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On the influence of social anxiety and autistic traits on gaze behavior and their relationship with ASD

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1. Introduction

1.1 Gaze behavior and social attention

Social interactions make up a major part of everyday life for most humans and is essential for social functioning (Shahrestani et al., 2014). Successful social interactions draw on many sources of communication, which may be verbal or nonverbal such as body language, mimics, gaze behavior, gestures etc. (Cañigueral & Hamilton, 2019). Thus, social stimuli are of the utmost importance for humans and a preference of such seems adaptive to survival. Social attention entails "phenomena linked to selective attention to eyes and faces, nonverbal social communication, and joint attention" (Falck-Ytter et al., 2023, p.8). Especially faces convey important information for social interactions such es emotional state, desires, or identity (Hessels et al. 2018). Therefore, it is not surprising that faces preferentially capture human attention from early on as even newborns, infants and toddlers demonstrate orienting to face-like patterns, preferential looking at faces and specific facial parts (e.g. eyes and mouth). In addition to these attentional biases across the life span joint attention plays a huge role in social interactions. This is linked to gaze cueing and gaze following as well as the initiation of joint attention (Falck-Ytter et al., 2023).

According to Cañigueral and Hamilton (2019) eye gaze has two functions: active sensing and social signaling. On the one hand gaze behavior is used to gain relevant information about the surroundings and especially in conversations about other people such as their intention to keep speaking or indications for turn taking additionally to their emotions, mental states, or intentions. On the other hand, it serves to signal one's own desires, emotions and interests. Therefore, gaze behavior helps us to receive the maximum amount of available information about our surroundings in addition to signaling relevant details to others.

Thus, deficits in social attention and gaze behavior may lead to many psychopathological issues and impairments in quality of life (Achterhof et al., 2022). However, the link might be bidirectional since psychological disorders can also exacerbate impairments in aspects of social attention and interactions. Therefore, social attention and gaze behavior have often been investigated in comparison to social attention in individuals with psychological disorders such as social anxiety disorder (SAD) or autism spectrum disorder (ASD).

1.2 Autism spectrum disorder (ASD)

According to Lord and colleagues (2020) autism spectrum disorder (ASD) is "a common, highly heritable and heterogeneous neurodevelopmental disorder that has underlying

cognitive features and commonly co-occurs with other conditions" (p.1). Furthermore, ASD is a persistent developmental disorder entailing behavioral, neurobiological, genetic, and cognitive aspects (Papagiannopoulou et al., 2014; Sharma et al., 2018). ASD appears to be more common in males than females with ratios ranging from 2:1 to 5:1 (Lord et al., 2020). The Global Burden of Disease study 2010 (Baxter et al., 2015) found a prevalence of 1 in 132 people equating 52 million people with ASD worldwide. However, prevalence rates are much higher in mental health settings with up to almost 10% (Tromans et al., 2018). Importantly, there is no evidence of ASD prevalence increasing over time, however, there seems to be an increase in diagnoses of ASD in children over the last years (Lundstrom et al., 2015). ASD has been found to have an immense impact on individuals during the lifespan (Brugha et al., 2011).

Studies have examined many risk factors of ASD, however according to Lord et al. (2020) these factors should only be seen as "reactive, independent or contributory for ASD" (p.2) instead of causal. In their meta-analysis these risk factors included advanced parental age, birth trauma especially due to hypoxia, maternal obesity, short intervals between pregnancies, gestational diabetes mellitus, and valproate use during pregnancy (Lord et al., 2020). Genetic heritability seems to be moderate and highly complex (Wang et al., 2015; Hallmayer et al., 2011). Many genes appear to be involved in ASD, however each one only to a small extent (Barlow, 2021). According to Ozonoff (2011) there is a 20% chance of families having another child with ASD if they have had a child with ASD already. Other neurobiological factors have been linked to ASD such as diminished oxytocin and amygdala abnormalities (Barlow, 2021; Modahl et al., 1998).

On the one hand, a dimensional classification can be applied to autism. Thus, autistic traits and differences therein can be measured along a continuum and might be applied to the general population. One questionnaire measuring the degree of autistic traits in adults with average intelligence is the Autism quotient (AQ) (Baren-Cohen et al., 2001). It entails five subdomains: social interaction, communication, attention to detail, attention switching and imagination. Individuals with ASD usually score significantly higher on the AQ than neurotypically developing individuals (Baren-Cohen et al.,2001).

On the other hand, a categorical classification can be found in the fifth edition of the diagnostic and statistical manual of mental disorders (DSM-V) and the eleventh edition of the international classification of disease (ICD-11). In the DSM-V five symptom clusters are essential to diagnose ASD and as in the ICD-11 symptoms are divided into two domains (American psychological Association (APA), 2013; World Health Organization (WHO), 2019).

According to the ICD-11 (WHO, 2019, 6A02 Autism spectrum disorder) ASD "is characterized by persistent deficits in the ability to initiate and to sustain reciprocal social interaction and social communication, and by a range of restricted, repetitive, and inflexible patterns of behavior, interests or activities that are clearly atypical or excessive for the individual's age and sociocultural context." To diagnose ASD evidence of impairments in all three subdomains of social communication and social interaction (social reciprocity, non-verbal communication and developing, maintaining, and understanding relationships) must be presented across multiple contexts. In addition, two of four subdomains of restricted, repetitive behaviors and interests (stereotyped, repetitive behaviors; insistence on sameness; highly restricted, fixed interests; and hypersensitivity or hyposensitivity or interest in sensory inputs) must be experienced currently or by history. An additional criterion is the early onset and development of symptoms. First signs and symptoms usually are detected during early childhood and most interventions focus on this age group (Bemmer et al., 2021). However. symptoms persevere into adulthood. ASD symptoms usually appear within the first three years (Jones et al., 2008) and some conceptualizations distinguish between early and regressive onsets (Ozonoff et al., 2008). Therefore, ASD diagnosis can often be determined during the preschool age. However, it is mentioned that symptoms might be masked or compensated for by learned strategies until social demands exceed the individuals' capabilities (APA, 2013; WHO, 2019).

Symptoms may vary depending on age. Typical symptoms of ASD at the preschool age are avoidance of mutual eye contact, resistance to physical affection, a lack of social imaginary play, delayed language onset, sensory sensitivities, social withdrawal, obsessive or repetitive preoccupations, and a lack of social interaction with peers shown by parallel play or disinterest (WHO, 2019). During middle childhood social adjustment deficits often become apparent with school entry or during adolescence. Often there is resistance against new experiences and changes in routines in addition to excessive focus on details, rigidity, and symptoms of anxiety. Demands and expectations in social situations become increasingly difficult with age leading to many individuals with ASD feeling overwhelmed and unable to cope. This in turn increases social isolation and exclusion (WHO, 2019). Moreover, both ICD-11 and DSM-V list significant impairments in current social, occupational, personal, family, educational or other important areas of functioning as criterion for ASD diagnosis.

The DSM-V differentiates between three levels of severity: 1. "requiring support", 2. "requiring substantial support" and 3. "requiring very substantial support". Moreover, individuals along the spectrum exhibit a full range of intellectual functioning and language abilities. Thus, according to ICD-11 it is important to distinguish between ASD with or without

disorder of intellectual development and severity and to determine the degree of language impairment in addition to loss of previously acquired skills. This shows how heterogeneous ASD phenotype and resulting symptoms and impairments might be. Manifestations and severity of specific impairments are influenced by age, verbal, and intellectual ability, as well as comorbidities and environmental context (WHO, 2019). Examples for atypical behavior and deficits in both subdomains of ASD according to ICD-11 are shown in Table 1.

In Addition to these behaviors ASD has been associated to poorer life quality, increased loneliness, fewer and poorer quality of close personal relationship, higher rates of experiencing bullying and ostracism in addition to higher mortality (APA, 2013; WHO, 2019; Jobe & White, 2007; Lord et al., 2020). Co-occurrence of ASD with other mental, behavioral, or neurodevelopmental disorders is common across the lifespan (WHO, 2019). The amount and severity of comorbidities and resulting mental health are key factors for disability, distress, and impaired functioning in ASD (Park et al., 2020).

Social motivation theory

There have been many theories trying to explain social impairments in ASD. Prominently, deficits in social cognition have been the focus of these theories for many years (Chevallier et al., 2012). These theories see the root cause of social impairments in different areas of deficits such as theory of mind (ToM) (Baron-Cohen, 1995), week central coherence (Frith, 1989) or executive functions (Pennigton & Ozonoff, 1996).

Another possible explanation is posed by social motivation theory. According to social motivation theory social motivation in individuals with ASD is diminished from an early age on and thus, the reason for the socio-cognitive impairments in ASD. Chevalier et al. (2012) define social motivation as a "set of psychological dispositions and biological mechanisms biasing the individual to preferentially orient to the social world (social orienting), to seek and take pleasure in social interactions (social reward), and to work to foster and maintain social bonds (social maintaining)" (p.231). All three aspects of social motivation have been shown to be decreased in ASD compared to neurotypically developing individuals.

Social orienting describes the innate preference for social signals such as faces, bodies and eye gaze. These signals have attentional priority over other stimuli, capture attention quickly and their changes are detected better (Chevallier, 2012; Fletcher-Watson et al., 2008; Senju & Johnson, 2009). Impairments in social orienting in ASD have been found frequently (Burnside et al.,2017; Falck-Ytter et al., 2013; Osterling et al., 2002; Sasson, et al., 2011; Wright et al., 2016).

Table 1

Examples of typical behavior in ASD

Deficits in initiation and sustaining social communication and reciprocal social interactions	Restricted, repetitive, and inflexible patterns of behavior, interests, or activities
• Understanding of, interest in, or inappropriate responses to the verbal or non-verbal social communications of others. • Integration of spoken language with typical complimentary non-verbal cues, such as eye contact, gestures, facial expressions, and body language. They may also be reduced in frequency or intensity. • Understanding and use of language in social contexts and ability to initiate and sustain reciprocal social conversations. • Social awareness, leading to behavior that is not appropriately modulated according to the social context. • Ability to imagine and respond to the feelings, emotional states, and attitudes of others. • Mutual sharing of interests. • Ability to make and sustain typical peer relationships	• Lack of adaptability to new experiences and circumstances, with associated distress, that can be evoked by trivial changes to a familiar environment or in response to unanticipated events. • Inflexible adherence to particular routines. • Excessive adherence to rules. • Excessive and persistent ritualized patterns of that serve no apparent external purpose. • Repetitive and stereotyped motor movements, such as whole body movements, atypical gait, unusual hand or finger movements and posturing. • Persistent preoccupation with one or more special interests, parts of objects, or specific types of stimuli or an unusually strong attachment to particular objects. • Lifelong excessive and persistent hypersensitivity or hyposensitivity to sensory stimuli or unusual interest in a sensory stimulus, which may include actual or anticipated sounds, light, textures, odors and tastes, heat, cold, or pain.

Note: Based on ICD-11, 6A02 (WHO, 2019)

In addition, social interactions and stimuli are related to both components of reward: Liking and wanting (Berridge et al., 2009; Fehr & Camerer, 2007; Hayden et al., 2007). Both aspects seem decreased in ASD compared to neurotypical (NT) participants and individuals with ASD have reported experiencing less pleasure in social interactions (Baren-Cohen & Wheelwright, 2003; Bauminger & Kasari, 2000; Chamberlain et al., 2007; Chevallier et al., 2012; Demurie et al., 2011; Leekam & Ramsden, 2006; Liebal et al., 2008).

Chevallier et al. (2012) conclude “early-onset impairments in social attention set in motion developmental processes that ultimately deprive the child of adequate social learning experiences, and that the resulting imbalance in attending to social and non-social stimuli further disrupts social skill and social cognitive development“ (p.234). Therefore, abnormalities in behaviors in social situations including atypical gaze behavior in ASD might be explained by diminished social motivation (Chevalier et al., 2012).

1.2.1 ASD, gaze behavior and social attention

One important and much researched deficit in non-verbal communicative behavior in ASD is atypical gaze behavior and social attention. Aberrant social orienting behavior in ASD might show in many ways e.g. looking more at backgrounds than characters and increased attention to non-social compared to social stimuli (Chevallier et al., 2012; Chevalliert et al., 2015; Chita-Tegmark, 2016; Riby & Hancock, 2008). Another common abnormality concerns attention to eyes. Many studies have found reduced fixations on and time spend looking at eyes in participants with ASD in comparison with neurotypical (NT) participants (Auyeung et al., 2015; Chevallier et al., 2015; Chita-Tegmark, 2016; Falck-Ytter et al., 2013; Freeth & Bugembe, 2019; Hanley et al., 2014; Hutchins & Brien, 2016; Jones et al., 2008; Kaliukhovich et al., 2022; Klin et al., 2002; Klin & Jones, 2008; Ma et al., 2021; Nakano et al., 2010; Papagiannopoulou et al., 2014; Reisinger et al., 2020; Riby & Hancock, 2008; Rice et al., 2012; Wang et al., 2015; Wright et al., 2016). On the one hand, avoidance of eyes might be explained by decreased social motivation in line with social motivation theory. On the other hand, eyes might be experienced as aversive by individuals with ASD and thus, might be avoided to prevent overarousal and distress (Dalton et al., 2005; Kliemann, et al., 2012; Tottenham et al., 2014).

Deficits in social attention seem to develop quite early and might have predictive value of ASD diagnosis as Jones et al. (2008) propose that the more a child looks at regions or aspects other than the eyes the more likely it might have ASD. Similarly, Chevallier et al. (2015) found differences in social attention to have classifying power between groups for dynamic social interaction stimuli but not less rich social stimuli. In their sample social attention differed only in the interactive task with children with ASD spending significantly less time looking at social stimuli and more time fixating on objects than the control group. Papagiannopoulou et al. (2014) examined the relationship between ASD and gaze behavior in children in a meta-analysis including 14 studies and found that children with ASD showed diminished attention to eyes and no significant difference in attention to mouths compared to neurotypical children.

The evidence for abnormal attention to mouths in ASD is incongruent. Some studies have found participants with ASD to demonstrate decreased attention (Chita-Tegmark, 2016; Kaliukhovich et al., 2022) whereas others have found increased attention to the mouth area (Dalton et al., 2005; Hutchins & Brien, 2015; Jones et al., 2008; Klin et al., 2002; Ma et al., 2021). Increased attention to the mouth area has been proposed to serve as a compensatory strategy in participants with ASD to gain social information with some studies linking it to higher social skills and verbal performance (Jones et al., 2008).

In two meta-analyses Chita-Tegmark (2016) and Ma et al. (2021) computed effect sizes for aberrant social attention in ASD compared to controls. Chita-Tegmark (2016) found a small effect for reduced attention to eyes (d = 0.33) and mouths (d = 0.25) as well as a medium effect of increased attention to the body (d = -0.48) and small effect (d = -0.34) for looking at non-social stimuli more often than control groups. Ma et al. (2021) included age and culture as moderators for their meta-analysis and discovered a moderate effect size for reduced attention to eyes (g = -0.60) and small effect (g = -0.16) for increased attention to mouths which was stronger for adults than children.

Also, social richness of stimuli could play an important role in social attention. In a study by Parish-Morris and colleagues (2019) adults with ASD looked more at hands and toys in addition to increasing their attention significantly less than the control group when watching a communicative compared to non-communicative scene. The influence of conversational topics on social attention was researched by Hutchins and Brien (2015). When talking about emotions children with ASD showed decreased attention to eyes and increased attention to the mouth. This difference between ASD and neurotypical (NT) could not be seen when talking about non-emotional topics.

In a review by Laskowitz et al. (2022) exploring social attention to faces in live interactions in ASD compared to control groups the majority reported similar social attention to faces during interactions (Cañigueral et al., 2021; Jones et al., 2017; Mirenda et al., 1983; Nadig et al., 2010) and nearly half of the studies could not find a difference in shared gaze (Barzy et al., 2020; Cañigueral et al., 2021; Jones et al., 2017; Ma et al., 2021). The other studies found reduced eye contact and shared gaze (Auyeung et al., 2015; Freeth and Bugembe, 2019; Hanley et al., 2014; Hutchins & Brien, 2016; Wang et al., 2015).

In one of these studies Auyeung et al. (2015) examined gaze behavior in a five-minute semi structured online interview between participants and a researcher. They were able to show that adults with ASD showed significantly less fixations on the eye regions during the social

interaction and lower proportion of total looking time at the eyes compared to the control group. However, they found no difference between the groups concerning fixations on or total time looking at the mouth or non-eyes-non-mouth region of the face. Cañigueral et al. (2021) compared a video, live online and face-to-face interaction and found increased attention to the experimenter's eyes for participants with ASD just at the beginning of the face-to-face but not the online live interactions.

This shows the importance of investigating gaze behavior in actual face-to-face interactions as did Freeth & Bugembe (2019) when looking at differences in social attention in ASD and NT modulated by gaze direction of experimenter and conversational phase. An experimenter and participant talked about four predetermined topics and participants were encouraged to speak about the topics for at least 30 seconds each. Afterwards the roles were switched with participants asking the experimenter questions and listening to their answers. When experimenters demonstrated direct eye gaze participants with ASD looked significantly less at the face than control group. Furthermore, NT but not ASD looked significantly more at eyes than mouth and for both groups more fixations on experimenter's face were reported when participants were listening instead of speaking.

In conclusion, many studies have found aberrant social attention in ASD, however only few have used actual social interactions and those have yielded mixed results with some studies finding reduced attention to eyes and mouths and other finding increased attention to eyes and mouths and others finding similar social attention in ASD and control groups.

1.3 Social anxiety

Another factor influencing social attention and gaze behavior is social anxiety (SA). SA "is a common human experience characterized by an intense fear of evaluation from others in social situations" (Morrison & Heimberg,2013, p.250). According to the APA dictionary of psychology SA is a "fear of social situations in which embarrassment may occur (e.g., making conversation, meeting strangers, dating) or there is a risk of being negatively evaluated by others (e.g., seen as stupid, weak, or anxious). Social anxiety involves apprehensiveness about one's social status, role, and behavior." SA is defined by autonomic symptoms of anxiety manifesting in specific or general social situations, a fear of negative evaluation or judgement, and avoidance of cues evoking anxiety (APA, 2013; Spain, 2018).

Familiar concepts include embarrassment, shyness, behavioral inhibition, and avoidant personality disorder. Even though there are important differences between these concepts, they sometimes are used interchangeably (McNeil & Randell, 2014; Leitenberg, 1990**).** Shyness

seems to be more heterogenous than social anxiety and even though there is an overlap in behavioral, cognitive, and somatic symptoms studies have shown that these concepts can vary not just in degree but also qualitatively (Heckelman & Schneider, 1995; Heiser et al., 2003; Poole et al., 2017).

An important distinction between subtypes of SA has been proposed by Mattick & Clarke (1998). They assumed that SA can be divided into two components: social interaction anxiety and social phobia. The latter consists of scrutiny fears such as being watched by others in addition to being judged or evaluated in a bad way while eating, drinking, or writing. Social interaction anxiety includes concerns about interactions such as distress when meeting and talking with other people, talking to friends and strangers, or attending a social gathering. In addition, SA might be differentiated into state (currently experienced in situation) and trait (general tendency to experience SA in most situations) SA.

Most people exhibit and experience social anxiety or self-consciousness to some extent in their life. This has been shown by high prevalence of sub-clinical social anxiety in general population (Knappe et al., 2011). SA exists along a continuum that ranges from "helpful and adaptive … to disabling and impairing" (McNeil & Randell, 2014, p. 3) and from a normal everyday experience to social anxiety disorder (SAD).

Spence and Rapee (2016) see SA as a personality construct in contrast to SAD which can be seen as an "interaction between social anxiety and life impairment" (p.52). According to ICD-11 (WHO, 2019) SAD is "Characterized by marked and excessive fear or anxiety that consistently occurs in one or more social situations such as social interactions, doing something while feeling observed, or performing in front of others. The individual is concerned that he or she will act in a way, or show anxiety symptoms, that will be negatively evaluated by others." (WHO, 2019, 6B04 Social anxiety disorder). Thus, SAD might relate to specific situations such as performing certain activities or more generally to vague fears of embarrassing oneself. As SA is quite normal to a certain extent one hallmark of SAD is avoidance of participation in desired activities or marked distress in such (APA, 2016). Also, the worries must be excessive considering the actual threat in addition to the fear being persistent for at least a couple of months. Furthermore, SAD symptoms must result in a significant impairment in personal, family, social, educational or occupational functioning. Even though the prevalence is already quite high for SAD, it is still assumed to be undertreated and mental health services are underused (Magee et al., 1996; Wang et al., 2005). Kessler et al., (2005) found social anxiety disorder (SAD) to be the third most common disorder with lifetime prevalence around 12%. In

a more recent study Kessler et al. (2012) found a lifetime prevalence of 11.2 % for girls and 6.2 % for boys aged 13 to 17 and 14.2 % for men and 11.8% for women aged 18 to 64. Niermann et al. (2021) discovered in a German regional epidemiological study that lifetime prevalence in adolescents between 14 and 21 was 6.6% and 12-months prevalence was 4.8%.

The etiology of SA is not straightforward. There are many factors interacting with and influencing each other. On an intrinsic level genes and temperamental style influence SA. There seem to be strong familial links of SAD (Elizabeth et al., 2006), however, Scaini et al. (2014) found substantial variation in heritability estimates of SAD in their meta-analysis. Thus, according to Spence and Rapee (2016) it is established that genetics play a role in SA and SAD. However, the exact genes and pathways are not clear yet. Important brain structures and neural pathways concerning SA are involved in processing of emotional stimuli, emotion regulation, higher cognitive processes, motivated behavior, and reward processing such as the amygdala, basal ganglia, hippocampus, and prefrontal cortex (Fox & Kalin, 2014; Caouette & Guyer, 2014). On the other hand, the personality especially behavioral inhibition (BI) and avoidant temperament style is linked to SA (Spence & Rapee, 2016; Wong & Rapee, 2016). BI is defined as a disposition to respond with heightened sensitivity to novel stimuli, and avoid unfamiliar situations and people (Kagan et al., 1984). Clauss and Blackford (2012) found a sevenfold increased risk of developing SAD in children, that have been classified with a BI temperament and other studies also suggest that BI is a risk factor for developing SAD later (Rapee, 2014).

Furthermore, environmental factors play an important role in SA. First, the relationship to peers and parents and negative life events shape SA levels. Socially anxious people are more likely to be rejected by peers, to be victimized by them and to have fewer friends and thus, experience aversive social outcomes more often (Blote et al., 2015; Crawford & Manassis, 2011; Spence & Rapee, 2016; Wong & Rapee, 2016). According to Spence and Rapee (2016) “adverse social outcomes, particularly with peers, increase the risk of developing and perpetuating social anxiety through their impact upon avoidance behaviors and negative beliefs and thoughts relating to peer interactions” (p.59). Moreover, overprotective parenting in addition to insecure attachment, and parental social anxiety has been linked to SA (Spence and Rapee, 2004; Wong & Rapee, 2016). Ollendick et al. (2014) and Wong and Rapee (2016) found that parenting behavior that communicates threat and anticipation of aversive outcomes will be learned by children and thus exacerbate their cognitive biases.

Lastly, proximal factors such as poor social skills and performance in addition to safety behaviors and cognitive aspects like beliefs and cognitive processes are involved in SA. In some

studies SA has been linked to impaired social skills. However, not all individuals with high SA or even SAD exhibit deficits in social skills (Beidel et al., 2010) showing that SA and reduced social skills do not have to go hand in hand (McNeil & Randell; 2014). Arguably the most important and researched factors of high SA and SAD are information-processing biases and safety behaviors (Morrison & Heimberg, 2013). A recent study has found higher levels of self-focused attention, safety-seeking behaviors and negative social thoughts and beliefs to significantly predict levels of SA (Figueiredo et al., 2023). Cognitive biases in SA and SAD include attention bias, interpretation bias, implicit associations, imagery and visual memories and their interrelations between each other (Morrison & Heimberg, 2013; Syal & Stein, 2014). Studies have shown that SA increases the attention to potentially threatening stimuli (Mogg & Bradley, 2002; Mogg & Bradley, 2004). In addition, people high in SA lead to interpret ambiguous situations and neutral facial expression more often as threatening due to interpretation biases (Winton et al., 1995). Memory biases and post-event processing cause individuals high in SA to remember negative events and threatening stimuli better and faster than neutral stimuli and further deficit oriented self-representations and beliefs. Safety behaviors are used to reduce SA, hide symptoms of SA and to feel more comfortable in SA inducing situations. Typical forms of safety behavior might be avoidance of social interactions or socially threatening situations, avoiding eye contact or showing abnormal gaze behavior, not speaking in front of people or other behaviors that try to mask somatic symptoms of SA like blushing or sweating (Morrison & Heimberg, 2013; Clark & Wells, 1995). However, these safety behaviors usually worsen performance in social situations and often lead to the person being perceived as weird and atypical.

1.3.1 SA, gaze behavior and social attention

Many studies have discussed aberrant gaze behavior in SA. Often this has been investigated by using eye tracking whilst showing participants with SAD or high SA pictures of neutral or emotional faces. Only a few studies have used more naturalistic designs employing public speaking or social interactions.

Some have found reduced eye contact in people with high SA and SAD (Chen et al., 2002; Horley et al., 2003; Moukheiber et al., 2010). In a systematic review Günther and colleagues (2021) found participants with SAD to avoid mutual gaze with eyes of negative and positive emotional but not neutral faces compared to controls in a single face viewing paradigm. In another systematic review examining gaze behavior in SAD and subclinical SA (Chen et al., 2020) they differentiated between facial viewing, public speaking, and interaction tasks. On the

one hand, most results of face viewing paradigms demonstrated avoidance of eyes in SAD and SA (Chen et al., 2020). However, the link seems clearer for SAD and results were more heterogeneous concerning SA. On the other hand, in experiments using social interaction paradigms only three out of five supported avoidance theory for SAD (Baker & Edelmann, 2002; Langer et al., 2017; Monti et al., 1984 in Chen et al., 2020) but results were more congruent for subclinical high SA in public speaking and interaction tasks with most studies finding avoidant gaze behavior (Dechant et al., 2017; Farabee et al., 1993; Hessels et al., 2018; Howell et al., 2016; Lin et al., 2016; Lowe et al., 2012). Chen and colleagues (2020) propose that the level of socio-evaluative threat in a situation is more important in high SA than SAD to express avoidant behavior. Thus, while participants with SAD differ in their gaze behavior from control groups during all situations individuals with high SA compared to low SA only differ in their behavior in more naturalistic situations posing a potential socio-evaluative threat.

Howell et al. (2016) investigated the relationship between gaze behavior and SA during a live interaction in a college sample of 20 female participants. Participants took part in a four-minute free conversation with a confederate over a webcam. Results showed that trait SA was negatively related to eye contact frequency and duration during conversation. Thus, the greater trait SA was the more eye contact avoidance was demonstrated.

On the one hand, gaze avoidance has been discussed as a social skills deficit, meaning people with SA and SAD have never learned or are unable to show appropriate gaze behavior in social interactions. On the other hand, eye and gaze avoidance can be seen as a safety behavior often used if total avoidance of situation is not feasible, shielding the individual from negative evaluations, reducing the likelihood of a confrontation, and serving as a form of emotional self-regulation to decrease emotional distress (Chen & Clark., 2017).

This is in accordance with Avoidance theory by Clark and Wells (1995) proposing that people with high SA perceive eyes as threatening and thus, avoid looking at them. Additionally, according to this model self-monitoring and self-focus of attention are increased in social situations instead of paying attention to the people involved in interactions, thus leading to decreased attention to people or specifically eyes. The individual seems to assume that the audience will evaluate them badly due to unattainable standards and uses “interoceptive information to construct an impression of themselves, which they assume reflects what other people observe, and that this information is relatively more important than observation of others' actual behavior” (Clark & Wells, 1995, p. 82). This might lead to safety behaviors such as avoiding eye contact, covering the face, or avoiding this type of situation in general.

Another model addressing atypical gaze behavior in SAD and SA was postulated by Rapee & Heimberg (1997). Instead of avoidance they assume individuals with high SA to demonstrate increased vigilance to threat. According to them, people with SAD see others as "inherently critical" (Rapee & Heimberg, 1997, p.742) and demonstrate a need for positive appraisal by others. Thus, people with SA look for signs of a possibly threatening situation or evaluation and therefore look more at the eyes and even show difficulties disengaging from the eyes due to their vigilance. There has been some empirical support for vigilance with studies finding people with SA to express increased attention to eyes (Gamble & Rapee, 2010; Mogg et al., 2004; Schofield et al., 2012; Boll et al., 2016; Brunet et al., 2009).

Similarly, Buckner and colleagues (2010) found SA to be related to vigilance for negatively cued faces. Individuals scoring high on the social interaction anxiety scale (SIAS) demonstrated difficulties disengaging from disgusted faces but not happy ones. Other studies have also found SAD patients taking more time to disengage from negative rather than positive stimuli compared to controls (Chen et al, 2017; Liang et al, 2016; Schofield et al., 2012). Moreover, Wieser et al. (2009) found increased attention to eyes in women with high SA compared to mid and low SA. Participants watched animated faces on a screen that reacted to the participant's gaze with either direct or averted gaze. Women high in SA also showed increased heart rate to direct gaze. Indicating direct gaze as a fear and threat relevant stimulus in social interactions for individuals with high SA.

Even though many studies show avoidance of eye contact and mutual gaze, and some found increased vigilance to faces and eyes, other studies, however, were not able to discover such differences in gaze behavior in high SA and SAD compared to control groups (Gregory et al., 2019; Langer et al., 2017). One interactive study found no differences in looking time at other people between SAD and controls, however participants with SAD looked at themselves for longer than controls, when shown a live video of their interaction partner and another one of themselves (Vriends et al., 2017). Results are likely influenced by the degree of SA and its operationalization, methodological differences, and demographic factors such as age, gender, and culture. Langer et al. (2017) demonstrated the importance of social settings by finding reduced eye contact in individuals with SAD only in social conflict conversation but not in social support situations. And even the conversational role of individuals influences gaze since avoidance of eye contact in participants with SAD could only be shown while talking and not while listening (Baker & Edelmann, 2002).

1.4 ASD & SA

SA often occurs in individuals with ASD and correlates with symptom severity and impairment (Bejerot et al., 2014; Cath et al., 2008; Kanai et al., 2011; Lever & Geurts 2016; Spain et al., 2016). According to Kuusikko et al. (2008) SAD is the most common anxiety disorder in ASD. Many individuals with ASD experience SA in social situations (Boulton & Guastella, 2021) and autistic individuals report increased SA symptoms compared to neurotypical individuals (Bejerot et al.,2014; Spain et al., 2018). According to Joshi et al. (2013) prevalence of SAD in ASD is significantly higher with lifetime (56%) and current (40%) comorbidity compared to the non-ASD group (19% lifetime; 16% current). Congruent with these findings Maddox (2014) found that 44% of her participants with ASD met diagnostic criteria for SAD in her sample. This is in line with Boultin & Guastella (2021) finding over 50% of their participants with ASD scoring above the clinical cut off on various SA measures and even 2/3 on the SIAS. In addition, Maddox and White (2015) discovered that autistic adults with SAD showed increased social interaction anxiety compared to adults with SAD only. It is important to note that most research concerning SA in ASD is conducted with individuals with high-functioning ASD only. The little research performed with a wide range of ASD seems to suggest that social anxiety is more common in high functioning individuals (Kuusikko et al, 2008). According to White et al. (2014) SA in ASD is influenced by structural and functional neurological abnormalities, shared genetic vulnerabilities and psychosocial factors (p.125).

One of these shared neurobiological abnormalities might be found in the amygdala. Many studies have linked ASD and SAD with atypical activation of amygdala and structural differences (Meisner et al., 2022). The amygdala has been found to be involved in social cognition, social learning, processing, decision making, emotion perception and processing in addition to fear related processes and behaviors (Gangopadhyay et al., 2021; Machado & Bachevalier, 2006; Rizvi et al., 1991; as described in Meisner et al., 2022). ASD has been linked to atypical activation of the amygdala. However, the direction remains unclear with some finding hyper- and other hypoactivation in response to faces and emotions. For example, in one study when watching unfamiliar faces participants with ASD showed diminished amygdala activation, however with familiar faces similar amygdala activation compared to control groups emerged (Pierce et al., 2001). On the other hand, Dalton and colleagues (2005) found greater right amygdala activation in ASD when looking at familiar and unfamiliar faces and the left amygdala showed increased activation in response to emotional faces compared to neurotypical participants. Similarly, the amygdala has been linked to SA as well. With studies showing increased amygdala activation during face and emotion processing and discrimination, fear-

relevant stimuli and before socially challenging tasks (Meisner et al., 2022). Few studies have looked at amygdala activation in ASD with SA. Kleinhans et al. (2010) found increased right amygdala activation in highly socially anxious participants with ASD during an emotional face matching task compared to non-anxious ASD.

Furthermore, SA and ASD have some overlap in symptoms regarding atypical behavior in addition to avoidance of social situations. Briot and colleagues (2020) note that the relationship between ASD and SA symptoms is complex due to them sharing similar dimensional symptoms with impairments in social interactions and eye contact. Thus, it might be difficult to determine whether ASD or SA is the root cause for symptoms such as social avoidance or failure to speak in social situations in people with ASD (APA, 2013).

White et al. (2011) found ASD traits to be positively associated to SA in a neurotypical sample. Furthermore, Bejerot et al.(2014) found autistic traits measured by the AQ to significantly correlate with SA scores. (r=0.67, p <.001) in ASD and non-ASD groups (r=0.55, p < .001). Importantly, Spain and colleagues (2018) found in their systematic review that increased social anxiety symptoms were associated with poorer social functioning in ASD. Both SAD and ASD can entail deficits of socials skills (White et al., 2014) and social distress can lead to social avoidance, reduced social functioning and poor relationships (Aderka et al., 2012; White & Roberson-Nay, 2009). White et al. (2014) distinguish social skill deficits in ASD and SAD by time of onset. They argue that social skill deficits develop in SAD due to social avoidance and thus, only appear over time after onset of the disorder. Contrary, social skills deficits in ASD should be present from early childhood on.

Furthermore, they differentiate avoidance in ASD and SA. In SA avoidance is supposed to be caused by fears of evaluation in contrast to ASD where the root cause is assumed to be social skills deficits that prevent appropriate initiation of social interactions and responses. Moreover, SA might lead to individuals being less assertive and responsive whereas individuals with ASD might act in a socially odd manner (White & Schry, 2011). They conclude that it is important to explore “reasons for social avoidance” and assess “inappropriate … unsuccessful attempts” of social interaction to distinguish between ASD and SAD (White et al., 2014, p. 124).

A bidirectional link has been proposed to contribute to the high prevalence of SA in ASD. Therefore, the typical social impairments in ASD might influence SAD development and maintenance and in turn this increased social anxiety could worsen preexisting social impairments (Bemmer et al., 2021; Boulton & Guastella, 2021; White et al., 2014). On the one

hand existing social impairments in ASD may lead to the individual feeling anxious in social situations and on the other hand socially anxious individuals with ASD might show heightened arousal influencing processing and interpretation of information (White et al., 2014).

Moreover, Briot and colleagues (2020) investigated the association between symptoms of SA and ASD in adolescents with ASD and found that SA was moderately correlated with ASD features represented by scores on the social responsiveness scale 2 (SRS-2). Especially the social communication and motivation subscales seemed to be linked to SA in their sample. This is in line with findings suggesting increased SA being associated to low social motivation in adults with ASD, which might be exacerbated by avoidance (Swain et al., 2015).

As previously noted, atypical eye gaze in social situations seems to be a commonality in ASD and SA. However, few studies have investigated how these concepts interact with each other. This was the goal for Maddox (2014) as she examined how ASD and SAD influenced gaze behavior on static pictures of faces depicting different emotional states. She compared ASD, SAD, healthy controls and ASD + SAD groups. Participants were shown 24 face pairs twice depicting either a happy, disgusted, or angry face next to a calm one for four seconds per face pairing. In comparison to individuals with SAD participants with ASD fixated less on face regions across all emotions. Additionally, combined ASD and SAD in participants lead to reduced fixation duration on happy faces compared to only ASD, SAD, and healthy controls. Fear of positive evaluation has been demonstrated in SA, however in this instance it seems that SA in ASD is expressed differently than SA in typically developing participants.

Kleberg et al. (2017) investigated how autistic traits and social anxiety influenced gaze behavior in an adolescent SAD group. It is important to note that ASD diagnosis was set as an exclusion criterion. Therefore, autistic traits and social anxiety traits were only operationalized dimensionally for this analysis. Participants looked at pictures of eye regions with direct gaze along with 3 nonsocial stimuli. Results showed participants with higher autistic traits taking longer to orient towards the eyes and participants higher in SA reorienting faster away from the eyes. Thus, demonstrating independent effects of SA and autistic traits on gaze behavior. This is in accordance with social motivation theory and avoidance theory.

However, it is important to not only look at the independent effects ASD and SA have on gaze behavior but also consider their interaction. Ni et al. (2022) examined the interactive influence of SA and autistic traits on gaze behavior in neurotypical college students. Participants looked at animated faces demonstrating five different emotions including happy, sad, angry, fearful, and neutral expressions for ten seconds and later had to make emotional judgements.

AQ and SA were significantly correlated. Additionally, autistic traits were found to correlate with avoidance of eyes at several stages of the experiment which could not be shown for SA. SA seemed to only affect duration of the first fixation on eyes, indicating that participants with high SA looked at eyes longer on their first fixation. Furthermore, they found autistic traits and social anxiety to have an interactive effect on the first fixations on the eyes. Thus, participants high in autistic trait and social anxiety demonstrated an early avoidance of the eyes and later maintenance of attention on eyes.

Hessels and colleagues (2018) looked at the relationship between autistic traits and SA traits in a general population sample. As they pointed out that most studies concerning eye gaze only used static pictures or videos and thus cannot be generalized to real interactions, they examined gaze behavior in dyads in a short online interaction. Participants looked at each other via a computer and were instructed to look at each other for five minutes. They were allowed to talk, however this happened seldomly. For pairs high in autistic traits, they found a decreased duration of two-way eye gaze but longer duration of one-way eye gaze. Additionally, SA scores were negatively related to duration of one-way eye gaze but linked to increased frequency of one-way eye gaze. Individually AQ and SA scores correlated negatively with dwell time on eyes and positively with dwell time on nose and no significant correlation with the mouth region was found.

Taken together the results of these studies indicate SA as an important factor contributing to atypical social attention in participants with ASD. Due to overlap of symptoms with ASD and the high prevalence of SA in neurotypical and neurodivergent adults it is essential to determine how SA influences gaze behavior.

2. Research Questions & Hypotheses

SA is a common experience in ASD and general population. Most studies have found increased SA in participants with ASD compared to control groups. Often studies concerning ASD recruit predominantly male participants. However, it is important to look at SA in female and male participants with ASD. There seems to be a lot of research examining the relationship between ASD and SA with social attention and gaze behavior independently. Most studies find highly socially anxious individuals to demonstrate reduced fixation duration and fewer fixations on the eye region during conversations supporting avoidance theory. Also, some studies linked increased attention to the mouth area to high SA. Concerning autistic traits and ASD similar results with decreased attention to eyes and increased attention to mouths have been published. Nevertheless, it remains unclear how exactly they each influence social attention due to

contrasting findings. Furthermore, it is necessary to look at the interaction between those variables since SA is extremely common in ASD and their symptoms overlap. Most studies have used static pictures or videos without an interactive component when investigating the relationship between SA, autistic traits or ASD and social attention. However, these results might not be applicable to real human interactions and thus, show low ecological validity. Others have used a live but online setting to investigate social attention in ASD and SA in a more naturalistic setting. Nevertheless, this does not equate to an interactive conversation in person. Based on the previously mentioned literature and the ambiguous results, in addition to restraints concerning the ecological validity of stimuli the goal of this thesis is to answer the following research questions and hypotheses in a more naturalistic setting:

R1: Do people with ASD have higher social anxiety than neurotypical participants (NT)?

H1.1: Individuals with ASD receive higher SIAS scores than neurotypical individuals.

H1.2: Total AQ scores correlate positively with SIAS scores.

H1.3: AQ communication and reciprocity scores correlate positively with SIAS scores.

H1.4: AQ social interaction and spontaneity scores correlate positively with SIAS scores.

R2: Does SA relate to gaze behavior?

H2.1: SIAS scores relate to fixations on eyes.

H2.2: SIAS scores relate to fixations on mouth.

R3: Do Autistic traits relate to gaze behavior?

H2.1: AQ total score relates negatively to fixations on eyes.

H2.2: AQ total score relates to fixations on mouth.

R4: Does SA moderate gaze behavior in people with ASD and NT individuals?

H3.1: The relationship between AQ and fixations on ROI (Eyes, mouth) is moderated by SIAS scores.

3. Methods

This thesis was embedded in a bigger research study conducted by Raimund Bühler at the department of clinical psychology of the university of Vienna. The study design included the administration of oxytocin, naltrexone, and placebo over four sessions as well as three tasks. However, this thesis focuses on the placebo condition and eye tracking task in addition to scores

on the questionnaires concerning autistic traits and SA to answer the research questions. Therefore, only those aspects of the procedure, task, and questionnaires will be reported.

3.1Participants

Initially this sample consisted of 79 participants of which 39 belonged to ASD group and 40 participants made up the control group. However, five participants in the ASD and seven in the neurotypical group dropped out prematurely and thus, did not fill out SIAS nor AQ. Therefore, they were excluded from any further analyses. The remaining sample size included 66 participants aged 18-70 years of which 34 identified as male and 32 as female. The ASD group consisted of 31 participants with 17 females and 14 males. Of the 35 neurotypical participants 15 were female and 20 male. All participants demonstrated a normal range of intelligence (See table 3). Recruitment of neurotypical participants was conducted via a participant database by the university of Vienna. High functioning ASD participants were recruited by using a database consisting of individuals with ASD that had already taken part in other clinical studies, by contacting organizations aimed at supporting individuals with ASD e.g. “Autistenhilfe Vienna” in addition to online recruitment via Instagram and Facebook. As a next step participants received a link via e-mail for an online screening. Exclusion criteria included: age below 18, no fluency in German, knowledge of Japanese Symbols (Kanji), visual impairment, pregnancy, a psychiatric or neurological disorder, taking psychiatric medication or regular drug or alcohol use or dependency. However, due to the high prevalence of comorbidities in ASD and common usage of psychiatric medication ASD participants were not excluded based on these two criteria. Additionally, individuals with ASD needed to present a diagnosis of ASD by a psychologist or psychiatrist.

3.2 Interview task

In order to measure gaze behavior in natural social interactions a dyadic interview was conducted between the experimenter and participant. Therefore, a semi-structured interview consisting of thirteen questions was used (see Table 2). Participants set across a table from the experimenter. They were instructed to put on eye -tracking glasses and not to move excessively. Adjustment of the eye tracker was followed by a short calibration. To calibrate the eye tracker participants were asked to fixate on a marker while circulating their head for 30 to 60 seconds. If the accuracy was satisfactory the interview began. The goal was to create a more naturalistic and comfortable environment for participants to behave as natural as possible during this interaction. Participants were free to answer the questions as detailed and elaborated as deemed appropriate by them. Questions became gradually more open and thus, required different

lengths of answers. Additionally follow up questions were asked to elicit a more natural conversation and ensure an interview length of approximately eight to ten minutes. At the end of the interview participants were encouraged to ask the experimenter any question they'd like.

Table 2

Questions asked during the interview

1. Hast du letzte Nacht gut geschlafen? / Did you sleep well last night?
2. Hast du in der letzten Nacht von etwas geträumt? / Did you dream of anything last night?
3. Hast du in der letzten Woche in einem Restaurant gegessen? Have you eaten at a restaurant within the last week?
4. Warst du in der letzten Woche draußen in der Natur? Have you spent time outside in nature during the last week?
5. Hast du in der letzten Woche ein Buch gelesen? Have you read a book within the last week?
6. Welchen Film oder welche Fernsehsendung hast du zuletzt gesehen? Hat er dir gefallen? Worum ging es darin? / What was the last movie or series you have watched? How did you like it? What was it about?
7. Was hast du am letzten Wochenende unternommen? / What did you do last weekend?
8. Könntest du mir bitte erzählen, was du am nächsten Wochenende vorhast? / Could you please tell me about your plans for next weekend?
9. Was war das interessanteste Ereignis, das du on der letzten Woche erlebt hast? / What was the most interesting thing happening to you during the last week?
10. Als du heute Morgen aufgewacht bist, hast du dich darauf gefreut, an dieser Untersuchung teilzunehmen oder war es für dich eher eine Verpflichtung? /When you woke up this morning were you looking forward to participating in this study or did it feel more like an obligation?
11. Könntest du mir bitte von deinem Weg zum Labor erzählen? Wie bist du hergekommen? Hast du lang gebraucht? Ist auf dem Weg etwas interessantes passiert? / Could you tell me about your route to this lab? How did you get here? Did it take long? Did anything interesting happen on your way?
12. Wie hast du dich nach der Verabreichung der Medikamente gefühlt? How did you feel after the drugs were administered?
13. Hast du noch irgendwelche Fragen, die du mit stellen möchtest? Do you have any questions for me?

3.3 Behavioral Data: Eye tracking

A Pupil Core eye tracking headset by Pupil Labs was used to collect data on participants gaze behavior. The eye tracker consists of one 200 Hz (192 x 192 px) pupil camera for each eye and an additional 60 Hz (720 p) one to record the participants field of view. The headset was connected to a laptop via a USB cable. The Pupil Labs Capture recording software was employed to record the interview and gaze behavior. Before starting a recording, the eye tracker had to be adjusted to the participant's head and a short calibration was conducted each session. If accuracy of the eye tracker was satisfactory the recording and the interview were started.

3.4 Questionnaires

3.4.1 Social interaction anxiety scale (SIAS)

To assess participants' social interaction anxiety a German version of the SIAS (Stangier et al., 1999) was administered on a laptop via SoSci Survey (Leiner, 2019) at the end of the first or last session. The questionnaire is made up of 20 items that must be scored on a Likert scale from zero to four. Items five, nine and elven are reversed items. Thus, total SIAS scores range between zero and 80. Stangier et al. (1999) and Rabung et al. (2006) found good consistency and retest reliability and results were comparable to the English version. Also, high correlations with other SA measures speak for high convergent validity (Stangier et al., 1999; Peters et al., 2012). A cut-off score of 35 was proposed for the German SIAS (Heinrichs et al., 2002). In addition to being useful in general population Boulton and Guastella (2021) concluded that the SIAS is useful to identify elevated social anxiety symptoms in ASD and shows adequate reliability and validity in this clinical group as well.

3.4.2 Autism Quotient (AQ-K)

The Autism quotient (AQ) (Baren-Cohen et al., 2001) was developed to investigate autistic traits and reflect the differences in sort and intensity of autistic traits on the autism spectrum and general population. It entails 50 items divided into five subdomains: social interaction, communication, attention to detail, and attention switching and imagination. A shortened German version (AQ-K) was developed by Freitag et al. (2007) containing only 33 items composing three factors (Social interaction and spontaneity, fantasy and imagination, and communication and reciprocity). Items are rated on a Likert scale from one to four. For each question a dichotomous scoring is employed with either one and two or three and four being rated as one or zero points depending on formulation of the item. Therefore, total scores range from 0-33. Freitag and colleagues proposed a cut-off score of higher than 17. They found a retest-reliability of 0.79 and good validity.

3.5 Procedure

After passing the screening for exclusion criteria participants were able select timeslots for four appointments. Each appointment they spend approximately three hours at rooms in the psychological faculty of the university of Vienna. Participants were instructed to wait in front of the building, where they were met by the experimenter and brought to the lab. As a next step they filled out a consent form and a routine drug and pregnancy test was conducted. Additionally, at the first appointment a verbal intelligence test was administered. Afterwards

two placebos were given to participants and waiting time followed. Then the three tasks were started, which included the interview. Order of tasks was randomized and counterbalanced between sessions and participants. Also, in the first or last session participants were asked to fill out questionnaires including the Social Interaction Anxiety Scale (SIAS) and Autism Spectrum Quotient (AQ) via SoSci Survey (Leiner, 2019). Afterwards a debriefing was conducted, making sure participants knew how and with whom to get in contact in case of any concerns, questions, or side effects. Participants were compensated with 40 Euros for each session in addition to money they could win during one of the other tasks.

3.6 Data analysis

Eye-tracking data was used to analyze number of fixations for each ROI (eyes, mouth) using the PupilLabs software program (Pupil Labs, n.d.). A minimum and maximum fixation duration was set at 80 ms and 220 ms. The number of fixations on these ROIs was divided by the length of the interview, thus controlling for the variance in length of the interview. Therefore, in this study gaze behavior is assessed via number of fixations on ROI per second averaged over the length of interview. For all analyses concerning gaze behavior fixations per second were transformed via square roots to meet statistical assumptions. All statistical analyses were conducted using SPSS 29 (IBM Corp, 2021).

To answer the first research question independent t-tests concerning total score on the SIAS and AQ-K were chosen to explore levels of SA and AQ in ASD compared to NT. Furthermore, Pearson moment product correlations were conducted to assess the relationship between AQ-k and SIAS scores. One linear regression for each region of interest (ROI: Eyes; mouth) was used to answer whether SA predicts gaze behavior. In addition, independent t-tests with group as independent and fixations on eyes and mouth as dependent variable and two linear regression with AQ and the ROI were conducted to explore the relationship between autism, AQ and gaze behavior. Lastly, moderation analyses were conducted looking at how the relationship between Autism Quotient (AQ) and fixations on ROI is moderated by SIAS scores using SPSS's macro Process (Hayes, 2013).

4. Results

There were no significant differences between ASD and NT group concerning age ($t(57.28)=1.52$, $p = .133$), sex (X^2 $(1, N = 66) = .945$, $p = .331$) or IQ ($t(45.36)= 1.40$, $p = .168$) Mean scores and standard deviations are depicted in table 3.

Table 3

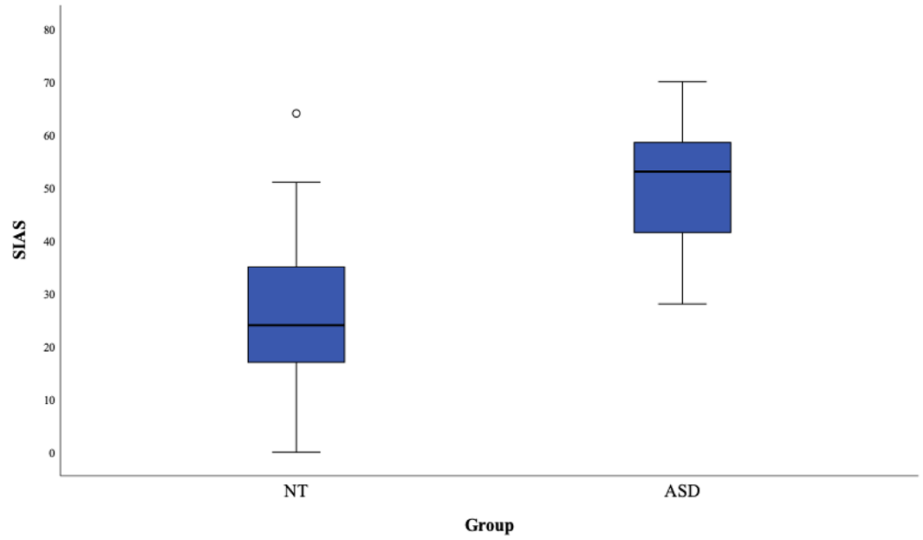
Means and standard deviations for age, IQ, AQ and SIAS in NT and ASD group, N =66.

NT	M	SD
Age		
ASD	34.32	13.55
NT	29.69	10.81
IQ		
ASD	112.29	18.69
NT	107	10.28
SIAS		
ASD	50.39	11.32
NT	25.45	13.83
AQ-K		
ASD	23.87	6.12
NT	9.14	4.35
AQ-C		
ASD	7.55	1.79
NT	3.49	1.77
AQ-S		
ASD	8.39	2.76
NT	3.00	2.49

An independent t-test was conducted with total SIAS score as dependent variable and group (ASD/NT) as independent variable. The t-test revealed significantly higher SIAS scores for ASD compared to NT group ($t(64) = 7.922$, $p < .001$).

Figure 1

SIAS scores in NT and ASD group.

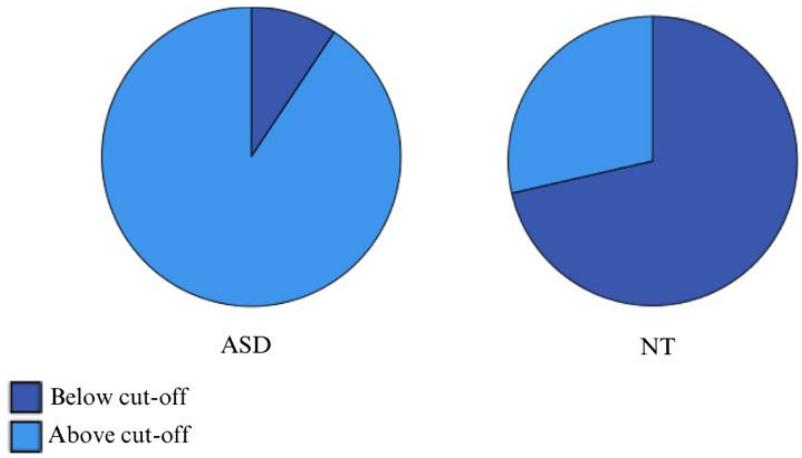


Note. N=66.

Furthermore, descriptive analyses revealed 90.6% of participants in the ASD group and 28.6% of NT participants scoring above the recommended cut-off score of 35 points on the SIAS.

Figure 2

Distribution of participants scoring above or below cut-off on SIAS divided per group.

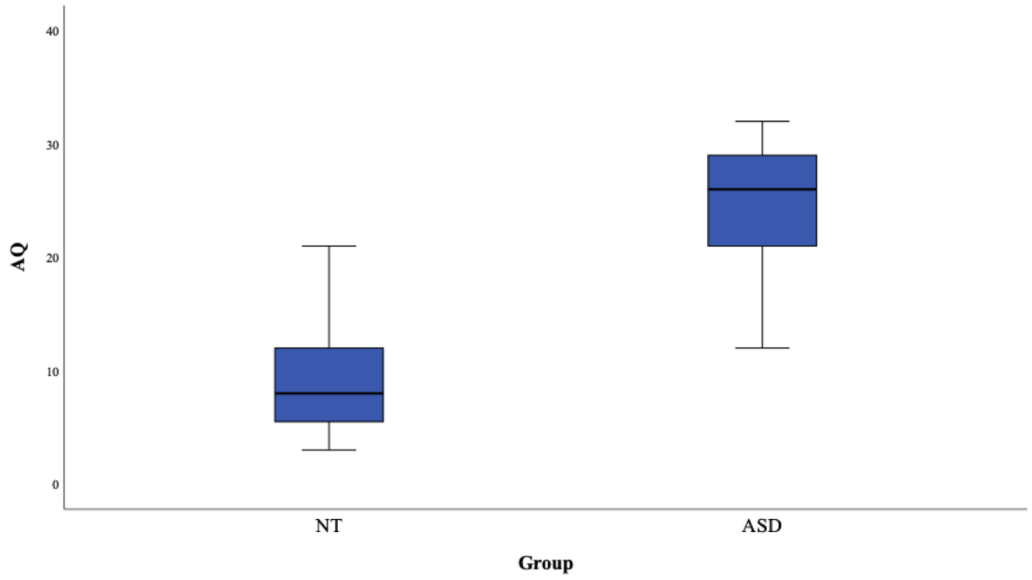


Note. N=66.

Three independent t-tests revealed significantly higher AQ total scores (AQ-K) ($t(53.39)=11.14$, $p<.001$), communication (AQ-C) ($t(64)=9.26$, $p<.001$) and social interaction (AQ-S) ($t(64)=8.34$, $p<.001$) factor scores in ASD than NT group.

Figure 3

AQ-K scores in ASD and NT group.

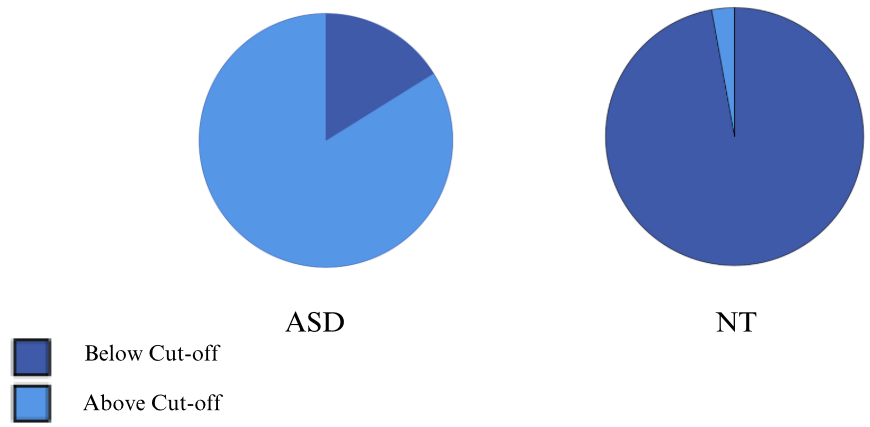


Note. N=66.

83.9 % of ASD and 2.9% of NT group exceeded the cut off score of 17 on the AQ-K.

Figure 4

Distribution of participants exceeding the AQ-K cut-off value of 17 in ASD and NT group.



Note. N=66.

In order to answer hypothesis 1.2, 1.3 and 1.4 three Pearson product moment correlations were conducted for SIAS scores and total AQ-K score, communication and reciprocity (AQ-C) factor and social interaction and spontaneity (AQ-S) factor on the AQ-K. All of which were highly significant (See table 4).

Table 4

Pearson Product Moment Correlations for SIAS and AQ_K, AQ-C and AQ-S.

		1	2	3	4
1.	SIAS	-	.854***	.797***	.812***
2.	AQ-K	.854***	-	.864***	.938***
3.	AQ-C	.797***	.864***	-	.732***
4.	AQ-S	.812***	.938***	.732***	-

Note. N = 66

*** $p < .001$

To answer the second and third research question linear regressions were performed for each ROI. Sample size was reduced to N = 54 due to some participants dropping out before performing the interview task in the Placebo-Placebo condition and not filling out SIAS or AQ. 23 (14 female; 10 male) belonged to ASD and 31 (17 female; 14 male) to NT group. There were no significant differences between ASD and NT group concerning age (t(53)=1.78, p = .080), sex (X^2 (1, N = 54) = 1.125, p = .289) and IQ (t(32.45)= 1.49, p = .146). Furthermore, the difference on SIAS (t(52) = 6.78, p < .001) and AQ-K (t(37.40) = 9.57, p < .001) remained significant. All assumption of linear regressions were met after data for fixations on eyes and mouth were transformed by square root.

Two independent t-tests with group (ASD/ NT) as independent variable and fixations on eyes and mouth as dependent variable revealed an almost significant group difference between ASD and NT for eyes (t(52)=-1.672, p =.050) but not for mouth (t(52)=.927, p=.385).

A linear regression was conducted to investigate the predictability of fixations on eyes by SIAS scores. However, the model did not reach significance (R^2= .028; F(1, 52) = 1.513; p = .224) and SIAS scores did not relate to fixations on eyes (b = -.168; t(52)= -1.230), p = .224). The model predicting fixations on mouth by SIAS scores was not significant (R^2= .012; F(1, 52) = .639; p = .428) and SIAS scores did not relate to fixations on eyes (b = -.110; t(52)=-5.603; p = .428).

Table 5

Mean and standard deviation for age, IQ, AQ and SIAS in ASD and NT group.

Variable		Mean	SD
Age			
	ASD	35.04	13.42
	NT	29.23	10.78
IQ			
	ASD	112.74	17.71
	NT	106.61	10.07
SIAS			
	ASD	51.04	11.96
	NT	25.55	14.33
AQ-K			
	ASD	23.87	6.12
	NT	9.14	4.35

Note: N=54

Another linear regression was conducted to investigate the predictability of fixations on eyes by AQ-K scores. However, the model did not reach significance (R^2= .049; F(1, 52) = 2.674; p = .108). AQ-k scores did not predict fixations on eyes (b = -.221; t(52) = -1.635, p = .108). Similarly, the model predicting fixations on mouth by AQ-k scores was not significant (R^2= .019; F(1, 52) = 1.024; p = .316). Thus, AQ-k scores did not predict fixations on mouth (b = -.139; t(52)=-1.012; p = .316).

To investigate whether SIAS scores moderate the relationship between AQ-K score and number of fixations on eyes or mouth two moderation analyses were conducted. For fixations on eyes neither the model (F(3, 50) = .8775, p = .459, R^2 =.050) nor the interaction (b = .000, 95% CI [-.001; .001], p = .932) were significant. Additionally, neither the model for fixations on mouth (F(3, 50) = .331, p = .803, R^2 =.020) nor the interaction reached significance ((b =.000, 95% CI [-.001; .001], p = .803).

5. Discussion

The purpose of this study was to investigate the influence of SA and autistic traits on gaze behavior in natural conversation, the prevalence of SA in a high functioning ASD sample and how SA might influence social attention in ASD. In a first step the relationship between autistic traits and SA in ASD and NT group was examined to further understanding of this association. Secondly, this study aimed to assess how SA and AQ individually relate to gaze behavior in dyadic conversations. Most studies have examined gaze behavior in ASD and SA with static pictures, videos, or online interactions. However, only few have investigated how SA and AQ influence gaze behavior during dyadic conversations in real life. Therefore, this study design bridges a gap in current research by investigating social attention in ecologically valid everyday life interactions. At last, the influence of SA on the relationship between autistic traits and gaze behavior was assessed. An important aspect of this study is the comparison of ASD group with NT group and assessment of autism in a categorical and dimensional manner via diagnosis and AQ. This sample includes female and male participants with ASD, which unfortunately is not always the case in studies investigating SA in ASD. This might be caused by ASD often being seen as a "male" disorder due to increased prevalence in men compared to women. However, it is of the utmost importance to also consider how ASD, autistic traits and SA present and interact in women.

5.1 SA, AQ and ASD

To answer the first research question SIAS and AQ scores in ASD and NT group were compared. In this study participants with ASD scored significantly higher on the SIAS and AQ than neurotypical individuals. Thus, demonstrating higher SA and autistic traits than NT participants. This is in accordance with most studies examining this relationship (Spain et al., 2018). In her study comparing ASD and combined ASD+SAD with NT group Maddox (2014) also found SIAS and AQ scores to be significantly higher in ASD than NT group and thus, elevated autistic traits and SA in ASD. This is congruent with results in Bejerot et al.'s (2014) study revealing higher SA scores in ASD than NT group. Interestingly, they also found ASD participants meeting SA criteria receiving higher AQ scores than other ASD participants. Therefore, SA might amplify social difficulties and anxiousness in ASD.

Also, SA was positively related to the Autism Quotient (AQ-K) and its factors communication and reciprocity (AQ-C) and social interaction and spontaneity (AQ-S). Thus, in this sample the higher SA was the higher the autistic traits were in participants. Those links might be based on the symptomatic overlap in autistic traits and SA, as social interaction anxiety

is higher in individuals scoring high on autistic traits concerning communication and social interactions. Similarly, Cath and colleagues (2008) also found SA measures to be positively related to autistic traits. Moreover, in their study a positive relationship was found between SA and communication factor and social skills factor as well as the total score of AQ. This positive link between autistic traits and SA was also shown by Spain et al. (2016) and Bejerot et al. (2014) revealing AQ scores to be highly correlated with SA scores in their sample. Therefore, suggesting a strong positive relationship between autistic traits and SA not just in ASD but also NT individuals.

In this study the level of SA in the ASD and NT group was extremely high. 28.6% in the NT group and 90.8% in ASD group exceeded the cut-off proposed by Heinrichs and colleagues (2002). This suggests that in this study participants were highly socially anxious, especially with ASD. Therefore, most of ASD and one third of NT group seem at risk for developing or already having a SAD. This association is in accordance with previous studies showing increased prevalence of SA and high comorbidity with SAD in ASD (Joshi et al., 2013). Nevertheless, compared to prevalence point and lifetime rates of SAD in ASD and NT this seems elevated. Other studies have also found high percentage of participants with ASD scoring above the recommended cut-offs on the SIAS with 50% (Maddox & White, 2015) and 2/3 (Boultin & Guastella, 2021). Further analyses in Maddox and White's (2015) study revealed SA expressed mildly by 21%, moderately by 29%, and severely by 21% of participants with ASD and thus only 29 % not affected by SA. However, none of these studies had a percentage as high as in this study with 90.8%. Moreover, in this sample SA scores (M = 50.88; SD = 11.47) in ASD group were similar (M=53.29, Maddox & White, 2015) or even higher than SA levels in groups with ASD and comorbid SAD (M = 49.20; Boultin & Guastella, 2021). Therefore, ASD seems to be strongly linked to heightened SA and autistic traits.

One possible explanation of high SA in ASD and 90.8% meeting the proposed cutoff might be that some participants with ASD also had SAD since they were not excluded based on diagnosis of other psychological disorders. However, this does not explain elevated SA levels in NT group since they were excluded based on any diagnosed psychological disorder including SAD. Nevertheless, in both groups undiagnosed SAD could be present. Another possible explanation lies in the cut-off values. For the German version a lower cut-off value than for the American version is suggested based on tests for specificity and sensitivity. However, in light of the high percentage of participants in NT and ASD groups scoring above the German cut-off this value might be considered too low for this sample. This finding underlines the importance of screening for other psychological disorders, especially SAD, in ASD patients. In addition, it

raises the question how exactly SA and AQ and ASD are linked and how to differentiate SA symptoms in ASD from autistic traits.

5.2 AQ, SA and gaze behavior

Concerning gaze behavior, a trend for less fixations on eyes in ASD compared to NT group almost reached significance. Therefore, in this sample participants with ASD tended to look less at eyes than NT participants. This trend is in accordance with theories about gaze behavior in ASD and previous studies examining this association. Social motivation theory (Chevallier et al., 2012) postulates reduced interest or importance of eye region for individuals with ASD and thereby leading to decreased attention to eyes. Another explanation of atypical gaze to eyes in ASD is based on the assumption that individuals with ASD might perceive eyes as aversive. Therefore, avoiding eyes to prevent overarousal and distress (Dalton et al., 2005; Kliemann et al., 2012; Tottenham et al., 2014). Only few studies have assessed gaze behavior in ASD with real-life dyadic conversations. However, results so far are mixed with many finding no difference in gaze behavior or reduced attention to eyes in ASD. In addition to social attention concerning the eyes, attention to the mouth area was examined in this study. However, results yielded no difference in gaze behavior concerning the mouth between ASD and NT group. Therefore, opposing Jones and colleagues (2008) assumption that participants with ASD look more at the mouth compared to NT group as a compensatory strategy for reduced eye contact.

Findings are in line with Freeth and Bugembe (2019). They found NT participants but not individuals with ASD paying significantly more attention to eyes than mouth. However, an important factor considered in their study was gaze direction of experimenter and conversational role such as listener or talker showing more fixations on experimenter's face when participants were listening instead of speaking. Those factors were not included in this study but might influence results as well. Hutchins and Brien (2015) also discovered reduced attention to eyes and increased attention to mouths in children when talking about emotional topics. Interestingly, with emotionally neutral conversational topics this difference was not shown. Therefore, emotional topics might exacerbate atypical gaze behavior in ASD. Even though questions in this study were not purposefully containing emotional topics, some participants talked about emotions and others did not. Thus, emotions addressed by participants when answering questions could add variability to results and might be a reason why only a trend for eyes and no differences at all concerning the mouth was found in this sample. Due to a similar study design findings are best comparable with Auyeung and colleagues' (2015)

results. Auyeung and colleagues (2015) found a significant difference in gaze behavior between ASD and NT groups for fixations on eyes but not mouth. Participants in the ASD group had fewer fixations on eyes and thus, looked less at eyes than NT participants. In addition to fewer fixation they also computed total looking time spent on eyes revealing participants with ASD spending less time looking at eyes than NT participants. Thus, taken together individuals with ASD seem to look less at eyes but no increased attention to mouths could be discovered.

In another step, it was tested whether scores on the AQ and therefore autistic traits could predict fixations on eyes and mouth. However, gaze behavior was not predicted by autistic traits in this study. In a study using a face viewing paradigms autistic traits did also not affect gaze behavior aimed at eyes or mouth (Greene et al., 2020). Similarly, Ni et al. (2022) could not find a relationship between overall looking time on eyes and mouth and autistic traits assessed via AQ scores but found avoidance of eyes for individuals with high autistic traits in several temporal stages. Therefore, using the average number of fixations might have cancelled out some differences during stages of the interview. Additionally, Forby and colleagues (2023) did not find any differences in fixations on eyes based on AQ scores when watching dynamic social interactions. Taken into account that the trend for reduced fixations on eyes was almost significant and most literature concerning actual social interaction finding an inverse relationship between autistic traits and gaze behavior it is surprising that autistic traits did not predict fixations on eyes at all in this sample. However, this does not mean that there is no association between the two. It just does not seem to be a linear one.

Additionally, it was tested whether SA could predict gaze behavior on eyes and mouth during a conversation. However, in this sample SIAS scores and fixations on eyes and mouth did not relate to each other. Thus, SA did not predict gaze behavior in NT and ASD participants. This is partly in line with Hessels and colleagues (2018) not finding any association between SA and gaze to mouths. Moreover, they discovered reduced attention to eyes. This supports avoidance theory of gaze behavior in SAD (Clarks & Wells, 1995). According to avoidance theory (Clarks & Wells, 1995) individuals with high SA perceive eyes as potential threat cues and thus, avoid looking at them. Therefore, avoidance of looking at eyes serves as a safety behavior, which often exacerbate preexisting abnormalities in social interactions. Previous studies examining the relationship between gaze behavior and SA have yielded inconsistent results with some finding reduced fixations on eyes (Chen et al., 2002; Horley et al., 2003; Moukheiber et al., 2010) and others finding increased attention to eyes (Gamble & Rapee, 2010; Mogg et al., 2004; Schofield et al., 2012; Boll et al., 2016; Brunet et al., 2009). The latter being in accordance with vigilance theory. Based on Rapee and Heimberg's (1997) model individuals

with high SA are assumed to show increased vigilance to possible threat. As they evaluate social situations as threatening people with heightened SA vigilantly look for signs of threat. Thus, showing difficulties disengaging from the eyes leading to heightened fixations on eyes. However, neither model can be supported by the results of this study. Therefore, these results can be seen in line with other studies finding no differences in gaze behavior based on SA. Gregory (2019) assessed eye gaze in NT participants and could not find any differences in fixations based on SA. Moreover, in a study by Langer and colleagues (2017) social setting in dyadic conversations influenced whether atypical gaze behavior was observed. Only in social conflict conversations reduced fixations on eyes was demonstrated by individuals high in SA but not in social support situations. Sine the interview task in this study did not equal a social conflict conversation, SA might not have been induced sufficiently to elicit aberrant gaze behavior in participants. Ni and colleagues (2020) tested vigilance-avoidance theory (Amir et al., 1998; Bögels & Mansell, 2004) assuming individuals high in SA being vigilant at first and later avoiding the eyes. Therefore, demonstrating more fixations on eyes in the beginning followed by reduced fixations. However, they did not find a relationship between SA and overall looking time at eyes. Similarly, Maddox (2014) did not discover any results supporting vigilance-avoidance theory or differences in gaze behavior related to SA. In this sample it might be that increased vigilance at first and later avoidance of eyes cancel each other out in the fixations per second score and thereby masking differences in gaze behavior based on SA. Furthermore, there seems to be a huge variation in how individuals with high SA or SAD pay attention to eyes, since some express avoidance, others vigilance and others combined vigilance with avoidance. Therefore, differences might be hidden by variability within the group. This was also addressed by Maddox (2014) finding no differences in social attention in ASD and SAD. In addition, most studies examining the association between SA and gaze behavior have used vastly different methodologies concerning stimuli, set up, participants and definition of gaze behavior. Therefore, results might not be comparable nor generalizable to other situations. Assessment of gaze behavior is complex and other indices of it might be contradicting each other.

Based on empirical evidence emphasizing the link between SA, AQ and gaze behavior and theoretical explanations on how SA furthers impairments in social functioning and atypical gaze behavior in ASD a moderation model was proposed to test whether SA moderates the link between autistic traits and gaze behavior. However, in this study neither the model nor the interaction reached significance and therefore SA did not influence the relationship between autistic traits and fixations on eyes or mouth in ASD and NT participants. Ni and colleagues

(2022) found an interactive effect of SA and autistic traits on the first fixation on eyes. Thus, the influence of SA and AQ on gaze behavior might not be significant during the whole interaction but only first fixations. In addition, using linear regression and moderation models based on linearity of associations might not have fitted data and therefore, the relationship between SA, AQ, and gaze behavior best. In light of this it is to assume that these constructs might not be linked in a linear way but could be associated in other ways.

5.3 Limitations

One limitation of this study is based on the sample size and composition. As data collection took longer than anticipated, only part of the data from the bigger research project was used for analyses. Inhibiting the sample from being matched based on age and sex between ASD and NT group. Furthermore, this led to almost significant trends for differences between groups for age and IQ, which might have influenced the results. In comparison to ASD NT participants tended to be a little younger and the variance in groups was not the same. In addition, this study was not conducted with a randomized sample but rather a convenience sample. Therefore, results' generalizability is reduced and cannot be assumed for all individuals with ASD nor everyone with high SA. This is even reinforced by the fact that only high functioning individuals with ASD were recruited, which does not represent all individuals on the autism spectrum. Furthermore, ASD participants were reached mainly via database of participants that had already taken part in studies at the university of Vienna, via support groups for individuals with ASD and social media. Therefore, only reaching a specific subgroup of people with ASD. Moreover, ASD participants were not excluded on basis of psychiatric medication or psychological disorders, which might mask possible differences in gaze behavior. In addition, this implies that ASD participants might have had SAD or other disorders interacting with gaze behavior, which might confound findings. In line with this, participants were not assessed for SAD. Thus, even NT participants might have had SAD but without ever receiving an official diagnosis. Another limitation concerns the assessment of SA. Similarly to how ASD was confirmed by a diagnosis and assessed via AQ, a more reliable evaluation of SA could have been yielded by an additional clinician's evaluation of SAD. This seems especially relevant since self-reports might be influenced by an array of factors. Adding to this, face validity of SIAS and AQ was perceived as high according to participants' comments. Another factor to be considered concerning self-report questionnaires in this sample is the occurrence of biases in general and alexithymia in ASD and possibly reducing accuracy of answers.

Moreover, some limitations are linked to the interview task. Even though this set up is already high in ecological validity compared to other study designs, there are still a few factors reducing comparability to everyday dyadic conversations. Firstly, the set up with eye-tracker adjustment and calibration vastly differs to normal interactions and does already give participants an idea of their gaze behavior being assessed. This knowledge might alter some gaze behavior, subconsciously making participants more aware of their eye movement. Also, the portable eye-tracker was not always comfortable for all participants and differences in how confounding this was to them might also have influenced how they behaved. This is additionally true for participants usually moving a lot during conversation since they were instructed not to do so, which might be rather unnatural for them. Furthermore, in terms of content and conversational roles during the interview a few adaptations could lead to a more natural conversation. One possible way would be for the participants to ask the experimenter more questions. This might be implemented similarly to Hessel and colleagues (2018). They switched roles between interviewer and interviewee. Therefore, gaze behavior was assessed not just when talking but also during listening phases, which has been proposed to vastly differ. Another possible improvement in terms of ecological validity could be to only define conversational topics and a time frame instead of formulating fix questions (Freeth & Bugembe, 2019; Howell et al., 2016). Thereby eliciting more natural conversations. Lastly, this study only investigated the association between SA, AQ and gaze behavior with statistical tests assuming linear relationships. As none of these tests reached significance one limitation of this study seems to be not testing for non-linear relationships between them.

5.4 Clinical relevance

These findings underline the importance of screening for other psychological disorder in ASD, especially SAD. Clinicians seem to struggle to differentiate between social disinterest or lack of social motivation and active avoidance of social interactions due to social anxiety when assessing difficulties in social interactions (Maddox, 2014). However, figuring out the root cause of atypical social behavior is essential to devise effective interventions. Therefore, addressing SA in ASD might alleviate some of the symptoms experienced in ASD concerning social interactions. In addition, social skills trainings combined with tailored CBT incorporating SA specific modules might be helpful to reduce SA in ASD. In a review Spain and colleagues (2017) examined four single case studies concerning adaptations to CBT for individuals diagnosed with ASD and SAD. Even though there were some differences, similarities in adaptations include identifying and challenging negative beliefs and thoughts about the self, exposure to social anxiety inducing situations, finding new coping mechanisms, and including

social skills trainings. Taken together results from these single case studies sound promising with decreased SA and increased social skill and activity levels. Furthermore, Bemmer and colleagues (2021) composed an eight-week group CBT intervention addressing SA and ASD specific domains at the same time. The intervention entailed social skills training, exposure tasks and behavioral experiment components. Results revealed a significant decrease in SA symptoms, improvement in social functioning including social motivation and restrictive, repetitive behaviors, and overall mood. Therefore, making a case to screen for SA and include SA specific aspects in the treatment of ASD.

5.5 Future research

To improve the understanding of how SA, AQ, and ASD are related and how exactly SA presents in ASD more research is needed. Therefore, more screening tools should be developed with better sensitivity and specificity to identify SA in NT, ASD, SAD, and ASD combined with SAD individuals. Regarding gaze behavior in relation to SA and autistic traits more research is needed in ecologically valid settings. Chen et al. (2020) note that methodological differences such as stimuli used, duration of stimuli presentation, and experimental set up could cause some of the incongruent findings in this field. Furthermore, gaze behavior is defined and assessed differently in most studies. Thus, investigating distinct aspects of gaze behavior like fixations, fixation durations, one- or two-way eye contact, first fixation, latency, and more. Thereby comparability of results in this domain is decreased. Future research should examine models of SA by Clarks and Wells (1995) and Heimberg (1997) in terms of fixations and fixation duration over the course of the interview to be able to compare it with the vigilance-avoidance model as well. In addition to assessing SA as a continuous trait it could be of interest to compare SA, AQ, and gaze behavior in SAD, ASD, and comorbid ASD and SAD. This could improve current knowledge of how SA, AQ, ASD, and SAD relate to gaze behavior and their interaction.

5.6 Conclusion

To conclude, this study has added to previous literature demonstrating a close link between autistic traits and SA, finding social interaction and communication factors of the AQ to be strongly associated with SIAS scores. Furthermore, SA in ASD group was elevated compared to neurotypical participants. Those results are in line with other studies and emphasize the importance of assessment and treatment of SA in individuals with ASD. In an ecological valid social interaction gaze behavior was measured to further the knowledge about social attention in everyday life. A trend for reduced attention to eyes was found in participants with ASD in comparison to NT group. Therefore, supporting social motivation theory

(Chevallier et al., 2012) and previous studies finding aberrant gaze behavior and social attention in ASD. However, contrary to compensation theory (Jones et al., 2008) for fixations on mouth no difference between ASD and NT group was found. Furthermore, neither AQ nor SA predicted fixations on eyes or mouth. Based on these results neither, avoidance, vigilance nor vigilance-avoidance theory of gaze behavior in SAD could be supported. Moreover, this study adds to inconsistent results concerning gaze behavior in ASD and SAD. In addition, in this sample SA did not moderate the relationship between AQ and gaze behavior. Therefore, a linear relationship between those constructs could not be demonstrated. All in all, more research is needed to better differentiate SA and autistic traits and further the understanding of how they are interrelated, as well as how SA and autistic traits influence gaze behavior independently and together.

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Tables

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Appendix

English Abstract

Autism spectrum disorder (ASD) is a persistent neurodevelopmental disorder entailing deficits in initiation and sustaining social communication and reciprocal social interactions as well as restricted, repetitive, and inflexible patterns of behavior, interests, or activities. ASD has been linked to heightened social anxiety (SA) with overlap in symptomology and impairments. One of the commonalties between ASD and SA is atypical gaze behavior. This study sought to investigate the relationship between autistic traits, SA, and gaze behavior in everyday life dyadic conversations in ASD and neurotypical (NT) participants. 66 participants filled out questionnaires assessing SA and autistic traits. 54 participants also took part in an interview task using a head mounted eye-tracker to measure fixations on eyes and mouth during the conversation. SA and autistic traits were elevated in ASD and strongly interrelated. SA and autistic traits did not predict gaze behavior in ASD or NT group. Additionally, no evidence for SA influencing the relationship between autistic traits and gaze behavior was found. Possible explanations, limitations, clinical relevance, and implications for future research are discussed.

Keywords: Autism spectrum disorder (ASD), Social anxiety (SA), gaze behavior, social attention, eye tracking.

German Abstract

Autismus Spektrum Störung (ASS) ist eine persistierende Entwicklungsstörung, die durch Defizite in der Initiation und Aufrechterhaltung sozialer Kommunikation und reziproker sozialer Interaktionen, genauso wie restriktive, repetitive und inflexible Verhaltensmuster, Interessen und Aktivitäten definiert wird. ASS weist einen starken Zusammenhang mit sozialer Ängstlichkeit (SA) auf. Beide teilen Gemeinsamkeiten in Symptomen und verursachten Einschränkungen. Zu diesen gehört auch atypisches Blickverhalten. Diese Studie untersuchte den Zusammenhang zwischen autistischen Eigenschaften, SA und Blickverhalten in dyadischen Unterhaltungen zwischen neurotypischen Teilnehmenden und Teilnehmenden mit ASS. 66 Teilnehmer*innen füllten Fragebögen zu SA und autistischen Zügen aus. 54 davon nahmen an einem Interview teil, währenddessen mit einem Eyetracker Fixationen auf Augen und Mund gemessen wurden. SA und autistische Eigenschaften waren stark miteinander verbunden und erhöht in Personen mit ASS. Jedoch konnten sie Blickverhalten auf Augen und Mund in Teilnehmenden mit und ohne ASS nicht vorhersagen. Auch konnte nicht nachgewiesen werden, dass SA die Beziehung zwischen autistischen Zügen und Blickverhalten beeinflusst. Mögliche Erklärungen, Limitationen, klinische Relevanz und Implikationen für Forschung werden erläutert.

Stichwörter: Autismus-Spektrum-Störung, soziale Ängstlichkeit, Blickverhalten, soziale Aufmerksamkeit, Eye-tracking.