IDENTIFYING ATTENTION COMMONALITIES AND DIFFERENCES BETWEEN ATTENTION-DEFICIT/HYPERACTIVITY DISORDER AND AUTISM SPECTRUM DISORDER

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Abstract

The present study examined one of Posner and Petersen's (1990) attention networks (i.e., orienting – the ability to selectively focus on pertinent information) in children with Autism Spectrum Disorder (ASD) as compared to Attention-Deficit/Hyperactivity Disorder (AD/HD). The orienting processes of disengagement (i.e., reallocation of attention away from one stimulus onto another) and shifting (i.e., movement of attention from one stimulus to another) were studied via a novel eye-tracking task designed to measure exogenous (externally-cued) and endogenous (internally-cued) attention. The study's purpose was to analyse whether unique orienting impairments are present in ASD that are separate from those observed in AD/HD. The ASD group showed marginally-significant delays with *exogenous* disengagement and shifting as compared to the AD/HD group. The AD/HD group showed significantly greater fixation durations when disengaging their *endogenous* attention as compared to the ASD group. In conclusion, patterns of unique orienting deficiencies appear to be present in the ASD population.

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Although there is a great degree of variability among individuals with Autism Spectrum Disorder (ASD), the primary symptoms of autism (according to the Diagnostic and Statistical Manual (Fourth Edition) – Text Revision (DSM-IV-TR)) have traditionally revolved around impaired social skills, delayed or non-existent language skills, and the presence of stereotypic, repetitive movements or interests (American Psychiatric Association, 2000). The DSM-5 has since modified the criterion for language impairment. The result is two main features that continue to remain necessary for the diagnosis of ASD (American Psychiatric Association, 2013): impairment in social communication and the presence of restrictive, repetitive patterns of behaviour. While the presence of these features is necessary for a diagnosis of ASD, abnormalities in attention have been noted in the disorder since its earliest accounts (Kanner, 1943). The prevalence of such attention impairments in ASD has also become better understood. For example, a study by Kaat, Gadow and Lecavalier (2013) found that 67% of parents of children with ASD rate their children as meeting the clinical cut-offs for Attention-Deficit Hyperactivity Disorder (AD/HD). Another large-scale study estimated that 31% of individuals with ASD fall within diagnostic criteria for AD/HD (Leyfer et al., 2006). With such high rates of attention abnormalities in Autism Spectrum Disorder, a question arises as to if these attention difficulties present in a unique manner within the ASD diagnosis, or if the presentation of such difficulties are also present in disorders whose primary impairment lies within the attention domain (i.e., Attention Deficit/Hyperactivity Disorder).

The present thesis aimed to further understand how the presentation of attention impairments often observed in ASD may differ from those of AD/HD. The thesis will begin with a description of models of attention, followed by research on the attention impairments seen in ASD, followed by those seen in AD/HD individuals. The thesis will then lead into the purpose of the present study, followed by the study's rationale, hypotheses and methodology. The present study was conducted in conjunction with larger dissertation projects at York University by Carly McMorris and Lisa Hancock, and as a result, the methodology of this thesis parallels descriptions of those research studies. The thesis will then lead to the description, followed by interpretation, of the results, and will end with study limitations and ideas for future research.

Models of Attention and Attention Measures

Posner and Petersen (1990) have characterized attention as an organic, multifaceted system comprised of three distinct networks (Petersen & Posner, 2012), each consisting of a unique group of cognitive capacities that are: (1) alerting— the ability to attain (phasic alerting) and subsequently sustain (tonic alertness or vigilance) attention, (2) orienting— the ability to selectively focus attention onto significant information from the general surroundings, and (3) executive control— the ability to manage attentional resources in order to realize a goal (e.g., planning). The aforementioned cognitive networks appear to be somewhat distinct from one another with respect to their behavioural, neurophysiological and neuroanatomical characteristics (Fan, McCandliss, Sommer, Raz & Posner, 2002; Fan et al., 2007; Raz & Buhle, 2006).

Three basic processes comprise the orienting network: 1) disengaging— the redirection of attention away from a stimulus; 2) shifting— the movement of attention from one stimulus to another; and 3) re-engaging— the initiation of attention onto a new stimulus (Posner & Peterson, 1990). When a cue in the external peripheral surroundings automatically causes a shift in the individual's attention, it is a reflexive type of attention, termed exogenous attention. When attention is consciously directed and internally-driven towards achieving goals, it is termed endogenous attention (Posner, 1980). The present thesis focuses on disengaging and shifting attention in response to exogenous as well as endogenous cues, both processes that are involved in the orienting network.

Posner and Fan (2004) maintain that distinctions in attention between typically developing (TD) individuals and individuals with attention impairments can be clarified using their model of attention. Along these lines, two widely-used paradigms have been employed to investigate the Posner model. The first common task is Posner's Attentional Cuing Paradigm (Posner, 1980), which requires participants to quickly identify a target stimulus that appears anywhere on a screen. Immediately prior to appearance of the target, a cue such as an arrow is displayed to assist in identifying the target's future position. These preceding cues either accurately delineate the target's future position (e.g., valid) or inaccurately prompt the participant (e.g., invalid), and the differential responses of the participant between valid and invalid cuing is named the "cue validity effect". To examine endogenous attention, centrally-located cues are displayed which require the participant to interpret the cue in order to determine the potential location of the upcoming target. An example of this would be an arrow that appears in the middle of the screen and points towards a space where the target will next appear. Conversely, exogenous attention can be examined via peripheral cues that tend to appear in the location of the upcoming target, such as a box that glows around an area of the screen where the target will appear next (Posner, Inhoff, Friedrich & Cohen, 1987; Posner, Petersen, Fox & Raichle, 1988). This test is designed to measure the orientation, engagement, disengagement, and shifting of attention. In the present study, endogenous attention processes were examined differently, wherein no external cue was explicitly provided to signal the participant when it is time to disengage or shift attention. The endogenous attention task in the present study also contained elements of the Eriksen Flanker Task (in that task, stimuli are presented adjacent to the target stimulus, with these stimuli either being identical to the target or varying in some dimension [e.g. orientation]; Eriksen & Eriksen, 1974), wherein the equivalent to "flanker" stimuli were always present.

The second common paradigm, which formed a part of this thesis, is the gap-overlap task and it is most commonly utilized to measure exogenous attention. In this task, the measured variable is the amount of time required for the participants to shift their gaze from a central fixation point to a stimulus that suddenly appears in the periphery. The task measures two types of attention abilities (i.e., disengagement versus shifting of attention). More specifically, if the central stimulus remains visible for some amount of time once the peripheral stimulus appears, there is an overlap in the timing of stimuli appearance, so this trial measures participants' abilities to disengage their attention from the central stimulus in order to fixate on the peripheral stimulus. If the central stimulus disappears before the peripheral stimulus appears, there is an apparent gap in the timing of stimuli appearance, so this trial measures participants' abilities to shift attention to a peripheral stimulus after the central stimulus they were previously looking at disappears.

Yet another type of attention task that is often used was created by Fan et al. (2002), and it is able to test the efficiency of each of the three attention networks separately in one attention paradigm. This attention task is called the Attention Network Test (ANT), and it encompasses features of both the Posner Paradigm (Posner, 1980) and the Eriksen Flanker Task (Eriksen &

Eriksen, 1974), thereby allowing researchers to simultaneously measure the effectiveness of each attention network, including their interactions.

Attention in Individuals with Autism Spectrum Disorder

Deficits in the visual orienting of attention (specifically disengagement and shifting) have been found in individuals with ASD, and this has been termed "sticky" attention. Early evidence of a visual orienting deficit came from Swettenham et al. (1998) who measured spontaneous attention shifting in 20-month-old ASD, developmentally delayed (DD) and TD infants during a short play session using observational and video analysis. Overall, the researchers demonstrated that infants with ASD exhibited lower frequencies of attention shifting compared to the other two groups. These finding were corroborated by Baranek (1999) via retrospective home video analysis which demonstrated that infants with ASD tend to exhibit less orientation to visual stimuli, while Maestro et al. (2002) showed that ASD infants tend to orient less often to people or voices as compared to TD infants. In addition, research by Dawson, Meltzoff, Osterling, Rinaldi, and Brown (1998) showed that children with ASD oriented less often to both social and non-social sounds when compared to children with Down Syndrome and TD children. Moreover, even when the children with ASD did orient their attention, they still showed slower orienting to the social sounds. These observed differences in the orienting network imply that the network's component processes of shifting or disengagement behaviors may be impaired in individuals with Autism Spectrum Disorder. Specifically, such results that show lesser frequencies of attentional shifting and slower disengagement latencies suggest that children with ASD seem to get "stuck" when their attention is oriented via an exogenous cue, hence the so-termed "sticky" attention impairments in this population.

To assess exogenous attention orienting abilities in older individuals with ASD, a variety of spatial cuing tasks are generally used. A study by Townsend, Harris and Courchesne (1996) used a Posner-style cuing paradigm to demonstrate that adults with high-functioning ASD showed delayed orienting as compared to TD adults when they were given short amounts of time to shift their attention (i.e., 100 ms gap between the cue and target). However, these authors also found that when ASD adults were given longer amounts of time (i.e., 800 ms or more gap between cue and target) they tended to demonstrate similar orienting capacities to the TD adults. Using another attention paradigm (the ANT), Keehn, Lincoln, Muller, and Townsend (2010) demonstrated that irrespective of differing task requirements between the two testing paradigms, individuals with ASD continued to present with delays in shifting their attention. Landry and Bryson (2004) used the gap-overlap task to compare children with ASD, Down syndrome and TD children, and found that the children with ASD were significantly slower in disengaging their visual attention during the overlap trials but their speed of attention shifting in the gap trials was unaffected. In addition to demonstrating delays in disengaging, the authors also showed that the number of times ASD children exhibited rapid shifts in attention was decreased when compared to the other two groups for the gap trials, which would suggest that these children are unable to effectively shift their attention even in situations where the peripheral and central stimuli are not competing for their attention (the peripheral stimulus appeared after the disappearance of the central stimulus). To frame these findings, Townsend and colleagues proposed the slowing hypothesis, which suggests that the exogenous orienting deficit in ASD is not a result of these individuals being unable to orient their attention, but that they are in need of greater lengths of time to do so when compared to their typically-developing peers (e.g., Townsend et al., 1996). Alternatively, the compensation hypothesis (Belmonte & Yurgelun-Todd, 2003) speculates that individuals with ASD compensate for their diminished exogenous orienting by depending more heavily on intact endogenous orienting.

Individuals with ASD have also been found to show discrepant behaviours for endogenous, as opposed to exogenous, orienting. Using an attentional cuing paradigm that employs peripheral and central cues, Renner, Klinger, and Klinger (2006) were able to demonstrate that individuals with ASD show deficient exogenous, yet typical endogenous, orienting. Somewhat in support of these findings are past neuroimaging studies with ASD, which have found atypical functioning of the brain circuits that control exogenous orienting, yet relatively intact brain circuits that control more voluntary, endogenous, orienting (Haist, Adamo, Westerfield, Courchesne, & Townsend, 2005). McMorris, Bebko, Wells, Weiss and Schroeder (2009) reanalyzed data from several studies in Dr. Bebko's laboratory and found that individuals with ASD perform similarly in their disengagement abilities to TD individuals when they are presented with a modified Preferential Looking Paradigm. In this paradigm, two dynamic, multi-modal stimuli were simultaneously presented side-by-side on the screen, resulting in a de facto endogenous (or self-generated) attention disengagement paradigm. Both stimuli presented the same video, except that only one of the videos had a synchronized, or matched, auditory and visual track (while the other video was out of sync with the only auditory track playing). This unique looking paradigm was used to examine endogenous attention in the present study as well, except that it consisted of four video stimuli being shown within each quadrant of the screen, and only one had its auditory and visual information matched.

Despite the numerous studies that have demonstrated that individuals with ASD exhibit deficient disengagement of attention during exogenous tasks, there have been studies that have found that individuals with ASD can show normal disengagement abilities (Kawakubo, Mekawa, Itoh, Hashimoto & Iwanami, 2004; Leekam, López & Moore, 2000; Mosconi et al., 2009). In an effort to explain these contradictory findings, some researchers (e.g. Keehn, Müller, & Townsend, 2013) claim that these discrepancies are a result of small sample sizes, which led to low statistical power and cohort effects (e.g., ASD sample size of seven participants in Kawakubo et al., 2004), or great variations in the gap-overlap task paradigms (e.g., Leekam et al., 2000). Some studies have also found intact shifting abilities in ASD individuals. For instance, Iarocci and Burack (2004) found that children with ASD and co-occurring developmental delay performed similarly to TD children when testing the children on an exogenous cuing task with a delay of 200 ms between the cue and target. Renner et al. (2006) speculate that such differences in results may be due to the varied chronological ages and IQ levels of the participants in different studies (i.e., Townsend et al. (1996) tested high-functioning adults, while Iarocci and Burack (2004) tested low-functioning young children). Renner et al. (2006) also comment that the participant sample in Townsend and colleagues' (1996) study had cerebellar abnormalities, while this was not measured in Iarocci and Burack's (2004) sample.

In summary, atypical impairments in attention, which tend to exhibit early in life (i.e., Baranek, 1999; Elsabbagh et al., 2009; Osterling and Dawson, 1994) and tend to be persistent and invasive (i.e., Burack, Enns, Stauder, Mottron, & Randolph, 1997), have been correlated in infants at higher-risk of developing ASD (i.e., at-risk due to having a genetic predisposition to the disorder because their older siblings have ASD; Elsabbagh et al., 2009; Zwaigenbaum et al., 2005). As a result, the aforementioned attention abnormalities are speculated to be the potential earliest signs that can differentiate children who will later be diagnosed with ASD (Zwaigenbaum et al., 2005). Additionally, more pronounced ASD symptomatology has been linked to some types of non-social attentional strength- (e.g., visual search) and weakness- (e.g., novelty detection) profiles in ASD (e.g., Belmonte, Gomot, & Baron-Cohen, 2010; Gomot, Belmonte, Bullmore, Bernard, & Baron-Cohen, 2008). According to researchers such as Keehn et al. (2013), these findings would suggest that attentional abnormalities may undermine the maturation process of more complex social and communication abilities. These researchers go on to state that as a result, understanding of the maturation of attention in individuals with ASD may help clarify the atypical or slowed developmental progression of attention in ASD, as well as reveal how these irregularities in attention may impact the expression of core behavioural and social deficits in ASD.

However, if there are such extensive implications of attentional difficulties, it may not be reasonable to expect that these findings would be limited to ASDs. If these cascading effects are due to attentional difficulties and not ASDs per se, then it is reasonable that other groups with known attention problems may show similar profiles on these paradigms, with similar resulting effects. The central focus for the present study is to compare performance on these tasks in children and adolescents with ASD versus with Attention Deficit/Hyperactivity Disorder. This topic is highly relevant to the current status of research in diagnostic criteria as outlined by the Diagnostic and Statistical Manual, 5th Edition (DSM-5) as the previously exclusionary criteria of an AD/HD diagnosis when diagnosing ASD (as was seen in the earlier version of the DSM) has now been eliminated (American Psychiatric Association, 2013). With this change, children can now be formally diagnosed with both ASD and AD/HD. As such, research on these populations will be needed in order to shed light onto the unique impact of AD/HD on ASD, and vice versa.

Attention in Individuals with Attention-Deficit/Hyperactivity Disorder

Attention-deficit/hyperactivity disorder (AD/HD), which is one of the most commonly occurring childhood disorders (Barkley, 1997), is characterized by persistent age-inappropriate symptoms of inattention and/or hyperactivity and impulsivity that are severe enough to result in deficits in life activities (see review in Barkley, 1997). The DSM-IV-TR used to outline AD/HD as being able to be broken up into three types, which varied based on the predominance of impulsivity, hyperactivity and inattentive symptomatology; AD/HD, Combined Type (ADHD/C) required clinically significant impairments in both attention and hyperactivity/impulsivity; AD/HD, Predominantly Inattentive Type (ADHD/I) required such impairment with only attention; AD/HD, Predominantly Hyperactive-Impulsive Type (ADHD/H-I) required such impairment with only hyperactivity/impulsivity (American Psychiatric Association, 2000). However, the DSM-5 has eliminated these subtypes based on research that would suggest that these subtypes do not possess long-term stability (e.g., Willcutt et al., 2012). These subtypes have instead become transformed into “specifiers” that dictate the most predominant symptoms visible at the time of assessment. Nonetheless, given that past AD/HD studies were conducted using the DSM-IV-TR criteria, the subtypes are preserved in the literature review below. However, the present study considers all the subtypes to be collapsible into the overarching disorder of AD/HD.

Research has shown repeatedly (primarily via variants of the Posner Paradigm) that individuals with AD/HD have atypical visual-spatial attention, wherein they demonstrate impairments in covert (or endogenous) attention (often referred to as being controlled by the anterior attention system (AAS) in AD/HD research; Posner & Petersen, 1990), which refers to the ability to voluntarily distribute attention to a spatial location (Carter, Krener, Chaderjian, Northcutt, & Wolfe, 1995; Nigg, Swanson, & Hinshaw, 1997). This is in contrast to the research that has been done on AD/HD exogenous attention abilities (often referred to as being controlled by the posterior attention system (PAS) in AD/HD research; Posner & Petersen, 1990), wherein this ability to reflexively or automatically allocate attention towards incoming information from the environment appears to be intact. For example, Casagrande et al. (2012) tested 36 children with AD/HD via two revised versions of the ANT and demonstrated that this population's exogenous orienting of visual-spatial attention seems to be intact, but that they show impairments in their voluntary control of attention. Furthermore, according to neuropsychological research, AD/HD individuals' poor performance arises from an overarching dysfunction of attentional control (i.e., the ability to allot attention to many environmental demands) rather than from the cumulative effect of unique attention impairments. In addition, the researchers were able to demonstrate the aforementioned deficit to be related to a broad impairment in the frontal executive functions (Boucugnani & Jones, 1989; Reader, Harris, Schuerholz, & Denckla, 1994), which are controlled by the prefrontal regions of the brain as well as their interrelated structures. These areas are responsible for mental abilities such as cognitive flexibility and strategic planning, including attentional control, regulation of time and space, and inhibition or preparation of responses (Reader et al., 1994). All these abilities (e.g., voluntary attentional control, executive functions) are potentially associated with performance on endogenous attention tasks, which were used to examine the disengagement and shifting abilities of the participants with AD/HD in the present study.

In contrast to the aforementioned past research is a meta-analysis by Huang-Pollock and Nigg (2003) that examined studies that used visual-spatial attention paradigms to assess orienting abilities in AD/HD. These researchers found that individuals with AD/HD do not seem to have major visual orienting impairments in either endogenous or exogenous attention. However, these authors urge the use of other paradigms, such as the ANT, to further elucidate the nature of the visual-spatial orienting network in children with AD/HD. They suggest that if an orienting impairment exists in AD/HD, perhaps it could be captured via the examination of higher-order attention that requires many cognitive manipulations, as opposed to the analysis of lower-order attention (such as that in visual-spatial orienting). Nonetheless, a plethora of past research supports the finding that AD/HD individuals have deficits in executive control (e.g., Jonkman et al., 1999; Jonkman, Van Melis, Kemner, & Markus, 2007; Lansbergen, Kenemans, & Van Engeland, 2007; Pasini, Paloscia, Alessandrelli, Porfirio, & Curatolo, 2007). Past studies also support the conclusion that this population shows deficits with tonic alertness (i.e., the ability to sustain attention, also called vigilance; Bellgrove, Hawi, Kirley, Gill, & Robertson, 2005) and phasic alertness (i.e., the ability to attain attention; O'Connell, Bellgrove, Dockree, & Robertson, 2006). One drawback (as stated by Casagrande et al., 2012) is that these studies examined each attention network separately, which is not able to provide insight as to what would occur when all three attention networks work unanimously, or how these networks interact.

In an attempt to address the abovementioned gap, researchers utilized the ANT paradigm, but have found inconsistent results for children and adults with AD/HD. For example, Oberlin, Alford, and Marrocco (2005) found that orienting and alerting in both the primarily inattentive (ADHD/I) and combined inattentive/hyperactive (ADHD/C) subtypes of AD/HD were similar to typically-developing individuals'. Nevertheless, they found that ADHD/C reacted slower when they were not provided with spatial cues, unlike ADHD/I individuals. Previous research that used the child-oriented version of the ANT (Rueda et al., 2004) also revealed no deficits in the attentional networks in children with AD/HD (e.g., Booth, Carlson, & Tucker, 2007). Hence, much research would seem to support the notion that the orienting network is intact in AD/HD (Berger & Posner, 2000; Huang-Pollock & Nigg, 2003). However, Casagrande et al. (2012) have argued that these findings may be due to the insufficient assessment of the attentional costs of reorienting attention in past research protocols. They also argue that the lack of invalid cues in these past studies may have made the paradigm too simple for an accurate assessment of the executive system. To support their argument, Casagrande and colleagues (2012) reference a study by Konrad, Neufang, Hanisch, Fink, and Herpertz-Dahlmann (2006), whose authors only discovered impairment in the executive system when invalid trials were present in the task. However, Mullane, Corkum, Klein, McLaughlin, and Lawrence (2011) incorporated invalid cues into their ANT paradigm and found that the children with AD/HD showed intact orienting abilities when compared to TD children. As a result, researchers have struggled to provide a comprehensive explanation for these inconsistent findings. The study by Casagrande et al. (2012) has attempted to clarify some of the past discrepancies in research by being the first study to concurrently assess the efficiency of each attention network as well as their interactions in children with AD/HD via the use of two revisions of the ANT. Interestingly, these researchers found that feedback played a large role in the efficacy of all the attention systems. For instance, the children with AD/HD showed intact orienting and executive control only when presented with a warning signal within the trial, presumably because it resulted in increased alertness. Similar to the conclusions by Pearson, Yaffee, Loveland, and Norton (1995), Casagrande and colleagues (2012) also found evidence that children with AD/HD have difficulty with flexibly orienting their attention on dispersed areas of large visual space.

In summary, research has consistently found that individuals with AD/HD show impairment with alertness (e.g., Bellgrove et al., 2005; O’Connell et al., 2006) and executive control (e.g., Jonkman et al., 1999; Jonkman et al., 2007). Though past research has been somewhat mixed in terms of the orienting network, a large body of research has also been finding (primarily via the use of a Posner-style Paradigm and the ANT) that individuals with AD/HD have atypical visual-spatial attention as well. Mainly, they have been found to show impairments in endogenous, rather than exogenous, attention abilities (e.g., Carter et al., 1995; Nigg et al., 1997). These deficits in endogenous attention abilities are likely associated with the identified executive control impairments mentioned earlier (Casagrande et al., 2012).

Present Study

The present study was an extension of ongoing dissertation studies by McMorris and Hancock (manuscripts in preparation). To elaborate further, their research examines engagement, shifting and disengagement in individuals with ASD in situations where a peripheral stimulus is presented in a gap-overlap task to signal disengagement or shifting, compared to situations where a new stimulus is not provided, such that the decision of where to allocate attention would be self-generated. The present study tested a new sample of children with AD/HD and used a subset of the same ASD participants and attention task conditions used in McMorris and in Hancock’s studies, with the goal of comparing the attention difficulties seen in individuals with AD/HD to individuals with ASD with co-occurring attention issues. A subset of the ASD population (i.e., children with ASD who also have co-occurring clinically-significant attention issues) was used in order to control for the variable of attention within the study design. In this manner, the unique effect of an ASD diagnosis would be observed when both groups are identified with impairments with attention. Hence, the present study attempted to compare disengagement and shifting in individuals with ASD with a newly collected sample of individuals with AD/HD in order to examine if the deficits in the orienting network seen in ASD are specific to the ASD diagnosis or are evident in another diagnostic group with attention differences, i.e., those with AD/HD.

In order to address the aim of the present study, this study compared AD/HD and ASD individuals on McMorris and Hancock's more ecologically-valid dynamic attention paradigms. The stimuli in the study allowed for many opportunities for the participants to shift and disengage their attention (for more detail, see McMorris [in preparation] and Hancock [in preparation] and the Methods section, below). As well, to allow for more generalizable results, some of the stimuli consisted of multi-modal videos and showed realistic stimuli (such as an actor telling a children's story). Such alterations to the stimuli allow for the testing of the orienting network in situations that are perhaps more typical in the child's daily environment. If the results were to show that the two groups have comparable impairments in their visual orienting, then this would suggest that the attention difficulties seen in some children with ASD are not unique to that diagnosis, but rather are seen in other disorders whose primary difficulty lies with attention. Hence, this would point to a general impairment in orienting across groups with attention difficulties, rather than one that is Autism-specific, as has been hypothesized to date.

Study Hypotheses

The main hypotheses for this exploratory study were as follows:

1.) If so-called 'sticky' attention in gap-overlap tasks is a unique deficit of the ASD (and not AD/HD) profile, then only children and adolescents with ASD should show greater difficulty disengaging and possibly shifting on this study's attention task's exogenous trials with still stimuli. On the other hand, if the disengagement difficulties seen previously in children and adolescents with ASD are due to attention issues that are not unique to the diagnosis, then the AD/HD group should perform similarly to the ASD group on the task.

2.) Previous research and the poster by McMorris et al. (2009) have found that children with ASD showed no impairments compared to typically developing children in disengagement and shifting for endogenous tasks where disengagement and shifting decisions were more consciously and internally generated. On the other hand, previous literature has indicated that children with AD/HD showed greater difficulty than typically-developing peers with endogenous attention tasks, though these studies have not ever used multi-modal video stimuli. Therefore, the AD/HD group should show slower, or at least differential, disengagement and shifting times on the present study's endogenous task than the ASD group.

Hence, the hypotheses for the study were framed within a double dissociation design to show if the results would be associated with diagnostic differences or would be associated with attention characteristics alone. Overall, it was hypothesized that the children with ASD should show greater attention impairments on the exogenous task, while the children with AD/HD should show greater attention impairments on the endogenous task.

The supplementary hypothesis for the present study was as follows:

1.) As a lack of preference for social stimuli is not a diagnostic feature of children with AD/HD, it was hypothesized that these children would show similar orienting patterns for the social and non-social stimuli. However, given children with ASD's difficulties with language and social stimuli, it was expected that children with ASD would demonstrate differential disengagement and shifting latencies to social-linguistic, as compared to non-social, non-linguistic stimuli in both the exogenous and endogenous trials.

Methodology

Participants

A total of 27 children participated in the study. All participants were between 6 and 16 years of age. Fifteen children with a diagnosis of an Autism Spectrum Disorder (ASD) according to DSM-IV-TR diagnostic criteria (American Psychiatric Association, 2000), who also have clinically significant attention difficulties (as measured by The Conners 3rd Edition) were recruited primarily through a research consortium (i.e., Autism Spectrum Disorders -- Canadian-American Research Consortium; ASD-CARC). As mentioned earlier, a subset of the ASD population (i.e., only those children with ASD who also have co-occurring attention issues) was used in order to control for the variable of attention within the study. In this manner, the unique effect of an ASD diagnosis would be observed when both groups are identified with impairments with attention. Data from most of the children in this sample were collected jointly as a part of dissertation projects by McMorris & Hancock and this Master's thesis.

Twelve children and adolescents with Attention-Deficit/Hyperactivity Disorder (AD/HD) were recruited for the present study through community organizations, private practices and online research organizations (e.g., Canadian ADHD Research Alliance (CADDRA), Centre for ADHD Awareness Canada (CADDAC), and Learning Disabilities Association of Ontario (LDAO)). This group encompassed children with a diagnosis of Attention-Deficit/Hyperactivity Disorder according to DSM-IV-TR diagnostic criteria (American Psychiatric Association, 2000), who had never been diagnosed with any form of ASD in the past. AD/HD participants were asked to refrain from taking any attention-influencing medication for a period of at least 24 hours prior to the testing session so that their performance on the attention task is not impacted by these medications. However, two children of the 12 who participated in the study could not refrain from medication.

Individuals from both clinical groups also met the following criteria in order to participate (these participation criteria are shared with the larger studies by McMorris and Hancock): They must be able to converse at least at a four-year-old child's language level in English (meaning that they can speak in three-to-five-word sentences), have typically-developing (or corrected to be normal) hearing and vision, and have no identified neurological deficits (e.g., damage to the brain). The two clinical samples were group-matched as closely as possible on chronological age and gender, as well as on non-verbal levels of intellectual and executive functioning (using The Differential Abilities Scale-2nd Edition and The Behaviour Rating Inventory of Executive Functioning), in order to ensure that these variables do not impact performance on the attention task. Given that ASD is commonly associated with language impairments, group-matching on verbal levels of intellectual functioning was not expected.

Measures

Diagnostic Measures.

To reconfirm diagnosis (beyond the measures mentioned below), parents of both the children with ASD and with AD/HD were asked to bring a copy of their child's diagnostic report to the testing session. The Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter & Le Couteur, 1994) and the child's diagnostic report were used as the primary method of reconfirming diagnosis in the ASD sample[1]. However, in some cases combinations of these measures with the other autism measures mentioned below were used as a secondary method of reconfirming diagnosis (e.g., when the families were unavailable to participate in the ADI-R).

The ADI-R is a semi-structured interview that is done with the parent of a child with suspected autism in order to assess the child for ASD symptomatology. It examines such avenues as the individual's early and current social development, interactions and play, repetitive and restricted behaviours and interests, and communication/language development. The ADI-R requires between 90 to 150 minutes to administer and score, and uses an algorithm to diagnose ASD that is based on DSM-IV-TR criteria. The ADI-R has been found to be a valid and reliable tool for diagnosing ASDs (e.g., Lord, Rutter, & Le Couteur, 1994; Lecavalier et al., 2006). In the present study, the children with ASD needed to have scores above the clinical cut-off (or within one point of the clinical cut-off) for a minimum of two out of three domain scores and needed to be over the age of onset cut-off in order to attain a positive reconfirmation of their diagnosis. Six children from the sample were missing ADI-Rs as these families were not available to participate in its administration. In these situations, a combination of these children's diagnostic reports, scores above the clinical cut-off on the Social Communication Questionnaire (SCQ) and scores in the range of Asperger Syndrome on the Krug Asperger Disorder Index (KADI) were used as an alternative method of reconfirming diagnosis.

Sections of the Kiddie-Schedule for Affective Disorders and Schizophrenia- Present and Lifetime Version 2009 Working Draft (KSADS-PL; Kaufman et al., 1997) were used to re-confirm diagnosis in the AD/HD sample. This semi-structured diagnostic interview is used to

[1] Special acknowledgement and thanks go out to Carly McMorris and Lisa Hancock, who conducted all the ADI-R interviews for the study.

assess a variety of psychopathologies in children and adolescents between the ages of 6 to 17 years of age, according to DSM-IV criteria. The full interview requires the completion of six different sections when it is used clinically, including 1) the unstructured Introductory Interview; 2) the Diagnostic Screening Interview; 3) the Supplement Completion Checklist; 4) the appropriate Diagnostic Supplements; 5) the Summary Lifetime Diagnostic Checklist; and 6) the Children's Global Assessment Scale (C-GAS) ratings. However, as the aim of the interview for the present study was only to re-confirm diagnosis and not establish a new diagnosis, only the Diagnostic Screening Interview and Diagnostic Supplement sections for the AD/HD category were administered. The previous version of the interview (1996), from which the 2009 working draft has been adapted, has concurrent validity, as well as high interrater agreement, and test-retest reliability (Kaufman et al., 1997). All participants included in the AD/HD sample fit the criteria for an AD/HD diagnosis according to their scores on the KSADS subsections.

Parent Measures.

The following parent rating measures were used in the larger study by McMorris and Hancock and were also used in the present study for a similar purpose. In particular, the BRIEF, the KADI, and the Conners were given to parents of children in both clinical groups to characterize the samples.

The Behaviour Rating Inventory of Executive Functioning (BRIEF; Gioia, Isquith, Guy, & Kenworthy, 2000) is a parent-report measure that was designed to measure executive functioning impairment in individuals between 5 and 18 years of age. Authors such as Toplak, West and Stanovich (2013) have questioned the BRIEF, given its low correlation with the mental constructs tested in performance-based measures of executive functioning. However, the BRIEF was used in the present study as a method of characterizing the samples on the constructs the BRIEF has been shown to measure, given that they may be related to performance on the attention task (e.g., goal-pursuit behaviours, aptitude with difficult problem-solving tasks in everyday life; Toplak et al., 2013; Gioia et al., 2000). It consists of 86 items that are presented via a questionnaire format and taps into abilities such as inhibition of behaviour, shifting of attention, emotional control, working memory, and planning and organization, and it is expected to take 10-15 minutes for parents to complete. This questionnaire has been found to have moderate to good reliability and strong validity (Gioia et al., 2000). The BRIEF has also been used to successfully assess the degree of executive functioning impairments seen in AD/HD (e.g., Shimoni, Engel-Yeger, & Tirosh, 2012) and in ASD (e.g., Gilotty, Kenworthy, Sirian, Black, & Wagner, 2002). Therefore, this questionnaire was used to characterize the ASD and AD/HD groups' executive functioning abilities.

The Conners 3rd Edition (Conners, 2008) is meant for use with 6- to 18-year-olds and was filled out via parent-report. This questionnaire's content scales assess inattention, hyperactivity/impulsivity, learning problems, executive functioning, aggression, and peer and family relations. The DSM-IV-TR Symptom Scales assess behavioral disorders such as AD/HD Inattentive, AD/HD Hyperactive-Impulsive, Conduct Disorder, and Oppositional Defiant Disorder. The questionnaire takes about 20 minutes for the parent to complete and it has strong reliability and validity (Kao & Thomas, 2010). To have been included in the ASD sample, the parents must have rated their chid with autism as being either Elevated (t score of 65-69) or Very Elevated (t score of 70 or higher) in the Inattention Subscale, *or* as Elevated or Very Elevated in the ADHD-Inattentive Subscale as well as High Average or higher in the Inattention Subscale in order to screen for children with attention difficulties. The children with AD/HD were screened similarly in order to be included in the AD/HD sample.

The Krug Asperger's Disorder Index (KADI; Krug & Arick, 2003) is a 32-item questionnaire for use with individuals between the ages of 6 to 22 years, and it requires about 15-20 minutes for parents to complete. The authors have shown it can make the fine-tuned distinction in the DSM-IV-R between ASD and Asperger Syndrome, as well as identify individuals who do not fit the criteria for Asperger Syndrome. It has been shown to have strong content-descriptive validity, criterion-predictive validity, and construct-identification validity, as well as strong reliability (Krug & Arick, 2003). There is no research to show the KADI’s sensitivity to reliably screen for ASD symptomatology in AD/HD children. However, given that this measure has among the strongest psychometric properties for assessing for Asperger Syndrome to date, it was used in order to evaluate the degree of Asperger Syndrome symptomatology present in the participants with AD/HD. Three children with AD/HD scored in the Very Low to Somewhat Likely range, while two children scored as High Likelihood for Asperger Syndrome, even though they had no previous history of ASD. The remaining seven children with AD/HD did not meet criteria for Asperger Syndrome (i.e., score totals on the cut-off items of the KADI were under cut-off). These results may suggest that the KADI cut-off score of 18 points or the item content would need to be altered in order to more accurately discriminate between children with AD/HD and children on the autism spectrum.

The following parent measure was also used within the larger studies by McMorris and Hancock, though the present study used them for a different purpose. This measure was included in the present study strictly for the purposes of inclusion/exclusion criteria (often in combination with the diagnostic interviews and reports) for the AD/HD and ASD samples (i.e., scores for ASD-based parent measures should be high for the ASD group and low for the AD/HD group).

The Social Communication Questionnaire – Lifetime Form (SCQ; Rutter, Bailey & Lord, 2003) was given to parents of both clinical samples. It consists of 40 items aimed at assessing communication and social functioning in individuals with a developmental level of above two years of age. The SCQ has good psychometric properties (e.g., strong convergent validity with the ADOS; Oosterling et al., 2010) and requires about 10 minutes for parents to complete. Kroger et al. (2011) found that the SCQ's mean scores can clearly differentiate between individuals with ASD as compared to AD/HD, though scores remain higher in children with AD/HD without ASD as compared to typically-developing children. They found that the cut-off of 11 can differentiate between AD/HD and high-functioning ASD with sensitivity of 87% and specificity of 83%. The authors conclude that the SCQ is a clinically valuable screening measure for high-functioning children with suspected ASD and children with AD/HD. Therefore, this measure was used for its clinical cut-off that can identify individuals who fit ASD symptomatology. In the present study, a cut-off score of 11 was employed instead of the traditional cut-off of 15 in order to reflect the research by Kroger et al. (2011). Using this cut-off, one child in each clinical group did not meet criteria (i.e., below cut-off in the ASD group, and above cut-off in the AD/HD group). These (low) rates of misidentification are not unexpected, given the sensitivity and specificity rates reported by the authors. In these situations, corroborating evidence for their respective diagnoses was found via their diagnostic reports and diagnostic interviews.

Cognitive Measure.

The Differential Abilities Scale, 2nd Edition (DAS-II; Elliot, 2007) is a standardized assessment of intellectual functioning. It has been normed for use with individuals between the ages of two years, six months (2:6) to seventeen years, eleven months (17:11). The DAS is broken down into the Early Years Cognitive Battery (which is further separated by the Lower and Upper Early Years batteries; Lower battery for use with children between 2:6 and 3:5 years of age, Upper battery for use with children between 3:6 and 6:11 years of age) and the School-Age Cognitive Battery (for use with children between 7 and 17:11 years of age). The six core subscales of the DAS-II were administered, which included such subscales as recall of designs, words definitions, pattern construction, and matrices. Assessment of the six core subscales lasts on average 45 to 60 minutes, and these scores then group together to provide a General Composite Ability (GCA), Verbal Composite, Non-Verbal Composite, and Spatial Composite score for each participant. The DAS-II is becoming progressively more frequently used in studies with special populations due to its unique features that make it well-suited to testing children with disabilities (e.g., low floors, nonverbal responses allowed on a large amount of the subtests, colorful and engaging manipulatives, a decreased sense of failure in the child with the implementation of item-set methods to subtests, and the implementation of teaching items to make sure that the children fully comprehend the task instructions; Deutsch & Joseph, 2003). In addition, the DAS-II has a smaller number of core subtests and the time needed to administer it is much shorter than other frequently used measures like the Wechsler Intelligence Scale for Children, 4th Edition (WISC-IV; Kuriakose, 2013). Given these reasons, and given that Kuriakose (2013) also recently found empirical evidence of convergent validity between the WISC-IV and DAS-II in children with ASD, the DAS-II was used in the present study to deduce the cognitive functioning of the sample of children with ASD. Participants with AD/HD also completed the DAS-II as previous studies have shown this measure to be a clinically useful tool for describing the cognitive functioning of individuals with AD/HD as well (e.g., Gibney, McIntosh, Dean, & Dunham, 2002).

Attention Measure.

Apparatus.

The attention paradigm and stimuli were created within Final Cut Pro by McMorris and Hancock as part of their studies, and presented via an eye-tracking program called Tobii through an attached Dell laptop. The task was displayed on a 26-inch TV monitor, which received the stimuli from an attached Dell laptop computer. The participants sat in front of the monitor so that their eyes were at the mid-point of the screen (both vertically and horizontally), and so that their eyes were at a distance of approximately 50-70 centimeters from the Tobii eye-tracker. The Tobii II X60 eye tracker was positioned as close to the bottom of the monitor as possible and tracked the participants' gaze via infrared signals.

***Stimuli*.**

Within the exogenous trials, each still stimulus was displayed in one or two of four equally-sized quadrants on the computer monitor. Moreover, the stimuli disappeared and reappeared randomly in each of the four quadrants within the presentation of each trial. Within the endogenous trials, four dynamic, multi-modal stimuli were presented at the same time within four equally-sized quadrants on the monitor.

The stimuli consisted of both still pictures (without auditory input) and dynamic, multi-modal videos. The pictures were either social (e.g., a person's face) or non-social (e.g., nuts and bolts on a string), while the videos were either social-linguistic (e.g., a person telling a children's story), or non-social, non-linguistic (e.g., a finger playing the piano).

Task and Design.

The present study's attention paradigm was developed for the larger studies by McMorris and Hancock, and only a subset of conditions that allowed for the measurement of participants' shifting and disengagement abilities were chosen. The exogenous trials were structured within a modified gap-overlap paradigm, while the endogenous trials were structured within an adapted Preferential Looking Paradigm. The attention task therefore measured both exogenous and endogenous attention. Participants' eye gaze data were analyzed for all conditions in the two clinical groups.

The experimental task consisted of 8 exogenous trials (i.e., 4 shifting trials and 4 disengaging trials, broken down into 2 social and 2 non-social trials within each attention trial) and 8 endogenous trials (i.e., 4 social, linguistic stimuli and 4 non-social, non-linguistic stimuli), resulting in a total of 16 trials. Each trial lasted 12 seconds. Both types of trials commenced with a three-second cartoon or flower animation, which was meant to keep the participants' attention focused on the centre of the screen between trials.

Exogenous Trials. The exogenous trials consisted of social (e.g., a still frame of a person telling a story) and non-social stimuli (e.g., nuts and bolts tied to a string, one finger of one hand pressing down on a piano key) that were presented as still pictures. Shifting trials did not have any overlap in the presentation of stimuli, so that the participant was shown one stimulus in one quadrant of the monitor for three seconds, at which point the stimulus disappeared and then reappeared in another quadrant for three seconds, after a short pause of 30 milliseconds. Disengagement trials, on the other hand, did present the participants with an overlap in the presentation of two stimuli, so that they were presented with one stimulus in one quadrant of the monitor for three seconds, at which point another stimulus appeared in a second quadrant, while the first remained (so that at this point, two similar stimuli were being presented in two different quadrants). The first stimulus then disappeared after 500 milliseconds, and the sequence repeated.

Within all the trials presented, each stimulus was shown for a duration of three seconds, and the pattern of movement of the stimuli occurred four times within each trial, thereby allowing for four instances per trial to examine shifting or disengagement abilities. The stimuli appeared and disappeared in random patterns amongst the quadrants and the stimuli were also randomized in terms of the order of shifting and disengagement trials presented. The still stimuli were presented so that when a stimulus moved to another quadrant, the second stimulus was the same stimulus as the first, but the information being shown within it was slightly different than the first. To explain further, if the stimulus was a still picture of a finger pressing one piano key, when a second still picture appeared in another quadrant, it showed the same piano keys and finger, yet with the finger pressing on a different key. Shifting and disengagement abilities were deduced via the speed (measured in seconds down to three decimal points) at which the participants' gaze moved from first stimulus to the second stimulus, once the second stimulus appeared.

Endogenous Trials. The endogenous trials consisted of the same social (e.g., a person telling a story) and non-social stimuli (e.g., nuts and bolts tied to a string hitting a table top, one finger playing the piano) that were presented as still pictures in the exogenous trials. Therefore, the main difference between the exogenous and endogenous trials was that the stimuli varied in whether they were still versus dynamic in presentation, with the added component of the accompanying auditory track in the dynamic stimuli. In the endogenous trials, the same stimulus was presented in each quadrant of the screen at the same time, so that four identical videos were playing at once. The videos only differed in their synchrony, such that only one of the videos had its auditory and visual track synchronized, while the other three videos were out of synchrony (i.e., one video was presented with a one-second delay, one was presented with a one-second advance, and one was presented with a three-second advance in relation to the only auditory track playing). Shifting abilities were not able to be reliably measured in the endogenous trials, as there was no opportunity for shifting within the trial (given that all four stimuli were presented at once and remained visible). Disengagement abilities were deduced via the mean number and duration of fixations (measured in seconds down to three decimal points) across the three non-synchronized quadrants as well as within the synchronized quadrant. If one group presented as having difficulties disengaging attention, then this would be reflected as fewer fixations within a trial and longer durations of the fixations. In short, there were no opportunities to observe shifting and multiple opportunities to observe disengaging within each endogenous trial.

Table 1 shows a visual depiction of the stimuli presented in the exogenous as compared to endogenous attention trials, both of which were shown to ASD and AD/HD children.

Table 1

Characteristics of the Stimuli within the Exogenous versus Endogenous Attention Trials

Exogenous	**Endogenous**
Shifting and disengagement examined	Disengagement only examined
Stimuli appearing and disappearing across four quadrants on the screen during one trial	Stimuli appearing in all four quadrants at the same time during one trial
Still pictures without auditory input	Dynamic, multi-modal videos
Synchrony not a variable	1 audio-visual synched video and 3 visually asynched videos without audio
Social and non-social stimuli	Social, linguistic and non-social, non-linguistic stimuli

Table 2 depicts all the measures administered to each group within the scope of the study.

Table 2

All Measures Administered to Each Clinical Group within the Present Study

	ASD	**AD/HD**
Attention Measure	Attention Task Consisting of All Exogenous and Endogenous Trials	Attention Task Consisting of All Exogenous and Endogenous Trials
Parent Measures	BRIEF, Conners 3rd Edition, KADI, SCQ - Lifetime Form	BRIEF, Conners 3rd Edition, KADI, SCQ - Lifetime Form
Cognitive Measure	DAS-II	DAS-II
Diagnostic Confirmation Measure	ADI-R	KSADS - Present and Lifetime Version (2009 Working Draft)

Procedures.

Upon arrival to the research session, the participants with ASD and their caregivers/parents discussed the informed consent (see Appendix A) with the examiner and then were asked to sign one copy and keep one copy for their records. The participants with AD/HD and their caregivers/parents similarly completed a slightly different informed consent form (see Appendix B). The participants from both clinical groups then completed the same assent form with the examiner (see Appendix C).

After the consent process was finished, the participants then completed the eye-tracking task. At the beginning of the task, participants' eye-movements were calibrated with the eye tracker via the presentation of a red ball that moved quickly across nine points on the screen. The participants then participated in the attention task, which lasted approximately a total of 5 minutes. The DAS-II was then administered upon completion of the eye-tracking task to participants from both groups. The total time commitment for the participants was about 60 to 90 minutes.

While the participants were engaging in the study, their parents were asked to complete a series of questionnaires (i.e., BRIEF, Conners, SCQ, and KADI). As well, if time permitted, the parents of the participants with AD/HD completed a subsection of the KSADS with the examiner during the testing session. If the KSADS could not be done on-site, then these parents were asked to complete the AD/HD subscale of the KSADS with the examiner at a later date via a phone interview. Similarly, parents of the children with ASD were asked to complete the ADI-R at a later date via a phone interview with the examiner. The total time commitment for the parents of participants was about 60 to 90 minutes during the testing session.

Once the participants finished with the study, they were given a personalized study certificate and a Chapters/Indigo gift card as a token of appreciation for their participation in the research session. Parents were also given the option of being partially compensated for their travel expenses. At the end, the examiner addressed any questions about the study and attempted to schedule a time to complete the ADI-R or KSADS, as needed. Parents were also given the option of indicating if they would like to be sent a synopsis of the study results once they become available.

Results

The variables used in all statistical analyses were the participants' shifting and disengaging skills. To elaborate further, the focus of the analyses for the exogenous trials revolved around how quickly the participants were able to disengage and shift their attention from one stimulus after the onset of a second stimulus. Only trials where the participant was looking at the overall screen a minimum of two seconds *and* was looking for a minimum duration of 0.2 seconds at the preceding stimulus prior to the onset of the new stimulus were included in the analyses, in order to ensure that statistics were only done on trials where the participant was engaging with the stimuli.

The focus of the analyses for the endogenous trials was the duration and frequency of eye fixations; difficulties disengaging would be reflected in longer and less frequent fixations, thereby resulting in longer mean fixation durations. Only trials where the participant looked at the screen for a minimum of two seconds *and* looked at a minimum of two different quadrants for at least 0.2 seconds each were used in the analyses, in order to ensure that the participants were engaged with the trial before disengaging their attention.

The primary research questions of the thesis sought to examine endogenous and exogenous attention abilities in individuals with ASD plus clinically significant attention difficulties versus individuals identified with only AD/HD in order to examine the similarities and differences of the deficits present within the orienting networks across the two disorders. To address these questions, disengagement and shifting statistics were aggregated within each clinical group and then compared between the groups. This aggregation of the fixation results and comparison across clinical groups was done separately for the exogenous (still) trials and for the endogenous (dynamic, multi-modal) trials. Within the exogenous trials, disengagement and shifting was defined by the time it took from the onset of a second stimulus to make an eye movement and fixate on that stimulus (see Figure 1). For shifting trials, the original stimulus disappeared in near-synchrony (gap of 30 milliseconds) with the onset of the second stimulus. For disengagement trials, the original stimulus remained visible for 500 milliseconds after the onset of the second stimulus, at which point it disappeared.

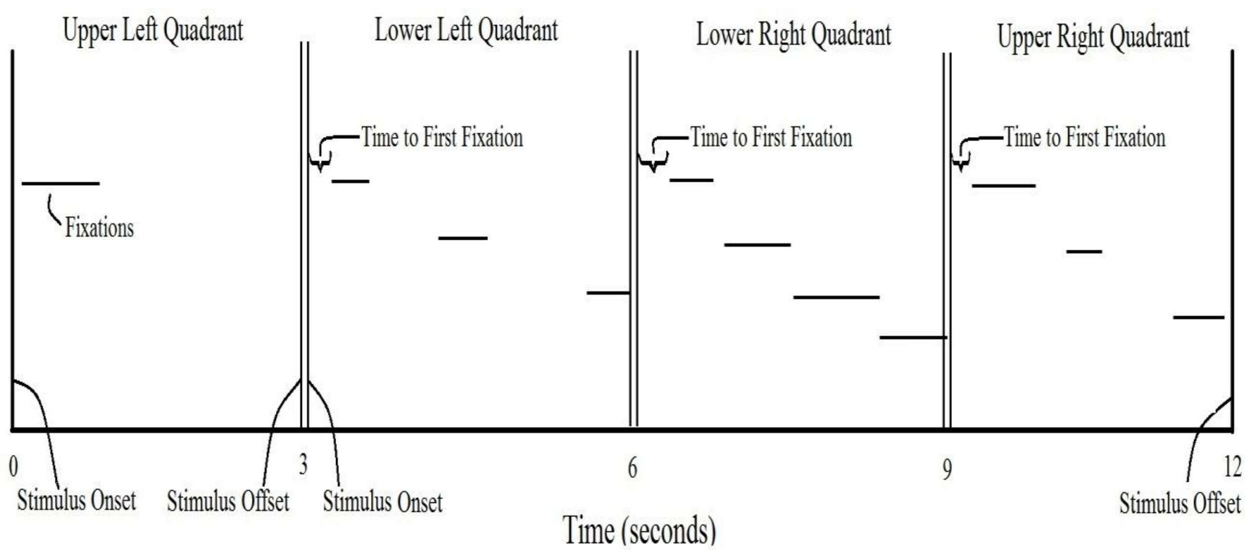

Figure 1. Timeline graphic depicting the time to first fixation measurement for the exogenous task, as displayed for one participant with ASD on a shifting trial with non-social stimuli (i.e., piano).

Within the endogenous trials, disengagement was measured by examining the overall number and duration of eye fixations within the four-screen array (separately for the synchronous and asynchronous quadrants), while shifting was not analyzed. Differences among stimulus type were also analyzed between the two clinical groups in order to examine if the stimulus type (social or non-social) resulted in any differential findings between the groups on each attention trial. Hence, analyses included a two (ASD versus AD/HD) by two (social versus non-social stimuli) by two (disengaging versus shifting) repeated measures ANCOVA (covariate: verbal IQ standard scores) for exogenous trials. Analyses for the endogenous trials included a two (ASD versus AD/HD), by two (social versus non-social stimuli) by two (synchronous versus asynchronous quadrant) repeated measures ANCOVA (covariate: verbal IQ standard scores).

Both significant and marginally-significant findings were reported and interpreted below for both endogenous and exogenous trials. Though many studies have chosen what has become the standard alpha level of .05 and beta level of .20 (which results in a power of .80) for evaluating findings, many authors (e.g., Banerjee, Chitnis, Jadhav, Bhawalkar, & Chaudhury, 2009; Rothman, 2010; Mudge, Baker, Edge, & Houlahan, 2012) have cautioned that these are in fact arbitrary values. Instead, they argue that the extent to which the researcher is avoidant of Type I error (i.e., falsely finding a non-existent effect) as opposed to Type II error (i.e., missing a real effect) should be considered before setting the alpha value for a study. The .05 alpha level places greater emphasis on minimizing Type I error (i.e., 5% occurrence rate) at the expense of accepting a higher rate of Type II error (i.e., 20% occurrence rate). However, the present study is exploratory, given the novelty of the experimental attention paradigm with these two clinical populations. As such, the interest was in a more balanced approach between Types I and II errors so as not to miss potentially important differences present between the groups, particularly with the limited sample sizes. Therefore, increasing the alpha value was done in order to decrease the chances of making a Type II error and correspondingly to increase the power of detecting a difference. As a result, significance is evaluated as $p \leq .05$ and marginal significance is evaluated as $.05 < p < .10$.

Group Characteristics

Independent *t*-tests between the ASD and AD/HD groups found that the two groups were non-significantly different on chronological age (in months), $t(25) = 1.04$, $p = .310$, *mean difference* = 9.67 and on nonverbal IQ standard scores as measured by the DAS-II, $t(21) = 1.42$, $p = .171$, *mean difference* = 9.85. The two groups also consisted of similar sex ratios (i.e., 15 males, 0 females in the ASD group and 9 males, 3 females in the AD/HD group). However, the groups were significantly different on verbal IQ standard scores, $t(21) = 3.23$, $p = .004$, *mean difference* = 23.42 and on general composite IQ scores, $t(19) = 2.58$, $p = .018$, *mean difference* = 17.84. As well, the difference between the two groups for the BRIEF General Composite Subscale T scores was found to be marginally-significant, $t(25) = 1.73$, $p = .096$, *mean difference* = 5.80. Nonetheless, T scores greater than 65 are considered within the clinically-significant range on the BRIEF and as both groups exceeded this cut-off, they were considered similarly impaired in executive functioning. As well, though the *p* value was within the upper borderline of the marginally-significant difference range, since both groups were above the cut-off for clinically relevant symptoms of impairment and the BRIEF was being used for sample characterization and not for predictive purposes, it was not included in any further analyses. In summary, the ASD and AD/HD groups were well-matched as groups on chronological age, sex, executive functioning and nonverbal IQ, and were not matched on verbal IQ or general IQ (see Table 3).

Independent *t*-tests between the ASD and AD/HD groups found that the two groups were significantly different on both the Conners Inattention Subscale and ADHD-Inattentive Subtype T scores, $t(22) = 4.46$, $p < .001$, *mean difference* = 10.6, and $t(25) = 4.03$, $p < .001$, *mean difference* = 10.82, respectively. However, the means of both Conners Subscales for both groups were above the clinical cut-off for clinically-significant attention issues (i.e., T score above 70). The ASD and AD/HD groups were also significantly different, as was expected, on the two measures that were meant to identify the presence or absence of ASD-like characteristics. Specifically, the two groups were significantly different on both the SCQ raw scores, $t(22) = 5.70$, $p < .001$, *mean difference* = 14.4, and on the KADI raw score totals of the first 11 items (these provide a screener for risk of ASD, max = 18), $t(24) = 3.67$, $p = .001$, *mean difference* = 11.6 (see Table 3).

Table 3

ASD and AD/HD Group Characteristics on Age, Sex, Executive Functioning, IQ and Questionnaires (i.e., Conners, SCQ, KADI)

Variable	Group	N	Mean	Standard Deviation	Significance Level
Age (Months)	ASD	15	125.00	26.62	.310
	AD/HD	12	115.33	20.40	
Sex[a]	ASD	15	15M:0F	--	--
	AD/HD	12	9M:3F	--	
BRIEF General Composite T Score	ASD	15	66.87	8.83	.096*
	AD/HD	12	72.67	8.45	
DAS IQ General Composite Standard Score	ASD	15	81.33	24.52	.018**
	AD/HD	12	99.17	9.57	
DAS IQ Verbal Subscale Standard Score	ASD	15	79.33	25.00	.004***
	AD/HD	12	102.75	11.50	
DAS IQ Nonverbal Subscale Standard Score	ASD	15	86.73	23.56	.171
	AD/HD	12	96.58	11.71	
Conners Inattention Subscale T score	ASD	15	75.40	7.94	< .001***
	AD/HD	12	86.00	4.18	
Conners ADHD-Inattentive Subscale T Score	ASD	15	72.93	7.85	< .001***
	AD/HD	12	83.75	5.53	
SCQ Raw Score	ASD	15	20.07	8.36	< .001***
	AD/HD	12	5.67	4.54	
KADI (First 11 Items) Raw Score	ASD	14	25.93	8.53	.001***
	AD/HD	12	14.33	7.38	

Note. ***** $p < .01$, **$p < .05$, *.05 < $p < .10$**

[a]Sex is categorized as M = # Males, F = # Females

Exogenous Attention Task

Based on the criteria specified above for screening out non-valid trials, a total of 10 values were screened out. All the values were from the ASD group and were missing as follows: 2 participants in the shifting/social trials, 2 in the shifting/non-social trials, 4 in the disengagement/social trials, and 2 in the disengagement/non-social trials. To resolve this issue with missing data, 10 multiple imputations calculations were conducted on the data to fill in the missing attention values based on the other information that was available (i.e., which group the participant belongs to (ASD or AD/HD), the participant's performance on other attention trials (social, non-social, shifting and disengagement), as well as the participant's IQ standard scores, chronological age, sex, and executive functioning T scores), following the procedures in Rubin (1996). The multiple imputation technique resulted in 11 separate data files, wherein one dataset included the original data with missing values and 10 datasets included the original data with missing data substituted with various probable values.

Once the missing data was filled with multiple imputations, a 2 x 2 x 2 ANCOVA was conducted to analyze the effect of Group (ASD versus AD/HD), Attention (shifting versus disengagement), and Social Nature of the Stimuli (social versus non-social stimuli) on the time it took to shift or disengage from one quadrant to the next. Verbal IQ standard scores were covaried out of the analysis in order to control for their effects, given that they were a significant ($p < .05$) or marginally-significant ($.05 < p < .10$) covariate in the original data set and in 9 out of 10 data imputation files, $F(1, 24) = 3.95 - 11.54$, $p = .002 - .058$, $\eta_p^2 = .141 - .325$, as well as significant in the preliminary analyses between the groups. ANCOVAs were conducted on the 10 sets of imputed data and 1 set of original data with missing values (see Table 4).

Table 4

Exogenous Trial Main Effects and Interactions for all Within- and Between-Subject Variables of all ANCOVAs (Covariate: Verbal IQ), including Original and Multiple Imputation Data

Within-Subjects Variables	**Data File**	**F Value**	**Significance Level**	**Partial Eta Squared**
Social	Original Data	1.26	.275	.062
	Imputation Data	.050 - .817	.375 - .824	.002 - .033
Social*Group	Original Data	.232	.636	.012
	Imputation Data	.045 - .926	.345 - .833	.002 - .037
Attention	Original Data	2.54	.128	.118
	Imputation Data	.508 - 7.99	.009 - .483*	.021 - .250
Attention*Group	Original Data	.225	.641	.012
	Imputation Data	.004 – 2.19	.152 - .948	<.001 - .084
Social*Attention	Original Data	.255	.620	.013
	Imputation Data	.842 - 5.38	.029 - .368*	.034 - .183
Social*Attention* Group	Original Data	.067	.798	.004
	Imputation Data	.006 - .690	.414 -.937	<.001 - .028
Between-Subjects Variable				
Group	Original Data	1.24	.279	.061
	Imputation Data	1.99 - 5.70	.025 - .172**	.076 - .192

Note. Effects that are marginally-significant (.05 < *p* < .10) or significant (*p* < .05) in 6 or more of the 10 multiple imputation data files are marked with a double asterisk.
Effects that are marginally-significant (.05 < *p* < .10) or significant (*p* < .05) in 4 or 5 of the 10 multiple imputation data files are marked with an asterisk.

All within-subject (i.e., social versus non-social stimuli, disengagement versus shifting trials) interactions and main effects were neither significant (i.e., significance is evaluated as $p < .05$) nor marginally significant (i.e., marginal significance is evaluated as $.05 < p < .10$) in six or more of the 10 imputed data sets. This cut-off point of six imputation files out of 10 was used in order to ensure that only the effects that were being observed at above-chance levels (i.e., occurring in above 50% of the files) would be considered. Nonetheless, a significant or marginally significant two-way interaction between Social Nature of the Stimuli (i.e., social versus non-social stimuli) and Attention (i.e., shifting versus disengagement) was found in five out of the 10 imputation files, $F(1, 24) = 2.95 - 5.38$, $p = .029 - .099$, $\eta_p^2 = .110 - .183$, while a significant main effect of Attention was found in four out of the 10 imputation files, $F(1, 24) = 4.47 - 7.99$, $p = .009 - .045$, $\eta_p^2 = .157 - .250$. Although these effects occurred in half or less than half of the imputation files, analysis of this significant data, and visual examination of Figure 2 (see below), would suggest that the data is trending towards these effects. Specifically, it would appear that within these significant imputation data files, disengagement of attention results in greater times to first fixation than the shifting of attention for both clinical groups, and across both social and non-social stimuli (though seemingly a greater difference for the non-social stimuli than for the social stimuli; i.e., $F(1, 24) = 1.39 – 7.21$, $p = .013 - .249$, $\eta_p^2 = .055 - .231$ for the attention difference on social stimuli, and $F(1, 24) = 13.74 – 17.02$, $p < .001 - .001$, $\eta_p^2 = .364 – .415$ for the attention difference on non-social stimuli). On the other hand, the difference in time to first fixation between social and non-social stimuli when examining attention disengagement and shifting separately may not be as important (i.e., $p = .247 - .874$).

The between-subject variable of Group (i.e., ASD versus AD/HD) was found to be a significant or marginally significant main effect in eight out of the 10 data imputation ANCOVAs, $F(1, 24) = 3.17 - 5.70$, $p = .025 - .088$, $\eta_p^2 = .117 - .192$. Although this main effect of Group was not found in the original data set with missing values ($p = .279$), visual inspection of the data, as shown in Figure 2 (see below), illustrates that across all the trial conditions (i.e., social and non-social stimuli, disengagement and shifting of attention), the time to first fixation for new stimuli was slower for the ASD group as compared to the AD/HD group. These results, including the significance of the imputation analyses but not the original data analyses with the excluded data, suggest that the power from the limited *n* may not be sufficient to detect differences present in the data. Figure 2 illustrates the means for time to first fixation within the original data set (n=10 ASD, n=12 AD/HD) across ASD and AD/HD participants, shifting and disengagement, and social and nonsocial stimuli in order to visually depict the relationships between the variables.

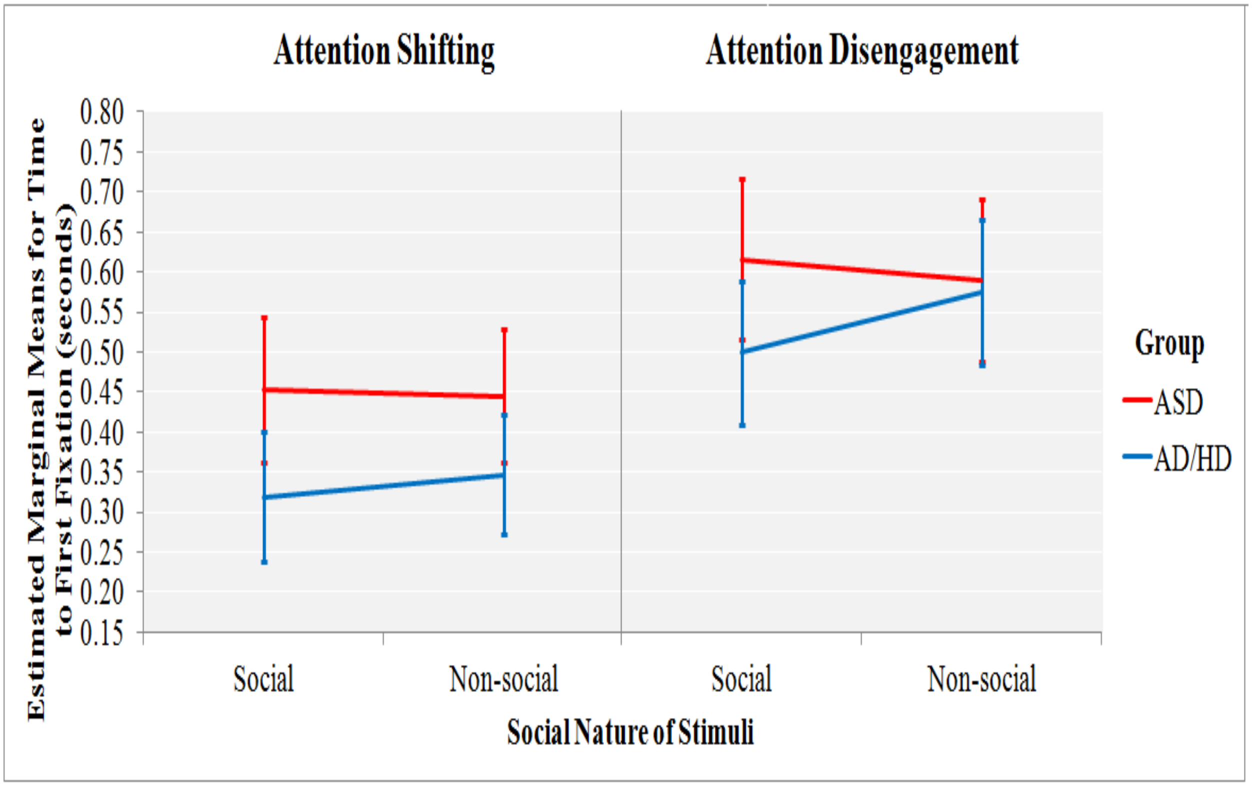

Figure 2. Mean time to first fixation for the original data with missing values (n=10 ASD and n=12 AD/HD) for Group and Social Nature of the Stimuli, separated by attention shifting and attention disengagement.

To further visually examine the differences between the groups, histograms of the original data for the ASD and AD/HD participants were graphed onto one chart in order to gauge the degree of overlap between the two samples (see Figure 3). The histogram would suggest that on average, for exogenous attention tasks, children with AD/HD are able to disengage and shift their attention faster than children with ASD.

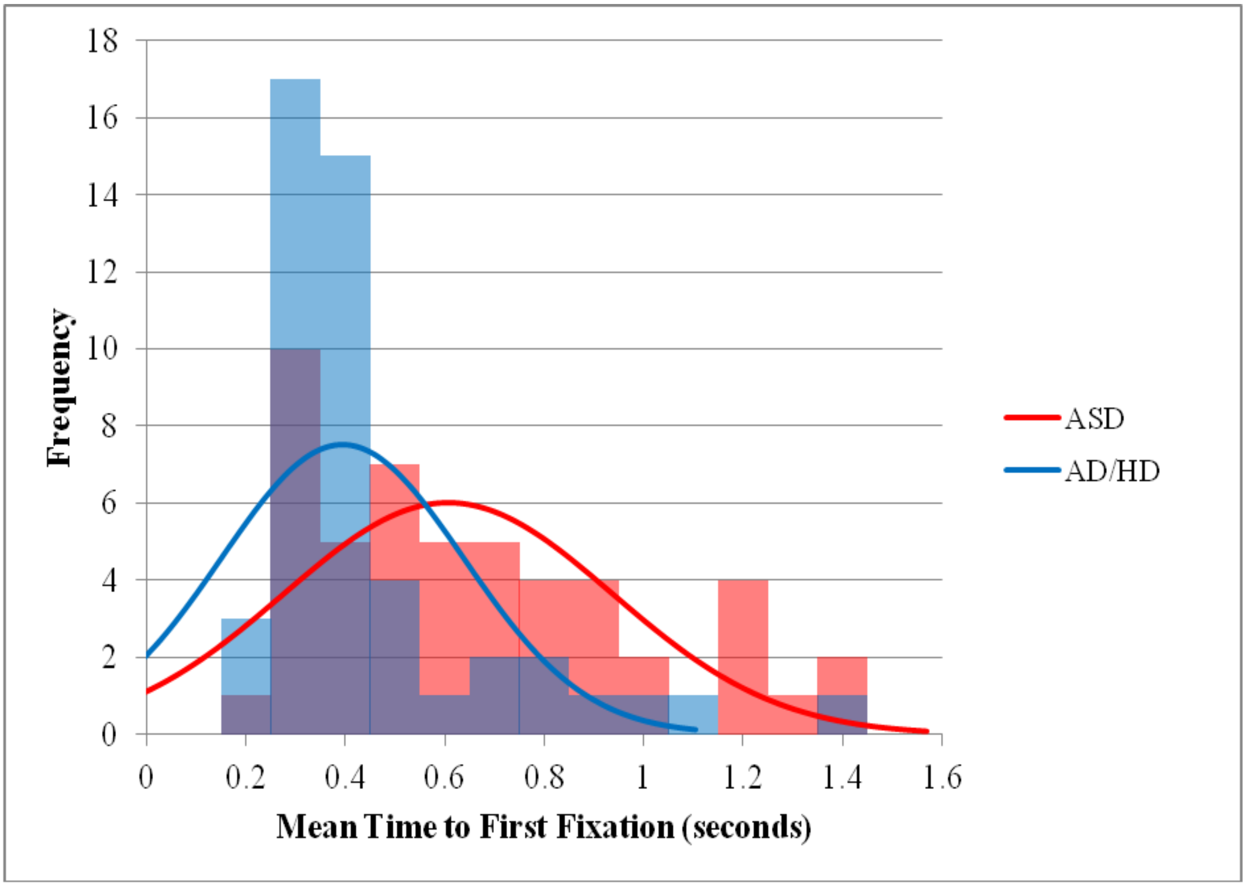

Figure 3. Mean time to first fixation in the exogenous condition for all participants across all social, non-social, shifting and disengagement trials, separated by Group (i.e., ASD versus AD/HD), for the original dataset.

Endogenous Attention Task

Based on the criteria specified above for screening out non-valid endogenous attention trials, a total of two values were screened out. Both the values were from the same participant in the ASD group and were missing as follows: 1 value in the non-social/synchronous screen, and 1 value in the non-social/asynchronous screen. Therefore, this one ASD participant with missing data values was excluded from the subsequent ANCOVA analyses, resulting in 14 ASD and 12 AD/HD participants being included in the analyses.

A 2 x 2 x 2 ANCOVA was conducted to analyze the effect of Group (ASD versus AD/HD), Synchrony of the auditory and visual input of the stimuli (synchronous versus asynchronous), and Social Nature of the Stimuli (social versus non-social stimuli) on mean fixation durations within a disengagement of attention paradigm. As with the exogenous trials, verbal IQ standard scores were covaried out of the analysis. Even though the covariate was non-significant for these trials, $F(1, 23) = .089$, $p = .768$, $\eta_p^2 = .004$, this was done because the ASD and AD/HD groups were significantly different on these scores in the preliminary analyses. A three-way interaction between Synchrony, Social Nature of the Stimuli and Group was significant for the mean fixation durations, $F(1, 23) = 5.01$, $p = .035$, $\eta_p^2 = .179$. The two-way interaction between Social Nature of the Stimuli and Synchrony of the Stimuli was also significant, $F(1, 23) = 4.82$, $p = .038$, $\eta_p^2 = .173$, as well as the main effect of Group, $F(1, 23) = 5.49$, $p = .028$, $\eta_p^2 = .193$. All other interactions and main effects were non-significant (i.e., $p = .679$ for the main effect of Social Nature of the Stimuli, $p = .342$ for the two-way interaction between Social Nature of Stimuli and Group, $p = .905$ for the main effect of Synchrony of the Stimuli, and $p = .138$ for the two-way interaction between Synchrony of the Stimuli and Group). These initial findings, and a visual depiction of the three-way interaction (see Figure 5 below), suggest that the children with AD/HD tend to show longer mean fixation durations than the children with ASD, though the extent of the group difference may vary based on the synchronicity, as well as the social nature, of the stimuli being shown.

To further comprehend the three-way interaction, the data were examined in a series of two-way interactions, separately for each level of a third variable. First, the interaction between the ASD and AD/HD Groups on each level of Synchrony of the Stimuli (synchronized versus asynchronized screens) was examined separately for each level of Social Nature of the Stimuli (i.e., social and non-social separately). Beginning with social stimuli, pairwise comparisons using the Sidak correction for multiple comparisons revealed that there was a significant interaction between the Group and the Synchrony variables, $F(1, 23) = 7.21$, $p = .013$, *mean difference* = .380. Further examination revealed that this significant effect between the groups was present in the social, synchronous conditions, though not in the social, asynchronous conditions ($p = .272$). Figure 4 depicts the social, synchronous trials between the ASD and AD/HD participants to visually depict the degree of overlap in these results.

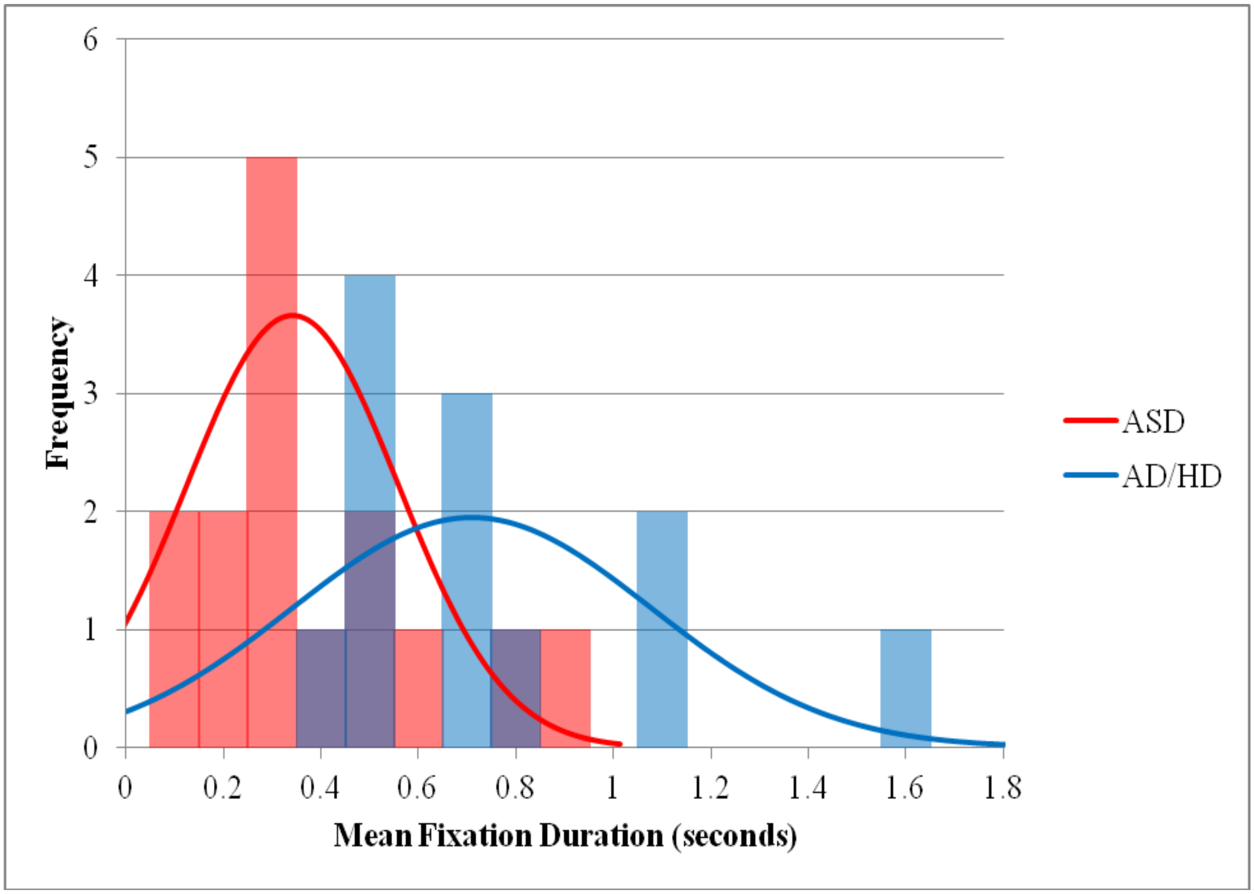

Figure 4. Mean fixation duration of the social, synchronous trials split up by Group. This figure depicts overlapped histograms for ASD and AD/HD participants on the social, synchronised condition.

When the non-social stimuli data were analyzed for differences between the ASD and AD/HD groups on each level of Synchrony, a significant effect between the groups was found for the non-social, asynchronous stimuli, $F(1, 23) = 6.42$, $p = .019$, *mean difference* = .182, though not for the non-social, synchronized stimuli ($p = .253$; see Table 5).

Table 5

Mean Fixation Duration Pairwise Comparisons between ASD and AD/HD on each Level of Synchrony of Stimuli, separately for each Level of Social Nature of Stimuli

Social Nature of Stimuli	**Synchrony of Stimuli**	**Group**	**Mean**	**F Value**	**Significance Level**	**Mean Difference (ASD vs. AD/HD)**
Social	Synchronous	ASD	.327	7.21	.013*	.380
		AD/HD	.707			
	Asynchronous	ASD	.324	1.26	.272	.090
		AD/HD	.414			
Non-Social	Synchronous	ASD	.403	1.37	.253	.143
		AD/HD	.546			
	Asynchronous	ASD	.314	6.42	.019*	.182
		AD/HD	.496			

Note. $^{**}p < .01$, $^{*}p < .05$

Following these analyses, the interaction between social and non-social stimuli on each level of Synchrony (synchronized versus asynchronized screens) was examined separately for each Group (ASD versus AD/HD). Beginning with the ASD group, there were no significant interactions or main effects present across both levels of Social Nature of the Stimuli and across both levels of Synchrony (i.e., $p = .387$ for the social versus non-social stimuli difference within the synchronous screens; $p = .754$ for the social versus non-social stimuli difference within the asynchronous screens). When these relationships were examined in the AD/HD group, a significant difference was found between social and non-social stimuli within the asynchronous screens, $F(1, 23) = 5.05$, $p = .035$, *mean difference* = .082. There were no other significant differences between social and non-social stimuli within the AD/HD group (i.e., $p = .101$ for social versus non-social difference within synchronous screens; see Table 6).

Table 6

Mean Fixation Duration Pairwise Comparisons between Social and Non-Social Stimuli on each Level of Synchrony of Stimuli, separately for each Group

Group	**Synchrony of Stimuli**	**Social Nature of Stimuli**	**Mean**	**F Value**	**Significance Level**	**Mean Difference (Social vs. Non-Social)**
ASD	Synchronous	Social	.327	.778	.387	.076
		Non-Social	.403			
	Asynchronous	Social	.324	.100	.754	.010
		Non-Social	.314			
AD/HD	Synchronous	Social	.707	2.92	.101	.161
		Non-Social	.546			
	Asynchronous	Social	.414	5.05	.035*	.082
		Non-Social	.496			

Note. $^{**}p < .01$, $^{*}p < .05$

Finally, to further examine the three-way interaction, the interaction between synchronous and asynchronous screens on each level of Social Nature of the Stimuli (social versus non-social) was examined separately for each Group (ASD versus AD/HD). The ASD group did not show any significant differences between synchronized and asynchronized screens within both the non-social and social trials (i.e., $p = .972$ for the synchronized versus asynchronized screen difference for social stimuli; *p* = .113 for the synchronized versus asynchronized screen difference for non-social stimuli). On the other hand, the AD/HD group showed a significant difference between synchronized and asynchronized screens specifically for social stimuli, *F*(1, 23) = 11.09, *p* = .003, *mean difference* = .293. However, they did not show a significant difference between synchronized and asynchronized screens on the non-social stimuli (*p* = .410; see Table 7).

Table 7

Mean Fixation Duration Pairwise Comparisons between Synchronous and Asynchronous Screens on each Level of Social Nature of Stimuli, separately for each Group

Group	**Social Nature of Stimuli**	**Synchrony of Screen**	**Mean**	**F Value**	**Significance Level**	**Mean Difference (Synch vs. Asynch)**
ASD	Social	Synchronous	.327	.001	.972	.003
		Asynchronous	.324			
	Non-Social	Synchronous	.403	2.71	.113	.089
		Asynchronous	.314			
AD/HD	Social	Synchronous	.707	11.09	.003**	.293
		Asynchronous	.414			
	Non-Social	Synchronous	.546	.703	.410	.050
		Asynchronous	.496			

Note. $^{**}p < .01$, $^{*}p < .05$

Figure 5 (see below) depicts the three-way interaction between Group (ASD versus AD/HD), Synchrony (synchronous versus asynchronous) and Social Nature of the Stimuli (social versus non-social stimuli) as observed on separate levels of Group. The results suggest that the children with AD/HD show longer mean fixation durations with social, synchronous stimuli and with non-social, asynchronous stimuli as compared to children with ASD. As well, the type of stimuli (i.e., its social nature and synchronicity) affects the mean duration of fixations for children with AD/HD. However, the children with ASD show similar mean fixation durations across the social and non-social, as well as the synchronous and asynchronous, stimuli, which suggest that synchronicity and social aspects of the stimuli do not significantly impact their disengagement abilities on this task.

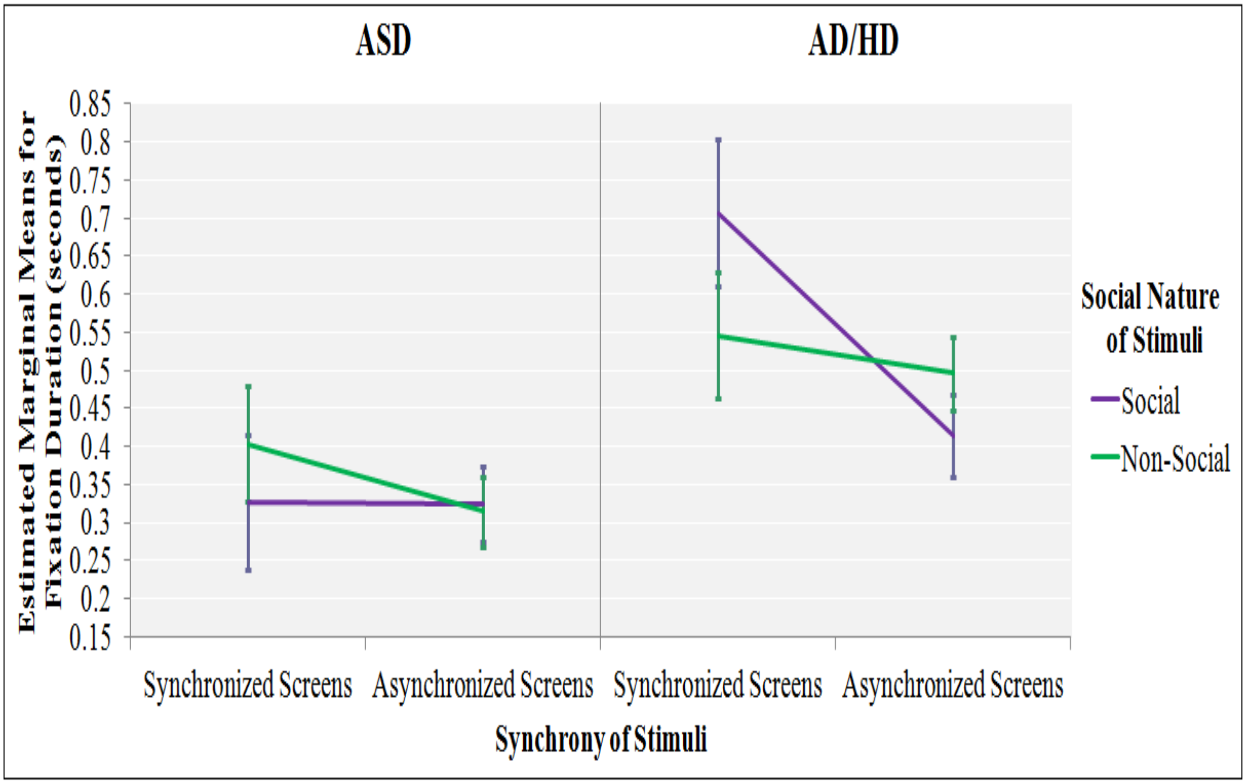

Figure 5. Estimated marginal means for fixation duration for the interaction of Synchrony and Social Nature of the Stimuli, displayed separately for each Group.

Discussion

This thesis sought to compare the shifting and disengagement abilities of children on the autism spectrum with co-occurring clinically-significant attention issues, with children with

AD/HD (without co-occurring ASD). The main hypotheses for this exploratory study specified that only children with ASD should show greater difficulty disengaging and possibly shifting on the exogenous trials with still stimuli if the results were to corroborate previous “sticky” attention research in children with ASD. On the other hand, if the disengagement difficulties seen in previous “sticky” attention research in children and adolescents with ASD were due to attention issues that are not unique to the diagnosis, then it was hypothesized that the AD/HD group would perform similarly to the ASD group on the task. In contrast, given the previous research by McMorris et al. (2009) that found that children with ASD show no impairments compared to typically developing children in disengagement on endogenous attention tasks, and the previous literature that has indicated that children with AD/HD show greater difficulty than typically-developing peers with endogenous attention tasks, it was hypothesized that children with AD/HD should show slower, or at least differential, disengagement abilities on the present study’s endogenous task than the ASD group. The supplementary hypothesis for the present study was that children with AD/HD should show similar patterns of orienting for both social and non-social stimuli (given that aversion to social stimuli is not a diagnostic marker of AD/HD). On the other hand, given children with ASDs’ difficulties with language and social stimuli, it was hypothesized that these children would demonstrate differential disengagement and shifting latencies to social-linguistic, as compared to non-social, non-linguistic stimuli in both the exogenous and endogenous trials.

Exogenous Attention

The results for the exogenous attention trials indicate that children with ASD and children with AD/HD showed significant and marginally significant group differences in 80% of the 10 data imputation files for the average amount of time it took for each group to fixate on a newly visible quadrant (i.e., ASD group showing delays as compared to AD/HD group). Non-significant differences were found between these groups in the original data file, as well as between the groups on both shifting and disengagement abilities and across social and non-social stimuli on all the data files (when taking into consideration only data that was significant or marginally significant in 6 or more out of the 10 imputed data files). Visual inspection of the data in Figures 2 and 3 support the majority of imputed data and suggest that the ASD group tends to shift and disengage attention across social and non-social stimuli at a rate that is slower than children with AD/HD. Moreover, visual examination of Figure 2 and analysis of significant effects within about half of the imputed data suggests a pattern of greater delays with disengagement as opposed to shifting attention for both clinical groups, with the difference in attention for non-social stimuli having the potential of being greater (i.e., lower p values) than that for social stimuli.

Given the small sample size (especially with additionally missing data values), the probability of committing a Type II error (i.e., missing a true significant effect in the results) was raised. Therefore, effects that were approaching significance (i.e., significant in 5 out of 10 imputation files, or effects with $.05 < p < .10$) were evaluated as possibly significant, or at least trending towards significance. Hence, the results suggest that there is an indication that children with ASD who also have co-occurring attention issues trend towards showing impairments with exogenous attention as compared to children with AD/HD. This trend is in support of previous attention research that has also found exogenous shifting and disengagement impairments in ASD (e.g., Townsend et al., 1996; Keehn et al., 2010). The children with AD/HD were able to shift and disengage their attention at much faster rates on average than children with ASD and, assuming that they did so at typical rates, seemingly intact exogenous abilities in the AD/HD children is also supported by previous research (e.g., Casagrande et al., 2012). However, the typicality of the AD/HD group's performance on the exogenous task cannot be confirmed without a typically-developing sample. Furthermore, the trend that suggests that the ASD and AD/HD groups may have a similar pattern of greater time to first fixation when disengaging, as opposed to shifting, attention warrants further study. The non-significant differences in mean time to first fixation between the social and non-social stimuli for the groups appear to corroborate the supplementary hypothesis for the AD/HD sample, while refuting the hypothesis for the ASD sample. However, it is possible that the results are in support of the notion that children with ASD may be born with a general deficit in exogenous orienting that is not necessarily specific to the social nature of the stimuli involved (Renner et al., 2006).

Hence, nothing definitive can be said about the uniqueness of the ASD group on the exogenous task. However, the main effect for group in the analyses suggests that the expected difference is present, although the *n* likely impacted on statistical significance (e.g., the original dataset only had 10 ASD participants and 12 AD/HD participants, which lowered the power significantly in finding a significant effect). Further research must be conducted in order to examine exogenous attention in a larger sample size in order to deduce if there is credibility in it being used as a diagnostic marker.

In conclusion, the present study's attention task presented the groups with ecologically-valid stimuli (i.e., social and non-social in nature), yet as still pictures in order to more closely parallel the stimuli used in past attention research (i.e., shapes and symbols). The multiple imputation results are consistent with a large amount of past ASD and AD/HD research and suggest a possible trend that may lend support to the hypothesis that regardless of shared attention issues between the samples, "sticky" exogenous attention is more pronounced within the autism sample. Nonetheless, results were less clear with the original dataset. Both of these outcomes indicate that larger sample sizes are needed to clarify the findings further.

Endogenous Attention

The results on the endogenous attention task suggest that mean fixation durations of children with AD/HD were significantly longer than those of children with ASD when the groups were presented with social, synchronous stimuli and with non-social, asynchronous stimuli. The two groups were not significantly different when shown social, asynchronous stimuli or non-social, synchronous stimuli. That is, the children with AD/HD showed an apparent "boost" in mean fixation duration when they were presented with social, synchronous stimuli (as opposed to social, asynchronous stimuli), while children with ASD did not show this effect. Finally, the children with AD/HD showed significantly greater mean fixation durations for non-social, asynchronous stimuli as opposed to social, asynchronous stimuli, while the children with ASD did not show this pattern of results.

Overall, the results for the children with ASD would suggest that these children looked similarly in duration across all social and non-social stimuli presented in either synchronous or asynchronous form. The general results for the children with AD/HD would suggest that these children looked differentially according to whether the stimuli were social or non-social, and whether the stimuli were presented in synchronous or asynchronous form. These results are in support of the study hypothesis for the ASD sample, and provide partial support of the hypothesis for the AD/HD sample. Specifically, the ASD results corroborate those of McMorris et al. (2009), who also found that in general, children with ASD did not demonstrate "sticky" attention impairments when disengaging their endogenous attention. Although an AD/HD sample was not tested in the McMorris et al. study, the pattern of results for their typically-developing sample compared to their ASD sample was similar to the present AD/HD compared to ASD samples. That is, these authors found a similar pattern of results wherein the typically-developing sample had a “boost” in mean fixation durations (i.e., longer durations) when presented with social, synchronous stimuli as opposed to other stimuli. Hence, the present research results suggest that children with ASD are not affected by the synchrony or social nature of the stimuli, while children with AD/HD are affected by both to varying degrees. This may suggest that there may be promise in examining the mean fixation durations of children with suspected ASD in order to search for these characteristic traits of the disorder (e.g., short mean fixation durations on social, synchronous stimuli). The differences in mean fixation duration may also reflect differences in degree of engagement with the stimuli (e.g., shorter durations implying less engagement). This effect seems to be most apparent in the contrast of fixation durations for the social, synchronous condition between the two clinical groups.

This study’s novel experimental attention paradigm that uses dynamic, multi-modal videos and social and non-social stimuli has not been previously used to examine attention in children with AD/HD. The patterns within endogenous fixation duration data for the children with AD/HD as compared to the data presented by McMorris et al. (2009) on typically-developing children would appear to support the notion that the children with AD/HD are not necessarily showing disengagement impairments (as has been often reported in past AD/HD research; Carter et al., 1995; Nigg et al., 1997). However, the present research can only statistically demonstrate that these children are performing differentially from children with ASD; this study cannot make any direct comparisons between typically-developing children and children with AD/HD. Nonetheless, the similar pattern of findings between the AD/HD sample in the present study and the TD sample in the McMorris et al. (2009) study may lend support to other past research that has found similar intact abilities via the use of alternative attention tasks (e.g., Berger & Posner, 2000; Huang-Pollock & Nigg, 2003; Mullane et al., 2011). One explanation for intact performance is that the children with AD/HD were much more engaged with the social and non-social videos (as opposed to the shapes and still pictures used in previous research), as evidenced by their longer fixation durations on certain stimuli. Longer fixation durations would also suggest that the children with AD/HD are perhaps more attracted to the stimuli, or are more compelled by it in general (in particular the “boost” in fixation duration observed with the social, synchronous stimuli), than are the children with ASD. Such findings are consistent with past research that has shown a lack of preference for social-linguistic stimuli in the ASD population (e.g., Maestro et al., 2002; Dawson et al., 1998). Finally, since much past research with AD/HD populations has used visual-spatial cuing tasks such as the ANT or Posner Paradigm, the effect of multi-modal videos has not yet been an area of study. The inclusion of such videos allows for the interesting addition of the synchrony of stimuli as a factor, which offers a unique perspective on endogenous disengagement in this population. Mainly, the children with AD/HD had significantly longer fixation durations when presented with social, synchronized stimuli and with non-social, asynchronized stimuli than did children with ASD, and it is possible this effect may be driven by the variation in synchrony. To elaborate further, it is likely (given the pattern of results mentioned above) that children with AD/HD have a typically-developing preference for, and greater engagement with, naturally-occurring social stimuli (i.e., a woman telling a story with her voice synched to her mouth movements) as opposed to unnaturally-occurring social stimuli (i.e., a woman telling a story with her voice not synched to her mouth movements). As a result, they showed significantly longer fixation durations for the synchronized social screens. It is also possible that non-social stimuli (e.g., a hand playing the piano) are not as engaging to these children as social stimuli so that when they are presented with it, children with AD/HD become easily distracted or bored. Hence, when these children are presented with a variation of this non-social stimuli (i.e., asynchronous videos), this may result in an increase in their interest, thereby leading to the observed greater fixation durations for the asynchronized non-social screens. These distinct variations in endogenous attention abilities in the AD/HD sample emphasize the integral role of intermodal perception (i.e., the connection between sight and sound) in the study of attention. Given the use of still stimuli in past attention research, future research may benefit from further examining this interaction between intermodal perception and attention. This may allow for greater understanding of the intricacies of the orienting network in individuals with AD/HD as well as ASD.

Limitations and Future Research

The sample size of each clinical group was a limitation to the thesis design as each group's *n* was small (i.e., n = 15 in the ASD, n = 12 in the AD/HD). Both the exogenous and endogenous attention paradigm analyses were also limited by large standard deviations (especially within the ASD group) due to small sample size. Increasing the sample size may result in more clustering of the data in future studies, which will allow for greater confidence in the possibility of using certain variables as diagnostic screening criteria for children with suspected ASD. The two groups were also not well-matched on general or verbal IQ, as there were a limited number of AD/HD participants who came forward for participation so participants could not be excluded from the sample to improve matching. This presented the study with a statistical issue since the use of IQ as a covariate via an ANCOVA design for samples with ASD has been disputed (Jarrold & Brock, 2004). As well, the use of a covariate in the present study (i.e., verbal IQ) pulled from the power the statistical design. Such power would be regained by matching the samples and avoiding the use of an ANCOVA. Moreover, the exogenous attention paradigm analyses were further limited by missing data, which decreased the precision of the analyses due to the use of multiple imputation techniques. In the case of the exogenous data, there are limitations to using multiple imputations to fill in the data based on statistical analyses of the patterns between the variables as it is possible that the true values would not be related in such a manner. In addition, given that the ASD group consisted of only individuals with additional attention issues, the results are not easily generalizable to all children with ASD. Hence, research with children with varying degrees of attention issues should be conducted to ensure that the pattern of results is readily applicable to all children on the autism spectrum. Lastly, the present study's attention paradigm should be used to examine exogenous and endogenous attention in typically-developing (TD) individuals in order to outline which abilities are intact in the AD/HD and ASD populations. This would allow for direct comparisons between ASD, AD/HD and TD groups in order to deduce if the ASD and AD/HD children are performing similarly to one another though differentially from TD children, or if one or both of the ASD and AD/HD groups are performing similarly to TD children.

The purpose of the present study was to look for potential group differences between ASD and AD/HD populations, not to examine within-group differences. Nonetheless, future studies with larger samples may benefit from examining within-group differences, such as attempting to correlate the severity of autism symptomatology (e.g., ADI-R domain raw scores, SCQ raw scores, etc.) with the degree of delay that is seen in exogenous attention or the shortness of fixation duration that is seen in endogenous attention in children with autism.

Similar research could also be done with individuals with ASD with co-occurring disabilities other than AD/HD in order to examine if the present study results are similarly replicated in different samples of individuals with ASD. Furthermore, given the novelty of the experimental task, it may be interesting to examine if altering the stimuli in some respects, such as the degree of linguistic content of the social stimuli, would impact the results for the children with ASD. This may fine-tune the effect in such a manner as to reveal if the group differences were due to the social aspect of the faces or the linguistic aspect of the stories. As well, given that the slowing hypothesis would suggest that the children with ASD should show impairments when the cue-to-target delay is shorter in duration, future research may benefit from varying the presentation length between the onset and offset of the various quadrants in the exogenous attention task in order to examine the effect of such timing. Finally, given the seemingly unimpaired endogenous attention abilities within the children with AD/HD, future research using typically-developing samples should be done in order to confirm this possibility. As intact functioning would be in conflict with a body of past AD/HD research that used non-social shapes and still images to show impairment (e.g., Casagrande et al., 2012; Carter et al., 1995), future studies may benefit from examining which aspects of the present study's endogenous attention task, if any, (e.g., dynamic, multi-modal videos, social stimuli, variations in synchrony) lend support to intact endogenous disengagement abilities in this population.

Conclusion

In conclusion, the present study results found a trend that "sticky" exogenous attention (i.e., delays in disengagement and shifting) was more pronounced in the children with ASD as opposed to the children with AD/HD, regardless of type of stimuli presented (i.e., social or non-social in nature). Given that past research with children with ASD has shown that visual-spatial attention abnormalities may undermine the maturation process of more complex social and communication abilities (e.g., Theory of Mind (i.e., the understanding that another's mental state is different from one's own) and joint, or shared, attention; Keehn et al., 2013; Dawson et al., 2004), this finding has large implications for the understanding and treatment of those with ASD. Specifically, early identification of this possible diagnostic marker may lead to earlier diagnosis and intervention for children with ASD. The present study results also revealed that the children with ASD and children with AD/HD did not show impairments with disengagement of their endogenous attention. However, the children with ASD did not reflect the profile of differences in disengagement according to the type of stimuli shown (i.e., synchronous or asynchronous, social or non-social stimuli), as was found in the children with AD/HD and has been found in past research with typically-developing children (McMorris et al, 2009). In terms of the children with AD/HD, their intact endogenous abilities in this study indicates that past research with symbols, shapes, and unimodal stimuli may not have accurately captured their actual attention abilities. Given that past research has found an improvement in orienting abilities in children with AD/HD with the administration of an auditory warning signal in order to increase alertness (Casagrande et al., 2012), it is possible that the intact endogenous abilities seen in the AD/HD group in this study reflected increased engagement and alertness due to the use of ecologically-valid, multi-modal and dynamic stimuli. In terms of the children with ASD, even though they showed intact abilities to disengage their endogenous attention, their pattern of results may indicate that they are not engaging with the stimuli in a manner that would reflect typical functioning. The absence of increased engagement with social, synchronized stimuli in this group is consistent with past research that has shown a lack of preference for social-linguistic stimuli in the ASD population (e.g., Maestro et al., 2002; Dawson et al., 1998). Nonetheless, the lack of typically-occurring differences in disengagement according to the synchrony of the stimuli for children with ASD may reflect issues with intermodal processing in this group. To elaborate, if this lack of disengagement differences is due to these children being unaware that some stimuli are synchronized while others are not, the possible repercussions of this would be consequential. For instance, this deficit in intermodal perception could translate to these children having difficulty connecting the sounds they hear in the environment to the sources of those sounds. As an example, while interacting with an adult, the child with ASD may not realize that the adult's speech sounds are coming from their corresponding mouth movements, which may result in that the child would becoming easily confused or distracted by the competing environmental noise. Such a break in communication would have the potential of resulting in large consequences for the child's ability to learn and intake new information. Ergo, the present study has revealed unique attention characteristics in both exogenous and endogenous visual-spatial orienting in children with ASD. Future research may benefit from further studying these unique attention features in order to examine the possibility of an attention-based diagnostic marker in this population, as well as the possibility of the implementation of an attention-focused intervention that may improve upon their ability to better engage their endogenous attention.

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Appendix A – ASD Informed Consent

INFORMATION LETTER

Information Processing in Autism Spectrum Disorders: Understanding Attention and Intersensory Processing as Core Deficits

Dear Parent,

Purpose of the Study

Two abilities are thought to help people interact socially: 1) attention (shifting your attention from one person or object to another); and 2) combining together what we see with what we hear (intersensory processing). Both attention shifting and intersensory processing are impaired in many children and adolescents with Autism Spectrum Disorders (ASD). Although these difficulties together could lead to other impairments in making sense of the world around us, there has only been limited research on how they work together. We are asking for your and your child's assistance in a research study to look at how they work together and how they impact on social understanding and communication in ASDs.

A better understanding of attention and intersensory abilities will help us identify central difficulties in ASD that may aid in the earlier detection of ASD. It may also provide insight into other characteristics of ASD, such as repetitive and rigid behaviours (for example, over selectivity/'narrow' focus), and social difficulties (e.g., joint attention, face-processing).

What will Participation Involve?

This study will involve children between the ages of 6 and 16 years of age who have been diagnosed with an Autism Spectrum Disorder (ASD). In order to participate, individuals must: a) have at least a 4-year-old verbal ability in English; b) normal or corrected-to-normal hearing and vision; c) no known neurological issues (epilepsy, brain injury, etc.), and d) a previous diagnosis of an ASD by a psychologist or psychiatrist according to DSM-IV-TR criteria. Children will be asked to watch a short video and some pictures that have been created specifically to understand how children attend to and understand what they see and what they hear. The images and video that children will see include a woman telling a story, a woman making voice sounds, a piano being played, and some animated cartoons. During the session, the child's eye movements will be video recorded and tracked using eye-tracking equipment.

Along with this there will one cognitive (thinking) activity examining children's problem solving skills (e.g., working with puzzles) and one language activity (e.g., looking at pictures). Additionally, the Autism Diagnostic Observation Scale (ADOS), a structured observation scale children and adults with ASD will be administered. Overall, the experiment should take no longer than one and a half hours for your child.

Parents will also be asked complete several questionnaires about a range of skills and characteristics of your child. These include thinking skills, self-control, communication and social skills, repetitive and sensory-type behaviors. An additional questionnaire will ask about your experiences obtaining a diagnosis for your child and any previous diagnoses that may have been given. We will also ask you to provide a copy of the diagnostic report for clarification. Parent involvement should take approximately 60 to 90 minutes.

Are there any Risks Involved?

All of the parts of this study have been reviewed and there are no risks involved. All information that is collected will be kept strictly confidential to the fullest extent possible by law. To ensure confidentiality, paper data will be stored in a locked cabinet, and other data will be stored on an external hard drive in an encrypted file that will be kept at the Child Learning Projects Lab at York University. The lab is also locked and only accessible by project personnel. All children will be given a participant number by which they will be identified. Data and audio-video recordings will be stored for an extended period after the study to enable comparison and combination with data in future studies. Once all projects in this line of research have been completed, all data and recordings will be destroyed (paper materials will be shredded and video will be destroyed). In the event that the results are published or presented, only grouped data will be used to guarantee anonymity. Any individual or personal information will be kept confidential. You will be provided with a small gift in appreciation for your participation. In addition, we will offer modest compensation for your travel, parking or transit, if you choose. This study is being conducted under the supervision of Dr. James Bebko, a professor at York University and a Clinical Psychologist.

Withdrawal from the Study: Participation is completely voluntary, *you or your child can withdraw from the study at any time* and it will not affect any of the services that you may currently be receiving. If you decide to stop participating, you will still be eligible to receive the promised compensation for agreeing to be in this project. Your decision to stop participating, or to refuse to answer particular questions, will not affect your relationship with the researchers, York University, or any other group associated with this project. In the event you withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Please read and sign the attached consent form indicating whether your child may or may not participate. Please feel free to ask me any questions or if you would like more information. Thank you for your interest and participation in this study, it is greatly appreciated!

Sincerely,

Sara Oczak
Master's Candidate
Psychology Department
York University

Carly McMorris
Doctoral Candidate
Psychology Department
York University

INFORMED CONSENT FORM

Information Processing in Autism Spectrum Disorders: Understanding Attention and Intersensory Processing as Core Deficits

By signing this form, I agree that I have read and understood the description of the study, and that I allow my child to participate. I understand that the information collected about my child during this study will remain completely confidential within the limits of the law and that we may choose to stop participating at any time. I understand that participation in this study will in no way affect any services that we are receiving now or in the future. I agree to have my child's participation and eye-movements video-recorded for purposes of later analyzing looking patterns.

Parent/Guardian Name (please print) ___________________________________

Parent/Guardian Signature ____________________ Date________________________

Relationship to the minor who is participating in this study: _____________________

Child's Name (please print): ____________________________________

Child's Date of Birth (d/m/y): ____________________________________

Child's current age (in years): _______________

Principal Investigator Signature__________________ Date ______________________

Questions about the Research? If you have questions about the research in general or about your role in the study, please feel free to contact us using the contact information below. You may also contact my Graduate Program – the Psychology Department Graduate office at (416) 736-5290. This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 309 York Lanes, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

Sara Oczak
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Supervising Professor
York University
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Phone: (416) 736 2100 (ext. 66250)

Additional Information ***(please complete the following information)***

Child's first language____________ Child's most frequently used language________

By the age of **3**, was your child's language the same as typically developing children? ☐ YES ☐ NO

My child's hearing: Estimated test date____________________

☐ has not been tested
☐ has been tested and no problems were found
☐ has been tested and the following difficulties were found:
____

My child's vision: Estimated test date_____________________
☐ has not been tested
☐ has been tested and no problems were found
☐ has been tested and the following difficulties were found:
____

Has your child **ever** received Intensive Behavioral Therapy (IBI: at least 20 hours of behavioral therapy a week)? (Please note: This question is only to help us understand your child's previous experiences)
☐ YES ☐ NO

* Limited compensation for your travel, parking or transit is available, if you wish; would you like to receive $10.00 to partially cover these costs? ☐ YES ☐ NO

1. Do you wish to receive a brief summary of the grouped findings of this study? (*Please note that it may be 12 months after completion of the study before all the results have been analyzed*)
☐ YES ☐ NO

2. Are you willing to be contacted for participation in future studies (no obligation)? ☐ YES ☐ NO

If you answered **YES** to either of the two above questions, please provide:

Name: ____

Mailing Address: ____

Telephone: ___________________________ Email:______________________

Appendix B – AD/HD Informed Consent

INFORMATION LETTER

Information Processing in Attention Deficit/Hyperactivity Disorder: Understanding Attention and Intersensory Processing

Dear Parent,

Purpose of the Study

Two abilities are thought to help people interact socially: 1) attention (shifting your attention from one person or object to another); and 2) combining together what we see with what we hear (intersensory processing). We are conducting a study on whether specific attention difficulties affect how individuals make sense of the world around them. We are asking for your and your child's assistance in studying this important question.
A better understanding of the nature of information processing abilities, specifically attention and intersensory processing, will help us better understand the development of such processes of attention in children and adolescents with ADD/ADHD.

What will Participation Involve?

This study will involve children between the ages of 6 and 16 years of age who have previously been diagnosed with Attention Deficit/Hyperactivity Disorder (ADD or ADHD). In order to participate, individuals must: a) have at least a 4-year-old verbal ability in English; b) normal or corrected-to-normal hearing and vision; c) no known neurological issues (epilepsy, brain injury, etc.), and d) a previous diagnosis of an ADD or ADHD by a psychologist or psychiatrist according to DSM-IV-TR criteria. Children should refrain from taking any attention-influencing medications (other medications that do not impact attention can be used during testing) for a period of at least 24 hours prior to the testing session. Children will be asked to watch a short video and some pictures that have been created specifically to understand how children attend to and understand what they see and what they hear. The images and video that children will see include a woman telling a story, a woman making voice sounds, a piano being played, and some animated cartoons. During the session, the child's eye movements will be video recorded and tracked using eye-tracking equipment.

Along with this, there will be a cognitive (thinking) activity examining children's problem solving skills (e.g., working with puzzles). Children should refrain from taking any attention-influencing medications (other medications that do not impact attention can be used during testing) for a period of at least 24 hours prior to the testing session. Overall, the experiment should take no longer than two hours for your child.

Parents will also be asked to complete several questionnaires about a range of skills and characteristics of your child. These include thinking skills, self-control, communication and social skills, repetitive and sensory-type behaviors, and other AD/HD-related questions. An additional questionnaire will ask about your experiences obtaining a diagnosis for your child and any previous diagnoses that may have been given. We will also ask you to provide a copy of the diagnostic report for clarification. Parent involvement should take approximately 90 minutes to two hours.

Are there any Risks Involved?

We do not foresee any risks or discomforts from your participation in the research. All information that is collected will be kept strictly confidential to the fullest extent possible by law. To ensure confidentiality, paper data will be stored in a locked cabinet, and other data will be stored on an external hard drive in an encrypted file that will be kept at the Child Learning Projects Lab at York University. The lab is also locked and only accessible by project personnel. All children will be given a participant number by which they will be identified. Data and audio-video recordings will be stored for an extended period after the study to enable comparison and combination with data in future studies. Once all projects in this line of research have been completed, all data and recordings will be destroyed (paper materials will be shredded and video will be destroyed). In the event that the results are published or presented, only grouped data will be used to guarantee anonymity. Any individual or personal information will be kept confidential. You will be provided with a small gift (a $10 gift card to either Chapters or Indigo) in appreciation for your participation. In addition, we will offer modest compensation for your travel, parking or transit, if you choose. This study is being conducted under the supervision of Dr. James Bebko, a professor at York University and a Clinical Psychologist.

Withdrawal from the Study: Participation is completely voluntary, *you or your child can withdraw from the study at any time* and it will not affect any of the services that you may currently be receiving. If you decide to stop participating, you will still be eligible to receive the promised compensation for agreeing to be in this project. Your decision to stop participating, or to refuse to answer particular questions, will not affect your relationship with the researchers, York University, or any other group associated with this project. In the event you withdraw from the study, all associated data collected will be immediately destroyed wherever possible.

Please read and sign the attached consent form indicating whether your child may or may not participate. Please feel free to ask me any questions or if you would like more information. Thank you for your interest and participation in this study, it is greatly appreciated!

Sincerely,

Sara Oczak
Master's Candidate
Psychology Department
York University

Carly McMorris
Doctoral Candidate
Psychology Department
York University

INFORMED CONSENT FORM

Information Processing in Attention Deficit/Hyperactivity Disorder: Understanding Attention and Intersensory Processing

By signing this form, I agree that I have read and understood the description of the study, and that I allow my child to participate. I understand that the information collected about my child during this study will remain completely confidential within the limits of the law and that we may choose to stop participating at any time. I understand that participation in this study will in no way affect any services that we are receiving now or in the future. I agree to have my child's participation and eye-movements video-recorded for purposes of later analyzing looking patterns.

Parent/Guardian Name (please print) ____________________________________

Parent/Guardian Signature __________________________ Date_________________________

Relationship to the minor who is participating in this study:
____

Child's Name (please print): _____________________________________

Child's Date of Birth (d/m/y): _____________________________________

Child's current age (in years): _______________

Principal Investigator Signature________________________ Date ____________________

Questions about the Research? If you have questions about the research in general or about your role in the study, please feel free to contact us using the contact information below. You may also contact the Psychology Department Graduate office at (416) 736-5290. This research has been reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and conforms to the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, please contact the Sr. Manager & Policy Advisor for the Office of Research Ethics, 309 York Lanes, York University (telephone 416-736-5914 or e-mail ore@yorku.ca).

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Email: jbebko@yorku.ca
Phone: (416) 736 2100 (ext. 66250)

Additional Information *(please complete the following information)*

Child's first language_________________ Child's most frequently used language____________

By the age of **3**, was your child's language the same as most typically developing children's?
☐ YES ☐ NO

My child's hearing: Estimated test date____________________

☐ has not been tested
☐ has been tested and no problems were found
☐ has been tested and the following difficulties were found: ____________________________

My child's vision: Estimated test date_____________________

☐ has not been tested
☐ has been tested and no problems were found
☐ has been tested and the following difficulties were found: ____________________________

Has your child **ever** received therapy for their Attention Deficit Diagnosis? (Please note: This question is only to help us understand your child's previous experiences) ☐ YES ☐ NO
Please describe: ____
____

Are they currently, or have they ever been, on any medications? ☐ YES ☐ NO
Please describe (e.g., amount, medication name, purpose of medication): __________________
____

* Limited compensation for your travel, parking or transit is available, if you wish; would you like to receive $10.00 to partially cover these costs? ☐ YES ☐ NO

1. Do you wish to receive a brief summary of the grouped findings of this study? (*Please note that it may be 12 months after completion of the study before all the results have been analyzed*)
☐ YES ☐ NO

2. Are you willing to be contacted for participation in future studies (no obligation)?
☐ YES ☐ NO

If you answered **YES** to either of the two above questions, please provide:

Name: ____

Mailing Address:
____

Telephone: ___________________________ Email Address: _____________________

Appendix C – ASD & AD/HD Assent Form

ASSENT FORM

Understanding Attention and Intersensory Processing

Why are we doing this study?
We would like to learn more about how people think about information and how they pay attention to and understand the things they see and hear.

What will happen during the study?
You will see some pictures and some special videos of people talking and some cartoons. We will use a computer to show us where you were looking and we will make a video recording of you while you are watching so we can see what you are looking at. After that we will do some activities where we will ask you to build things, tell us about some words, and look at some pictures. When we are finished you will be given a small gift.

Are there good or bad things about the study?
Most kids like to watch this video and think the study is fun. We don't think that there are any bad things about the study.

Who will know about what I said or did in the study?
If you are part of this study, your name will not be given to anyone. We won't tell anyone about what you said or did. We will not show the videotape of you to anyone and will erase the video once the results are of no more use for us. Also, we will destroy any papers that we used in the study.

Can I decide if I want to be in the study?
You can decide if you want to be in the study. It is O.K. if you do not want to be part of the study. It is O.K. if you say yes now and change your mind later. Your parents know about the study and have said that you can be in it. Please ask questions that you have at any time.

Assent:
The study has been explained to me. I know that I can ask questions about the study at any time. I know that I can decide to stop at any time. I have been told that all of the videos and other information collected will not be given to anyone. It will only be seen by the research team.

______________________________ ______________________________
NAME SIGNATURE

______________________________ ______________________________
Sara Oczak (Researcher) DATE
Carly McMorris (Researcher)