The Impact of Attention Network Dysfunction on Social Skills Deficits
In Autism Spectrum Disorder

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Abstract

Impairments of attention are among the most consistently reported cognitive deficits in autism, and they continue to be a key focus of research. This is undoubtedly due to the importance of typical attention function to the development of many so-called "higher level" cognitive operations, and to the likely involvement of attention dysfunction in certain clinical features of autism. Such impairments of these functions may have a crucial impact on the social difficulties observed in children with Autism Spectrum Disorders. Specifically, deficits in executive control, set-shifting, working memory, and inhibitory control bear major significance for social cognition and self-regulation of behavior in dynamic social contexts. Such difficulties interfere with the ability to process social cues and respond appropriately in social situations. The neuroanatomical structure includes the DLPFC, anterior cingulate cortex, and subcortical structures involving the basal ganglia and cerebellum, among other regions, which constitute pivotal social competencies and social cognition (Heyder, Suchan, & Daum, 2004; Wager & Smith, 2003). An exploratory thrust into how dysfunctions in one important attentional network, namely the executive control network, would impact impaired social skills development characteristic of ASD, forms the centerpiece of this review article. We also discuss the development of such networks and their implications for social cognition in ASD. Further clarification of this relationship is needed to inform the development of more effective interventions targeting social functioning in ASD.

Keywords: Attention Network Dysfunction, Social Skills Deficits, Autism Spectrum Disorder.

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1. Introduction

Autism is a Pervasive Developmental Disorder characterized by impairments in social interaction and communication in addition to stereotyped behaviors and cognitive deficits (Diagnostic and Statistical Manual of Mental Disorders (4th Edn), American Psychiatric Association, Washington, D.C., 1994). Individuals with ASD commonly have significant difficulties in adjusting to social situations, understanding social cues, and appropriately interacting with others. These are believed to stem from impairments within social cognition-that is, the cognitive processes involved in perceiving and responding appropriately to others' emotions, intentions, and behaviors.

A growing body of research is complementing these social challenges as deeply interlinked with dysfunctions in the brain's attention networks. The attention system is considered to play a basic role in governing how individuals maintain, sustain, direct, and shift attention to stimuli in the environment. Especially, the executive control network is thought to be responsible for higher-order cognitive functions, including working memory, cognitive flexibility, and inhibitory control, which are crucial for adaptive social behavior (Miyake et al., 2000; Huizinga, Dolan, & van der Molen, 2006). Dysfunction in these networks is increasingly recognized as a key contributor to the social difficulties experienced by individuals with ASD.

The executive control network is not a single entity; rather, it is a very complex, multi-dimensional system involving multiple areas of the brain, primarily within the prefrontal cortex. This includes the dorsolateral prefrontal cortex (DLPFC) and the anterior cingulate cortex (ACC), which are critical for processes like shifting attention, regulating impulses, and maintaining cognitive flexibility. Additionally, structures such as the basal ganglia and cerebellum are involved in the fine-tuning of motor and social responses (Heyder, Suchan, & Daum, 2004; Wager & Smith, 2003).

Damage in the neural circuits connecting these regions might result in difficulty in regulating social behavior, reading and reacting to social interactions, and generating appropriate, fluid social interactions. It therefore follows that in devising the much-needed interventions, an essential precursor will involve how dysfunction of the attentional networks in autism contributes to core impairments of this disability. Particularly, executive network function attention control targeted treatments would most probably give avenues that offer immense hope toward improvements in social competency among affected populations.

The relationship between impairment within an attentional network and specific characteristics of the observed social deficit is thus assessed in this context regarding their underlined neuroanatomical structure, cognitive determinants, and suggestions for prospective therapeutics that might mitigate impairments related to this disabling disorder.

2. Literature Review

2.1. Attention Network Dysfunction in Autism Spectrum Disorder

Attention is a fundamental cognitive process that allows people to focus, shift, and maintain mental resources on relevant tasks. Several studies have suggested that dysfunction in the attention network is a major contributor to the cognitive and social difficulties seen in autism spectrum disorder. The attentional network is so complex, including various brain regions, including the prefrontal cortex, parietal cortex, anterior cingulate cortex, and subcortical structures such as the basal ganglia and cerebellum. (Fan et al., 2005; Posner & Petersen, 1990). In Children with ASD, deficits in alertness, orientation, and the executive attention network can lead to impairments in selective attention, sustained attention, and cognitive flexibility—key functions that are critical for effective social interactions (Luna et al., 2004; Keehn et al., 2013). Some studies indicate that attention networks in individuals with ASD may be dysfunctional, leading to impairments in the selective attention and prioritization of social stimuli. Following this line of thought, it could be suggested that individuals with ASD may be unable to direct attention to those aspects deemed most important socially—for instance, faces, reciprocity, emotions, body language, or intonation—those crucial features associated with determining the feelings and intentions of another person. This may also lead to social withdrawal, inappropriate reactions, and problems in maintaining social relationships because of the failure to control attention. (Corbett et al., 2014; Lawrence et al., 2009).

Case Example 1 (*Yassir*): To illustrate that, a 10-year-old child with ASD, observed in the association where I'm working, showed much difficulty in sustaining attention during social interaction, mostly with peers. After a few attempts to communicate, the child gave up because he could not concentrate on the social context of the communication; that is, he was not able to focus on the body language and facial expressions, which, therefore, led to a misunderstanding and withdrawal. The given example illustrates how dysfunction of attention networks hinders social interaction in ASD.

2.2 **Executive Functioning and Social Skills in ASD**

The role of executive functions (EF) in ASD has been a topic of extensive research. g functions are higher-order cognitive processes that control goal-directed behavior, including working memory, cognitive flexibility, and inhibitory control (Diamond, 2013). These functions are crucial for managing social situations, as they allow individuals to plan, adjust their behavior based on social feedback, and adapt to changing social contexts (Zelazo et al., 2008). Deficits in executive functioning are commonly observed in individuals with ASD, particularly in relation to social skills (Ozonoff et al., 2004; Hughes et al., 2009).

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One key component of executive functioning is cognitive flexibility, which allows individuals to shift attention between tasks and adjust their behavior based on new social information. Impaired cognitive flexibility in ASD can lead to rigid behaviors, difficulty understanding others' perspectives, and challenges in regulating emotions in social situations (Langen et al., 2009). Furthermore, deficits in inhibitory control can result in socially inappropriate behaviors, as individuals with ASD may have difficulty suppressing impulsive actions or responses during social interactions (Geier et al., 2009).

The studies we review also suggest that dysfunction in the fronto-parietal attention network in ASD may contribute to challenges in maintaining sustained attention during social exchanges, leading to a reduced capacity for social engagement (Klin et al., 2009). This difficulty in sustaining attention may contribute to the social communication impairments that are characteristic of ASD, as individuals may struggle to attend to important social cues over time.

Case Example 2 (*Saad*): For example, a child in a structured intervention program demonstrated severe difficulties in shifting attention between social tasks during a group activity. Despite verbal prompts, the child exhibited inflexibility and struggled to engage with peers. This case highlights the critical role of cognitive flexibility in social functioning and how deficits in this area can affect social engagement.

2.3. Neural Mechanisms Underlying Attention and Social Skills Deficits:

Attention network dysfunction in ASD has been probed using neuroimaging studies that have shown alterations in brain regions regulating attention in ASD subjects. So, fMRI studies have quite consistently reported that the ASD group exhibited altered activation of the dorsolateral prefrontal cortex (DLPFC) and the anterior cingulate cortex (ACC), two principal regions involved in cognitive control and regulation of attention shifting and emotional regulation. (Minshew & Williams, 2007; Uddin et al., 2011). These findings suggest that dysfunction in these brain regions may underlie Difficulties in the modulation of social interaction, as the individual may not be able to regulate their attention and behavior appropriately in a social context. Hence, dysfunction of the attention network in ASD contributes to an impaired ability in the processing of sensory and emotional stimuli of the environment; more so when interaction with people takes place due to the difficulty of processing emotional expressions like facial expressions, bodily postures, or even in processing vocal intonation factors vital to social interaction-making the subject in question lack effective communication altogether. (Klin et al., 2002; Schultz, 2005). Moreover, sensory Deficits integration could further intensify the social challenges of ASD individuals, which in return makes it quite complex for them to have reciprocal interactions and develop the most appropriate peer relations.

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2.4. Interventions Targeting Attention and Social Skills Deficits

Because attention networks are central to social functioning, interventions targeting attention regulation and executive functioning have been put forth as potentially effective avenues for improving social skills deficits in ASD. Cognitive-behavioral therapies (CBT), focusing on improving skills in executive functioning, have been shown with varying degrees of promise for improving social skills in both children and adults with ASD. (Klinger & Dawson, 1994; Wood et al., 2009). These interventions specifically focus on the capacity of individuals with ASD to focus, shift attention, and inhibit impulsive responses in social interactions to improve their social skills.

More recently, a few studies have looked at the use of technology-based interventions, including computer-based training programs, aimed at improving attention and executive functions in individuals with ASD. (Green et al., 2017). Some of these programs incorporate structured, repetitive tasks that strengthen the control of cognition and attention regulation in hopes of generalizing these skills to real-life social contexts. Moreover, combined training in attention and social skills has been shown to improve both attention regulation and social competencies. Programs involving role-playing, video modeling, and social narratives have been able to improve the social communication skills of individuals with ASD by teaching them how to focus on relevant social cues and adapt their behaviors in social situations (Howlin et al., 2000; Odom et al., 2013).

2.5 Atypical Attentional Networks and the Emergence of Autism

Early attentional dysfunctions in autism spectrum disorder (ASD) might interfere with the development of sociocommunicative abilities. Brandon Keehn, using Posner's model of attentional networks: alerting, orienting, and executive control, puts forward a hypothesis linking atypical attentional mechanisms, specifically impaired disengagement, with the emergence of core autism symptoms. (Posner and Petersen 1990; 2012). Conceptualized attention as being composed of three functionally independent attentional networks, which subserve a different set of cognitive processes: the alerting, orienting, and executive control networks. The three networks have been shown to have some degree of behavioral, neurophysiological, and neuroanatomical independence. (Fan et al., 2007; Fan, McCandliss, Sommer, Raz, & Posner, 2002; Fan, McCandliss, Fossella, Flombaum, & Posner, 2005; see Raz & Buhle, 2006, for a recent review)

2.5.1 Alerting Network

The alerting network is responsible for achieving and maintaining a state of sensitivity to incoming information. Alertness is divided into tonic and phasic components:

Tonic alertness is a state of general wakefulness or arousal, whereas vigilance or sustained attention refers to the voluntary maintenance of alertness at a certain level. Phasic alertness is a more transient alert state, modulated by a behavioral or experimental cue. These elements mirror the tonic and phasic features of Sokolov's orienting response (Sokolov, 1963).

2.5.1.1. Neuroanatomy of the alerting network

The neuroanatomy of alerting involves a network of subcortical and cortical regions. The core arousal center is made up of the nuclei of the reticular formation in the brain stem, especially the locus coeruleus-norepinephrine (LC-NE) system. (see Robbins & Everitt, 1995, for review). The neuromodulator associated with the alerting network appears to inhibit spontaneous neural activity, allowing for increased neural response to sensory stimulation.

2.5.1.2. Development of the alerting network

The alerting network undergoes significant developmental changes in early infancy. One of the major components, tonic alertness, develops rapidly between 2 to 24 weeks of age, as evidenced by toy manipulation and babbling that accompany increased arousal levels (Dittrichova & Lapackova, 1964). Attention in this period functions to modulate arousal in response to both external stimuli and internal states (Karmel, Gardner, & Magnano, 1991). The autonomic nervous system also shows significant maturation, for example, in stimulus orienting as measured by heart rate deceleration, which shows very fast adaptation in the first year of life (Reynolds & Richards, 2008). In addition, the development of phasic alertness has also been studied using event-related potentials (ERP). The Nc component, an index of stimulus orienting, is present early in the first year of life and increases in amplitude while decreasing in latency as infants age (Richards, 2003). With increasing age in children, this early component gradually develops into the more mature P3 waveform, reflecting the development of the alerting network with age and into adolescence (Courchesne, 1978).

2.5.1.3 Alerting network in ASD

Research on the alerting network in autism spectrum disorder (ASD) reveals complex findings that are inconsistent with both tonic arousal and phasic alertness. Some early studies point to hyperarousal (Hutt et al., 1964), while others suggest hypoarousal (Rimland, 1964) or even dysfunctional modulation of arousal (Ornitz & Ritvo, 1976). Hyperarousal is considered one of the mechanisms involved in overselective attention and reduced responsiveness to stimuli (Liss et al., 2006; van Engeland, 1984). Moreover, physiological studies reveal abnormalities, including altered skin conductance, heart rate, and pupil size, some of which indicate heightened arousal (Palkovitz & Wiesenfeld, 1980), while others report lowered or normal arousal levels (Stevens & Gruzelier, 1984; Zahn et al., 1987; Ming et al., 2005; Anderson & Colombo, 2009).

The phasic alertness is also affected in asd. Impairments have been reported in reduced N1c responses to new stimuli (Bruneau et al., 2003) and in reduced P3 amplitudes to novel stimuli

(Ciesielski et al., 1990; Courchesne et al., 1985). This is further supported by functional imaging studies showing atypical brain activation to novel stimuli (Gomot et al., 2006, 2008). Interestingly, despite these differences, the sustained attention of people with ASD is usually normal relative to their typically developing counterparts (Garretson et al., 1990).

Rapid development during infancy, further maturation well into early school age, and final stabilization only in adolescence, that is just how complex the alerting network truly is. Also, the differences in heart rate variability and task-related activation patterns in ASD hint at difficulties not only in the levels of arousal but also in the modulation of alertness to context. These findings emphasize how atypical activation during tasks may reflect either over-focusing or a reduced ability to engage with novelty. While great strides have been made in the understanding of these mechanisms, inconsistencies in findings still abound, making it difficult to come to definitive conclusions regarding alerting network dysfunction in ASD.

2.5.2 Orienting Network

The orienting network is central to selecting sensory information by enabling attention to disengage from one stimulus, shift to another, and reengage. Unlike alerting mechanisms, which uniformly enhance attention across the visual field, the orienting network focuses on specific areas, thereby improving the processing of relevant stimuli (Posner et al., 1984). The alerting and orienting systems are interconnected: enhanced alertness can increase the effectiveness of orienting, while reorienting attention acts to restore balanced levels of arousal (Corbetta & Shulman, 2002). Visual attention could be overt, which includes the movement of the head or the eyes, or covert, wherein such movements do not occur, as described (Posner et al., 1984). Reflexive orienting is automatic and internally generated by external stimulation, whereas voluntary orienting is goal-directed and modulated by internal goals. Reflexive orienting usually involves non-predictive cues-for example, cues that are valid 50% of the time-whereas predictive cues-for example, those valid 80% of the time-drive both reflexive and voluntary mechanisms. (Jonides, 1981).

2.5.2.1 Neuroanatomy of the Orienting Network

The orienting network relies on several interconnected brain regions; The Superior Parietal Lobe integrates sensory inputs and plays a key role in shifting and maintaining spatial attention (Corbetta & Shulman, 2002).

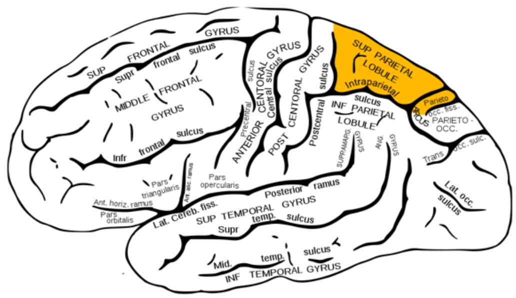

Figure 1. The role of the Intraparietal Sulcus in attention.

The Intraparietal Sulcus is critical for prioritizing and allocating attention to visual and spatial information (Mesulam, 1990).

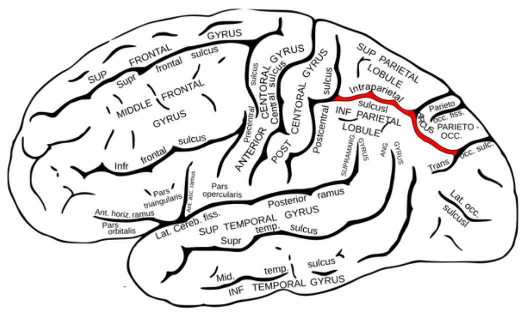

Figure 2. The role of the Intraparietal Sulcus in attention.

The Superior Parietal Lobe integrates sensory inputs and plays a key role in shifting and maintaining spatial attention (Corbetta & Shulman, 2002).

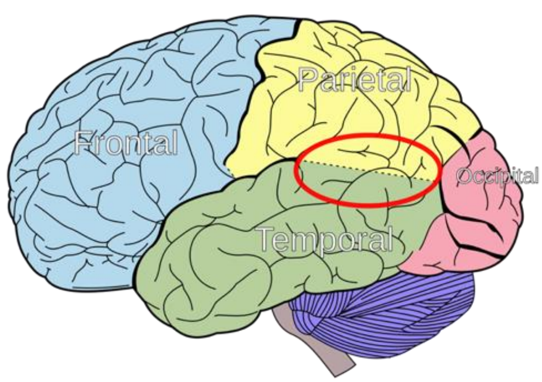

Figure 3. The role of the Temporal-Parietal Junction (TPJ) in attention reorientation.

These regions control voluntary eye movements, integrating visual and motor functions to direct attention (Mesulam, 1990).

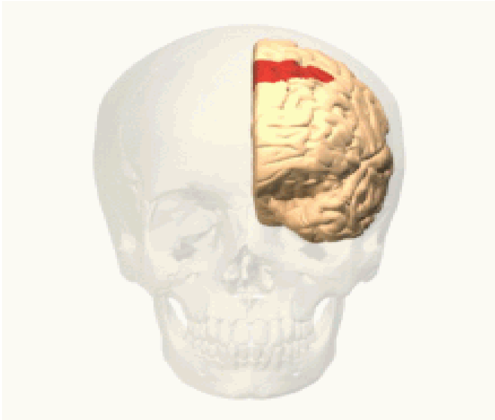

Figure 4. Frontal Eye Fields (FEF)

This figure illustrates the brain structures involved in reflexive and voluntary attention processes. The **Thalamus** and **Superior Colliculus** are shown as key structures supporting reflexive attention and rapid shifts in focus, as described by Rafal (1998).

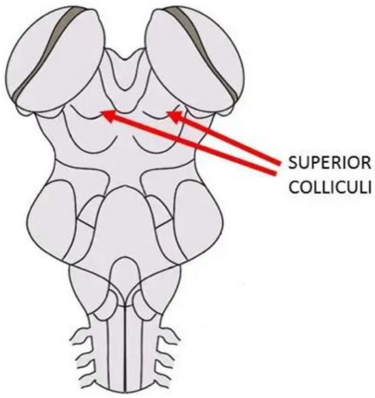

Figure 5: Thalamus, Superior Colliculus, and Attention Networks

The cerebellum also participates in overt and covert attention processes (Akshoomoff et al., 1997). Reflexive attention is controlled by subcortical and posterior cortical areas, while voluntary attention depends on a frontal-parietal network (Rafal, 1998). Acetylcholine, the neuromodulator of this network, facilitates attention reorienting by accelerating it and widening the attentional field (Thiel et al., 2005).

2.5.2.2 Development of the Orienting Network

The orienting network undergoes significant development from infancy through adolescence:

- **2 to 3 Months**: The maturation of cortical layers 4, 2, and 3 allows for smooth pursuit of moving objects and anticipatory eye movements (Johnson, 1990).
- **4 to 7 Months**: Infants reveal enhanced attention shifting and disengagement skills, which are basic skills for orienting efficiency, and show covert attention skills (Johnson, 1990; Hood, 1995).
- **3 to 7 Years**: Children improve their orienting abilities by responding more to external cues, which in turn enables them to shift attention effectively (Ruff & Capozzoli, 2003).
- **8 to 10 Years**: Near-adult levels of attention shifting are observed, with improved speed and accuracy in responses (Rueda et al., 2004).
- **Adolescence**: Continued refinements in speed, accuracy, and efficiency occur, enabling better performance in tasks requiring complex attentional control (Casey et al., 2005).

Neuroimaging studies have pointed the finger at changes in the developmental activity of the brain: younger children activate the right temporal-parietal junction, while older children and adolescents also involve the superior frontal gyrus and insula, which reflects more elaborated attentional mechanisms. (Konrad et al., 2005).

2.5.2.3 The orienting network in ASD

Deficits in orienting visual attention are consistently observed in individuals with autism spectrum disorder (ASD). Many studies support the hypothesis of early orientation difficulties, both observational and retrospective video analysis studies. For example, Swettenham et al. (1998) studied 20-month-old infants with ASD, TD children, as well as those with DD during a five-minute free play session. They found that infants with ASD had reduced attention shifting compared with both the TD and DD groups. Moreover, infants with ASD oriented less toward visual stimuli, human voices, or their names. (Baranek, 1999; Maestro et al., 2002; Osterling & Dawson, 1994).

Dawson et al. (1998b) extended this study to include orienting to both social and nonsocial stimuli with 5-year-old children with ASD, DS, and TD children. The findings were that the children with ASD oriented to both kinds of stimuli less often than both comparison groups did, and the children with ASD who did orient were slower in attending to social stimuli. These findings were extended to a larger sample of 4-year-olds by Dawson et al. (2004). For individuals with ASD who are older, several different spatial cuing paradigms have been utilized to assess orienting. These tasks have generally incorporated response times (RT) for cued location to assess visuospatial orienting as well as the time to disengage and reorient attention. Results have suggested slower orienting among individuals with ASD, which was related to cerebellar vermis hypoplasia, for example, Townsend et al., 1996, 1999; Harris et al., 1999. More recently, other studies also using the ANT task report slower attention shifts among children and adolescents with ASD (Keehn et al., 2010).

Ristic et al. (2005) also examined the ability of individuals with ASD to reflexively orient towards endogenous gaze cues. Individuals with ASD performed similarly to TD participants in regards to validity effects of predictive cues. However, they performed poorly compared with TD participants on non-predictive cues. That would mean that even though persons with ASD might have difficulty with reflexive orienting, they can control attention volitionally in specific contexts. Conversely, other studies report inconsistent results, showing that individuals with ASD might process gaze cues differently than TD individuals do (Vlamings et al., 2005).

These findings are also supported by a series of neuroimaging studies. For example, Greene et al. (2011) illustrated that while TD individuals demonstrated increased brain activity to social cues, individuals with ASD did not. Renner et al. (2006) and Pruett et al. (2010) extend this work by exploring how different types of orienting cues-exogenous and endogenous processed in ASD, and their findings suggest that reflexive, exogenous orienting is often impaired, while voluntary, endogenous orienting may remain relatively intact, although atypical. The results pointed out that attention deficits in ASD are complexly related to the pathophysiology and involve various brain networks contributing to orienting processes.

2.5.3 Disengagement of attention

Attentional disengagement can be quantified by saccadic eye movement paradigms, specifically by comparing response times in gap and overlap conditions. In the latter, the fixation cross remains on screen during target onset, and the individuals need to overcome the inhibitory effect of the ongoing fixation, resulting in slower disengagement. Conversely, under the gap condition, when the fixation cross disappears before the target appears, ocular inhibition is released and disengagement is made more efficiently. This would imply that the gap effect results from two components: 1) a general warning effect (phasic alerting) produced by the fixation offset, and 2) a release of inhibition following the disappearance of a foveal stimulus, as well as preparing for a saccadic response. (Kingstone & Klein, 1993; Taylor, Kingstone, & Klein, 1998).

Children with ASD, studies such as Landry and Bryson (2004) found significantly increased latencies to disengage visual attention in the overlap condition, but no differences were found in the gap condition. Of more importance, however, is the striking drop in saccade frequency exhibited by the ASD group for fast attentional shifts-a saccades occurring between 100-300 ms-under the gap condition that suggests children with ASD are inefficient not only in their ability to disengage attention in the overlap condition but also in making an attentional shift under conditions where this disengagement mechanism is in less contention with a central stimulus.

Impaired disengagement has been described in several cohorts, including low-functioning adults with ASD (Kawakubo et al., 2007) and at-risk infants (Elsabbagh et al., 2009; Zwaigenbaum et al., 2005). For at-risk infants, the ability to disengage attention at 6 months did not differ between those with an ASD sibling (high-risk) and those with a typically developing sibling (low-risk). Whereas by 12 months, the high-risk group showed significant delays in disengagement latencies, 25% had prolonged disengagement, and such infants later went on to receive a diagnosis of ASD by 24 months, thereby suggesting that early attentional disengagement difficulties may be an early biomarker for ASD. Although the literature is generally supportive of the impaired disengagement hypothesis in ASD, several findings have conflicting conclusions. For example, several studies find no evidence for atypical disengagement in ASD (e.g., Kawakubo et al., 2004; Leekam et al., 2000; Mosconi et al., 2009), possibly because of methodological differences, small sample sizes, or different experimental paradigms. More precisely, Goldberg et al. (2002) did not report differences either in the disengagement or in the facilitation of visual attention within adolescents with ASD, though a decrease in the frequency of express saccades was reported to be there as defined by latencies of 80–140 ms.

To summarize, attentional disengagement deficits in ASD begin at infancy and persist across the lifespan. These appear to involve impairments in both the reflexive and voluntary components of the orienting network, including a distributed set of brain areas such as the dorsal frontal-parietal cortical network and subcortical structures involving the thalamus, superior colliculus, and cerebellum. Although the exact mechanisms are still complex, disrupted attentional disengagement appears to be an important part of the cognitive phenotype in ASD, carrying important implications for early diagnosis and intervention.

2.5.3.1 Methods

In our study, we investigate the link between attentional network dysfunctions and deficits in social skills in children diagnosed with autism spectrum disorder. We have chosen two male participants, aged 10 and 5 years of age, respectively, Yassir and Saad, both from clinical profiles that documented difficulties with attention and pronounced social deficits. Both participants are currently receiving therapeutic and educational programs at the Association Ikhlas, an institution that specializes in interventions related to autism. Selection was made to ensure that the characteristics of the participants fit the purposes of the study.

Yassir: Yassir was diagnosed with ASD at 6 years and presents with significant social impairments like limited eye contact, difficulty in social reciprocity, and difficulty with transitions during activities, especially during structured play sessions.

Saad: At the age of 5, Saad shows early signs of ASD, such as severe language delays, reduced social engagement, and repetitive behaviors. His symptoms make him a relevant subject in studying how attentional network dysfunctions impact the development of social skills in children with ASD.

2.5.3.2 Study Design

Our study design is to explore how attentional network dysfunction may contribute to the development of social skills impairments in children with ASD. Given the exploratory nature of the present study, a thorough investigation into the cognitive and social behaviors of each participant was conducted through a combination of diagnostic assessments, direct observations, and neuropsychological examinations. The assessments administered included:

Clinical Evaluations: PEP-3 for Saad and ComVOOR for both participants to evaluate cognitive, social, and emotional functioning. Structured and unstructured behavioral observations at the Association Ikhlas, focusing on attention-related tasks and the consequent effects on social interactions.

Neuropsychological Assessments: Specific tests to measure selective attention, sustained attention, and the ability to shift attention. These assessments were derived from established literature on attentional networks in ASD (Roth et al., 2020) and alterations in brain plasticity (Harrison et al., 2019), emphasizing the role of the fronto-parietal attention network in individuals with ASD.

2.5.3.3 Intervention Protocols

For ***Yassir*** and ***Saad***, individualized intervention plans were developed, targeting their attention deficits and the parallel social difficulties. These interventions were evidence-based and aimed at enhancing attentiveness and social function.

***Yassir's* Intervention Plan:** This intervention also focused on improving social communication skills through structured social games, role-playing exercises, and transition strategies. Visual prompts, breaking tasks down into steps, and reinforcement strategies were utilized to address the attentional deficits, especially sustained attention and shifting attention. Based on the attention network dysfunction framework, interventions to increase peer interactions and to help the child shift attention were implemented during play sessions, when attention deficits were most salient. (Posner & Petersen, 1990).

***Saad's* Intervention Plan**: This plan focused on helping Saad develop basic social interaction skills through activities like turn-taking games and exercises that encouraged joint attention. In an attempt to improve his attention problems, such as focusing on specific tasks and shifting attention, we implemented activities including matching games, memory exercises, and visual tracking tasks that are appealing to him and thus capture his attention. Also, some special consideration has been taken in providing regular sensory breaks to avoid overstimulation since he usually develops with lots of difficulties that hinder his concentration. Further, structured initiations from adults promote social contacts, a strategy adopted from research findings revealing a peculiar attention pattern in the attention mechanisms of autistic children (Tian et al., 2019).

2.5.3.4 Data Collection

Data collection lasted for 4 weeks and consisted of direct behavioral observations, structured assessment, and caregiver feedback. It was done to observe and record attention-related behaviors and social interactions in structured and naturalistic environments.

Attention Metrics: Key metrics of attentional dysfunction include response times, task completion rates, and the ability to shift focus during cognitive tasks. These metrics are informed by current research on attention dysfunction in ASD. (Harrison et al., 2019).

Social Skills Metrics: Social engagement was quantified by eye contact, appropriate social responses, and the frequency of social initiation and reciprocity during structured social tasks. The aforementioned metrics had been developed in a fashion that can concurrently demonstrate associations of attention deficits with social engagement while specifying how attentional network dysfunctions might contribute to mediating social difficulties characteristic of ASD.

2.5.3.5 Analysis

A mixed-methods analytical approach was employed to analyze the data. Quantitative data were analyzed by descriptive statistics, including task performance measures such as task completion time and frequency of attention shifts. Qualitative data, derived from observational notes and behavioral coding, were analyzed to examine social interactions and their relationship with attentional dysfunction. The analysis was grounded in the conceptual framework established by research on attentional networks in ASD, particularly the dysfunctions within the orienting and executive control components of attention (Posner & Petersen, 1990). Data were interpreted in light of neuropsychological models of attention and social cognition, including theories of brain plasticity and the role of the fronto-parietal network in ASD (Harrison et al., 2019). The inter-rater reliability procedure was performed to ensure that the observational data were reliable, while caregiver feedback was used to make sure that the data collection was valid through triangulation.

3. Results

3.1 Participant Overview

Our research participants were two males, Yassir, a 10-year-old, and Saad, a 5-year-old, both diagnosed with ASD. They had been enrolled in therapeutic and educational programs at the Association Ikhlas, where they were observed and tested for cognitive, social, and attention difficulties. Yassir had problems with eye contact, social reciprocity, and transition situations, especially in play. Saad demonstrated early signs of ASD, including significant language delays, limited social engagement, and repetitive behaviors.

3.1.1 Attention Deficits

Neuropsychological assessments showed that both participants had significant attention deficits. Yassir had difficulties with sustained attention and shifting attention, which were most prominent during transitions and social interactions. He showed difficulty attending to social cues and, as a result, frequently became disengaged. In Saad, significant difficulties were identified with selective attention and shifting attention, especially in tasks that required him to sustain his attention to social stimuli. These attention dysfunctions were in line with findings in the literature regarding the role of the fronto-parietal network in ASD (Roth et al., 2020; Harrison et al., 2019).

3.1.2 Social Skills

Both participants exhibited social skill deficits that were directly influenced by their attentional difficulties.

Yassir: Dysfunctions in attention increased the difficulties that Yassir showed in social areas like eye contact, social reciprocity, and transitions. His potential to have reciprocal interaction during structured social tasks was reduced. He would often not recognize body language or facial expressions, leading to misunderstandings with peers. This finding further supports the conceptual framework of Roth et al. (2020), which suggested that deficits in attention networks are one of the contributing factors to social impairments in ASD. During playtime, Yassir's behavior followed a pattern where, if attention was not guided or structured, he would become disengaged and frustrated. However, with the application of interventions, such as visual cues, task breakdowns, and reinforcement, his peer interaction improved, thus showing that targeted interventions may help address attention-related social deficits.

Saad: Saad had significant delays in language development and social interactions, along with impairments in focused attention. He was largely unable to focus his attention on and process social stimuli in social interactions with peers and adults. His initiation of social contact was at a minimum, and when he did respond, it was usually delayed or inappropriate. However, structured activities for attention training, such as matching games or memory exercises, helped Saad become more attentive to social stimuli. Gains in attention were realized, but his fully developed sensory problems, such as sensitivity to noise and overstimulation, were the biggest barriers to socializing. Sensory breaks and structured interactions guided by adults thus became intrinsic components of intervention in the problem of attention difficulties.

3.1.3 Correlation Between Attention and Social Skills

The analysis revealed a strong correlation between attention deficits and social skill difficulties in both participants. Specifically, attention dysfunctions in selective attention and shifting attention were found to directly impede social interactions. This was particularly evident when both children were required to attend to multiple social cues (e.g., eye contact, facial expressions) or shift attention between different social contexts (e.g., transitioning from one activity to another). These results are in line with the findings of Posner and Petersen's (1990) attention network model, which suggests that dysfunction in the orienting and executive control components of the attentional network plays a critical role in impairments in social behavior in ASD.

3.1.4 Intervention Outcomes

The remediation approaches concerning attention deficits seemed to have some tangible impact on the students in terms of their socialization skills. For instance, in Yassir, visual cuing, task segmentation, and reinforcement techniques applied during structured play activities like 'playtime interactions' increased the levels of social reciprocity. Saad was able to make progress in his ability to sustain attention during goal-directed activities such as well-structured memory games, and taking breaks to avoid excess stimuli. In contrast, Saad's progress was slower, hinting that maybe the area of social skills was wider and the area of sensory processing difficulties would be narrower and would probably take time and more focused intervention to show better results.

3.1.5 Summary of Key Findings

Accordingly, both subjects presented notable cognitive dysfunction that added to the deficit in social skills, thus supporting this hypothesis that attentional disturbances are a contributor to the social impairments associated with ASD in children. Among these, some of the important issues in social situations are attentional difficulties, including selective attention, sustained attention, and switching of attention.

The interventions focused on the lists of tasks, visual cues, and emotion regulation helped decrease some of the social difficulties characteristic of mood disorders, although with varying degrees of improvement in the participants.

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Results are in agreement with the literature concerning the role of cognitive networks in ASD and suggest that focused attention may be a major factor for children with ASD who demonstrate improved social skills.

4. Discussion

For the discussion of our study which explore the development of the orienting network in typical children and individuals with Autism Spectrum Disorder (ASD), in this discussion of our study which explore the development of the orienting network in the typical children and individuals with ASD, focuses on how attention shifting and disengagement influence cognitive and social development. The advancement of the attention-orienting Networks plays a crucial role in the acquisition of cognitive skills, including memory, concentration, and social interaction abilities, which impact as we said, impact the social skills. Hence, understanding these developmental processes and how they are impacted in ASD can inform interventions, such as the use of mixed reality (MR), which aims to enhance these skills in children with autism.

4.1 The Development of the Orienting Network in Typical Children

Attention is served by a gradually maturing orienting network in which development consists of refinement of subcortical as well as cortical pathways mediating attention. According to Johnson (1990), early attention in infants involves a subcortically mediated process resulting in reflexive shifts of attention. An inhibitory pathway has been shown to appear around one month in the infant, whereupon looking becomes obligatory. The ability to engage in smooth pursuit and anticipatory eye movements starts at two to three months, and by four to seven months, the infant's ability to shift attention covertly and overtly improves quite a bit. This course of development culminates in refined visual attention, which becomes adult-like at about eight to ten years of age. (Johnson, 1990). By 12 months, the infants develop the ability to disengage efficiently shown in the gap-overlap paradigm milestone in child development-underpins the ability to switch focus from one thing to another important component for social and cognitive ability; Kingstone & Klein, 1993. Children show significant improvements in attention switching in early childhood from 4 to 7 years. Adult patterns start to emerge around seven years, as shown by Johnson (1990. This developmental trend reflects the gradual optimization of orienting attention, which is so crucial in social and cognitive tasks.

4.2 Attentional Impairments in ASD

In contrast, individuals with ASD demonstrate alternative patterns of attentional control and disengagement. Many findings point to disrupted orienting of visual attention in individuals with ASD during infancy up to teenage years. For instance, infants with ASD are less likely to orient their attention to visual stimuli, to the sound of human voices, or to the calling of their own name, compared to TD infants (Baranek, 1999; Maestro et al., 2002). Moreover, Dawson et al. (1998b) extended that children with ASD show delays in orienting to social and non-social stimuli in their later childhood as well (Dawson et al., 2004). The atypicality in the development of the orienting network thus appears to result in problems with engaging and shifting attention for individuals with ASD toward relevant stimuli. One of the most salient deficits within ASDs indeed concerns the impaired disengagement of attention. Evidence indicates that individuals with ASD present longer latencies to disengage attention, especially when conditions require the involvement of inhibitory control, as in the overlap condition of the gap-overlap paradigm (Landry & Bryson, 2004). This suggests that persons with ASD encounter more difficulties in overcoming the inhibiting action of central stimuli during shifting. While there are conflicting findings in some studies, the consensus is that attention disengagement is a core impairment in ASD. These include the work of Kawakubo et al. (2007) and Leekam et al. (2000).

Neuroimaging findings also support these behavioral results. For example, Greene et al. (2011) demonstrated that TD individuals have more brain activity in response to social cues than individuals with ASD do, with less activation in the latter for brain areas implicated in attention orientation, including the right temporoparietal junction and superior frontal gyrus. These studies specifically point out that in ASD, the attentional disengagement and shifting involve the participation of the dorsal frontal-parietal cortical network and subcortical structures such as the thalamus and superior colliculus.

4.3 Illustrating Impairments with Case Examples

The cases of Yassir and Saad are also real-life examples to go along well with the theoretical discussion above. These serve as a practical illustration of how these attentional impairments manifest themselves in children with ASD and highlight the importance of targeted interventions. As mentioned in the Methods section,

Yassir: He has difficulties in shifting attention and disengagement. The jumping on the table and asking for his schoolbag were his indications of difficulties in the regulation of attention in transitions. These behavioral interventions-sound punishment-facilitated compliance by Yassir; however, attentional difficulties continue to be a major barrier to transitions. This supports the idea that impairments in attention disengagement are common in children with ASD.

Saad: Saad also has selective attention and limited social engagement, features common in the impairment of attention among individuals with ASD. His difficulty in focusing on social cues and the very limited responses to his name are signs of a challenge in the systems of both orienting and disengagement of attention. The findings indicate problems shifting the focus of attention from one stimulus to another in social contexts among children with ASD, which confirms previous studies.

These case studies highlight the need to develop interventions that address attentional impairments, particularly in disengagement and transition between tasks. The experiences of both Yassir and Saad draw on the importance of individualized interventions that could improve attention regulation and thus facilitate better engagement with social and cognitive stimuli.

4.4 Implications for Intervention and the Role of Mixed Reality

Attentional impairments in ASD suggest that remediation programs regarding attentional control may be possible. Considering shifting difficulties and the disengagement of attention in children with ASD, interventions that enhance attentional flexibility could substantially improve cognitive and social functioning. Mixed reality, which merges real and virtual environments, is a promising tool in facilitating such skills. MR can also afford children with ASD the opportunities to practice attentional shifts in dynamic contexts that closely resemble real-world scenarios by providing a controlled, immersive environment. Such an approach with MR coincides with Johnson's 1990 developmental model of attentional networks, in which smooth pursuit and saccadic-anticipatory eye movements emerge between two to three months, and refinement continues through the start of life. It may be that MR provides repeated experiences in task completion that will eventually elicit appropriate shifting and disengagement in attention processes and thereby hasten its maturation among children diagnosed with ASD.

The study further suggests that the specific impairment in both the orienting and disengaging of attention pertains to particular cerebellar and superior colliculus areas. Brain MR interventions might be specifically tailored to affect the integrity of the brain in those regions to enhance brain plasticity and thus improve attentional skills among children with ASD. Moreover, the potential of MR for immediate feedback and progressive challenges may favor further improvement of children with ASD, both in shifting attention and in general cognitive and social skills.

4.5 Concluding Remarks

In our discussion, we try to bring out the developmental trajectory of attention, the difficulties in orienting, and the disengagement of attention in children with ASD. Given the clear link between attentional impairments and social and cognitive development, interventions targeting these deficits become imperative. It has the potential to offer a promising approach toward solving these problems by creating an immersive environment that promotes attention flexibility, which will support cognitive and social development. Case studies on Yassir and Saad have shown how attentional impairments manifest themselves in real-life settings and again bring into focus the need for individualized interventions. Future research should examine the efficacy of MR treatments in attention shifting and disengagement, as well as their effects on the overall cognition and social function gains in children with ASD.

5. Conclusion

Results obtained in this work point to the importance of attentional networks, especially the orienting network, for cognitive and social development in children with Autism Spectrum Disorder. Atypical development of such networks the one characteristic of impaired shifting and disengaging of attention in children with ASD, strongly influences the ability of such children to interact socially, to respond to events in the environment, and to behave adequately. Central attention deficits are crucial not only in cognitive delays but also in social skills deficits that characterize ASD.

In addition, the theoretical insights from developmental attentional models, as described by Johnson (1990), supported the fact that impairment in shifting and disengagement is revealed in children with ASD, illustrated by two cases: Yassir Sabri and Saad Bogarn. These two examples very clearly explain that impairments in attentional processes lead to difficulties in managing transitions and engaging in social interactions and responding to stimuli, which are incidents that impede social and cognitive development. Interventions that target attention regulation are critical in improving the social and cognitive outcomes of children with ASD. MR has emerged as a potentially promising new tool for enhancing shifting and disengagement. MR offers controlled, immersive environments in which children with ASD can practice shifting and disengagement in both an engaging and effective manner. Future studies need to be conducted on MR and other attention-focused interventions with respect to the outcomes that improve the development of attentional control and social skills in children with ASD.

To sum up, the understanding of the developmental trajectory in attentional networks, both in typically developing children and those with ASD, gives important insights into the mechanisms underlying social skills deficits in ASD. The present study also points out the need for targeted interventions aimed at dysfunctions in attention, which, in addition to cognitive gains, could ensure social integration and a better quality of life in children with ASD.

References

[1] Allen, G., & Courchesne, E. (2010). Atypical attentional networks and the emergence of autism. *Journal of Child Psychology and Psychiatry, 51*(11), 1251-1259. https://doi.org/10.1111/j.1469-7610.2010.02257.x

[2] Keehn, B., Lincoln, A. J., Müller, R.-A., & Townsend, J. (2010). Attentional networks in children and adolescents with autism spectrum disorder. *The journal of child psychology and psychiatry.*

[3] Allen, G., & Courchesne, E. (2001). Attention function and dysfunction in autism. Frontiers in Bioscience (Landmark Edition), 6(3), 105–119. https://doi.org/10.2741/allen

[4] Baranek, G. T. (1999). Autism during infancy: A retrospective video analysis of sensory-motor and social behaviors at 9-12 months of age. *Journal of Autism and Developmental Disorders*, 29(3), 213–224.

[5] Dawson, G., Meltzoff, A. N., & Osterling, J. (1998b). Attention and joint attention in children with autism. *Journal of Autism and Developmental Disorders*, 28(6), 619-632.

[6] Dawson, G., Webb, S. J., & McPartland, J. (2004). Understanding the nature of face processing impairment in autism. *Mental Retardation and Developmental Disabilities Research Reviews*, 10(4), 221–228.

[7] Elsabbagh, M., Johnson, M. H., & The British Autism Study of Infant Siblings (2010). Infants at risk for autism show atypical visual attention to faces. *Developmental Science*, 13(3), 3-21.

[8] Greene, D. J., & Korgaonkar, M. S. (2011). Altered brain activation to social stimuli in individuals with autism spectrum disorder. *Journal of Neuroscience Research*, 87(10), 1–17.

[9] Harris, G. J., & Townsend, J. (1999). The role of the cerebellum in autism spectrum disorders. *Developmental Psychopathology*, 11(4), 1–11.

[10] Johnson, M. H. (1990). Cortical maturation and cognitive development: A view from developmental neuroscience. *Developmental Psychology*, 26(2), 301–317.

[11] Kawakubo, Y., & Nakahachi, T. (2007). Saccadic eye movements in autism spectrum disorder. *Journal of Autism and Developmental Disorders*, 37(9), 1214–1225.

[12] Keehn, R., Müller, R. A., & Townsend, J. (2010). Attention and brain function in autism: A neuroimaging perspective. *Developmental Disabilities Research Reviews*, 16(4), 148-156.

[13] Kingstone, A., & Klein, R. M. (1993). The gap effect in the gap-overlap paradigm. *Psychological Science*, 4(4), 268–272.

[14] Landry, S. H., & Bryson, S. E. (2004). Attention and disengagement in children with autism: A preliminary investigation. *Journal of Autism and Developmental Disorders*, 34(5), 535–546.

[15] Maestro, S., Muratori, F., & Cesario, A. (2002). Joint attention and social orientation in children with autism. *Developmental Science*, 5(5), 433-442.

[16] Mosconi, M. W., & Sweeney, J. A. (2009). The relationship between attentional control and social functioning in children with autism. *Developmental Psychopathology*, 21(3), 445–468.

[17] Osterling, J., & Dawson, G. (1994). Early recognition of children with autism: A study of first birthday home videotapes. *Journal of Autism and Developmental Disorders*, 24(3), 247–257.

[18] Pruett, D. W., & Webster, R. G. (2010). Attentional processes in autism spectrum disorders: Differential effects on exogenous and endogenous cues. *Journal of Neurodevelopmental Disorders*, 2(2), 121–129.

[19] Ristic, J., & Kingstone, A. (2005). Eye gaze and attentional orienting in children with autism. *Journal of Autism and Developmental Disorders*, 35(2), 147–159.

ISSN: 3009-500X

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[20] Swettenham, J., & Conway, S. (1998). The development of visual orienting in infants: A comparison of typical, delayed, and autism-spectrum children. *Journal of Autism and Developmental Disorders*, 28(4), 235–246.

[21] Townsend, J., & Harris, G. (1996). The cerebellar vermis and attention: A neurodevelopmental perspective on autism. *Journal of Clinical Neuropsychology*, 18(6), 809–817.

[22] Taylor, C. T., Kingstone, A., & Klein, R. M. (1998). The effects of central and peripheral cues on covert orienting of attention. *Psychological Science*, 9(2), 70–77.

[23] Vlamings, P. H., & van der Geest, J. N. (2005). Gaze cueing in autism spectrum disorder: Investigating differences in spatial orienting. *Journal of Experimental Child Psychology*, 91(3), 333–344.