Judgments of Social Dimensions of Faces in Individuals with High-Functioning Autism
The aim of the present study was to investigate if individuals with high-functioning autism differ from typically developing (TD) individuals in judgments of social dimensions from faces. Thirty-two individuals with high functioning autism and sixty-seven TD individuals rated 196 synthetic faces representing 7 social dimensions. Overall, both groups performed similarly on the judgment tasks. However, some group differences emerged for ratings of Competence and Likeability in the Autism Spectrum Disorder (ASD) group. Furthermore, alexithymia, or emotion-blindness, was found to be a possible indicator of ability to judge social dimensions in the ASD group. Implications of present results in relation to prior and future research on social interaction on the autism spectrum are discussed.

Social situations contain a number of cues that reveal the nature of a social context. Many of these cues are nonverbal, meaning that they are wordless pieces of information about a social situation. Nonverbal information about a social context can be acquired in the interpretation of nonverbal expressions conveyed by people around us, like their tone of voice, facial expressions, body language, and physical appearance (Manusov, 2004; O’Sullivan, Ekman, Friesen & Scherer, 1985). These nonverbal cues are automatically integrated into a complete impression of a person (Baron & Bourdreau, 1987), and guide us in our understanding of the individual and the social context. The ability to send and receive nonverbal cues thereby enables information exchange and bonding with individuals in our social group (Tomasello, 2008), and is considered to be a prerequisite for a high-functioning social life (Onsager, 2014). Conversely, a reduced ability to send and receive nonverbal expressions may lead to impaired social functioning. This notion is especially prominent in individuals with Autism Spectrum Disorder (ASD), as social impairment is the most characteristic feature of ASD (American Psychiatric Association, DSM-V, 2013). The social interaction deficit in ASD is especially protruding in situations that include reciprocity of nonverbal cues. For example, a nonverbal cue such as tone of voice may go by unnoticed in an individual with ASD, and can cause confusion or an overly literal interpretation of the verbal content (World Health Organization, 2011). In sum, the social interaction deficit in ASD is therefore in all likeliness attributable to a deficit in one or many areas of the nonverbal realm.

Prior research on the perception of nonverbal information in ASD has been primarily focused on the perception of emotional expressions, especially from faces. Some researchers have attributed the impairment in interpreting facial expressions to a general emotion-processing deficit in ASD (Gaigg, 2002; Hobson; 1986; Hobson, 1986a, b; Hobson, Ouston & Lee, 1988; Weeks & Hobson, 1987; Kennedy & Adolphs, 2012; Lozier, Vanmeter & Marsh, 2014), but despite existing support for an overall emotion-reading deficit in ASD (Uljarevic & Hamilton, 2012; Nuske, Vivanti & Dissanayake, 2013), individual studies provide inconsistent results, as some studies report no differences between ASD and TD individuals on emotion reading ability (Jones et al., 2011; Ozonoff, Pennington & Rogers, 1990; Castelli, 2005; Evers, Kerkhof, Steayert, Noens & Wagemans, 2014). These inconsistencies indicate that difficulties in the social life of someone with ASD cannot be attributed to an overall emotion-reading deficit, but possibly to deficits in other nonverbal cues. Thereby, the present study is aimed at investigating if a different group of nonverbal cues will reveal a nonverbal perception deficit in ASD. Specifically, the present study will be focused on how individuals with ASD perceive social traits from emotionally neutral faces.
Social Difficulties on the Autism Spectrum

ASD was originally defined as an innate inability to form the biologically provided affective contact with people, and children with ASD were described as being self-absorbed, emotionally cold, distanced, retracted and indifferent to other people (Kanner, 1943; Asperger, 1944). Since then, ASD has progressed into an umbrella-term that encapsulates a number of disorders on a continuum, e.g., the autism spectrum (APA, DSM-V, 2013). This continuum describes a set of neurodevelopmental disorders that are defined on the basis of two core criteria, from which the severity of one’s symptoms determines one’s level of ASD and position on the spectrum. The first criterion is defined by lasting difficulties in social interaction. These difficulties are manifested in a lack of socio-emotional reciprocity, reduced understanding and use of nonverbal cues like body language, facial expressions or eye contact, reduced understanding and interest in social situations, incomprehension of the coherence between verbal and nonverbal communication (Lord et al., 2000; World Health Organization, 2011), and a difficulty in understanding, regulating and maintaining relationships. The second criterion is defined as a restricted range of interests and activities. This includes repetitive motor- as well as behavioral patterns, like a stereotypical verbal and body language, disinclination to change, and sensory hypersensitivity (APA, DSM-V, 2013). Although these criteria define different groups of symptoms, they both contain characteristics that may explain the emergence of social struggle in individuals with ASD.

The reduced ability to interact in social situations causes great psychological distress for individuals with ASD (Forgeot d’Arc et al., 2016). In childhood, children with ASD are subjects of bullying more often than TD peers or siblings (Zablotsky, Bradshaw, Anderson & Law, 2013), and although some of the motor symptoms associated to ASD may decrease exponentially with aging (Billstedt, Gillberg, & Gillberg, 2007), the social difficulties often persist throughout their lives (Tobin, Drager, & Richardson, 2014). In fact, on a group level, adults with ASD experience more loneliness and social exclusion, and have fewer social relationships (Bauminger & Kasari, 2000; Lasgaard, Nielsen, Eriksen & Goossens, 2010; Levy & Perry, 2011) and more difficult romantic relationships (Levy & Perry 2011; Renty & Roeyers, 2007), compared to TD individuals. ASD is also associated to an overall reduced quality of life (Billstedt, Gillberg, & Gillberg, 2011; Howlin, 2000; Lin, 2014; Renty & Roeyers, 2006), and higher rate of suicide and suicidal thoughts (Cassidy, Ropar, Mitchell & Chapman, 2014), compared to TD individuals. Taken together, social impairment may be considered as the most profound feature of ASD, possibly leading to a number of psychological issues. A better understanding of the ASD point of view in social situations would illuminate how friction and misunderstandings in social situations occur. By extension, a greater understanding of how TD and ASD individuals differ in their perception of the components of social situations could possibly reduce misunderstandings, conflicts and distress in the future.

Prior research on the perception of nonverbal information in individuals with ASD has been primarily focused on the perception of basic emotions conveyed in faces (Uljarevic & Hamilton, 2012; Nuske, Vivanti & Dissanayake, 2013). Although individual studies on ASD and perception of emotions are fragmented in their opinions of whether or not ASD is associated to a general emotion-reading deficit, two meta-analyses have revealed that despite a humble effect size, difficulties with emotion reading may be considered to be a diagnostic marker of ASD (Lord et al., 2000; APA, DSM-V, 2013; Uljarevic & Hamilton, 2012; Nuske, Vivanti & Dissanayake, 2013). However, difficulties with emotion reading is also typical for alexithymia, which is a sub-clinical condition defined as a difficulty to express, perceive and describe emotions of others and themselves (Nemiah, Freyberger & Sifneos, 1970). Some researchers have suggested that it is the presence of alexithymia, or emotion-blindness, that explains the ambiguous body of knowledge on emotion-recognition ability on the autism spectrum (Bird & Cook, 2013; Cook, Brewer, Shah & Bird, 2013). Individuals with alexithymia can often come across as lacking empathy, acting self-
centered or seeming bored or distant in conversations – much like Kanner’s (1943) earliest descriptions of autistic children. Intriguingly, alexithymia is present in 40-65% of the autistic population (Berthoz & Hill, 2005), but despite their frequent co-occurrence (Bird & Cook, 2013), alexithymia does not ensure that someone is autistic; nor does an autism diagnosis ensure that one has got alexithymia. In fact, recent reports have shown that differences between ASD and TD individuals in emotion reading tasks are not attributable to the autism diagnosis, but the presence of alexithymia (Bird & Cook, 2013; Cook et al., 2013). Therefore, one explanation for the ambiguous body of knowledge on emotion reading ability in ASD could be that it is the level of alexithymia that determines one’s ability to read emotions, and not the autism diagnosis per se, e.g., the alexithymia hypothesis of autism. Assuming that level of alexithymia predicts basic emotion reading ability from faces, could by extension mean that level of alexithymia could also predict other types of nonverbal information from faces.

Furthermore, some reports suggest an intact ability in ASD populations to accurately recognize basic emotions, alongside a disadvantage in their recognition of ambiguous and complex facial expressions (Adolphs, Sears & Piven, 2001; Baron-Cohen, Wheelwright & Jolliffe 1997; Philip et al., 2010). Consequently, some researchers have turned from investigating perception of facial expressions of basic emotions (anger, happiness, fear) to investigating face perception on a more ambiguous spectrum (trustworthiness, attractiveness, dominance). Surely, basic emotions as conveyed through facial expressions provide information that helps us govern our behavior in concordance with our social context. However, an interpretation of someone’s mental state is not confined to the impression of their emotional dimensions, but also their social dimensions. A growing body of evidence suggests that people rapidly and coherently attribute social traits to faces that are emotionally neutral (Todorov, Olivola, Dotsch & Mende-Siedlecki, 2015; Todorov, Pakrashi, & Oosterhof, 2009; Zebrowitz & Montepare, 2005). For example, a big-eyed, plump-cheeked face will elicit a different social response compared to a tired, haggard-looking face. Assuming that our judgments of social dimensions from faces are an extension of nonverbal communication leads us back to the association between ASD and social impairment. In order to understand why and how individuals with ASD are impaired in their social functioning, one starting point is to investigate how these individuals interpret social dimensions from emotionally neutral faces.

First Impressions of Social Traits Predict Social Outcome

The initial piece of nonverbal information that we acquire from our peers is most likely the components that constitute a first impression (Albright, Kenny & Malloy, 1988). Asch (1946) described impression formation as an automatic conclusion about someone’s character derived from a rapid judgment of his or her appearance. In fact, as little as a 34-millisecond exposure to an emotionally neutral face is enough for us to form an impression about their personality, like whether or not we experience them to be trustworthy or dominant (Todorov, et al., 2009), and although first impressions are based on a very limited amount of information (Ambady, Bernieri, & Richeson, 2000), that impression is likely to persist and proceed to govern our social behavior, despite future character revisions (Lutz-Zois, Bradley, Mihalik & Moorman-Eavers, 2006; Selfhout, Denissen, Branje & Meeus, 2009; Sunnafrank & Ramirez, 2004). Consequently, first impressions are significant predictors of how we are likely to behave in social situations.

Since the early 20th century, there has been high consensus among researchers in that humans attribute specific personality traits to specific appearances (Todorov et al., 2015). Despite claims made by early researchers that specific facial traits correspond directly to one’s personality traits (Lombroso, 1876/2006; Galton, 1907), to date, no such scientific evidence exists (Olivola & Todorov, 2010). However, the idea that people attribute specific personality traits to specific facial
appearances remains intact (Todorov et al., 2015; Rule & Ambady, 2008; Willis & Todorov, 2006), indicating that specific appearances elicit specific responses consistently in a population. Gibson (1979) stated that human faces provide adaptive information about the social interactions they afford, meaning that social significations of faces predict social outcome. For example, it has been reported that an aggressive looking face elicits avoidance and defensive responses (Balaban, 1995; Marsh, Ambady, & Kleck, 2005) and thick eyebrows and wide jawbones are perceived as dominant (Petrican, Todorov, & Grady, 2014; Willis & Todorov, 2006), whilst attractive faces are associated to traits like outgoing, socially competent, intelligent, healthy and sexually responsive (Eagly, Ashmore, Makhijani & Longo, 1991; Feingold, 1992; Langlois, Rubenstein, Larson, Hallam & Smoot, 2000; Zebrowitz, Hall, Murphy & Rhodes, 2002; Zebrowitz & Rhodes, 2004) and having a higher upward economic mobility (Elder, 1969). Conversely, asymmetrical and less attractive faces are perceived as less intelligent and less healthy (Rhodes et al., 2001; Zebrowitz et al., 2002; Zebrowitz and Rhodes, 2004).

Specific appearances also predict social outcomes beyond our everyday interactions, as attractive individuals are often advantaged in occupational settings and the juridical system (Langlois et al., 2000; Zebrowitz, 1997), and politicians with competent-looking faces have a higher likeliness of electoral success in the U.S. compared to baby-faced individuals (Todorov et al., 2005; Antonakis & Dalgas, 2009; Poutvaara, Jordahl & Berggren, 2009). Moreover, judgments of untrustworthiness also predict sentencing decisions (Blair, Judd & Chapleau, 2004), such as death versus life sentences among convicted murderers (Wilson & Rule, 2015). However unlikely it may sound that physical appearance predicts outcomes like whether or not you win the election or receive the death penalty, this evidence is based on a high inter-rater consensus across different populations (Todorov et al., 2015).

Some have explained the attribution of specific traits to specific faces to the overgeneralization effect (Zebrowitz, 1996; 1997; Zebrowitz & Montepare, 2006), which poses that a face’s resemblance to an emotional state may be misattributed to a personality trait that is associated to that state (Said et al., 2009). For example, a face that resembles happiness is perceived as more trustworthy than a face that resembles aggressiveness (Montepare & Dobish, 2003; Oosterhof & Todorov, 2009; Said, Sebe, & Todorov, 2009). Thereby, the overgeneralization effect can help explain wherein the judgment of a face emerges. Whether we like it or not, judgments of our peers’ physical appearance guides us when we adapt to our environment, and by extension, adds to our overall ability to interact based on nonverbal cues within our social context (Hassin & Trope, 2000; Todorov et al., 2008; Todorov et al., 2015; Zebrowitz & Montepare, 2008).

**Social Judgments from Faces in Individuals on the Autism Spectrum**

Current knowledge on the judgment of social dimensions has been primarily focused on TD populations. Consequently, less is known about how clinical groups distinguished by a social interaction deficit perceive these seemingly universal social attributes. So far, it is agreed that abnormal judgments of nonverbal expressions may explain part of the social interaction deficit in ASD, and that group differences between ASD and TD individuals are most prominent in experimental tasks with complex or ambiguous nonverbal expressions (Uljarevic & Hamilton, 2012; Nuske, Vivanti, Dissanayake, 2013). However, research on how individuals with ASD judge social traits specifically is so far scarce as well as inconclusive. Individuals with ASD have been reported to both perform similarly (Walsh, 2016) and abnormally (Adolphs et al., 2001) compared to TD individuals in judgments of trustworthiness, as they rate untrustworthy faces abnormally high (e.g., more trustworthy), compared to TD individuals (Adolphs et al., 2001). Moreover, individuals with ASD have been reported to recognize higher-order social/mental states that are signaled by the eyes (e.g., flirtatiousness) abnormally (Baron-Cohen, Wheelwright & Joliffe, 1997). Furthermore,
Adolphs et al., (2001) reported that individuals with ASD rated socially negative faces as less negative than the control group, whilst giving ratings similar to the control group on socially positive faces. In the same turn, Philip et al., (2010) reported significant differences between ASD and TD groups in their judgment accuracy of faces displaying ‘trustworthiness’, ‘attractiveness’ and ‘approachability’. In conclusion, individuals with ASD are supposedly less sensitive to subtle social signals compared to TD individuals, in addition to possibly having a normative ability to perceive basic emotions (Philip et al., 2010), suggesting a specific rather than global face-processing deficit. Taken together, these studies demonstrate a likeliness of abnormal social judgments from faces in individuals with ASD, but the results are somewhat inconclusive. Further scientific investigation is therefore needed before we know why, and how it is, that individuals with ASD find some facial features harder to recognize than others.

Summary
Research so far indicates that impairment in social interaction in part can be predicted by ability to communicate nonverbally. Nonverbal communication is in part constituted by the formation of first impressions, which in turn can be understood by investigating how people judge both emotional and non-emotional faces. Although research on ASD and face perception suggests a group disadvantage in judgment accuracy of complex emotional expressions, less is known about how ASD individuals form first impressions, and how they judge social dimensions specifically from emotionally neutral faces. Further research is needed before it can be determined how individuals with ASD perceive nonverbal information, and by extension, interpret and act in accordance to their social context.

Aim of study
The present study is aimed at investigating if individuals with ASD perceive social traits differently compared to TD individuals, and in addition, if level of alexithymia affects ability to recognize social traits.

Method
Data for the present study was collected at two occasions. Data for the ASD group was collected at centers for daily activities aimed at individuals with high-functioning autism or Asperger’s syndrome in 2016/2017. Data for the TD group was collected as part of a larger study on perception of faces and aging, conducted at the Department of Psychology, Stockholm University in 2014 and 2015 (e.g., Cortes, Laukka, & Fischer, 2016). Both groups received movie vouchers in return for their participation. The tests took approximately an hour to complete.

Participants
The sample for the ASD group included 32 clinically diagnosed young adults with normal intelligence (14 female). All participants were diagnosed with Asperger’s Syndrome or High functioning autism (one participant with atypical autism). High-functioning autism or Asperger’s syndrome includes typical autistic traits such as repetitive interests and activities, but the language and intellectual ability is usually intact (APA, DSM-V, 2013). Out of these 32 participants, 24 had co-morbid disorders such as ADHD (7 people), ADD (6 people), depression (4 people), anxiety disorder (5 people), bipolar disorder (1 person), Tourette’s syndrome (1 person), schizophrenia (1 person) and PTSD (1 person). All participants in the ASD group receive occupation at daily activity centers in Stockholm, Sweden. To qualify for daily activity service, a person must have been granted LSS, which is the Swedish act on Support and Services for Persons with Certain Functional Impairments, meaning that they are of working age, but their functional impairment (in this case ASD) prevents them from joining the labor force or going to into education. The aid officer of the
The ages in the ASD group ranged between 20 and 35 years ($M = 26.25$, $SD = 3.66$).

The TD group included 67 healthy participants with normal intelligence (35 female), with the majority being students at Stockholm University. Ages within the TD group ranged between 18 and 30 years ($M = 23.34$, $SD = 2.85$).

**Material**
Apart from two surveys in paper form that were used for the ASD group, both groups conducted the same computerized face-perception test, using MediaLab software (Jarvis, 2010). Lenovo gaming laptops were used for the ASD group, and stationary Hewlett-Packard computers were used for the TD group.

**Procedure**
Before each testing, participants in both groups signed an informed consent form that described the purpose of the study, outlined the nature of the tests and provided a guarantee that the test results will be untraceable back to separate individuals, and that each participant is free to decline from the study at any time during the test. Tests were not conducted until each participant had read and signed the informed consent form. Participants for the ASD group were recruited from information ads sent to the activity centers by email, with a description of the purpose of the study and what their contribution would entail, including a description of the tests, estimated time to finish the tests, and a vow that they would remain anonymous. Appointments to carry out the study were booked as soon as the activity centers responded that they had individuals who were interested in participating. Data for the ASD group was collected individually in quiet, secluded rooms at the activity centers. Participants in the TD group were recruited from paper ads on pin boards at Stockholm University and from Studentkaninen.se, which is a website that compiles scientific studies in need of test subjects. Stationary computers and high quality headphones were used. Bookings for the experiment were made based on the convenience of the participant and the experiment leaders.

**Diagnostic measures of ASD**
Because level of autism is negatively associated to face reading ability, the Ritvo Autism Asperger's Diagnostic Scale (RAADS-14) was used as a supplemental assessment tool for level of autistic traits in the ASD group in the present study. The RAADS-14 survey is a shortened version of the RAADS-R, which is a screening tool designed to assess prevalence of autistic traits (Eriksson, Andersen, Bejerot, 2013). The RAADS-14 includes 14 statements that are organized into three subscales, e.g., mentalizing deficits (MD), sensory reactivity (SR) and social anxiety (SA). The participant is asked to rate each statement in RAADS-14 as “True now and when you were younger (<16 years old)” (1), “True only now” (2), “True only when you were younger” (3), or “Never true” (4). The final test score of the RAADS-14 ranges between 0 and 42, where scores > 31 points indicate that autism is found, 14-30 points indicate likeliness of autism, and scores < 13 points indicate no autistic symptoms. In a clinical trial (Eriksson et al., 2013), adults ($n = 135$) with normal IQ and high-functioning autism scored a median of 32 points on the RAADS-14, compared to a group of TD adults ($n = 590$) who scored a median of 3 points. The ASD group in the present study scored a mean of 25.7 points (SD=8.9), indicating a likeliness of autism in the group. Cronbach’s alpha analyses revealed $\alpha = .70$ for the total RAADS-14 scale, $\alpha = .69$ for the MD subscale, $\alpha = .63$ for the SR subscale, and $\alpha = .47$ for the SA subscale.
**Alexithymia**

For the present study, level of alexithymia in the ASD group was assessed in order to investigate possible associations with perception of social traits. Alexithymia was assessed with the TAS-20, which is a 20-item self-report scale (Bagby, Parker & Taylor, 1994). TAS-20 is divided into three subscales that are difficulty-describing feelings (DDF), difficulty identifying feelings (DIF) and externally oriented thinking (EOT). Each item describes a statement, which is rated using a 5-point Likert scale where 1 = strongly disagree and 5 = strongly agree. The TAS-20 test score is the sum of all 20 items, and uses cutoff scoring where ≤ 51 points = non-alexithymia, 52-60 points = possible alexithymia, and ≥ 61 = likely alexithymia. Each subscale represents one distinguishing trait of alexithymia, and may be calculated separately (Bagby et al., 1994). The TAS-20 takes approximately five minutes to complete. Cronbach’s alpha analyses of the TAS-20 survey and the three subscales revealed α = .70 for the total TAS-20, α = .73 for DDF, α = .80 for DIF, and α = .49 for EOT.

**Social Judgments**

Judgment of social dimensions from faces was measured using the Computer-Generated Faces (CGF) of Oosterhof and Todorov (2008; 2011). CGF is a set of synthetic, emotionally neutral, Caucasian faces that represent specific social traits. CGF is based on the assumption that trait inferences from faces originate from a functionally adaptive mechanism, meaning that facial similarities of expressions that signal avoidance- or approach behavior will evoke a corresponding response (Todorov et al., 2008). Specifically, the CGF is based on a set of photographs of faces that signal approach or avoidance behavior, which have been translated to computer-generated faces that represent the intended trait (Todorov et al., 2008). Consequently, this data-driven approach can be used to exaggerate or reduce facial features associated to a social trait, and by extension, enables the possibility to carefully manipulate facial features into optimal representations of specific social traits (Todorov et al., 2008).

In the present study, a set of 7 social dimensions (attractiveness, competence, dominance, extraversion, likeability, threat, and trustworthiness) presented in seven levels of distinctiveness (LD), (ranging from -3 to 3) was used (see Figure 1). Stimuli were presented in 7 blocks (one block per social dimension) of 4 different faces x 7 LDs (28 items) for a total of 196 items. Subjects were asked to rate each social dimension, for example trustworthiness, on a scale ranging from 1 (Not trustworthy) to 9 (Very trustworthy). The CGF experimental task took approximately 20 minutes to complete.

![Figure 1: Examples of Computer Generated Faces (CGF) from Oosterhof and Todorov (2011). The example shows seven levels of trustworthiness. (Used with permission).](image-url)
Results

Results Section 1: Comparing Social Perception between ASD and TD

A 7x2 mixed-design ANOVAs with level of trait-distinctiveness (LD) (ranging between -3 and 3) as within-participants factor, and diagnosis (ASD/TD) as between-participants factor were calculated separately for the ratings of each social dimension. Mean ratings for each social dimension are shown in Figure 2, for both the ASD and TD group and each LD. No significant main effect of group (diagnosis) was found for any of the social dimensions. However, a trend appeared which suggested a difference between groups in their ratings of attractiveness was detected: \( F(1, 97) = 3.83, p = .053 \), \( \eta^2 = .04 \).

Main effects of LD were found for all dimensions: Attractiveness, \( F(6, 582) = 131.07, p < .001, \eta^2 = .57 \); Competence, \( F(6, 582) = 154.90, p < .001, \eta^2 = .06 \); Dominance, \( F(6, 582) = 188.02, p < .001, \eta^2 = .66 \); Extraversion, \( F(6, 582) = 224.12, p < .001, \eta^2 = .70 \); Likeability, \( F(6, 582) = 167.54, p < .001, \eta^2 = .62 \); Threat, \( F(6, 582) = 272.79, p < .001, \eta^2 = .73 \); and Trustworthiness \( F(6, 582) = 93.59, p < .001, \eta^2 = .49 \), indicating that ratings from both groups increased in accordance with the increased LD in each social dimension.

Significant interaction effects for group x LD were observed for Competence, \( F(6, 582) = 3.84, p < .001, \eta^2 = .02 \), and Likeability, \( F(6, 582) = 4.84, p < .001, \eta^2 = .002 \). Trend level interactions were also observed for Dominance \( F(6, 582) = 1.75, p = .074, \eta^2 = .01 \), and Threat \( F(6, 582) = 1.98, p = .067, \eta^2 = .01 \). The interactions in ratings of these social dimensions indicate that ratings of the ASD group were overall more modest in the far ends of the LDs compared to ratings of the TD group. Results of Fisher’s LSD post-hoc tests revealed that the scores of the ASD and TD groups differed significantly (\( p < .05 \)) for LD 2 and 3 of Likeability. No other post-hoc pairwise comparisons were statistically significant.
Figure 2.
Mean ratings of the ASD and TD groups for each LD in each social dimension are presented in panels (a) to (g), where the y-axis represents CGF test scores ranging between 1 (not at all distinctive) and 9 (very distinctive).
Results Section 2: Effects of level of alexithymia and autistic traits

The ASD group was divided into groups scoring high- and low on TAS-20 and RAADS, respectively, using median split (see Table 2 for descriptive statistics for the high- and low-score groups). Separate 7x2 mixed ANOVAs were calculated for each social dimension and each control variable (TAS-20 and RAADS), with LD as a within-subjects variable (7 levels) and group (2 levels: high and low scoring group) as a between-subjects variable.

Table 2: Descriptive Statistics for mean scores in the high/low scoring groups of RAADS-14 and TAS-20.

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<th>Mean (SD)</th>
<th>Range</th>
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<tbody>
<tr>
<td>TAS-20</td>
<td>Low</td>
<td>16</td>
<td>46.93 (7.15)</td>
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<tr>
<td></td>
<td>High</td>
<td>16</td>
<td>62.44 (4.26)</td>
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<tr>
<td>RAADS-14</td>
<td>Low</td>
<td>16</td>
<td>18.56 (5.24)</td>
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<tr>
<td></td>
<td>High</td>
<td>16</td>
<td>32.81 (5.36)</td>
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Level of alexithymia

No significant group differences in ratings of social dimensions based on level (high/low) of alexithymia (Level of TAS) were found for any social dimension. Significant interaction effects between Level of TAS x LD in each social dimension were found for Attractiveness, F(6, 180) = 2.41, p = .039, η² = .031, Likeability, F(6,180) = 3.35, p = .004, η² = .043, and Extraversion, F(6, 180) = 2.17, p = .048, η² = .017. The interactions are displayed in Figure 3 and suggest that mean scores of the high alexithymia group are higher in the lowest LD:s compared to the low alexithymia group, and lower in the highest LD:s compared to the high alexithymia group for these social dimensions. Results of Fisher’s LSD post-hoc tests revealed no significant pairwise differences between the high and low Level of TAS groups for any of the social dimensions for which significant interaction effects were observed.

Figure 3. Mean ratings of the high- and low TAS groups for each LD in each social dimension are presented in panels (h) to (j), where the y-axis represents test scores ranging between 1 (not at all distinctive) and 9 (very distinctive).
Level of autism

No significant group differences in ratings of social dimensions based on level (high/low) of autism (Level of RAAADS) were found for any social dimension. Furthermore, no interaction effects of Level of RAAADS x LD were observed.

Discussion

The present study was aimed at investigating if ASD and TD individuals differ in their judgments of social traits from emotionally neutral faces, and also if level of alexithymia affects judgments of social dimensions. This question was derived from the assumption that individuals with ASD are impaired in their social functioning, possibly as a result of a face-processing deficit in the interpretation of complex facial expressions.

Attractiveness was the only social dimension that generated a considerable difference in ratings between the ASD and TD group in the present study. Specifically, the ASD group rated each face on the attractiveness dimension higher (e.g., more attractive) than the TD group, although this difference did not reach conventional criteria for statistical significance (p = .053). Prior studies where measures of social traits similar to the ones of the present study have been used, have also reported abnormal judgments of attractiveness in ASD (Best, Wilkinson, Strauss & Minshew, 2009; Philip et al., 2010; Roy, Dillo & Osterhagen, 2016). For example, Best et al., (2009) reported abnormal ratings of attractiveness alongside normative ratings of unattractive faces, and Roy et al. (2016) found a stronger randomization in attractiveness ratings in ASD individuals compared to controls. These results indicate that ASD individuals experience a higher level of uncertainty in ratings of attractiveness, and by extension, a lower sense of facial attractiveness. This uncertainty is proposed to result from a reduced ability to judge facial attractiveness in respect to averageness, meaning that individuals with ASD can distinguish atypical or non-average faces as being unattractive, but do not necessarily perceive averageness as something attractive (Best et al., 2009).

Significant interaction effects between group and LD were found for Competence and Likeability, alongside interaction trends for Dominance and Threat. In these cases, the ASD group rated the lowest LDs for Competence and Likeability higher than the TD group, and the highest LDs as lower than the TD group. More specifically, the ASD group ratings showed a higher variability in ratings on the far ends of the LD spectrum for Competence and Likeability compared to the TD group, resulting in less extreme group means. This result could be interpreted as an increased incertitude towards more exaggerated facial features in the ASD group. Prior reports have presented similar indications to the ones obtained in the present study (Roy et al, 2016). Despite the fact that no significant group differences were observed for ratings of Trustworthiness in the present study, Adolphs et al., (2001) reported that individuals with ASD rated untrustworthy faces as more trustworthy than TD individuals, thereby supporting the suggestion that exaggerations of facial features elicit a higher level of uncertainty in the ASD group. Although some effects of group (ASD/TD) and LD across the social dimensions were detected, it is clear that the mean ratings of each LD for each social dimension were very similar between these groups, especially for Extroversion and Threat. The similarity of these ratings indicates that the CGF test elicits very coherent responses, even between groups that are presumed to differ in ability to perceive facial expressions. However, if we assume that perception of social dimensions actually is an extension of perception of complex emotional expressions, the present results indicate that the CGF test does not capture the presumed between group difference in perception of facial traits. Although ASD has been previously associated with reduced sensitivity in perception of facial expressions, no differences in ratings of social dimensions with respect to low- or high ASD group
were observed in the present study. Prior research on perception of faces on the autism spectrum and its relationship to emotion recognition ability has shown that one can be autistic without being impaired in perception of emotional expressions (Philip et al., 2010; Baron-Cohen et al., 1997). In line with this notion, the ASD-group of the present study scored a mean that confirmed the presence of autism, but no difference in perception of social traits was detected between the high- and low scorers of autistic traits. An initial interpretation of these results was that ASD, alongside social interaction deficits, is distinguished by traits that are not directly associated to ability to perceive facial expressions. This is reflected in the autism measure used in the present study, as the three subscales of the RAADS-14 (mentaling deficits, sensory reactivity and social anxiety), are not representative measures for face perception or social interaction. If emotion recognition ability and ability to make judgments of social dimensions were related, it would indicate that group differences in level of autistic traits should also be determinants of ability to perceive social dimensions. However, no such relationship was detected in the present study. This suggests that even if an assessment of level of autism indicates presence of autism in a group of individuals, that assessment will not automatically guarantee abnormal perception of complex facial expressions such as social dimensions. A further interpretation was that the reduced ability to perceive emotional expressions in ASD is not related to judgments of social dimensions, meaning that the perception of emotional and emotionally neutral faces reflect separate face reading abilities. Although perception of social dimensions in all likeliness does not explain the social interaction deficit in ASD, the fact still remains that one or more components of the nonverbal realm impedes the understanding of social situations in individuals with ASD (World Health Organization, 2011; Lord et al., 2000).

An initial calculation showed no main effect of alexithymia on overall ratings. However, significant interaction effects were found for Attractiveness, Likeability and Extraversion. More precisely, for these social dimensions, the high alexithymia group scored items with the lowest LD as higher than the low alexithymia group, and items with high LD as lower than the low alexithymia group. Post-hoc pairwise comparisons did not reveal significant differences between LDs of these dimensions, indicating that ratings of LDs were very similar between groups. No prior studies have investigated the impact of alexithymia on social judgments of faces specifically. Consequently, the relationship between alexithymia and social judgments from faces observed in the present study are interpreted tentatively. First, although the high-alexithymia group ratings of each LD increased linearly in relation to the LD of Attractiveness, Likeability and Extraversion, the far ends of the LD spectrum were rated more modestly (e.g., less extremely) than the low alexithymia group. This result suggests that individuals in the high alexithymia group are able to distinguish between LDs, but with less certainty and more modesty than the low alexithymia group. Second, an individual born with alexithymia was also possibly born with a reduced ability to integrate perceptions of facial expressions to the impression of traits in a social personality. By extension, an individual with alexithymia in all likeliness uses more distinguishable cues, like the sum of unmistakable expressions and contents of verbal speech, to form an impression of someone’s social traits.

Furthermore, in the present study and in prior studies, it has been assumed that individuals who are generally considered to be impaired in nonverbal reciprocity (e.g., individuals with ASD or high alexithymia) use the same semantic labels for nonverbal language as TD individuals. The argument here is that although ASD and TD individuals both have an idea of what constitutes a trustworthy person, there is no guarantee that this judgment is derived from the same cues (e.g., is trustworthiness a behavior or a physical appearance?). Specifically, if we have two groups that initially differ in the in-group criteria for what constitutes a trustworthy person, the group differences might not be entirely comparable. In conclusion, it is proposed that individuals with reduced ability to communicate nonverbally may use different measures for judging social
dimensions, meaning that the mere exposure of a neutral face is not enough to judge whether or not the faces are attractive, likeable or extrovert.

**Limitations and Future Directions**

Limitations of the present study were principally most incident to statistical power and methodology. First, the present study was limited by a small sample size of the ASD group \( n = 32 \), and the use of median split in the comparison of the high/low levels of autism and alexithymia groups, both of which are likely to have resulted in a lower statistical power than desired. Although it was acknowledged that the use of median split implies a significant information loss, alternative analyses (e.g., regression analysis) were not considered to yield as conclusive results for the present study. For example, although regression analyses would have revealed the relationship between ratings for each LD in each social dimension and level of autism/alexithymia, the results would have been incalculable and difficult to interpret as separate analyzes would have been required for each LD.

Furthermore, the present study was based on the assumption that emotion-recognition ability is related to judgments of social dimensions, because both are derived from the interpretation of faces. However, before such a statement can be validated, further investigation of the relationship between perception of basic emotions and social dimensions is necessary – that is, whether or not social dimensions are an extension of our emotional language, or if they are a separate spectrum of nonverbal cues. By extension, the present study and future studies would benefit from a complementary basic emotion-recognition test and an alexithymia test for the TD group. In that way, it would be possible to establish the relationship between emotion-recognition ability and judgments of social dimensions, and to either confirm or dismiss the idea of presence of alexithymia as overall predictor of ability to make social judgments.

Taken together, one could either argue that there is need for more sensitive measures of social interaction, or that the face-perception deficit in ASD is due to individual differences within the group. For example, some have argued that synthetic pictures of faces are not as ecologically valid measures as dynamic recordings of people, because they do not elicit a response similar to real-life encounters (Uljarevic & Hamilton, 2012; Nuske, Vivanti & Dissanayake, 2013). Furthermore, it has been proposed that presence of alexithymia determines one’s emotion-reading ability, and not the mere ASD diagnosis. Assuming that emotion-reading ability from faces is associated to a general face-reading ability, leads to the conclusion that measures of alexithymia are vital before one can draw conclusions on the nature of face-reading ability in individuals with ASD. These points should be taken into account before drawing conclusions about how social judgments correspond to the forming of an impression of a person in a real-life interaction in populations of individuals with ASD.

**Conclusions**

Although no significant group differences were observed between the ASD and TD group in ratings of social dimensions, results of the present study indicate that the highest and lowest Lds for Competence and Likeability yielded notable differences in ratings between groups. Similarly, the individuals in the high Alexithymia group made different social judgments of faces displaying very high or very low LDs in Attractiveness, Likeability and Extraversion compared to the low Alexithymia group. These results converge in that the highest and lowest LD ratings for these social dimensions were rated more modestly in the ASD and high Alexithymia group, compared to the TD and low Alexithymia group. In the same turn, no differences between the high and low ASD groups were detected, even though ASD is generally associated to an overall face perception deficit. Taken together, these results indicate that the ASD diagnosis in itself does not entail an abnormal ability to
make social judgments of faces. Rather, a separate trait within the ASD diagnosis, such as alexithymia, could be a possible determinant of ability to make social judgments from faces.

It is known that social dimensions conveyed by first impressions are important indicators of how a social interaction will proceed. However, many questions regarding initial assumptions and methodology must be answered before we can form a general idea of how individuals with ASD use nonverbal cues such as judgments of social dimensions to understand, and adapt, to their social environment.
Reference List


Galton, F., (1907), Vox Populi.


