SOCIAL ATTENTION AND EMPATY IN HIGH FUNCTIONING WOMEN WITH AUTISM SPECTUM DISODERS

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Abstract

Women with autism spectrum disorders (ASD) have become focus of research only recently, thus far there is little knowledge about the female phenotype of ASD in relation to social information processing. This study focused on social cognition in high functioning women with ASD with specific focus on social attention and empathy. Participants consisted of 31 women with ASD and 29 non-clinical controls. Social attention was assessed by measuring eye fixation patterns using eye tracking while participant watched four movie clips of children expressing specific emotions. Empathic abilities were assessed using the informant reported Interpersonal Reactivity Index (IRI). Results show deceased fixation duration on the face and mouth in women with ASD compared to non-clinical controls, no differences were found in fixation duration on the eyes, objects and outside the areas of interest. In addition, women with ASD had a reduced ability to take the other's perspective, a reduced ability to imagine the actions and feelings of (fictional) characters, and experienced more personal distress in stressful situations compared to non-clinical controls. In women with ASD, a negative correlation was found between personal distress and total fixation duration to the face. It is concluded that women with ASD have a deviant attention in social situations and reduced cognitive empathic abilities, but have more distress in social situations al well. It is suggested that an attentional deployment hypothesis might explain the findings. These findings stress the need for adjusting diagnostic assessment and treatment of women with ASD to the female phenotype of ASD.

Keywords: autism spectrum disorders, women, social attention, empathy

Autism spectrum disorders (ASD) are characterized by qualitative impairments in social interaction (American Psychiatric Association [APA], 2013). These impairments include a reduced sharing of affect, not being able to properly initiate or react to social interaction, deviations in eye-contact and an insensibility to nonverbal communication. Processing social stimuli adequately and effectively is necessary for observational learning, imitation, metalizing, and reward learning (Frith, & Frith, 2012), thus for successful social learning and social adjustment. Impairments in social interaction affect daily functioning in individuals with ASD by them not being able to establish and maintain reciprocal relationships due to a misunderstanding of the feelings, thoughts, and intentions of other people (Klin, Jones, Schultz, Volkmar, & Cohen, 2002a). Even very young children with ASD show impairments in emotion recognition (Chawarska, & Shic, 2009), shared attention (i.e., focusing on where the observed attention of individuals is by following the direction of their gaze; Charman, 2003), orienting towards visual as well as auditory social stimuli (Pierce, Conant, Hazin, Stoner, & Desmond, 2011; Kuhl, Coffey-Corina, Padden, & Dawson, 2005), and show an insensitivity to social rewards which persists into adulthood (Dawson, Bernier, & Ring, 2012). Moreover, individuals with ASD have demonstrated impairments in face processing (Dawson, Webb, & McPartland, 2005), emotion recognition (Golan, 2008), and empathic abilities (Baron-Cohen, 2004), which are asserted to be crucial processes in accomplishing successful social interactions.

A drawback of former studies focusing on ASD is that samples have been dominated by men, resulting in little knowledge about the problems in social interaction of women with ASD. The male-female gender ratio of ASD is estimated at 4.3:1, in individuals with average to high intellectual abilities this ratio increases to 5.5:1 (Campbell, Davarya, Elsabbagh, Madden, & Fombonne, 2013). This might explain the overrepresentation of men in studies on ASD and thus the biased focus on the male phenotype of ASD. Women with ASD have become focus of research only recently, thus far there is little knowledge about the female phenotype of ASD. Nevertheless, it is argued that the female phenotype of ASD differs from the male phenotype of ASD. For example, it is reported that girls with ASD have greater communication impairments and show more anxious and depressed behavior than boys with ASD (Hartley, & Sikora, 2009). Moreover, girls with ASD can involve more in pretend play compared to boys with ASD (Auyeung et al., 2009), although they seem to lack the profound understanding (Knickmeyer, Wheelwright, & Baron-Cohen, 2008). As for adults with ASD, gender differences are manifested as women having greater impairments in the social domain than men (Kirkovski, Enticott, & Fitzgerald, 2013). Furthermore, it is argued that they have more autistic symptoms when self-reports are used (Lai et al., 2011), which might indicate that women experience their social impairments as a bigger limitation in social functioning than men do. Taken together, despite the evidence being somewhat diverse and inconsistent, it could be stated that differences between the male and female presentation of ASD are probable. The little research on the female phenotype of ASD has shown that, overall, females seem to be more interested in social interaction than males, yet they appear to be more impaired in their social functioning and experience bigger

limitations due to their disorder. The core mechanisms explaining this are yet unknown, more research is needed to examine the female phenotype of ASD in explaining their impairments in social interaction. The present study aims at describing the female presentation of ASD with respect to social functioning by examining attention to social stimuli and empathy using objective and sensitive measures.

One of the mechanisms that could be associated with the impairments in social interaction women with ASD experience, is a deviant social attention (Itier, & Batty, 2009). Social attention is the spontaneous attention to socially relevant stimuli, for example to people and in particular their faces and eyes (Klein, Shepherd, & Platt, 2009). This is believed to be crucial for providing oneself with information about the emotional state of the other, thus for successful engagement in social interactions. Typically developing adults tend to focus more on the face of an individual and on the eyes in particular (Boraston, & Blakemore, 2007), and even typically developing infants already look more at the eye region than the mouth region of faces (Haith, Bergman, & Moore, 1979). Focusing gaze on social cues and the face and eyes of individuals is important for understanding social information and for successful social interaction (Itier, & Batty, 2009). Problems with focusing on these areas could be essential to impairments in social interaction. So far, social attention in relation to ASD has never been assessed in an sample consisting of merely women.

Former studies focusing on fixation patterns have shown differences between children as well as adults with ASD compared to control groups, although the results varied. Some studies reported differences in fixation duration between individuals with ASD compared to typically developing individuals, in particular less attention to the eye region (Klin, Jones, Schultz, Volkmar, & Cohen, 2002b; Pelphrey et al., 2002; Dalton et al., 2005), more attention to the mouth region (Spezio, Adolphs, Hurley, & Piven, 2007; Klin et al., 2002b), less shared attention (Charman, 2003) or more attention to bodies and objects within the social scene (Klin et al., 2002b). However, no differences in fixation patterns are reported as well (Boraston, & Blakemore, 2007). The differences in fixation patterns observed in individuals with ASD compared to neurotypical individuals are thought to be related to the core behavioral impairments individuals with ASD experience (Deruelle, Rondan, Gepner, & Tardiff, 2004). More specifically, decreased attention to social stimuli predicts more severe, primary socially related, ASD symptoms (Bal et al., 2010; Kirchner, Hatri, Heekeren, & Dziobek, 2011). Fixation patterns in women with ASD in relation to their deviant impairment in social interaction has not yet been focus of research. Since women with ASD tend to be more interested in social interaction (Kirkovski et al., 2013), but at the same time show greater social impairments than men with ASD (Attwood, 2007), research on social attention in relation to social functioning in these women is warranted.

When individuals focus less on social stimuli, their amount and quality of social information is limited. Having less social information could result in a reduced ability to react in an empathic way.

For this reason, studying empathy in relation to social attention could provide meaningful information on the terrain of social cognition. Empathy is the understanding of other's intentions, as well as sharing their emotions and predicting their behaviors (Baron-Cohen, 2004). This is necessary for effective social interaction because it helps people to respond appropriately to another person's affective state by understanding the reasons and motives of the other's state and thus predicting their actions, while at the same time setting aside their own needs and desires. Previous research indicates that ASD are associated with reduced empathic abilities (Baron-Cohen, 2002). The cognitive component of empathy represents the labeling and understanding of the other's feelings, for which a Theory of Mind (ToM) is necessary, i.e., the ability to take the perspective of others by understanding their mental and affective states (Baron-Cohen, Leslie, & Frith, 1985). ToM is believed to be impaired in individuals with ASD, which hinders them in their empathic responses. In comparison, the affective component of empathy stands for the appropriate emotional response of an individual to another individual's affective state (Baron-Cohen, 2004). It is suggested that the cognitive component of empathy is especially impaired in individuals with ASD (Dziobek et al., 2008). Differences in empathic abilities between men and women with ASD are reported, but are inconclusive (for example, see: Schneider et al., 2013; Auyeung et al., 2009; Lai et al., 2011). Differences in brain activation between men and women with ASD during an empathy task are found, in which women had decreased activation in the bilateral medial frontal gyrus compared to men, a gender difference that was not found in the control group (Schneider et al., 2013). Also, women with ASD showed decreased activation of midbrain and limbic regions compared to neurotypical women. These differences in brain activation stress the need for research assessing the role of empathy in relation to the problems women with ASD experience related to social functioning. Research focusing on empathy in women with ASD is scarce, especially studies focusing on cognitive empathy in women with ASD.

The previously discussed studies regarding individuals with ASD show differences in results regarding fixation patterns, empathy and social functioning. These inconclusive results could be explained by the different phenotypes between females and males with ASD. The mixed evidence on the terrain of social interaction and social functioning emphasizes the need for research on women with ASD in these areas and the mechanisms causing these proposed gender differences. Focusing on women with ASD could provide valuable information about the female representation of ASD and therefore could provide a framework for the interpretation of earlier evidence. Moreover, the lack of knowledge about the female phenotype of ASD could lead to women with ASD being un- or misdiagnosed (Kirkovski et al., 2013). In addition, women with ASD tend to receive their diagnosis later in life than men with ASD (Kirkovski et al., 2013). Nevertheless, the problems these women seem to experience in social functioning stress the need for more knowledge concerning the female presentation of ASD. Prior evidence to difficulties in social interaction of women with ASD is mainly based on observations or self-reports, the present study aims to investigate social attention using

sensitive en ecologically valid measures by assessing eye fixation patterns and relate these to measures on the behavioral level.

Present study

The present study focuses on social information processing in women with ASD with specific focus on social attention and social cognition by assessing eye-tracking measures and empathy. It is investigated if social attention and empathy is different in women with ASD compared to non-clinical women. First, social attention is studied by analyzing differences in fixation patterns between women with ASD and non-clinical women when they are watching movie clips of social scenes. An attempt was made to create an ecologically valid task by assessing social attention through showing real-life moving social scenes of children expressing emotions which were not played by actors. Based on former studies showing differences in fixation patterns between individuals with ASD and non-clinical individuals (Klin et al., 2002b) it is hypothesized that women with ASD show different fixation patterns compared to the control group by them focusing less on social stimuli and more on nonsocial stimuli. Second, empathic abilities in women with ASD compared to non-clinical women is assessed. Based on the study of Dziobek et al. (2008), it was hypothesized that women with ASD show less empathy, and especially less cognitive empathy than non-clinical women. Third, the role of social attention in relation to empathic abilities in women with ASD is investigated. Because attention to social cues is necessary for understanding social situations and the other's feelings, it is hypothesized that social attention (i.e., eye fixation patterns) can be related to the level of empathy in women with ASD.

Methods

Participants

A total of 60 adult women participated in this study, of which 31 women with ASD forming the ASD group, and 29 non-clinical women forming the control group. Participants with ASD were recruited through a letter containing written information about the study and inviting them to participate, which was handed out to them by clinicians of a large psychiatric outpatient department in The Netherlands. Participants of the control group were recruited though the distribution of written information about the study in public areas. Inclusion criteria were an IQ $\geq$ 80, an age $\geq$ 18, no neurological conditions, no psychopathology in the control group, and no co-morbid borderline personality disorder and an independent clinical diagnosis of an autism spectrum disorder according to the DSM-IV-TR in the ASD group.

The ASD group was recruited from a psychiatric outpatient department (Centrum Autisme Rivierduinen) serving a large region in The Netherlands and specialized in diagnostic assessment and treatment of adults with ASD. All women with ASD were classified with an autism spectrum disorder

according the DSM-IV-TR criteria (APA, 2000). An assessment protocol is used that was in use since 2003, including questionnaires, an interview with the patient and with informants (e.g., parents, spouses, other family members) concerning (early) development en current behavior, expert clinical observations, information from treating physicians, psychiatric history, and (neuro)psychological tests. Consensus regarding the diagnostic classification of ASD had to be reached by psychiatrists (with experience in the field of autism) and by a consensus meeting with a multidisciplinary team. Participants of de control group were screened on current psychopathology using the MINI 5.0.0 (Overbeek, Schruers, & Griez, 1999). None of the included participants in the control group met criteria of current psychopathology on axis 1 and axis 2 of the DSM-IV-TR (APA, 2000).

Information of the participants of the ASD group and control group is included in Table 1. Mean age did not differ significantly between groups ($t(58) = .32$, $p = .750$), neither did the mean number of children ($t(58) = .74$, $p = .464$). Education level differed significantly between groups ($t(57) = -2.16$, $p = .044$): education level for women with ASD ($M = 5.77$) was significantly lower than the control group ($M = 6.72$). Mean autism traits as measured with the Social Responsiveness Scale for Adults (SRS-A) differed significantly ($t(52) = 10.06$ $p < .001$). As Table 1 shows, the vast majority of the women with ASD scored above the cut-off on the SRS-A, which was a T score ≥ 60. T scores below 60 are within the normal range, scores ≥ 60 are strongly associated with a clinical diagnosis of an autism spectrum disorder in high-functioning individuals. In the control group, one participant scored above the threshold. This participant was included in the analyses since she did not influence the outcomes of the analyses. All participants had normal or corrected-to-normal vision. Participants received a voucher of 15 Euros and travel costs reimbursement after completing the assessment. Written informed consent was obtained from all participants.

Table 1. Participant information

	ASD	Control
Age (*M*(*SD*))	41.43 (11.41)	40.39 (13.43)
Children (*M*(*SD*))	.30 (.47)	.21 (.42)
Education level-low (%)	6.70	0.00
Education level-medium (%)	50.00	27.60
Education level-high (%)	43.30	72.40
SRS-A < cut-off (normal range %)	20.70	96
SRS-A ≥ cut-off (mild to severe range %)	79.30	4

Note. For variables age and children, $N = 60$; for education level, $N = 59$; for SRS-A, $N = 54$. Education level-low: less than high school; Education level-medium: high school or college; Education level-high: degree or higher. SRS-A cut-off T score = 60.

Instruments

Apparatus. The Tobii T120 eye tracker (Tobii Technology, Sweden) was used to measure gaze fixation patterns by using a corneal reflection technique to measure gaze patterns at 120 Hz. Participants were seated 65 cm from the LCD screen where the movie clips were shown. First, a nine-point calibration procedure was carried out after which the four movie clips were shown. Analyses of the gaze data was done by defining areas of interest (AOIs) using the dynamic AOI tool of Tobii Studio version 3.0.2. The following AOIs were defined: 'eyes', 'mouth', 'face' (with eyes and mouth included), 'objects', and 'outside AOI' (on screen but outside any of the AOIs), for which fixation duration was calculated.

Movie clips. Four movie clips with a duration of approximately one minute were shown. The movie clips showed children between the ages of two to seven years that were expressing specific emotions. The movie clips were real-life scenes of children (i.e., not played by actors), filmed by a spectator, selected and obtained from YouTube (www.youtube.com). Because auditory stimuli are a part of social cues in social scenes, audio input was included. The spoken language in the movie clips was English. These kind of movie clips were chosen to maximize the ecological validity of the social scenes presented to the participants. A pilot study determined the two primary emotions by identifying the two most reported emotions for the four movie clips. The primary emotion pairs were angry/sad, fear/upset, pain/upset and happy/surprised for the four movie clips. The angry/sad clip shows a boy and a girl fighting over toys. The fear/upset clip presents a girl in the back seat of a car screaming while going into a car wash. The pain/upset clip demonstrates a girl getting an injection from a nurse. The happy/surprised clip shows a boy opening a present on Christmas day.

Interpersonal Reactivity Index. The informant version of the Interpersonal Reactivity Index (IRI) is a 28-item questionnaire designed by Davis (1980) to assess empathy in daily functioning. Empathy is measured using four seven-item subscales. First, 'perspective taking' concerns the ability to take the other's perspective (e.g., "Before criticizing somebody, I try to imagine how I would feel if I were in their place"). Second, 'fantasy' assesses the ability to imagine the actions and feelings of (fictional) characters (e.g., "After seeing a play or movie, I have felt as though I were one of the characters"). Third, 'empathic concern' measures the ability to have feelings of warmth and concern towards other individuals (e.g., "I often have tender, concerned feelings for people less fortunate than me"). Fourth 'personal distress' assesses the tendency to experience distress, for example anxiety, in stressful situations, preventing the individual to effectively help others (e.g., "I tend to lose control during emergencies"). The subscales 'perspective taking' and 'fantasy' are thought to represent the cognitive empathy construct. The subscales 'empathic concern' and 'personal distress' are reported to represent the affective, emotional component of empathy. The questionnaire is filled in by an informant by the means of a 5-point Likert scale ranging from A = does not describe me well, to E = describes me very well. The questionnaire has satisfactory psychometric properties (Davis, 1980).

Procedure

The current tasks were part of a larger test battery. After a calibration period, participants watched the four movie clips with the notion that they were answering questions about them afterwards. Participants were instructed to sit still and be quiet during the movie clips. After each movie clip, participants filled in questionnaires. The IRI was filled in by an informant who knew the participant well, such as a partner, parent or close friend.

Data-analyses

Since education level differed significantly between the ASD and the control group, education level is controlled for in the analyses by including it as a covariate if it was correlated with one or more of the variables of interest. Total fixation duration of the AOIs within the four movie clips were summed to get the total fixation duration of the individual AOIs across the four movie clips. MANCOVA was used to assess the multivariate main effect of group (ASD, control) and multivariate interaction effect of group*education level. When the multivariate effect of group was significant, univariate effects of group were inspected for specific AOIs. MANCOVA was used to investigate the group differences in empathic abilities, using the four subscales of the informant reported IRI, controlling for education level. When the multivariate effect of group (ASD, control) was significant, univariate effects of group were inspected. The relation between the AOIs and empathic abilities was assessed using correlations, for which Pearson's *r* was used. Only variables that showed significant group differences (ASD, control) were included in correlation analysis. The level of significance was set at $p < .05$. For calculating effect sizes, Cohen's *d* was used. Participants with missing data were deleted listwise in analyses. Analyses were conducted using the computer program SPSS Statistics.

Results

Social attention

MANCOVA with the five AOIs 'face', 'eyes', 'mouth', 'objects', and 'outside AOI', with education level as covariate, indicated a significant multivariate main effect of group (ASD, control; $F(5,46) = 2.87$, $p = .024$), indicating that group differences were present for specific AOIs. The main multivariate effect of the covariate education level was not significant ($F(5,46) = 1.45$, $p = .226$). Univariate group effects are presented in Figure 1. Significant univariate group effects were found for the AOIs 'face' ($F(1,50) = 5.95$, $p = .018$), and 'mouth' ($F(1,50) = 4.37$, $p = .042$). That is, the ASD group fixated a shorter duration at the face and the mouth during the film clips than the control group. Effect sizes for these group differences were medium in size ($d = .69$ and .48, for AOIs 'face' and 'mouth' respectively). No significant group effects were found for the AOIs 'eyes' ($F(1,50) = .03$, $p = .876$), 'objects' ($F(1,50) = 3.04$, $p = .087$), and 'outside AOI' ($F(1,50) = .03$, $p = .859$). Figure 2 shows a visual illustration of the differences in fixation patterns of the ASD group and control group.

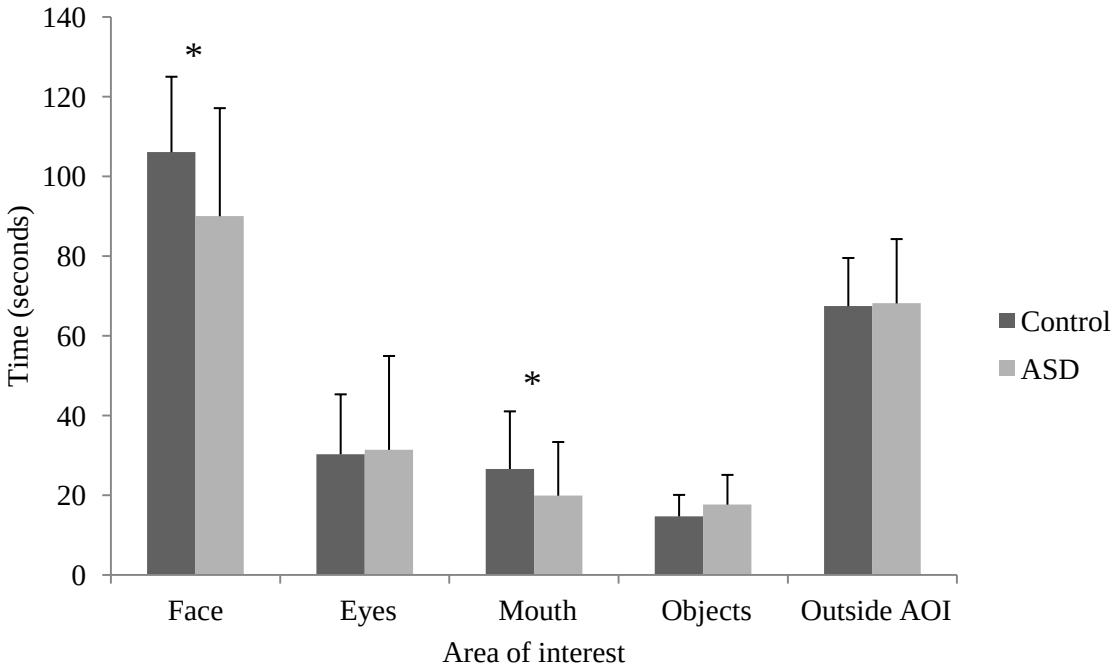

Figure 1. Total fixation duration (M, SD) within the AOIs during the movie clips for ASD group and control group separately. Note. * $p < .05$

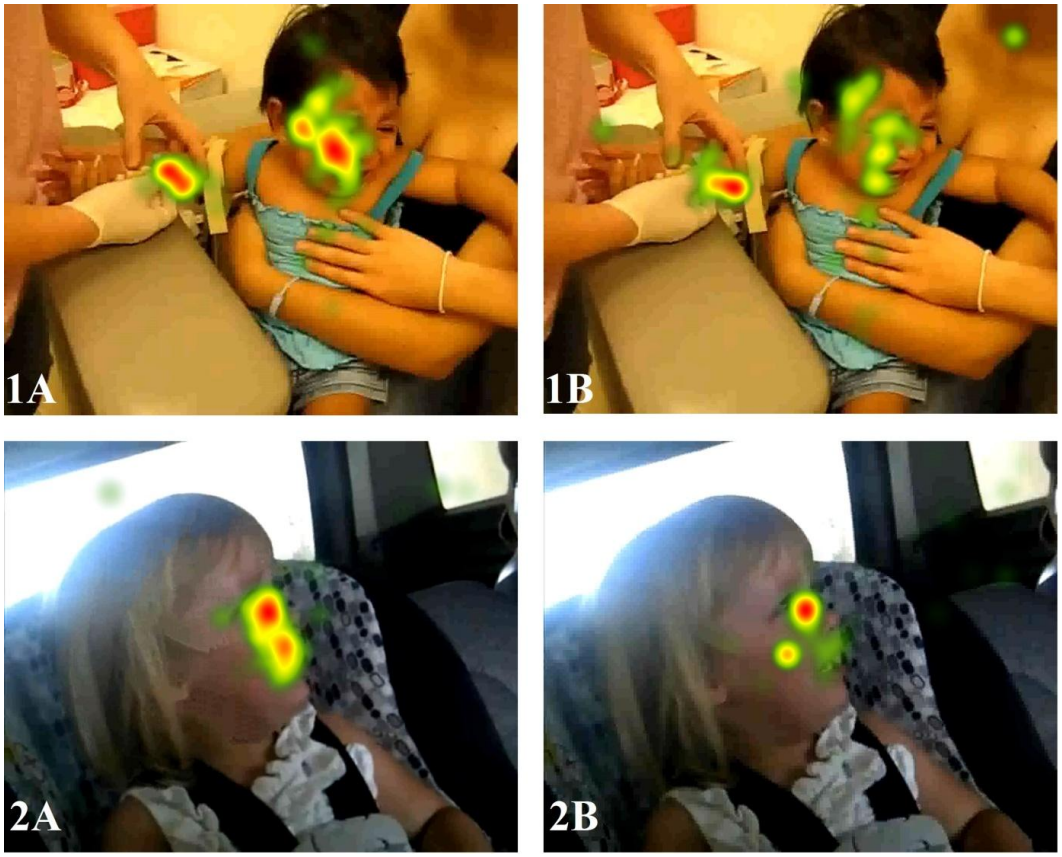

Figure 2. Heat maps of total fixation duration reflecting group differences between control group (A) and ASD group (B) on AOI 'face' while participants watched the pain/upset movie clip (1), and on AOI 'mouth' while participants watched the fear/upset movie clip (2).

Empathic abilities

MANCOVA with the four IRI subscales 'perspective taking', 'fantasy', 'empathic concern', and 'personal distress' as reported by informants and education level as covariate, indicated a significant main multivariate effect of group (ASD, control; $F(4,46) = 9.47$, $p < .001$), demonstrating that group differences were present for specific empathy subscales. Again, the main multivariate effect of the covariate education level was not significant ($F(4,46) = 1.58$, $p = .195$). Univariate group effects are presented in Figure 3. Significant univariate group effects were found for three of the four IRI subscales. Namely, the ASD group scored significantly lower on the subscale 'perspective taking' than the control group ($F(1,49) = 15.31$, $p < .001$, $d = 1.18$), meaning that the ASD group had a reduced ability to take the perspective of others compared to the control group. In addition, women with ASD scored significantly lower on the subscale 'fantasy' than the control group ($F(1,49) = 5.22$, $p = .027$, $d = 0.63$). This indicates that the ASD group had a reduced ability to imagine the actions and feelings of fictional characters than the control group. Third, the ASD group had a significantly higher score on the subscale 'personal distress' than the control group ($F(1,49) = 32.55$, $p < .001$, $d = -1.62$). In other words, the ASD group experienced more distress in stressful situations than the control group. The univariate group effect of the subscale 'empathic concern' was not significant ($F(1,49) = .33$ $p = .571$).

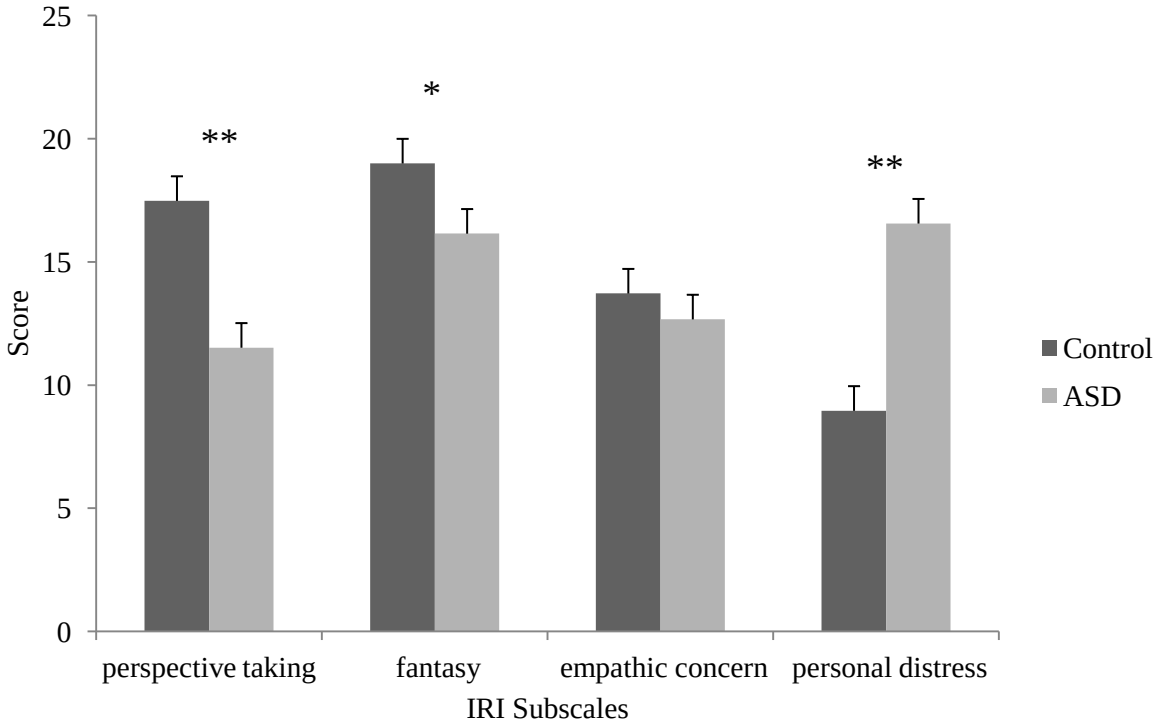

Figure 3. Empathy scores (M, SD) of the four subscales of the IRI (informant reported) for ASD group and control group separately. Note. * $p < .05$, ** $p < .001$

Relation between social attention and empathic abilities

For the ASD group, the relation between social attention and informant reported empathic abilities was assessed, using only those variables that showed significant group differences (ASD, control). Correlations are listed in Table 2. Within the ASD group, the IRI subscale 'personal distress' was significantly negatively related to the total fixation duration within the AOI 'face' during the four movie clips (r = -.42, p = .041). Thus, for the ASD group, higher personal distress was related to lower total fixation duration to the face. Other correlations were not significant.

Table 2. Correlations between AOIs and IRI subscales (informant reported) for the ASD group (only variables included that showed significant group differences between ASD group and control group).

		Area of interest	
		Face	Mouth
IRI subscale	Perspective taking	.33	.07
	Fantasy	.15	.33
	Personal distress	-.42*	.05

Note. N = 25. * p < .05. For correlation analyses, Pearson's r was used.

Discussion

Previous research indicated that ASD are associated with impairments in social functioning. Women with ASD have become focus of research only recently, thus far there is little knowledge about the female phenotype of ASD in relation to social cognition and social functioning. In the present study, social attention and empathic abilities in women with ASD were assessed using sensitive and objective measures including behavioral as well as eye tracking measures. It was investigated whether women with ASD, compared to non-clinical women, differed in attention towards social stimuli based on eye fixation patterns while they were watching movie clips of social scenes. Furthermore, differences in empathic abilities between the two groups were investigated. In addition, it was examined if deviant social attention in women with ASD was related to their empathic abilities. Results showed that women with ASD focused less on social stimuli, as was indicated by a shorter fixation duration on the face and the mouth during the movie clips compared to non-clinical women. No differences in fixation duration were found in the other AOIs. When empathic abilities were investigated, results indicated that women with ASD, compared to non-clinical women, had a reduced ability to take the other's perspective, had a reduced ability to imagine the actions and feelings of (fictional) characters, and experienced more personal distress in stressful situations. When the relation between social attention and empathic abilities was examined for women with ASD, higher personal distress was related to lower total fixation duration to the face.

Previous research has suggested that women with ASD appeared to be more impaired in their social functioning than men with ASD (Kirkovski et al., 2013), and that they experienced more social problems (Lai et al., 2011). Therefore, the possible differences in phenotypical presentations of ASD between men and women need to be taken into consideration, and as a consequence, one should be cautious generalizing literature focusing on men with ASD to women with ASD. The literature focusing on women with ASD is scarce, studies on the female phenotype of ASD and core mechanisms explaining their impairments in social interaction are warranted. The present study aims at filling this gap in knowledge in the field of women with ASD by describing the female presentation of ASD with respect to social cognition and social functioning. This study shows that even high functioning women with ASD have impairments in social attention and empathy, findings that should be used as focus of diagnostic assessment and treatment of women with ASD within clinical practice, aiming at adjusting assessment and treatment of women to the female phenotype of ASD.

The finding that women with ASD fixated a shorter duration on the face and mouth of the characters of the movie clips compared to non-clinical women, supports the hypothesis that individuals with autism focus less on social stimuli (Klin, 2002b). By focusing away from social stimuli, women with ASD could miss crucial social information that informs them about the emotional state of others, and this might be one explanation for their impairment in social interaction (Itier, & Batty, 2009). It is argued that the deviant fixation patterns found in individuals with ASD were associated with more social impairment (Klin, 2002b). In non-clinical individuals, fixating on the mouth is thought to be beneficial to successfully process language (Lewkowitz, & Hansen-Tift, 2012). In men with ASD, increased looking at the mouth was associated with better social abilities (Klin, 2002b). This could be an indication that the decreased fixation duration on the mouth that was found in this study might be related to the impairments in social functioning reported in women with ASD.

Although speculative, an explanation for orienting less on social stimuli could be that women with ASD become too physiologically aroused when looking at social stimuli, resulting in them looking away from such stimuli in order to downregulate their affective arousal levels. This is proposed earlier for individuals with ASD by Dalton et al. (2005), who argued that looking away from social stimuli is a strategy for individuals with ASD to prevent affective overarousal caused by social stimuli and that this process could be mediated by brain activation in limbic regions. Further evidence to support this hypothesis comes from the field of Klinefelter Syndrome (KS), in which it is shown that men with KS experience increased affective arousal levels while watching similar movie clips (Van Rijn, Barendse, van Goozen, & Swaab, 2014). An ‘attentional deployment hypothesis’ is proposed, in which men with KS avoid social stimuli in order to decrease their affective arousal. Since it is argued that men with KS have an increased risk to have a comorbid ASD (Van Rijn, Swaab, Aleman, & Kahn, 2008), it is possible that this hypothesis could also be applied to individuals with ASD. Indeed, this study found that those women with ASD who experienced more personal distress looked less at the face, a finding that might indicate that women with ASD have trouble decreasing

their affective arousal levels caused by attention to social stimuli. As a result, they focus less on the face and miss crucial social information. Further research could test this hypothesis by assessing heart rate, skin conductance or by using functional neuroimaging in women with ASD.

The higher levels of personal distress individuals with ASD experience compared to non-clinical controls are reported before in individuals with ASD (Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007; Dziobek et al., 2008), and is in line with the attentional deployment hypothesis. It was found that women with ASD who experienced more personal distress looked less at the face, a finding that could explain differences in personal distress between women with ASD and non-clinical women. Since women with ASD have less information about the state of the other on which they could act, and cannot label the information that they have correctly, they cannot downregulate increased arousal levels caused by focusing on social stimuli. On the other hand, the found negative relation between personal distress and fixation duration to the face also indicated that women with ASD who look more to the face experience less personal distress. This seems contrary to the attentional deployment hypothesis, since this hypothesis suggest that attention to social stimuli increases affective arousal levels, which cannot be effectively downregulated due to mislabeling of the social information. In general, women with ASD experience higher levels of affective arousal when paying attention to social stimuli, which they cannot effectively downregulate resulting in orienting away from social stimuli. However, it could be the case that those women who have learned to label social information correctly are able to understand the social situation and decrease their affective arousal levels. They are able to focus longer on social stimuli such as the face and thereby will gain the social information they need to understand the social situation and effectively downregulate their affective arousal levels. Although speculative, this means that there might be a changing point where attention to social stimuli, that increased affective arousal levels before, becomes beneficial for those women that are able to label the social information correctly and thus understand the social situation and can downregulate their affective arousal levels. This effect can be expressed in an inverted U-shape curve. If true, this means that if treatment focuses on paying attention to and label social stimuli correctly, in addition to enhancing cognitive empathic skills such as perspective taking, these skills may function as a mechanism to effectively downregulate affective arousal levels in stressful situations. Furthermore, higher levels of personal distress in individuals with ASD might be associated with the possibility that women with ASD have reduced abilities to identify and describe their own states of personal distress, for which the term ‘alexithymia’ is used (Booth-Butterfield, & Booth-Butterfield, 1990). Alexithymia is found to be related to reduced empathic abilities and increased affective arousal in individuals with ASD (Bird et al., 2010). Future research needs to conclude if higher levels of alexithymia are can also be related to women with ASD and their pattern of reduced empathic abilities.

Interestingly, women with ASD seemed to spend as much time looking at the eyes as non-clinical women did. Since the eyes are a specific part of the face, and findings indicate that women with ASD looked less to the face than non-clinical women, it is interesting to find that this decrease in

social attention is not present in the eye area of the face. This finding is not in line with the hypothesis of women with ASD focusing less on social stimuli, but since the literature on eye fixation patterns is somewhat inconsistent, is in line with some studies focusing on adults with ASD (Kirchner, Hatri, Heekeren, & Dziobek, 2011; Chawarska, & Shic, 2009). Several studies proposed that fixation to the eyes was related to reduced social abilities in individuals with ASD, such as reduced communicative competence (Klin et al., 2002b), and reduced social responsiveness (Speer, Cook, McMahon, & Clark, 2007). This might indicate that looking to the eyes is not as beneficial for women with ASD as it is for non-clinical individuals, possibly due to their increased personal distress when focusing on social stimuli. The specific pattern of women with ASD spending less time fixating on the face and mouth and equal time fixating on the eyes compared to non-clinical women could possibly be specific to the female phenotype of ASD. The motivation of women with ASD to look to the eyes could be explained by their use of observational learning, a technique women with ASD apply more often than men with ASD do (Attwood, 2007; Lai, 2011). As a result, women with ASD observe that eye contact is a socially accepted way of interacting with others, and thus they look as often to the eyes of a person as non-clinical women do.

Concerning cognitive empathic abilities, this study found that women with ASD, compared to non-clinical women, had a reduced ability to take the other's perspective, and had a reduced ability to imagine the actions and feelings of (fictional) characters. This findings correspond to the literature reporting impaired empathic abilities in individuals with ASD (Baron-Cohen, 2002). Since these two subscales are thought to correspond with the cognitive empathy construct, it could be argued that women with ASD seem to have a deficit in cognitive empathy. This is in line with literature concerning ASD, in which it is argued that individuals with ASD are especially impaired in the cognitive empathic domain (Dziobek et al., 2008). At the same time, it is argued that parents stimulate pretence play more strongly in their daughters than in their sons (Lindsey, Mize, & Pettit, 1997), which could result in girls being more stimulated to take someone else's perspective and could lead to a bigger understanding of others in real life. However, contrary to non-clinical women, women with ASD seem not to benefit from this social environmental influence as indicated by the findings of the present study. This could be due to an impairment in ToM which is thought to underlie their reduced cognitive empathy.

Overall, looking at the findings concerning empathy, it seems that women with ASD have reduced empathic abilities, mostly manifesting in the cognitive domain of empathy but also with respect to personal distress. Theories such as an impairment in ToM or cognitive empathy seem to be adequate as overall explanation for deviances in empathic abilities in women with ASD, although they do not explain the elevated levels of personal distress in these women. Treatment should be focusing on those domains of empathy that are most impaired in women with ASD. More research is needed to replicate this pattern of empathic abilities in women with ASD and to explore the underlying mechanisms causing this specific pattern of empathic abilities such as their deviant attention to social

stimuli. For example, the attentional deployment hypothesis could be assessed as an underlying mechanism in the reduced empathic abilities and deviant attention to social stimuli in women with ASD.

A strength of the present study is the presentation of the eye tracking task, in which an attempt was made to create an ecologically valid task by assessing social attention through showing real-life moving social scenes of children expressing emotions. It is argued that task presentation may confound the results found within eye tracking studies focusing on social attention (Guillon, Hadjikhani, Baduel, & Rogé, 2014). Different task presentations of social stimuli could play a role in the diversity of findings reported in the literature of ASD, since former studies differed in presenting static pictures of faces as opposed to movie clips containing moving faces. Also, they differed in presenting social stimuli such as faces with and without the surrounding stimuli that we perceive in daily life. These differences in task presentation could lead to differences in attention to the face and specific areas of the face. Since the present study strived to present an ecologically valid task by showing movie clips that were not played by actors, including surrounding visual stimuli and auditory stimuli, the findings could be better generalized to daily social interactions than, for example, tasks with static faces and no social context. However, one could argue that the found fixation patterns were dependent on the given instruction to the participants, in which they were told that they had to answer questions about the movie clips afterwards. At the same time, it is argued that visual fixation patterns in individuals with ASD are independent of the type of instructions given before the task (Pelphrey et al., 2002), so this seems unlikely.

The present study has some limitations. First, since the majority of individuals diagnosed with ASD is low functioning (Fombonne, 1999), and the participants in this study consisted of high functioning women, it is unknown if the findings from this study can be generalized to lower functioning women with ASD. On the other hand, the findings of this study highlight the impairments in social functioning of individuals with ASD. All participants in this study were high functioning and lived independently, yet, despite their learning potential, they had problems in social functioning. This indicates that impairments in social cognition and social functioning are a core symptom of ASD. Second, the sample size of the participants with ASD was relatively small when calculating correlations between AOIs and empathic abilities, so these findings should be interpreted with caution. In order to draw firm conclusions, these findings need to be replicated with larger samples. Third, fixation duration within an AOI could not be compared across movie clips, due to differences in size on screen of the AOIs across the movie clips. Fourth, focusing on the macrostructure of social attention by assessing fixation duration to the AOIs in isolation may not have been the only way to effectively assess the role of social attention in relation to the impairments in social functioning of women with ASD (see Guillon et al., 2014). During social interaction, not every moment contains the same amount of relevant social information, indicating that measures such as predictive saccades or

the microstructure technique ‘distance to reference point’ (D2R; see Falck-Ytter, 2013) could add useful information to the field of social attention in women with ASD.

The present study suggests a deficit in social attention, i.e., deviant fixation patterns in social situations in women with ASD. Also, impairments in empathic abilities in women with ASD were found, suggesting that, overall, women with ASD experience reduced cognitive empathic abilities, but also more personal distress. This indicates an impairment in social cognition in women with ASD and stresses the importance of acknowledging the impairments in social functioning these women experience. In addition, these findings give insight in the female phenotype of ASD, as well as the role of social cognition within the broader phenotype of ASD. Understanding the empathic profile in women with ASD as a part of social cognition is important in adjusting diagnostic assessment and treatment of women with ASD to the female phenotype of ASD. This might result in the diagnostic assessment of high functioning women with ASD earlier in life and thereby increasing their chances of benefitting from treatments aiming at increasing their social functioning. Treatments should be focused on increasing cognitive empathy and decreasing levels of distress in women with ASD by labeling the social information they perceive adequately. Deviances in attention to social stimuli and social cognition should be taken into consideration when trying to increase empathic abilities in these women. Further research is needed to gain more insights in the female phenotype of ASD in relation to social cognition and social functioning, with specific focus on diagnostic assessment and treatment of women with ASD. For example, treatments aiming at decreasing personal distress in women with ASD by labeling social information adequately could be assessed by means of effectiveness as well as increases their attention to social stimuli.

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