown to not only improve their attention to the activities within the session, but also their recollection of the content of the session (Anderson & Morris, 2006; Attwood, 2003; Attwood, 2004). The overall impact of the differential processing of social situations over time is not fully understood, but it has been claimed that it could lead to atypical development of neural circuitry, thus impacting the overall functioning of regions associated with social information processing (Dawson, Webb & McPartland, 2005; Webb, 2008). Wood and Schwartzman (2013) suggest that the integration of the child's interests into the session makes the material more memorable, and that through repeated exposure and practice of new skills, new behaviors emerge, which can suggest changes in functioning down to a neural level.

Current literature has begun to examine EM deficits not only in relation to the recollection of past experiences, but also to 'future thinking' which refers to one's ability to consider future situations and their potential outcomes (Terrett, Rendell, Raponi-Saunders, Henry, Bailey & Altgassen, 2013). Lind and Bowler (2010) found that individuals with ASD demonstrate deficits in imagining possible future circumstances when compared to a neurotypical population. Episodic future thinking is believed to be a more complex cognitive process that relies on the retrieval of past experiences to

hypothesize about future events. Considering the EM deficits presented in ASD, it is logical that these impairments would impact future thinking (Lind & Bowler, 2010). Brewin (2006) suggests that CBT can be effectively used to create or modify memories so that appropriate past incidents are recalled to direct adaptive behavior in current or future situations.

Employing specific strategies when delivering CBT to individuals with ASD has improved efficacy. By altering cognitive understanding of social situations, improvements in the quantity and quality of social interactions has been observed (Bauminger, 2002; Bauminger, 2007; Wood et al., 2009). Part of the success of these trials can be attributed to the consideration paid to using creative and concrete methods of teaching cognitive social structures, which can combat deficits in abstract cognitions low motivation, and inconsistent attention to tasks (Minshew, Meyer & Goldstein, 2002). Repetitive practice of new social behaviors across settings such as in therapy, at home, at school, or with peers has also been found to improve the likelihood that these adaptive behaviors will be exhibited (Brewin, 2006; Tulving, 1979). Finally, attributing positive emotion to the practice of these behaviors can improve the likelihood of recall when in a social situation (Anderson, Cohen & Taylor, 2000). This finding corresponds with previous EM research which suggests memories related to positive emotions are often better recalled than those relating to a negative emotions (Peters, 1987; Stokes, Dritschel, & Bekerian, 2008).

Utilizing CBT has been found to be effective in remediating the severity of social deficits in ASD (Bauminger, 2002; Bauminger, 2007; Wood et al., 2009). By employing common components of CBT such as cognitive restructuring, emotion recognition in self

and in others, theory of mind, and behavioral practice (Drahota, Wood, Sze & VanDyke, 2011), while placing the majority of the emphasis on social awareness and interpersonal interactions, major components of EM that have been found to be impaired in ASD could be remediated (Tulving, 1979). Additionally, by integrating the child's interests, which is frequently utilized in CBT with ASD (Wood & Schwartzman, 2013), the child is more likely to be aroused by and attentive to the content of the session and therefore demonstrate improved recall (Maras et al., 2012). Finally, through repetitive practice of the adaptive behaviors both in session and in other environments, it is more likely that the child will demonstrate them in future interpersonal interactions (Lind & Bowler, 2010).

Research Questions and Hypotheses:

1) Does age, severity of ASD symptoms, IQ, working memory, verbal ability, processing speed, and/or narrative ability impact treatment outcome?

- *Hypothesis*: Higher age and lower ADOS scores will predict better treatment outcomes. In addition, higher scores in each of the identified cognitive areas, as well as narrative ability, will also impact better treatment outcome.

2) Can long-term autobiographic episodic memory deficits commonly observed in children with ASD be remediated through the use of cognitive behavioral therapy?

- *Hypothesis:* Episodic memory ability is somewhat dependent on personal identity and an understanding of the fluid dynamics of a social exchanges

that form memories, therefore, a treatment that targets social awareness could remediate this deficit.

3) Can short-term non-autobiographic episodic memory deficits related to lack of social understanding commonly observed in children with ASD be remediated through the use of cognitive behavioral therapy?

- *Hypothesis:* The severity of episodic memory deficits in children with ASD can be remediated through the use of CBT that focuses on the development of theory of mind and social competence.

Chapter 2: Method

Participants

  The study sample was comprised of 73 participants (59 male, 14 female) who were recruited through university psychology and psychiatry departments and autism research center, as well as community referrals such as Regional Centers, schools, and ASD support groups. IRB approved flyers were distributed throughout the greater area of a major metropolitan city. Participants were between the ages of 6-13 years old (M=9.64, SD=1.83) with a mean IQ score of 106.21 (SD=14.96) and mean ADOS score of 11.59 (SD=4.27). The breakdown of sample ethnicities includes Caucasian (n=38, 52.1%), African-American (n=1, 1.4%), Asian (n=9, 12.3%), Hispanic (n=7, 9.6%), Middle Eastern (n=3, 4.1%), other (n=12, 16.4%), and non-disclosed (n=3, 4.1%). Of the participants, only 14 (19.1%) families did not disclose family socioeconomic status. Two (2.7%) reported an income below $50,000; eight (10.9%) reported an income between $50,000-$70,000; Seven (9.5%) reported an income between $70,000-$90,000; and, Forty two (57.5%) reported an income greater than $90,000. Descriptive information for participants and their families are displayed in Tables 1 and 2.

  In order to participate in the study, participants were required to meet diagnostic criteria for autism or autism spectrum disorder (ASD) based on the Autism Diagnostic Observation Schedule (ADOS; Lord, Rutter, DiLavore & Risi, 2002) and the Autism Diagnosis Interview-Revised (ADI-R; Lord, Rutter & LeCouteur, 1994). They also needed to have an IQ of 70 or higher as determined by the administration of four subscales of the Wechsler Intelligence Scale for Children (WISC; Wechsler, Kaplan, Fein, Kramer, Morris, Delis & Maerlender, 2004) to obtain an estimated Full Scale Intelligence Quotient. Finally, participants were mandated to either not be taking any

psychiatric medication or be on a stable dose of psychiatric medication for at least one month prior to assessment and throughout the duration of treatment.

Measures

Autism Diagnosis Interview-Revised (ADI-R; Lord et al., 1994). This 93-item standardized interview provides a comprehensive autism spectrum diagnostic assessment. The ADI-R provides reliable and valid diagnoses of autism spectrum disorder for individuals with a mental age above 2 years. Domains assessed by the ADI-R include social, communication, and repetitive behaviors. Authors of the ADI-R provide a recommended algorithm for diagnosis and classification of autism (Lord et al., 1994). This measure was administered at the pre-treatment assessment time point as part of the diagnostic eligibility criteria.

Autism Diagnostic Observation Schedule-Second Edition (ADOS-2; Lord et al., 2002). This semi-structured, standardized protocol for observation of social and communicative behavior associated with autism provides reliable convergent data for diagnosing children with autism spectrum disorders (Lord et al., 1989). The ADOS contains four modules suited for a range of developmental and communicative abilities; each module assesses four domains: social, communication, social-communication, and restricted and repetitive. The cut-off score varies by module. The validity and reliability of the cut-off scores have been determined to be robust (Lord et al., 2000). This measure was administered at the pre-treatment assessment time point.

Autobiographical Memory Task (AMT; Williams & Broadbent, 1986) The AMT is a measure that assesses personal memory by providing the participant with a cue word and then asking the individual to tell about an event that he/she associates with the

word. In this study, the participant was administered five trials in which he/she was prompted, "Tell me about a time you felt ____." Each trial consisted of one of the following emotions: happy, sad, embarrassed, angry, or nervous. All responses were provided orally with no written component required. There was no specific instruction given to the length, amount of detail, or time period during which the memory occurred. Rather, participants were allowed to respond to the question and provide as much information as he/she desired. While this measure has not been studied extensively in ASD, it has been shown to have good reliability in a number of studies (Stokes et al., 2008). Details on the procedures and scoring of the AMT are given below. This measure was administered at both pre and post-treatment assessment time points.

Episodic Memory Inventory (EMI; Zielinski & Wood, 2014*).* The Episodic Memory Inventory examines memory encoding and recall for recently viewed social events. Each participant was presented with 5 two minute videos in which a character experienced a different emotion (happiness, anger, embarrassment, sadness, or fear; see AMT above). After watching the videos, the participant was later asked to recall the event. This measure was designed to examine non-verbal recall, verbal recall with a visual cue and verbal recall without a visual cue, and to examine how preference impacts memory encoding and recall. Total time for administration was 20 minutes. Details on the procedures and scoring of the EMI are given below. This measure was administered at both pre and post-treatment assessment time points.

Narrative Ability Measure (Suh, Eigsti, Naigles, Barton, Kelley & Fein, 2014). The narrative component of the assessment is included in the administration of the ADOS-2 (Lord et al., 2002). Within Module 3, there is a task that involves having the participant

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tell a story from a book, *Tuesday*, that has only pictures as contextual cues. Participants' narrative ability was assessed by having them narrate the *Tuesday* book as they looked at pictures (Wiesner 1991). Details on administration and coding are provided below. This measure was administered at the pre-treatment assessment.

Wechsler Intelligence Scale for Children–IV (WISC-IV; Wechsler et al., 2004). The WISC-IV is a test of general intelligence for youth 6 to 16 years old. The WISC-IV generates a Full Scale IQ (FSIQ), representing overall cognitive ability, as well as four other composite scores: Perceptual Reasoning Index (PRI), Processing Speed Index (PSI), Working Memory Index (WMI), and Verbal Comprehension index (VCI). For the purpose of this study, an abbreviated WISC-IV was administered to determine estimated FSIQ and indices. The Matrix Reasoning subtest was administered to examine perceptual ability, the Vocabulary subtest was used to measure verbal ability, the Coding subtest assessed processing speed, and the Letter-Number Sequencing subtest examined working memory. The estimated FSIQ was calculated based on the participant's scores on these four subscales. This measure was administered at the pre-treatment assessment time point as part of the eligibility criteria.

Procedure

Assessment

After being recruited and meeting initial criteria based on the phone screen, participants and their parents were administered the eligibility assessment. This assessment consisted of the ADI-R for parents and the ADOS and four WISC-IV subscales (Letter-Number Sequencing, Matrix Reasoning, Vocabulary, and Coding) for the children. As part of the ADOS-2, the examiner administered the Narrative Ability

Measure. The examiner began the activity by saying, "Let's look at this book. It tells a story in pictures. Can you tell me the story as we go along?" All narrations were transcribed. They were then coded based on the number of story elements included in their narration. A story element is defined as an essential feature of the story such as the character, the character's action(s), and at times information on the setting. This coding scheme, which is based on the work of Suh and colleagues (2014), was implemented by determining the overall percentage of essential features (number of essential features identified by the participant divided by the number of essential features available per page multiplied by 100) each participant identified.

After meeting all eligibility criteria for the study, participants were administered the Episodic Memory Inventory and Autobiographical Memory Task. In these measures, participants were shown a series of five stories, each of which depicted one of five emotions (happy, sad, angry, nervous, and embarrassed). The stories consisted of five slides which included a still image and words explaining an aspect of the story and ended with a film of a child portraying the emotion that corresponded to the story. The written language component of the slide was read aloud to children as they followed along visually (see Figure 1).

The stories and videos were chosen based on the following criteria: depicting an emotion, portraying a plotline, no additional contextual cues (such as background music or the actor/actress identifying his/her emotion), and the use of child actors sustaining an emotional expression for at least 10 seconds. Since the focus of the study was to examine understanding and recall of non-autobiographical social events, the main goal of the video was to exemplify a social situation in which the main character experienced

an emotion brought on by the events of the story including his/her interaction with the other characters. The images of the events of the story were static, but the video portraying the emotion was at least 20 seconds in length and included a close up on the character's face to allow the participant the opportunity to utilize contextual clues from the story as well as facial cues to encode information about the event. The participants viewed these videos, and then completed the AMT questions (see below). Other study related activities were then administered that took approximately half an hour to complete, and then the EMI was administered (see below). The order in which the videos were screened by participants as well as the order of the stories during the recall was counterbalanced as part of the experimental design.

As previously explained, during the administration of the AMT participants were given 5 emotional words (happy, sad, angry, nervous, and embarrassed) one at a time, which corresponded to the story they just viewed, and asked to tell about a time when he/she felt this emotion. Responses received two separate codes for each story shared in response to the emotional cue (Williams & Broadbent, 1986; Stopa & Jenkins, 2007). The first code was based on whether or not the event shared was personal. Stories that were better classified as semantic memories (i.e. in response to the word happy the participant responded "my dog") received a code of "0" and stories that were an autobiographical memory received a code of "1." The second code was based on the time period of the memory and received one of three scores.   A specific memory (i.e. the participant responded to the prompt happy with "the day I got my dog") was coded as a "2." A memory that was more general in nature was fit into one of two categories; categoric (i.e. participant responded to the prompt happy with an unspecific time period

"when I watch TV") which was coded as a "1" or extended (longer than a day, i.e. participant responded to the prompt happy with "during my trip to Hawaii") which was coded as a "2". The codes from the type of memory (autobiographical or semantic) and time period (specific, general-categoric or general-extended) were added together to provide a sum total for the story shared by the participant per emotional prompt.

About 30 minutes after completing the AMT, participants completed the EMI (Zielinski & Wood, 2014). The order and type of recall were counterbalanced. First, participants were presented with an image of the main character depicting an emotion portrayed in the last scene of the movie for each of 4 stories. From this group of images participants were asked to choose their favorite story by being prompted, "Here are pictures from the movies that you just watched. I would like to do an activity with the pictures. First, please choose your favorite of these four movies." This served as the preferred choice for the preferential trial and was placed aside until this trial was administered.

For the non-verbal condition, participants were given a series of 6 images from a story and asked to sequence the images in the order they occurred. The assessor prompted the participant by saying, "Please put these images in the same order that they occurred in the film." This sequencing portion of the trial examined non-verbal recall as there was no expressive language requirement placed on the participant. The cards were then collected so that there was no longer a visual cue and the participant was asked to recall the events that occurred in the story by hearing the following prompt, "Now I would like you to tell me what happened in this film. Please explain everything that happened in this story starting at the beginning." This component of the

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trial served as the mixed condition in which participants received a full visual prompt, which was sequenced and removed, and then they were verbally asked to recall the events of the story.

In the verbal only condition participants were prompted verbally to recall the events of a specific story. For example, the participant was prompted **"**Now, please think about the story in which the boy got sent to the principal's office. Please explain everything that happened in this story starting at the beginning…**"** The participants completed this trial without a visual cue.

The preferred and non-preferred conditions both consisted of a single visual prompt. Participants were presented with the image from the scene of the film in which the child actor portrayed a specific emotion. For the preferred condition, participants were presented with the image of the child actor portraying a specific emotion from the story they identified as their favorite. The image for the non-preferred trial was randomly assigned for each participant depending on the order of recall in the counterbalance of trials. After presenting the image to the participant, he/she was prompted to recall the story with the instruction, "Now I would like you to tell me what happened in this film. Please explain everything that happened in this story starting at the beginning." Following the conclusion of the verbal prompt, the visual cue was removed, so the participant did not have any visual aide during their recall of the story. The only variation in administration of these two trials is that the participant chose which story he/she wanted to recall for the preferred trial, whereas the participant was randomly provided with a story to recall in the non-preferred trial.

The responses were coded on the following criteria: number of sequenced events, number of correct details, and overall number of details sequenced correctly. All responses were first transcribed and then coded using differing scales for each criteria (Zielinski & Wood, 2014). For the number of events sequenced code, the video was broken into the number of slides presented to the participants (either 6 or 8). One point was given for each pair of events sequenced in the correct order, plus one additional point was given if the participant accurately identified the first and last event of the story, making the maximum score assigned to this criteria equal to the total number of slides for each condition. For the number of correct details recalled criteria, one point was assigned for each detail noted that described either who, what, when, where, or why as it pertained to the story; participants received only one point for each detail and no points for repeated details. Finally, the overall number of details correctly sequenced combined the prior two criteria. A coding scheme was developed that again broke down the story by each of the slides (Zielinski & Wood, 2014). Then a specific number of correct details was assigned to each slide in order for a point to be earned. For example, if a participant correctly sequenced the event of the story and recalled a determined number of the relevant details from that specific event, then a point was assigned. Like number of correct details, the participant could earn a maximum of 6 or 8 points for overall number of details correctly sequenced.

The assessment procedures outlined in this section for the EMI and AMT were repeated at the post-treatment assessment time point.

Treatment

Participants were randomly assigned to one of two conditions: Individual or group cognitive behavioral therapy (CBT). After matching participants based on age, IQ, ADOS score and gender, they were randomized by using computer generated conditions to ensure balanced sample sizes and negate confounds that could potentially impact treatment outcome. See Table 2 for a breakdown of condition demographics. Participant condition was not revealed to the assessors prior to the completion of the final assessment.

In the individual CBT condition, doctoral and post-doctoral level clinicians worked with families for 32 weekly sessions, each of which lasted 90 minutes in duration; half of the session was spent with the therapist intervening with the child 1:1, and during the other half, the therapist divided their time between the parents and the family. The treatment was developed by Dr. Wood and based on a modified version of a previous CBT intervention (Wood et al., 2009). The intervention consisted of a manualized modular treatment approach designed to target core autism symptoms.

Treatment began by establishing rapport between the participant, parents and therapist as well as teaching the participant a cognitive schema that could be used when facing difficult or anxiety provoking situations. Early in the 32 weeks, a comprehensive hierarchy was developed identifying all behaviors, including conversational, perspective-taking, and friendship skills; restricted and repetitive behaviors; and emotional and behavioral problems. Target areas to intervene on were identified and a treatment plan was developed by utilizing a scaffold structure where intervention began in areas that were noted as less difficult and worked up towards

areas of greater difficulty. To support the participants as they worked through increasingly difficult situations, a reward system was also established with the family early in treatment.

In general, treatment initially focused on decreasing any disruptive behaviors that might interfere with socialization such as difficulty with emotion and behavioral regulation. Once externalized behaviors were managed, any rigidity, which, in autism, generally presents as restricted or repetitive behaviors, narrowed areas of interest, the need to do things the same way and concrete thinking was targeted (South, Ozonoff, & McMahon, 2005). After participants demonstrated increased flexibility, then several subsequent sessions were dedicated to improving social communication skills. Within these sessions, areas such as listening, questions, comments, reciprocity, non-verbal skills, and subtleties like humor and figurative language were worked on.

The final and main focus of treatment was the interpersonal relationship deficits commonly associated with ASD (Travis & Sigman, 1998). The intervention in this area varied from initiating and responding to social overtures from peers at school and in the community (e.g., joining in play at recess and the park) to being a good host or guest on a playdate or sleepover. Previously targeted areas such as flexibility in terms of going along with other's ideas in play and communication skills were integrated as appropriate. These skills were practiced across several environments including home, school, and the community. Often as part of the intervention, therapists collaborated with school personnel to observe participants at school and integrated skill development and practice into the school day.

The group intervention was similar to the individual condition in several ways. Treatment consisted of 32 weekly 90 minute sessions. Group size was generally six children between the ages of 6 and 13. Additionally, there was parent involvement as parents attended a group with a therapist while children attended their group. All therapists were doctoral or post-doctoral level students. Many of the same areas were focused on in this intervention such as flexibility, communication skills and social skills. Each session consisted of a lesson where therapists provided the participants with an overview of the session and skill that was addressed as well as a period dedicated to practicing.

Conversely, for this intervention there was a set protocol with session guidelines, goals, and activities for each of the 32 sessions. Additionally, there were no weekly homework assignments and there was no personalized school collaboration (school contact is limited to observation of the child at the school). Parents were provided with an overview of the session topic during their group, but were not given personalized behavioral change strategies for their child. The main defining difference between the two conditions was that the individual treatment was tailored to each participant's unique set of needs where the group protocol was pre-planned and delivered in a consistent systematic manner.

Chapter 3: Results

Inter-rater Reliability

Inter-rater reliability was calculated for coders of the AMT, EMI, and ADOS to test for agreement between raters. To calculate inter-rater reliability, 10% of the cases were dual coded. On the AMT, raters demonstrated strong reliability for total scores (ICC=.86). On the EMI, raters demonstrated acceptable reliability for total scores (ICC=.81). Finally, on the ADOS, raters demonstrated strong reliability for total scores (ICC=.89). A copy of coding guidelines for all three measures can be found in the appendix.

Attrition and Missing Data

As is a frequent occurrence in clinical research, attrition was experienced in each treatment condition. In the group treatment condition, 5 participants (13%) dropped out before completing the intervention, reducing the sample from n=38 to n=33. In the individual treatment condition, 4 participants (12%) dropped out before completing the intervention reducing the sample from n=35 to n=31.

In addition, there were also a few cases in which the data from either the pre-treatment or post-treatment assessment was lost due to technical difficulties. In the group treatment condition, 5 participants (13%) did not have pre-treatment data reducing the sample from n=38 to n=35. In addition, post-treatment data from 3 group participants was lost reducing the sample from n=33 (while factoring in attrition) to a final n=30. In the individual treatment condition, 4 participants (11%) did not have pre-treatment data reducing the sample from n=35 to n=31. In addition, post-treatment data

from 2 individual participants was lost reducing the sample from n=31 (while factoring in attrition) to a final n=29.

Aim 1: Determine if age, severity of ASD symptoms, narrative ability, overall IQ, working memory, verbal ability, and/or processing speed impact EM ability.

To answer this question, Hierarchical Linear Modeling (HLM) was used. HLM is a more complex type of regression that allows one to examine the variance in outcome data when predictors vary at different levels such as within-person and between-person (Woltman, Feldstain, MacKay & Rocchi, 2012). In other words, this type of analysis allowed for the examination of change in autobiographical memory functioning as a product of treatment condition and time. It was hypothesized that autobiographical memory in children with autism would improve post cognitive behavioral therapy treatment, with the greatest improvement shown in the group that received individual treatment rather than group treatment.

The first aim of the study sought to understand if various cognitive processes and additional factors had an impact on EM functioning at treatment outcome, thus effecting performance on memory measures. To test these relationships, HLM was used. All scores were centered around the grand mean to remove variance and create a standardized score within the factors. It was hypothesized that higher scores in the given cognitive areas would improve the participant's ability to access the intervention, thus resulting in better outcomes on memory measures post treatment.   It was also predicted that participants who demonstrated better narrative skills, included more relevant details and less irrelevant details, would perform better on the memory measures. Finally, it was thought that older participants would improve more than

younger children through treatment. Participant overall IQ, working memory, verbal

ability and perceptual reasoning skills were not found to impact treatment outcome as

results were insignificant.

Several factors were identified as impacting change in performance on the

Autobiographical Memory Task from pre- to post-treatment (See Tables 3 and 4).

Analyses were run to examine the relationship between these different factors and

performance on the AMT while factoring in the impact of time. Participants whose

cognitive processing speed was higher demonstrated more improvement on the AMT at

post treatment than participants whose processing speed was lower (β= -3.39, p<.05;

see Figure 2).

Additional scores on several aspects of the ADOS were found to impact

performance outcomes on the AMT. Participants whose ability to clearly narrate a story

improved with treatment also demonstrated greater post-treatment gains on the AMT

(M=.65, SD=.15, β= 1.75, p<.05; see Figure 3). When narrating a story, participants

who included more irrelevant details exhibited less improvement on the AMT at post-

treatment than participants who included fewer irrelevant details (β= -1.50, p<.01; See

Figure 4).

In addition, two factors related to narrative performance were approaching

significance in their impact on AMT performance at post-treatment.   The more critical

story elements the participant identified during their narration of the story was found to

be related to their improvement they made on the AMT at post-treatment (β= 8.09,

p<.10; See Figure 5). Also, the more relevant details a participant included in their

narration, the better they performed on the AMT at post-treatment (β= 1.67, p<.10; See Figure 6).

Two factors were also found as predictors for change in performance on the Episodic Memory Task from pre- to post-treatment (See Tables 3 and 5) . Analyses were run to examine the relationship between these factors and performance on the EMI while factoring in the impact of time. As the participant's age increased, their performance on the EMI decreased (M=9.65, SD=1.82, β= -2.66, p<.05; See Figure 7). In addition, the participant's pre-treatment scores on the ADOS were found to impact participant performance on the EMI at post-treatment. Participants who scored higher on the ADOS at pre-treatment performed poorer on the EMI at post-treatment than participants who scored lower on the ADOS (M=11.59, 4.25, β= -0.92, p<.10; See Figure 8).

Additional analyses were run to explore if the relationship between the predictors and the outcome measures also held when factoring in condition. There was not a relationship found between condition, AMT performance, and narrative ability or processing speed. There was also no relationship found between condition, EMI performance, and ADOS score.   The only predictor that was found to have a relationship with EMI performance when factoring in condition was participant age (β= 3.95, p<.05).

Aim 2: Determine if long-term autobiographical memory deficits found in ASD can be remediated through cognitive behavioral therapy.

In order to run this analysis, the program Hierarchical Linear and Nonlinear Modeling, 7th Edition (HLM-7; Raudenbush, Bryk & Congdon, 2015) was used. The

total score for all AMT trials was calculated and used as the outcome variable. Robust standard errors were used as a hedge against the possibility that outcome variables had skewed distributions. The change in participant performance on this measure was tested from time point 1 (pre-treatment assessment) to time point 2 (post-treatment assessment) while factoring in the participant's treatment condition (See Tables 6 and 7). While the groups did not vary statistically at pre-testing (Group M=15.98, SD=3.72; Individual M=14.95, SD=4.65), there was a significant difference at post-test (β= -3.39, p<.05; Group M=15.04, SD=3.34; Individual M=16.56, SD=3.42), in that the participants who received individual treatment demonstrated improved performance on the AMT at post-treatment, where the group treatment participants' performance on the AMT declined at post-treatment, indicating an interaction of treatment condition and time (see Table 7; Figure 9).

Aim 3: Determine if short-term non-autobiographical memory deficits found in ASD can be remediated through the use of cognitive behavioral therapy.

To test this aim, HLM was again utilized. This analysis allowed for the examination of change in non-autobiographical memory functioning as a product of condition and time. It was hypothesized that non-autobiographical episodic memory would also improve in children with autism post cognitive behavioral therapy intervention, with the greatest improvement shown in the group that received individual treatment rather than group treatment.

The total score for all EMI trials was calculated and used as the outcome variable. The change in participant performance on this measure was tested from time point 1 (pre-treatment assessment) to time point 2 (post-treatment assessment) while

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factoring in the participant's treatment condition (See Tables 6 and 8). At the pre-

treatment assessment, the two treatment conditions differed significantly (Group

M=18.78, SD=9.36; Individual M=14.55, SD=8.98; β= 8.50, p<.05), with group treatment

participants demonstrating higher EMI scores over individual treatment participants. At

post-treatment, group treatment participant's performance on the EMI declined, where

individual treatment participant's performance improved resulting in significant changes

in performance on the EMI from pre- to post-treatment (Group M=17.52, SD=5.12;

Individual M=16.43, SD=4.44; β= -7.93, p<.05), indicating an interaction effect of

condition and time (see Table 8; Figure 10).

Chapter 4: Discussion

Episodic memory is one of many cognitive processes that influences social functioning, and deficits in EM can magnify social impairments. Episodic memory supports several aspects of socialization such as conversation maintenance, development of close relationships, and social problem solving (Crane & Goddard, 2008). Each of these areas has been identified as an area of weakness in social skills for individuals with ASD. Additionally, it has been found that deficits in episodic memory (EM) remain relatively stable throughout the lifespan for many individuals. Therefore it is likely that this deficit impacts individuals via its effects on socialization through all stages of development.

However, the etiology of the EM presentation in ASD is not likely to be as simple as a generalized encoding or recall deficit. In fact, encoding and recall of declarative information is often a strength for many people with ASD (Minshew & Goldstein, 2001). The role of autonoetic awareness in EM is likely critical in understanding the ASD-related deficits, as there are numerous sequential steps in development that are required for the emergence of episodic memory. Starting almost at birth, there are a series of skills related to self-awareness, each of which is a pre-requisite for the next, which are essential to EM development (Lind & Bowler, 2008). These skills include awareness of one's own emotions, conceptual self-awareness or differentiating the self from others, and the use of personal pronouns (Lind & Bowler, 2008). When examining these metarepresentation skills, deficits are present in ASD essentially from the beginning of development.

This study sought to determine the extent to which EM deficits in children 6-13 years of age with high-functioning ASD were relative as opposed to malleable and amenable to psychosocial intervention. The overarching aim was to understand which, if any, cognitive processes and extenuating factors, such as narrative ability, IQ, and age, impacted the remediation of EM deficits in children with ASD. In addition, this study explored if an intervention that targeted social cognition could be used to remediate the severity of EM deficits in this population. In particular, this study examined if cognitive behavioral therapy could improve long-term autobiographical EM, short-term non-autobiographical EM, or both.

While several factors were found to impact the improvement of both autobiographical and non-autobiographical EM in participants in both conditions, not all predicted factors had an impact on EM performance. For example, while full scale intellectual quotient was hypothesized to potentially impact treatment outcome, it did not have an effect on participant performance on EM measures at post-treatment. In addition, working memory also did not have a relationship with EM performance after treatment, potentially because this area was not targeted during the intervention. While verbal ability was also thought to effect post-treatment EM performance, this hypothesis was not validated possibly due to the higher verbal ability of participants included in the sample of children with high functioning autism. Finally, perceptual reasoning skills were not found to impact treatment outcome as results were insignificant.

However, several factors were found to impact EM performance after treatment. Participants whose cognitive processing speed was relatively higher than the group mean prior to beginning treatment demonstrated significantly greater improvement in

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autobiographical EM by posttreatment as compared to participants whose processing speed was lower at treatment onset. Social deficits have previously been tied to processing speed in that if individuals are not able to process rapidly incoming interpersonal information, then their overall understanding of the situation will be diminished (Faja et al., 2009). For example, individuals with ASD have been found to demonstrate a delay when processing faces (McPartland et al., 2004), a critical component of a social event, which provides key information about the context of the interaction. Therefore, it is logical that individuals who were better able to process rapid incoming information might be better able to track and act upon the multiple social components emphasized in the intervention in real time, thus supporting autobiographical EM.

As predicted, narrative ability impacted improvement on autobiographical memory measures between the pre-treatment and the post-treatment assessment time points. Participants whose ability to clearly narrate a story improved with treatment also demonstrated improved autobiographical memory skills by post-treatment. Through psychoeducation, cognitive restructuring, practice and modeling, participants were given scaffolded support in sharing experiences with conversational partners, such as addressing a topic introduced by the partner, deciding on a relevant anecdote to share, identifying several core details of the story most important for others' comprehension of the event, and including a beginning, middle, and end, all areas previously found to be missing in ASD (e.g., Goldman, 2008).

Repeated in vivo practice coupled with the social cognitive supports offered throughout the CBT intervention (e.g., brainstorming on others' perceptions of different

approaches to relaying a narrative) may have aided the participants in developing

coherence in their personal narratives by focusing on the conversational partner's need

to understand the event as a whole rather than in disjointed details (e.g., Frith, 1989).

Also supporting narrative clarity was the finding that participants who included fewer

irrelevant details in their narrations at pre-treatment demonstrated more improvements

in autobiographical episodic memory over the course of treatment. Emphasizing details

that add to the main story line results in improved sharing of information as the

conversational partner forms a clearer understanding of the event (Solomon, 2004).

While it is typical for children with ASD to include more irrelevant details than typically

developing children (Losh & Capps, 2003), these results suggest that those with

relatively better initial skills in this domain were more able to benefit from CBT

treatments (individual or group) in terms of gains during treatment in autobiographical

EM skills.

Also possibly contributing to treatment outcomes in autobiographical EM skills

was the inclusion of critical information during pre-treatment narration. Results,

approaching significance, indicated that the more story elements, or key components, a

participant included in their narration of a story, the more they improved in

autobiographical EM over the course of treatment. Just as individuals with ASD have

been found to include excessive extraneous details in many narratives, there is also a

tendency to leave out key aspects of a story (Capps et al., 1998; Ochs & Solomon,

2008).   Individuals with ASD have been found to provide fewer details, which provide

clarity and entertainment for the listener, and fewer references to emotional states of the

characters involved (Capps et al., 2000). By teaching participants to monitor the

experience of their listener to provide clarity and details during the interventions, perhaps their narrations improved, thus positively impacting their ability to share autobiographical episodic memories (Tartaro & Cassell, 2007). These results again suggest that those with relatively stronger narrative skills at pretreatment were more likely to benefit and make more gains in autobiographical EM over the course of treatment.

Two factors impacted gains in non-autobiographical episodic memory functioning during CBT treatment. First, participants who were younger in age demonstrated more improvement in their non-autobiographical EM after treatment than older children, which was contradictory to the original hypothesis. The emergence of skills required to form episodic memories is generally seen around age four years, but it is dependent on various factors such as the development of noetic awareness (Lind & Bowler, 2008). There are many brain regions associated with EM, such as the frontal lobe (Klein et al., 1999), but as the brain develops, the strength of neural pathways, whether adaptive or maladaptive, increase. It was thought that older participants would perform better due to the dependency of EM on the maturation of various brain regions and developmental processes. However, these findings suggest the opposite. One possibility is that the earlier in life that a child receives this type of intervention, the more malleable their brain systems, resulting in more room for modified processes such as noetic awareness, which in turn impact social understanding and EM. Alternatively, perhaps there is a developmental openness to the core socialization skills for the younger participants, on average, allowing a greater "dose" of the intervention to be absorbed.

An additional finding was that participants with lower total scores on the ADOS demonstrated greater gains on non-autobiographical memory measures during treatment. The ADOS is scored in a manner where the higher the overall score, the more severe the autism symptom presentation. It has been found that individuals with more severe autism tend to have more identified deficits in EM than individuals who are higher functioning (Boucher & Mayes, 2012). Some children on the spectrum with lower functional profiles present with cognitive impairment, more severe social and communication deficits, and tend to lack overall awareness (Boucher, Mayes & Bigham, 2008). It is therefore understandable in some ways that children with more severe ASD symptoms might not benefit as much from an intervention which focused on social understanding, thus impacting the amount of improvement in their non-autobiographical episodic memory that is reliant on an understanding of observed social situations. In point of fact, these results as a whole suggest that children with less severe cases of ASD at intake were generally likely to benefit more from the interventions than were other children.

Results from this study suggest that EM deficits in children with ASD can be remediated through the use of cognitive behavioral therapy. Specifically, the children who received individual therapy demonstrated improved long-term autobiographical memory at post treatment over children who received group therapy. It is documented that in order to understand a personal experience, one must also be able to integrate aspects of the event such as the emotional, sensory, social and cultural factors that shape the experience (Conway, 2001; Conway & Pleydell-Pearce, 2000). The cognitive behavioral therapy that participants received incorporated recognition of one's own

emotional experience, an understanding of one's actions and how they impact others

and the overall trajectory of the event, and detection of key elements such as setting

and social norms which impact the outcome of the situation, all while engaging in

repeated practice of identifying and communicating these aspects of occurrence

(Drahota et al., 2011; Wood et al., 2009). This targeted intervention likely assisted in a

more thorough understanding of the various factors that contribute to an event and an

enhanced ability to integrate these elements to re-create a comprehensive experience

thus improving recall. The intervention also focused on developing autonoetic, or self,

awareness. For participants who received the individual CBT, there was more

opportunity to individualize this component of the intervention. An improved

understanding and experience of themselves within an event likely contributed to

improved recall (Millward et al., 2000; Wheeler et al., 1997). Therefore, these results

suggest that when targeting autobiographical episodic memory, a customized approach,

such as the individually administered CBT utilized in this study, is more effective than a

group-based social skill oriented treatment in remediating the deficits found in children

with ASD.

This study also demonstrated that non-autobiographical EM skills in children with

ASD can be increased through the use of CBT. Unexpectedly, pre-treatment scores on

a non-autobiographical EM measure differed between conditions in that group therapy

participants' scores were significantly higher than individual CBT treatment participants'

scores. This represents a failure of randomization to produce completely equivalent

groups on this variable at pre-treatment. However, at post-treatment, the group therapy

treatment participants' non-autobiographical EM was shown to decline over time,

whereas participants who received individual CBT therapy demonstrated significant improvement in non-autobiographical EM over time. Wheeler and colleagues (1997) claim that this type of EM is reliant on noetic awareness, or knowledge of the world. This type of awareness is learned through observation; however if there is a lack of understanding of experiences, then memories created by watching an event may be incomplete. In addition, noetic awareness is reliant on "theory of mind," or an ability to understand another individuals' perspective (Baron-Cohen, 2000). While both treatments integrated the development of noetic awareness and theory of mind, individual CBT therapy allowed for a targeted intervention with a focus on the areas that were a personal challenge for each individual child. For example, the CBT intervention focused on teaching theory of mind skills by helping participants understand the feelings and actions of others involved in the event (Bauminger, 2002) as well as integrating strategies such as asking others to clarify their actions or verbalizations (Sofronoff et al., 2007). Individualized CBT allowed the therapist and child to practice this skill in a variety of contexts over several weeks to provide an opportunity for participants achieve a positive response in session.

Limitations

There were several limitations to this study. First, the sample was comprised of a majority of Caucasian males, and was not fully representative of a more diverse population. Studies have shown that factors such as race can impact diagnosis and treatment related outcomes (Mandell, Listerud, Levy & Pinto-Martin, 2002). In addition, the majority of participants came from families of relatively higher socioeconomic status. These factors limit the generalizability of the results.

This study sample also consisted only of children with high-functioning ASD. Participants were required to have an IQ above 70 to ensure that they could fully participate in the intervention. Due to the language demands and higher order cognitive skills required to participate in cognitive behavioral therapy (Bauminger, 2007; Wood et al., 2009), it was presumed that children with a lower IQ would find aspects of the interventions less accessible. The Center for Disease Control and Prevention (2012) approximated that individuals with high-functioning ASD make up a little more than 60% of the population of those with ASD. Therefore, the results of this study cannot be generalized to the larger population.

In addition, was no typically developing comparison group included in this study. While the main purpose of this study was to better understand episodic memory deficits in children with ASD receiving CBT treatment specifically, a comparison group would have potentially been informative. It has been well documented in the literature that there is a difference between EM functioning in individuals with ASD and typically developing individuals (Bowler et al., 2007; Millward et al., 2000).

Finally, decreased availability of data due to participant drop-out and technical difficulty was an additional limitation. Attrition is a problem commonly faced in clinical research, which can limit statistical power and generalizability of results (Leon, Mallinckrodt, Chuang-Stein, Archibald, Archer, & Chartier, 2006). Overall, 13% of group participants, and 12% of individual participants were lost to attrition over the course of intervention. In addition, 8% if group participant's data and 6% of individual participant's data was lost due to technical difficulties. While this decrease in number of participants from pre to post assessment time points raises questions about the

meaningfulness of the data, since the attrition rate is less than 15% the integrity of the data was likely uncompromised.

Future Directions and Conclusions

While this study examined only some of the potential factors that contribute to episodic memory gains in children with ASD participating in CBT treatments, there are many other areas that could impact this process and should not be overlooked. For example, general expressive language skills are integral to sharing personal memories (Klein et al., 1999). However, the language processes involved in retelling an event are complex and pragmatic language has been found to be impaired in individuals with ASD (Quill, 1997). Therefore, there is the possibility that for some, personal memories are intact, but that language deficits prevent the individual from fully expressing his or her recollection of events.

The relationship between EM and social deficits in ASD was explored with the goal of bringing attention to this relatively unexplored area as well as preliminarily discussing social impairments in ASD by intervening through episodic memory. Without the ability to use information from past experience to anticipate a social interaction, regulate behavior, and/or contribute to a reciprocal conversation meaningfully, social relationships are limited. While the relationship between EM and social functioning is not entirely clear, researchers hypothesize that episodic memory deficits contribute to the presentation of autism symptoms in ways that have yet to be fully understood (Bowler & Gaigg, 2008).

Therefore future research should focus on exploring new areas that could potentially impact EM and social functioning. For example, given the patterns of low

social motivation seen in ASD (Maras et al., 2012), there is the possibility that individuals with ASD experience particularly low levels of arousal as compared to typical peers when observing social events, leading to relative differences in the formation of social memories. Examining the physiological response of individuals with ASD to social-emotional material could provide a better understanding of what information is arousing to them and potentially how they process social situations. An understanding of how arousal moderates the relationship between memory and social competence could provide new insight into social impairments.

There has been research which suggests that perhaps there are no impairments to the episodic memory systems, but rather outside confounds create the presentation of a deficit (Bowler et al., 2000). By examining the various factors that contribute to EM such as the encoding and recalling processes, the neurological and psychological aspects of EM, and the interaction between these components, there is the potential to understand the true nature of how this area of memory presents in ASD. The relationship between social functioning and EM has been clearly documented (Crane & Goddard, 2008). Therefore seeking to remediate EM deficits could decrease social deficits found in ASD and inform the development of future social interventions for individuals with ASD, an area that continues to require exploration. It is important for future research to examine not only the etiology of episodic memory impairments in autism, but also what areas of functioning, such as socialization, are impacted by this deficit and to explore the development of an efficacious treatment designed to target episodic memory deficits in autism.

Chapter 6: Tables

Table 1

Group and Individual Condition Demographics for Participants and Families

_____

| | Group | | Individual | |
	N=	%	N=	%
Sample	38	52.01%	35	47.95%
Participant Sex				
Male	32	84.21%	27	77.14%
Female	6	15.79%	8	22.86%
Participant Ethnicity				
Caucasian	17	44.74%	21	60.00%
African-American	1	2.63%	0	0.00%
Asian	6	15.79%	3	8.57%
Hispanic	4	10.53%	3	8.57%
Middle Eastern	1	2.63%	2	5.71%
Other	7	18.42%	5	14.29%
Not Reported	2	5.26%	1	2.86%
Socioeconomic Status				
<$50,000	2	5.26%	0	0.00%
$50,000-$70,000	3	7.89%	5	14.29%
$70,000-$90,000	4	10.53%	3	8.57%
>$90,000	19	50.00%	23	65.71%
Not Reported	10	26.32%	4	11.43%

Table 2

Group and Individual Condition Descriptive Statistics

	Group (n=38)		Individual (n=35)	
	Mean	SD	Mean	SD
Age	9.45	1.54	9.86	2.10
ADOS Score	11.59	4.25	11.60	4.34
FSIQ	105.74	13.89	106.74	16.28
Verbal Ability	10.55	3.21	11.12	3.26
Perceptual Ability	11.45	3.58	11.06	3.61
Processing Speed	7.89	3.42	9.03	3.49
Working Memory	9.18	4.11	9.18	3.52
Narrative Ability	.62	.15	.71	.14

Table 3

Predictor Statistics

Predictor	Mean	SD
Processing Speed	8.46	3.46
Narrative Ability	.65	.15
Age	9.65	1.82
ADOS Score	11.59	4.25

Table 4

HLM Results for AMT Predictor Measures

Measure	β Coefficient	Standard Error	*p*-value
IQ-Processing Speed	0.27	0.13	0.05
ADOS Global 1: Clarity of Narrative	1.75	0.73	0.03
ADOS Global 3: Irrelevant Details	-1.50	0.48	0.01
ADOS Story Elements	8.09	4.45	0.09
ADOS Global 2: Amount of Detail	1.67	0.86	0.07

Table 5

HLM Results for EMI Predictor Measures

Measure	β Coefficient	Standard Error	*p*-value
Age	-2.66	1.09	0.02
ADOS Score	-0.92	0.52	0.08

Table 6

HLM Results for AMT and EMI Outcome Measures

Measure	β Coefficient	Standard Error	*p*-value
Autobiographical Memory Task (AMT)	-3.39	1.31	0.02
Episodic Memory Inventory (EMI)	-7.93	3.79	0.04

Table 7

Pre/Post Condition Statistics for AMT

Condition/Timepoint	Mean	SD
Pre Treatment Group	15.98	3.72
Post Treatment Group	15.04	3.34
Pre Treatment Individual	14.95	4.65
Post Treatment Individual	16.56	3.42

Table 8

Pre/Post Condition Statistics for EMI

Condition/Timepoint	Mean	SD
Pre Treatment Group	18.78	9.36
Post Treatment Group	17.52	5.12
Pre Treatment Individual	14.55	8.98
Post Treatment Individual	16.43	4.44

Chapter 6: Figures

Figure 1. *Example Story Presentation from Episodic Memory Inventory (EMI)*

One day Christine lost her special diary

She looked all over her room for it

After looking all over the house, she decided to have a look in her brother's room, but it wasn't there either

While she was going through all of his things, she accidentally knocked his laptop off his desk and broke it

Now she is waiting for her brother to come home. She wonders what he'll do when he finds out she was snooping through his room and broke his laptop

Now watch this and see what happens next…

Figure 2. *Impact of Processing Speed on Pre- Post Treatment Performance on the Autobiographical Memory Task (AMT)*
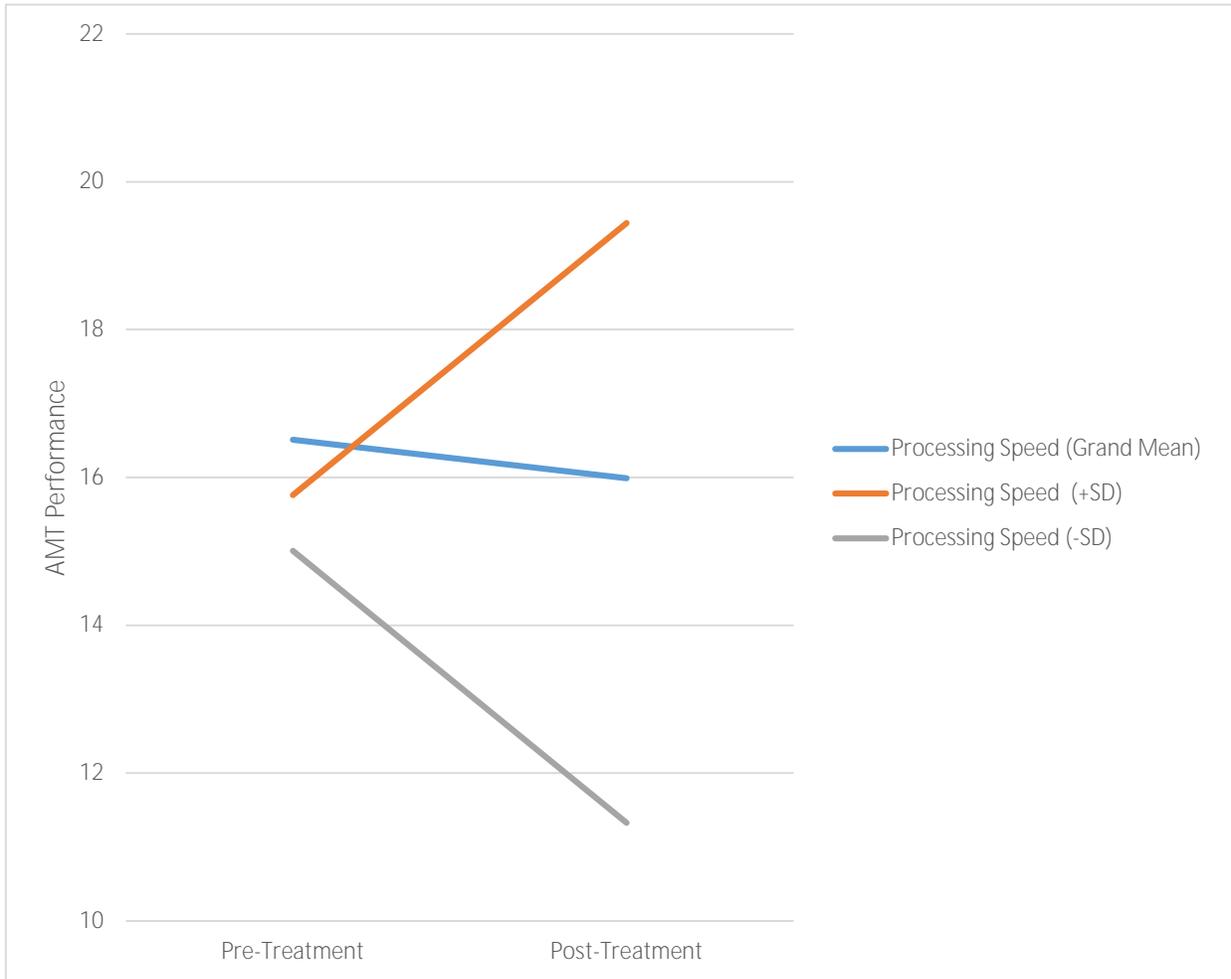
* Processing Speed (Grand Mean) = WISC Processing Speed centered around Grand Mean
* Processing Speed (+SD) = WISC Processing Speed 1 Standard Deviation above the mean
* Processing Speed (-SD) = WISC Processing Speed 1 Standard Deviation below the mean

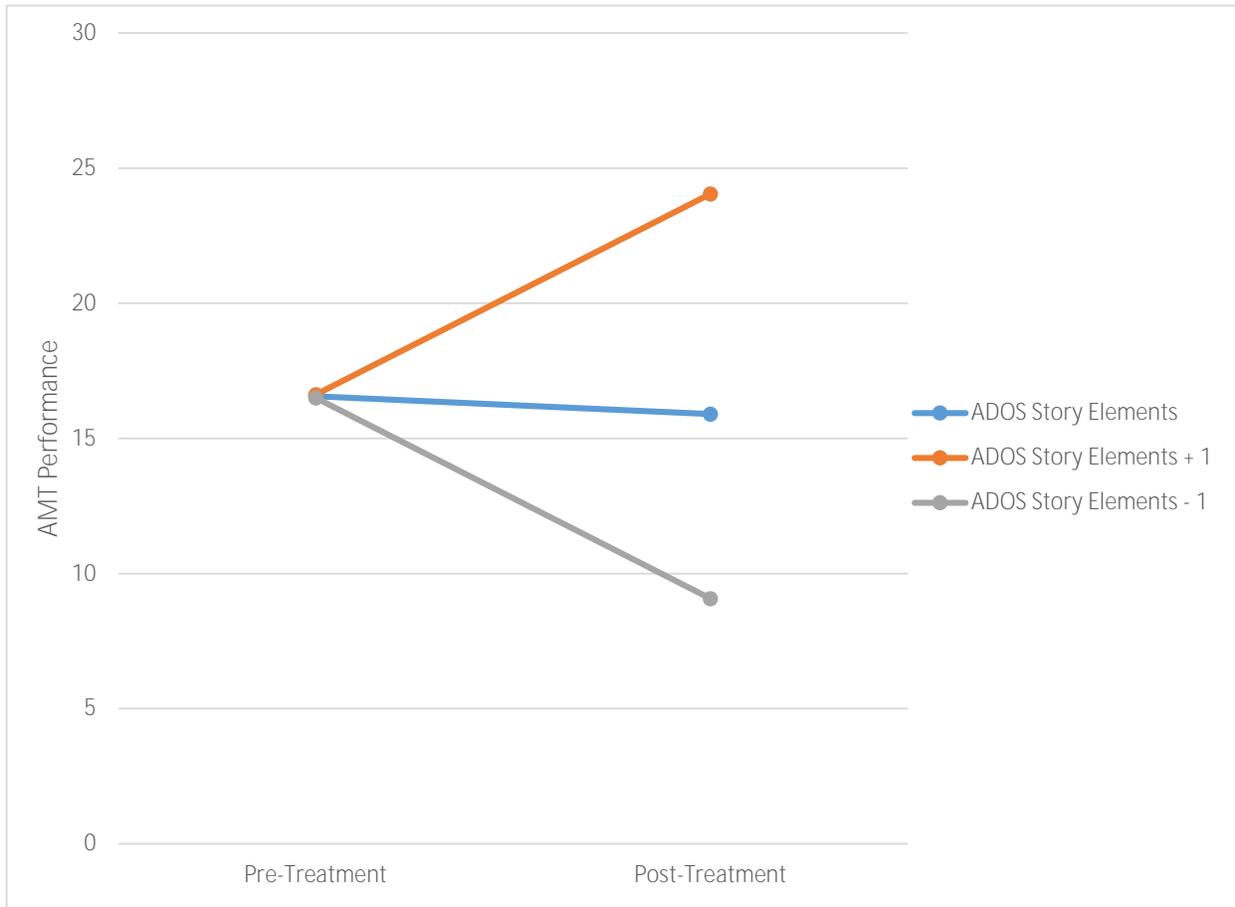Figure 3. *Impact of Narrative Ability on Pre- Post Treatment Performance on the Autobiographical Memory Task (AMT)*
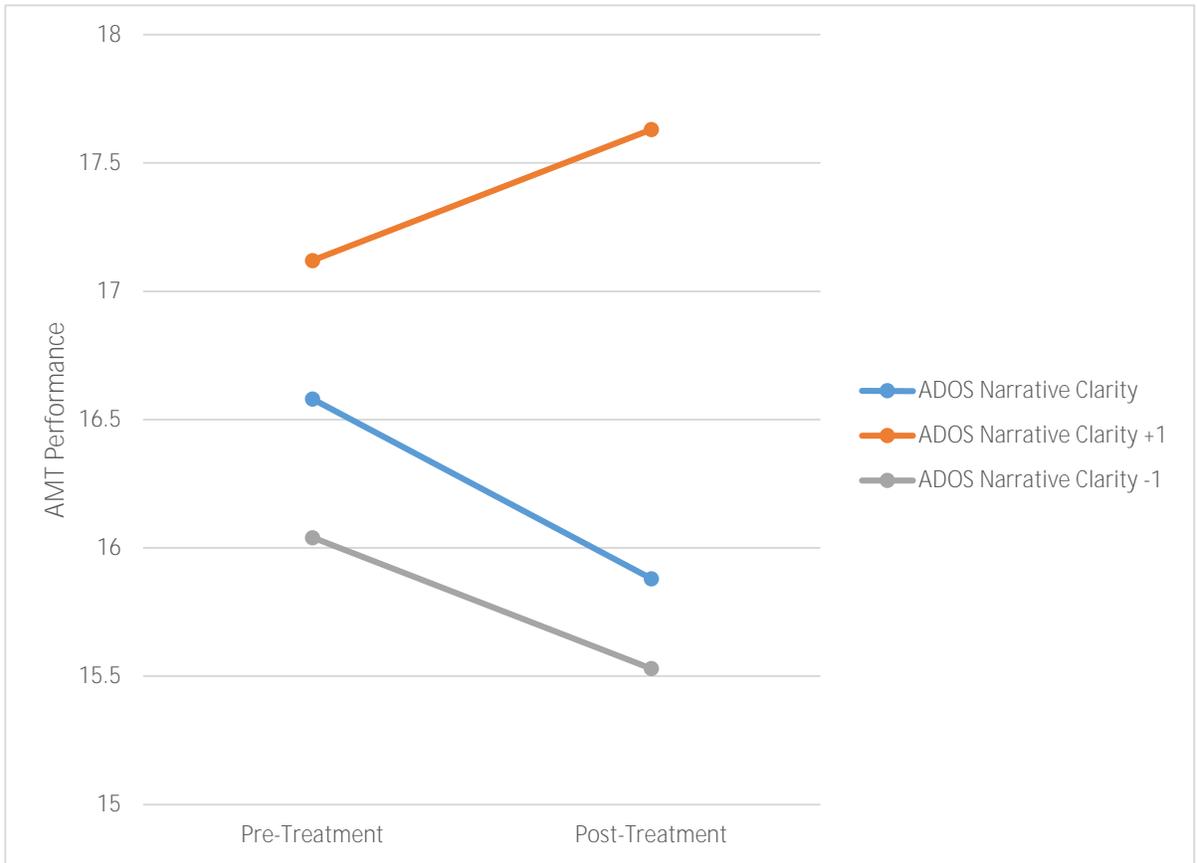
* ADOS Narrative Clarity = Clarity of Participant's narration of story centered around Grand Mean
* ADOS Narrative Clarity (+1) = Clarity of Participant's narration of story +1 above the mean
* ADOS Narrative Clarity (-1) = Clarity of Participant's narration of story -1 below the mean

Figure 4. *Impact of Inclusion of Irrelevant Details in a Narration on Pre- Post Treatment Performance on the Autobiographical Memory Task (AMT)*
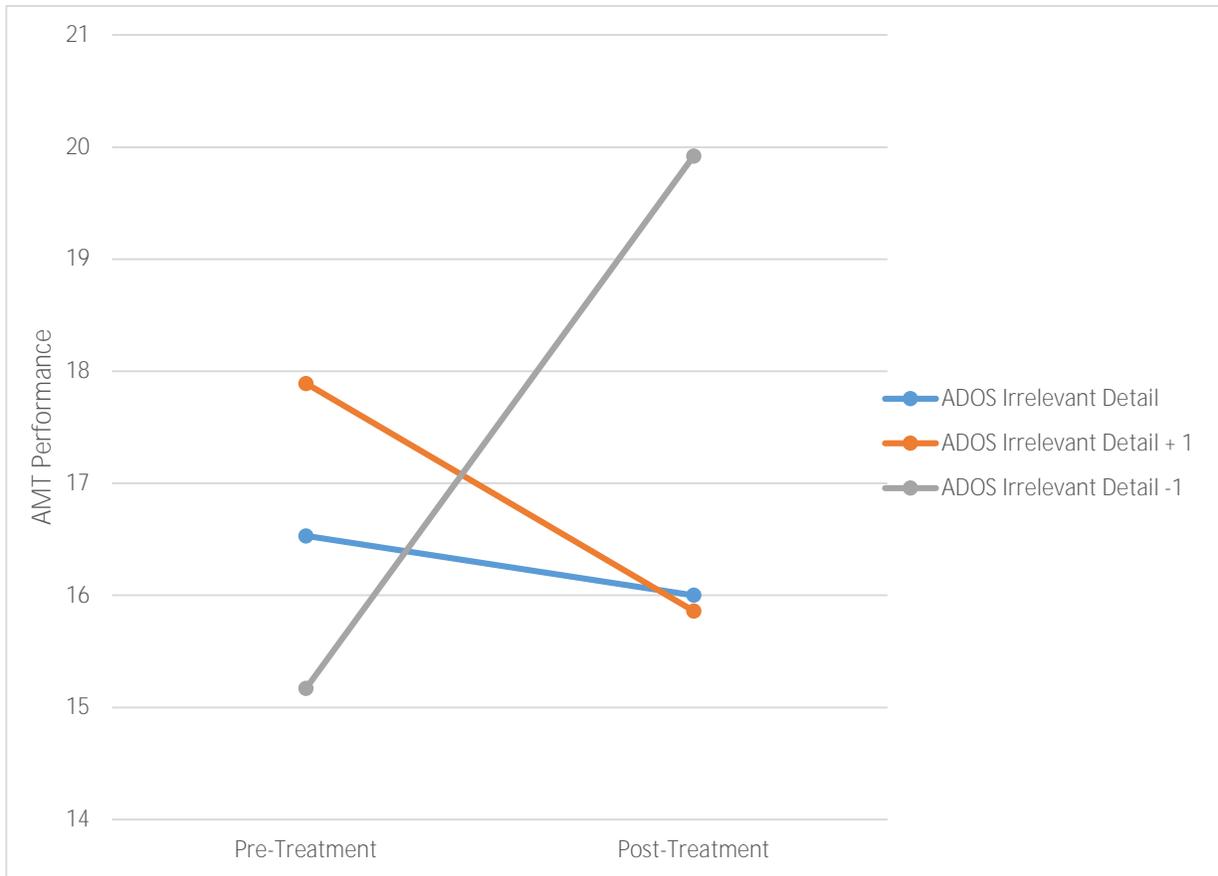
* ADOS Irrelevant Detail = Amount of Irrelevant Details included in Participant's narration of story centered around Grand Mean
* ADOS Irrelevant Detail (+1) = Amount of Irrelevant Details included in Participant's narration of story +1 above the mean
* ADOS Irrelevant Detail (-1) = Amount of Irrelevant Details included in Participant's narration of story -1 below the mean

Figure 5. *Impact of the Inclusion of Story Elements in a Narration on Pre- Post*

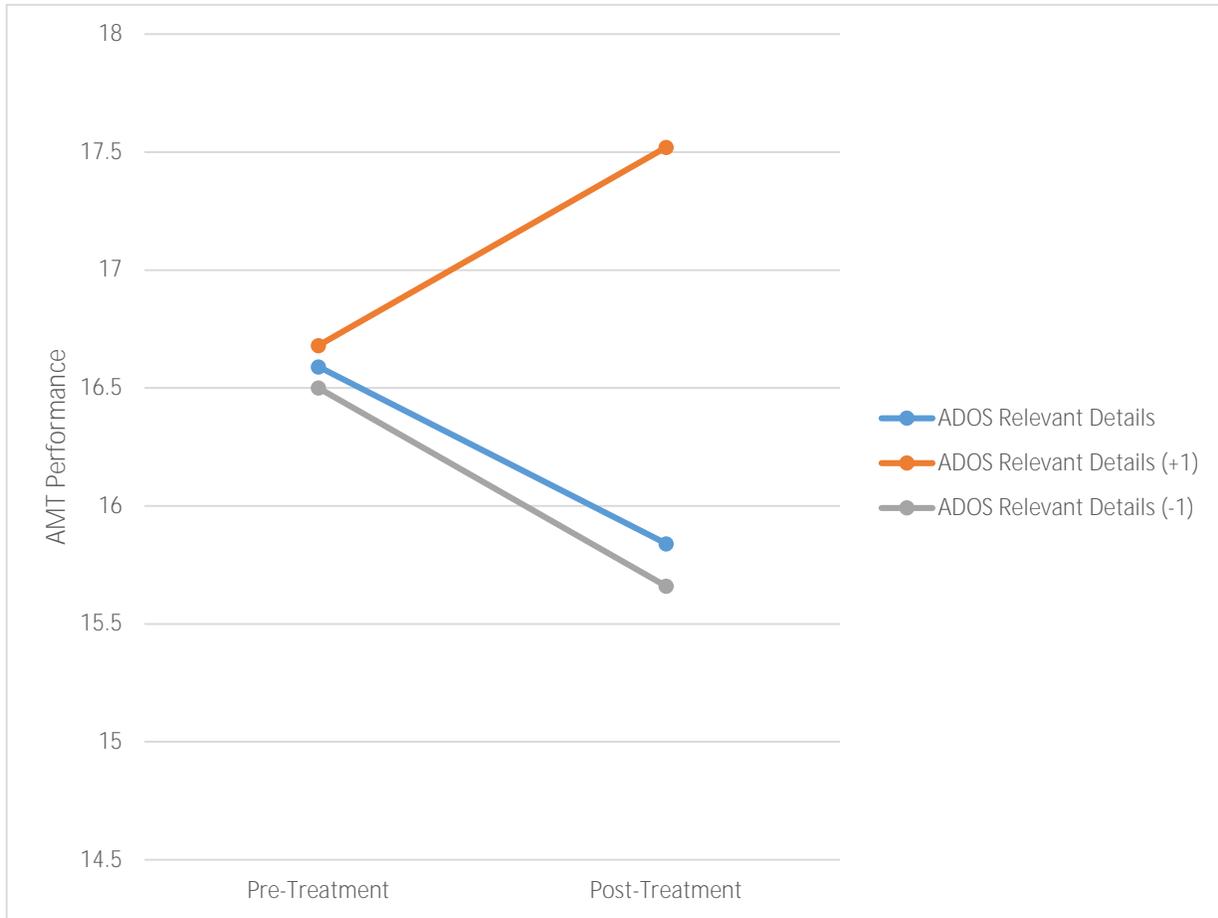*Treatment Performance on the Autobiographical Memory Task (AMT)*

* ADOS Story Elements = Number of Story Elements included in Participant's narration of story centered around Grand Mean
* ADOS Story Elements +1 = Number of Story Elements included in Participant's narration of story +1 above the mean
* ADOS Story Elements -1 = Number of Story Elements included in Participant's narration of story -1 below the mean

Figure 6. *Impact of the Inclusion of Relevant Details in a Narration on Pre- Post Treatment Performance on the Autobiographical Memory Task (AMT)*

* ADOS Relevant Details = Number of Relevant included in Participant's narration of story centered around Grand Mean
* ADOS Relevant Details +1 = Number of Relevant Details included in Participant's narration of story +1 above the mean
* ADOS Relevant Details -1 = Number of Relevant Details included in Participant's narration of story -1 below the mean

Figure 7. *Impact of Participant Age on Pre- Post Treatment Performance on the*

Episodic Memory Inventory (EMI)
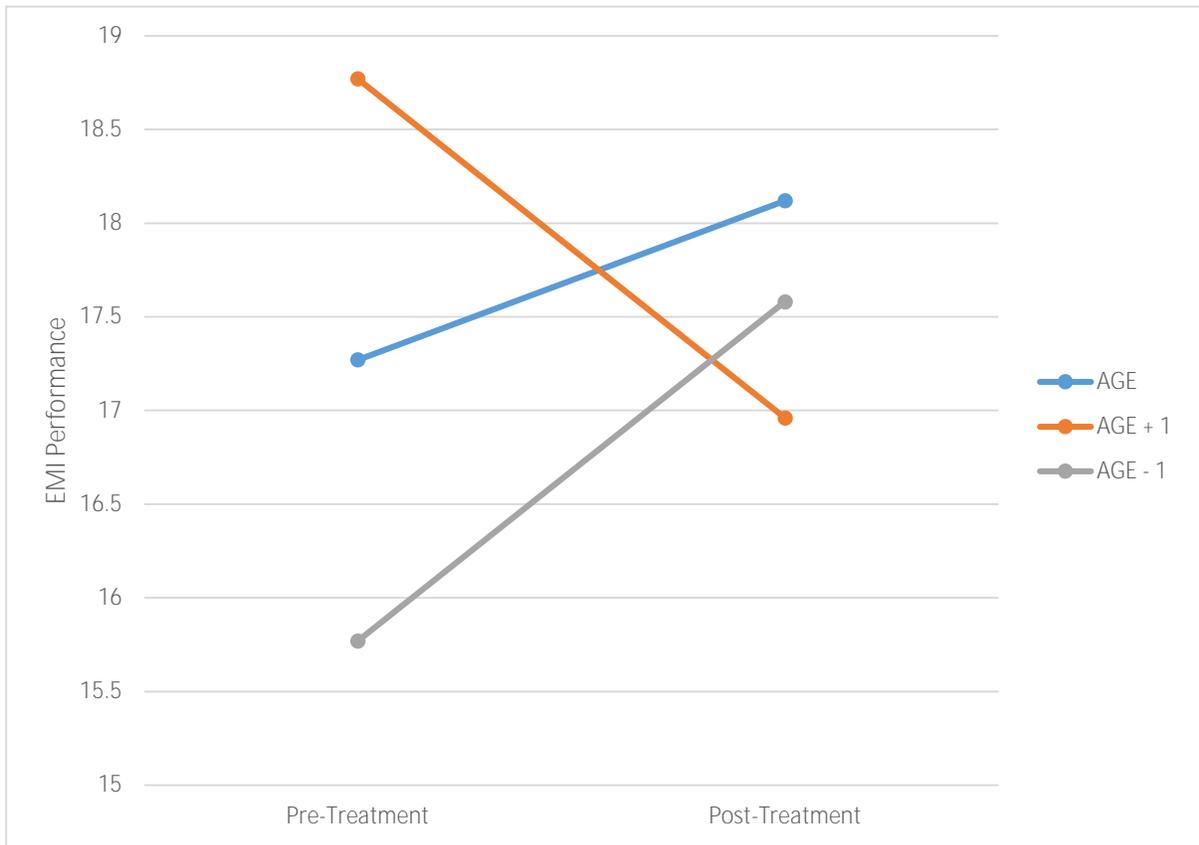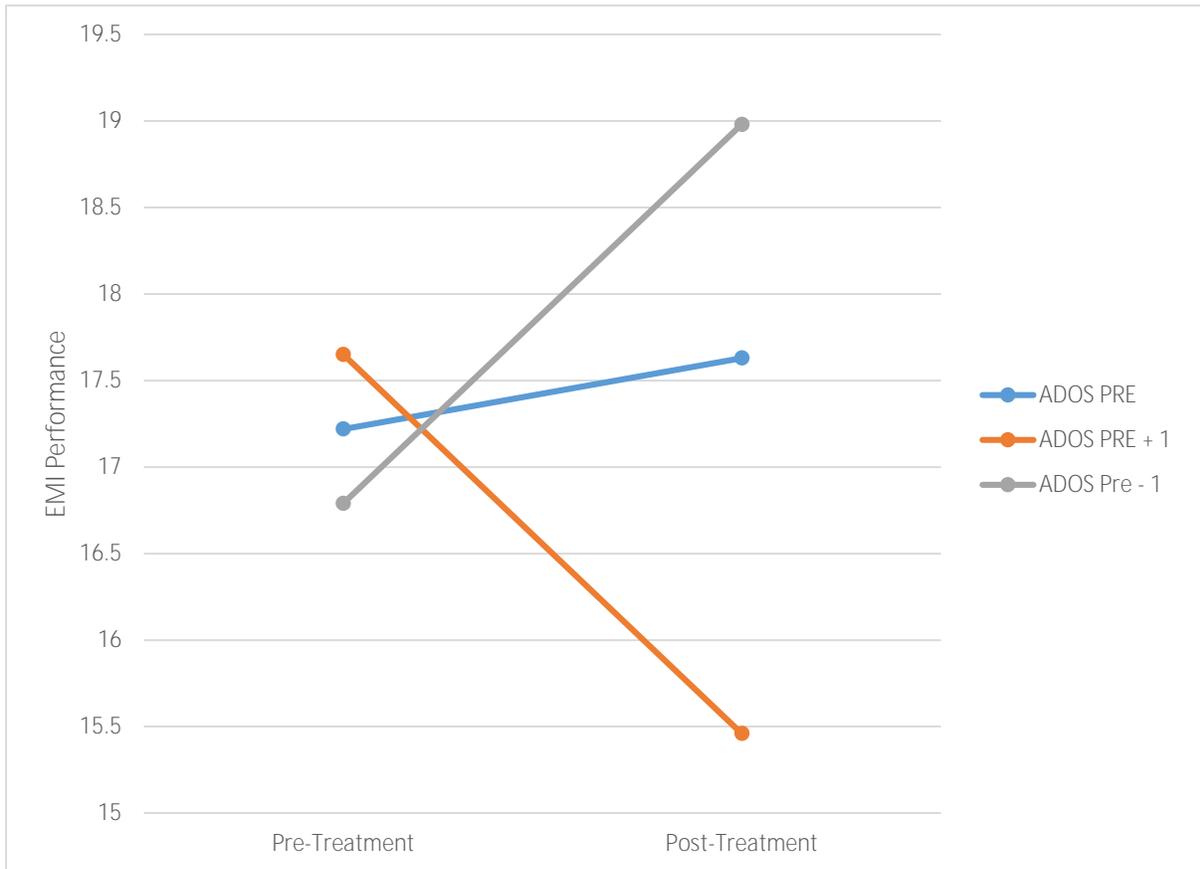

* Age = Participant Age centered around Grand Mean
* Age +1 = Participant Age +1 above the mean
* Age -1 = Participant Age -1 below the mean

Figure 8. *Impact of Pre-Treatment ADOS Score on Episodic Memory Inventory (EMI)*

Pre- Post Treatment Performance

* ADOS Pre = Participant performance on the ADOS at Pre-Treatment centered around Grand Mean
* ADOS Pre +1 = Participant performance on the ADOS at Pre-Treatment +1 above the mean
* ADOS Post -1 = Participant performance on the ADOS at Pre-Treatment -1 below the mean

Figure 9. *Group v Individual Treatment Condition Change in Autobiographical Memory Task (AMT) Performance from Pre- to Post-Treatment*
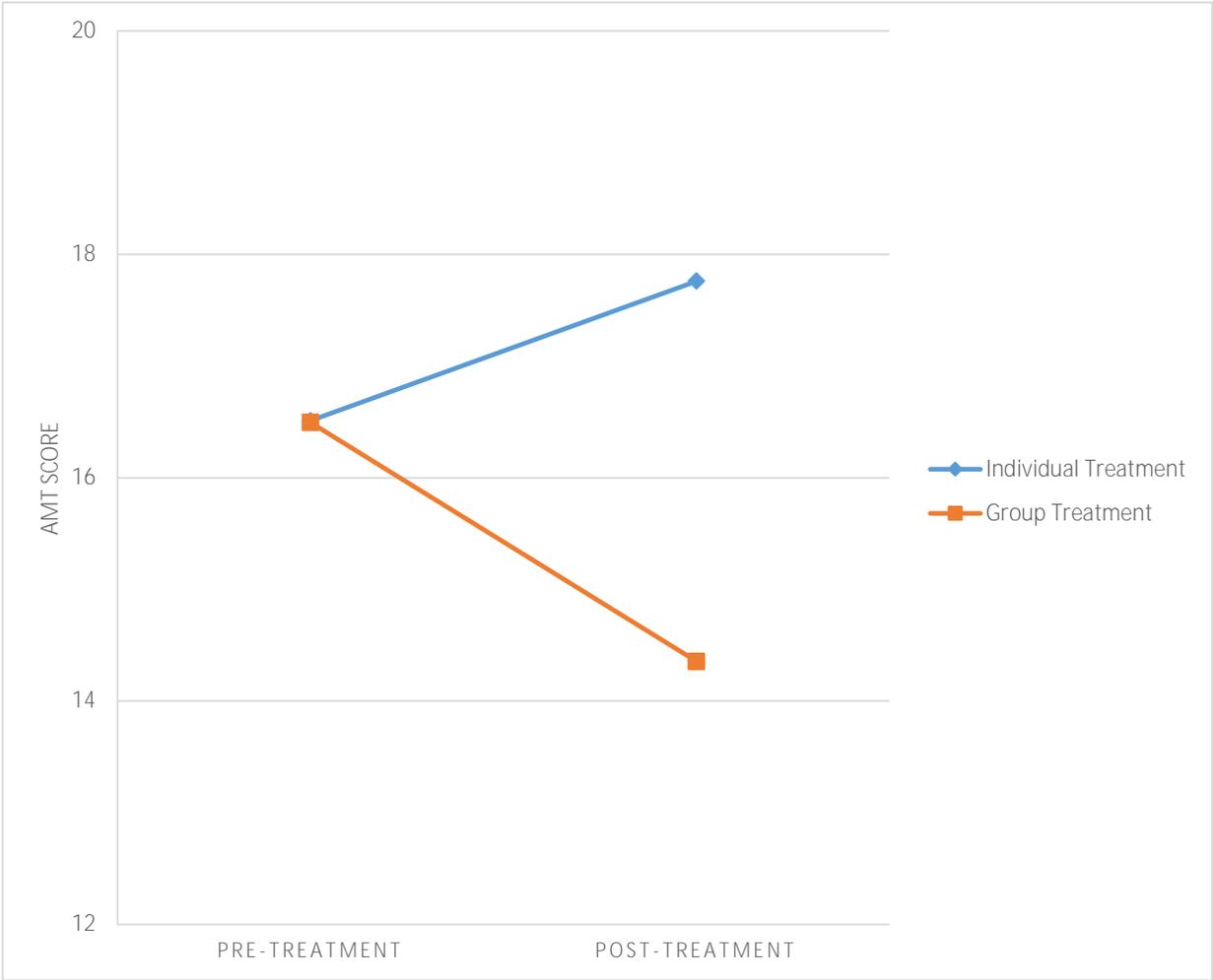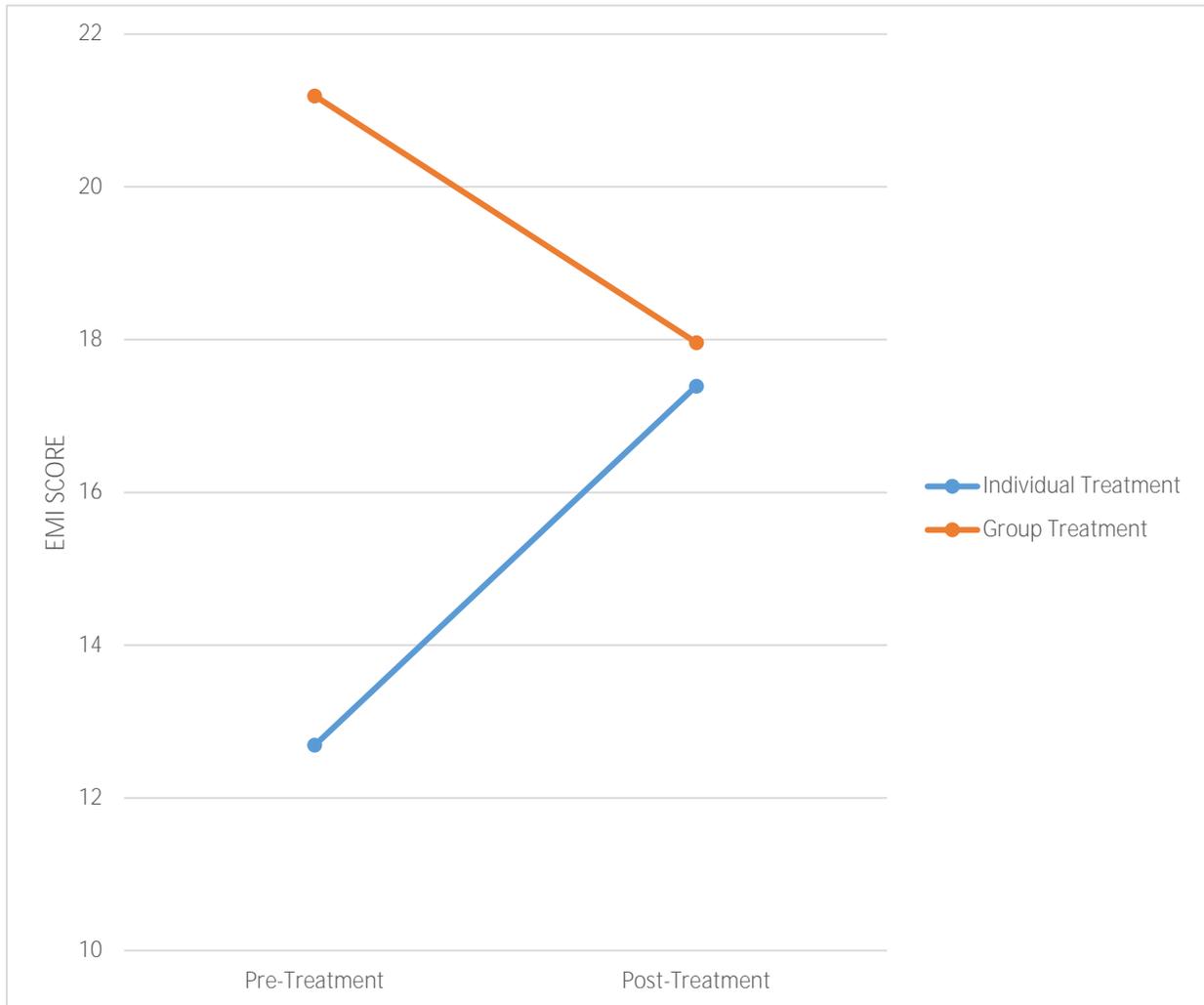
Figure 10. *Group v Individual Treatment Condition Change in Episodic Memory*

Inventory (EMI) Performance from Pre- to Post-Treatment

Chapter 7: Appendix

Appendix A. *Autobiographical Memory Task Coding Scheme*

AUTOBIOGRAPHICAL MEMORY TASK		
Autobiographical Memory (AM)	A memory that denotes a personal event	**AM:** "The time I went to…." **Code:** 2
Semantic Memory (SM)	A memory that denotes a factual event	**SM:** "In 1492 Columbus…" **Code:** 1
Time Period **Categoric (C)**	**C:** Denotes an unspecified amount of time	**C:** "When I play my video game" **Code:** 1
Extended (E)	**E:** Denotes an extended period of time	**E:** "When I was on vacation in Hawaii: **Code:** 2
Specific (S)	**S:** Denotes a specific period of time	**S:** "The day I got my dog" **Code:** 2
*NOTE: If child parrots example provided in story, subtract 1 point from memory code Nervous: Child tells about a time he/she broke something Embarrassed: Child tells about a time he/she was on stage, messed up on stage or during performance Angry: Child tells about a time he/she was accused of something he/she didn't do, had money stolen Happy: Child tells about a time he/she got a Happy Meal, or a toy from McDonald's (Note: Do not subtract a point of child shares story of receiving a video game) Sad: Child tells about a time he/she hurt his/her brother/sister		

Appendix B. *Episodic Memory Inventory Coding Scheme*

CODE	EXPLANATION	EXAMPLE
EPISODIC MEMORY INVENTORY		
Relevant Detail (RD)	A detail that explains who, what, when, where, or why	
Who	Who was involved in the event	**Nervous:** Christine, her brother, She, the girl, etc. **Sad:** Gordy, Sean, friend, father, his brother, the boy, etc. **Embarrassed:** Miles, his mom, Graham, his friend, some of the kids are mean, younger students, teachers **Angry:** Sam, Dillon, everyone, teacher, principal, mom and dad **Happy:** Danny, the boy, his uncle, parents, mean kid, his brother
What	What happened in the event	**Nervous:** Lost diary, looked in her room, looked in brother's room, knocked laptop off desk, broke laptop, waiting for brother, wonders what he'll do **Sad:** wrestling, fell out of treehouse, thinks dad is mad/hates him, goes into woods, tells friend, cries, etc. **Embarrassed:** attends a school, has to perform, chooses song, thought friend would play music, friend gets sick, friend cannot perform, miles sings by himself, kids tease younger students, kids laugh at Miles **Angry:** mom gave money, money missing, Dillon blames Sam, everyone believed Dillon, teacher blamed Sam, sent to principal's office, no recess, calls parents

		Happy: dying for PSP, parents said they couldn't afford it, uncle came to visit, went jet skiing, went to batting cage, went to little league game, got base hit, went for pizza, told problems, mean boy, brother singing, no PSP, went to McDonald's, got PSP.
When	When did the event occur	**Nervous:** One day, after looking all over house, while looking, now **Sad:** Last year, now, for life, before the accident, one day **Embarrassed:** at the end of the year, at the talent show **Angry:** after recess, for the next month, while waiting **Happy:** the longest time, lots of times, one day, first day, second day, third day, after the game, last day
Where	Where did the event take place	**Nervous:** her room, her brother's room, **Sad:** In the backyard, in the treehouse, in a wheelchair, in the woods **Embarrassed:** at school, at the talent show **Angry:** at school, principal's office **Happy:** from Oregon, jet skiing, batting cages, little league game, to have pizza, McDonald's drive thru
Why	Why did the events of the situation unfold	**Nervous:** when he finds out she as snooping in his room **Sad:** He was paralyzed, has to be in a wheelchair, dad is mad at Gordy for what happened, **Embarrassed:** has to perform at talent show, choose's mom's favorite song, friend gets sick, some kids are mean **Angry:** because money was missing, in big trouble, can't believe he was blamed, no recess, parents called

		Happy: couldn't afford one, unprepared,
Irrelevant Detail **(IrrD)**	A detail that does not answer who, what, when, where, why, or how	**Nervous:** Her brother's room was messy **Sad:** Sean wore a basketball jersey with #4 on it **Embarrassed:** The mean boy had blonde hair **Angry:** The teacher wore glasses
Pair	1 point for each detail listed in the order it occurred; Also count if the first and last detail are correct	**Nervous** 1. One day Christine lost her special diary 2. She looked all over her room for it 3. After looking all over the house, she decided to have a look in her brother's room, but it wasn't there either 4. While she was going through all of his things, she accidentally knocked his laptop off his desk and broke it 5. Now she is waiting for her brother to come home. She wonders what he'll do when he finds out she was snooping through his room and broke his laptop 6. Here is Christine waiting for her brother to come back from school. (video).
		Sad 1. Last year, Gordy was play wrestling with his brother Sean in the backyard 2. The wrestling continued up in their tree house, but then something bad happened. 3. Sean fell out of the tree house and was paralyzed. Now, Sean can no longer walk and will have to be in a wheelchair for the rest of his life.

			4. Before the accident, Sean had been a start basketball player for his school team. Now Gordy thinks that their dad is really mad at Gordy for what happened, even though it was a total accident.
			5. One day he went out in the woods with his friend and told him about it.
			6. Here is Gordy talking to his friend about what happened (video)
			<u>Embarrassed</u>
			1. Miles attends a school in England called Finsbury School.
			2. At the end of the year, he had to perform a song in the school talent show, so he chose his mom's favorite song.
			3. Miles thought that his friend Graham was going to play his instrument while Miles sang. But, Graham started feeling sick and was not going to be able to perform with Miles.
			4. So Miles had to sing by himself at the talent show, without any music playing.
			5. Some of the kids at Miles' school are kind of mean and like to tease younger students.
			6. Here is Miles performing the song in front of all of the other kids and teachers (video).
			<u>Angry</u>
			1. This is Sam's seatmate, Dillon. Dillon's mom gave him twenty dollars to bring to school for a fieldtrip.
			2. After recess, Dillon's twenty dollars had gone missing. Dillon blamed Sam for taking the money. Everyone in the class believed Dillon, but it wasn't true.
			3. Even their teacher believed Sam took the money.

		4. So Sam was sent to the Principal's office. The Principal told Sam that he was in big trouble.
		5. For the next month, instead of going to recess, he'll have to wait in the principal's office. Sam can't believe that everyone blamed him for something that he didn't even do.
		6. Here he is, waiting while the principal calls his mom and dad (video).
		Happy 1. Danny had been dying to have a PSP handheld video game for the longest time. He had asked his parents lots of times, but they said they couldn't afford one and he would just have to find something else to do. 2. Then one day, Danny's favorite uncle came to visit from Oregon. 3. On the first day of the visit, Danny's uncle took him jet skiing. 4. On the second day of the visit, Danny's uncle took him to the batting cages. 5. On the third day of the visit, Danny's uncle took him to a little league game, and Danny got a base hit. 6. After the game, they went to have pizza and Danny told his uncle about some of his problems. He told his uncle about a mean kid on the baseball team; he told his uncle about how his brother always sings awful songs; and he told his uncle about not being able to get a PSP. 7. On the last day of the visit, Danny's uncle took him to the drive-thru at McDonald's. But Danny was totally unprepared for what was inside of his happy meal. 8. Here is Danny opening his happy meal (video).

Incorrect Detail (IncD)	Inaccurate report of detail in story	**Nervous:** Christine broke her father's laptop. **Sad:** Sean was a star baseball player **Embarrassed:** Miles wanted to perform alone **Angry:** Sam was given money for lunch. **Happy:** Danny's favorite grandfather came to visit.
Exact Phrasing (EP)	Language used in child's report of video is exactly what was stated in the video	**Nervous:** "Christine lost her special diary" **Sad:** "then something bad happened" **Embarrassed:** "Miles attends a school in England called Finsbury school." **Angry:** "told Sam he was in big trouble." **Happy:** Danny was totally unprepared for what was inside"
Emotion Recognition (ER)	Identification of the emotion depicted by main character of story	**Nervous:** Nervous, worried, concerned, anxious **Sad:** sad, upset, unhappy, **Embarrassed:** embarrassed, scared to perform alone, uncomfortable, humiliated **Angry:** angry, mad, annoyed, frustrated, upset **Happy:** happy, excited, pleased, glad, delighted

Z-SCORE CALCULATION

Sequential Details (SD)	Code Episodic Memory Inventory responses for total detail recall in sequential order (SD) *Note: Each story event denoted by a number (1-6) must have the indicated # of details in order to receive a score of SD	<u>**Nervous**</u> 1. <u>One day</u> <u>Christine</u> <u>lost</u> her special <u>diary</u> (2/4) 2. <u>She</u> <u>looked</u> all over <u>her room</u> for it (1/3) 3. <u>After looking all over the house</u>, <u>she</u> decided to have a <u>look</u> in <u>her brother's room</u>, but it wasn't there either (2/4) 4. <u>While</u> she was going through all of his things, <u>she</u> accidentally <u>knocked</u> <u>his laptop</u> <u>off his desk</u> and <u>broke it</u> (3/6) 5. <u>Now</u> <u>she</u> <u>is waiting</u> for <u>her brother</u> to <u>come home.</u> She <u>wonders</u> what he'll do

	Ex: 2/4 = participant must note 2 out of 4 details from the event As scored in the Pair category; award 1 point for each detail listed (SD) in the order it occurred; Also count if the first and last detail are correct	when he finds out she was snooping through his room and broke his laptop (3/7) 6. Here is Christine waiting for her brother to come back from school. (video). (1/1)

Sad

1. Last year, Gordy was play wrestling with his brother Sean in the backyard (2/5)

2. The wrestling continued up in their tree house, but then something bad happened.   (1/3)

3. Sean fell out of the tree house and was paralyzed. Now, Sean can no longer walk and will have to be in a wheelchair for the rest of his life. (4/8)

4. Before the accident, Sean had been a star basketball player for his school team. Now Gordy thinks that their dad is really mad at Gordy for what happened, even though it was a total accident. (5/10)

5. One day he went out in the woods with his friend and told him about it. (2/5)

6. Here is Gordy talking to his friend about what happened (video) (2/4)

Embarrassed

1. Miles attends a school in England called Finsbury School. (1/3)

2. At the end of the year, he had to perform a song in the school talent show, so he chose his mom's favorite song. (2/5)

3. Miles thought that his friend Graham was going to play his instrument while Miles sang. But, Graham started feeling

		sick and was not going to be able to perform with Miles.(4/8)
		4. So Miles had to sing by himself at the talent show, without any music playing. (2/4)
		5. Some of the kids at Miles' school are kind of mean and like to tease younger students. (2/5)
		6. Here is Miles performing the song in front of all of the other kids and teachers (video). (1/3)
		Angry
		1. This is Sam's seatmate, Dillon. Dillon's mom gave him twenty dollars to bring to school for a fieldtrip. (2/4)
		2. After recess, Dillon's twenty dollars had gone missing. Dillon blamed Sam for taking the money. Everyone in the class believed Dillon, but it wasn't true. (5/10)
		3. Even their teacher believed Sam took the money. (1/3)
		4. So Sam was sent to the Principal's office. The Principal told Sam that he was in big trouble. (3/7)
		5. For the next month, instead of going to recess, he'll have to wait in the principal's office. Sam can't believe that everyone blamed him for something that he didn't even do. (4/7)
		6. Here he is, waiting while the principal calls his mom and dad (video). (1/3)
		Happy
		1. Danny had been dying to have a PSP handheld video game for the longest time. He had asked his parents lots of times, but they said they couldn't afford one and he would just have to find something else to do (4/9).

		2. Then <u>one day</u>, <u>Danny's favorite uncle</u> came to <u>visit</u> from <u>Oregon</u>. (2/4) 3. On <u>the first day</u> of the visit, <u>Danny's uncle</u> took <u>him</u> <u>jet skiing</u>. (2/4) 4. On the <u>second day</u> of the visit, <u>Danny's uncle</u> <u>took hi</u>m to the <u>batting cages</u>. (2/4) 5. On the <u>third day</u> of the visit, <u>Danny's uncle</u> took <u>him</u> to a <u>little league game</u>, and <u>Danny</u> got a <u>base hit.</u> (2/5) 6. <u>After the game</u>, <u>they</u> went to <u>have pizza</u> and <u>Danny</u> <u>told </u>his <u>uncle</u> about some of <u>his problems</u>. He <u>told</u> his uncle about <u>a mean kid</u> on the baseball team; he told his uncle about how <u>his brother always sings awful songs</u>; and he told his uncle about <u>not being able to get a PSP</u>. (5/11) 7. On the <u>last day</u> of the visit, <u>Danny's uncle</u> took him to the <u>drive-thru at McDonald's</u>. But <u>Danny</u> was totally <u>unprepared</u> for what was inside <u>of his happy meal</u>. (3/6) 8. Here is <u>Danny</u> opening his <u>happy meal</u> (video). (1/3)

Appendix C. *ADOS Narrative Coding Scheme*

Adapted from Suh et al. (2014)

STORY ELEMENTS:

Tuesdays

Page 1
1. Something about Mr. Turtle (how he feels, what he does)
2. Frogs flying on lily pads

Page 2
3. Frogs doing tricks/having fun on lily pads
4. Frogs scaring/chasing birds

Page 3
5. Frogs flying/floating (toward houses, etc.)

Page 4
6. Man eating a sandwich
7. Man sees frog
8. Frog waves at man

Page 5
9. Frog flying into clothesline

Page 6
10. Frog with cape
11. Frogs flying through window
12. Frogs flying through chimney

Page 7
13. Grandmother sleeping
14. Frogs watching TV
15. A frog changing the channel with his tongue

Page 8
16. A frog flying
17. A dog chasing the frog

Page 9
18. Frogs chasing the dog

Page 10
19. Frogs and lily pads falling/frogs landing on houses

20. Frogs fall
21. Frogs are back in the water

22. Detective investigating/trying to figure out what happened
23. Dog sniffing lily pad (or mention of the dog)
24. Mention of police, ambulance, other dogs.
25. Man telling the newswoman what had happened

26. Shadow by the barn
27. The sun is setting

28. Pigs are flying

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