

RESEARCH REPORT

Non-linguistic comprehension, social inference and empathizing skills in autistic young adults, young adults with autistic traits and control young adults: Group differences and interrelatedness of skills

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Abstract

Background: Despite increasing knowledge of social communication skills of autistic people, the interrelatedness of different skills such as non-linguistic comprehension, social inference and empathizing skills is not much known about. A better understanding of the complex interplay between different domains of social communication helps us to develop assessment protocols for individuals with social communication difficulties.

Aims: To compare the performances of autistic young adults, young adults with autistic traits identified in childhood and control young adults in social communication tasks measuring non-linguistic comprehension, social inference and empathizing skills. In addition, to examine associations between the different social communication measures.

Methods & Procedures: Autistic young adults ($n = 34$), young adults with autistic traits ($n = 19$) and control young adults ($n = 36$) completed the extra- and paralinguistic scales of the Assessment Battery for Communication (ABaCo), the

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Faux Pas Recognition Test, Social–Pragmatic Questions (SoPra) and the Empathy Quotient (EQ).

Outcomes & Results: Group differences were found in the performance in the ABaCo, SoPra and EQ scores. Compared with the control young adults, autistic young adults scored lower. The performance of the young adults in the autistic traits group fell in between the other two groups. There were no group differences in the Faux Pas Recognition Test. The variability within the groups was large in all measurements. In the control group, there was a significant correlation between EQ and SoPra scores and between the Faux Pas and SoPra scores. In the autistic group, a significant correlation was found between Faux Pas and SoPra scores. Also, other patterns were observed but these were not statistically significant.

Conclusions & Implications: The young adults with autistic traits fell in between the control and autistic young adults, highlighting the presence of the continuum in the terms of features of social communication. The results support other current research that suggests that theory of mind and other social communication skills may not be universally or widely impaired in all autistic individuals without cognitive deficits. Although all tasks examined social communication skills, only a small number of significant correlations were found between test scores. This highlights that clinical conclusions about a person's social communication should be based on the outcomes of different types of methods measuring different aspects of social communication. It is clear that the interrelatedness of different social communication skills needs further research.

KEYWORDS

autistic adults, autism spectrum disorder, autistic traits, non-linguistic expressions, empathizing skills, social inference

What This Paper Adds

What is already known on this subject

For successful communication, the ability to infer others' emotions, intentions and mental states is crucial. Autistic people have difficulty with many aspects of social communication. However, the associations between different aspects of social communication need to be better understood.

What this paper adds to existing knowledge

The unique contribution of this study is to compare the performance of autistic people not only with that of a control group but also with people with childhood autistic traits. This provides an understanding of the interrelatedness of different social communication skills in people with varying degrees of autistic traits.

This study used four assessment methods focusing on three different social communication elements (non-linguistic comprehension, social inference and empathizing skills). These elements have complex relationships to one another, some being closely overlapping, some more distally related and some reflect more complex multifactorial elements. This study shows that although groups differ from each other in most of the assessments, the performance of different

groups overlapped showing that many autistic young adults can perform well in non-linguistic and social inference tasks in structured assessment contexts.

What are the potential or actual clinical implications of this work?

Our findings suggest that in the assessment of social communication, self-reports and clinical assessments can be used effectively together. They can complement each other, pointing out the strengths and weaknesses of a person, leading to more personalized therapeutic interventions.

INTRODUCTION

Social communication is an important component of everyday living allowing people to interact with each other in different social and societal environments. According to the American Speech–Language–Hearing Association’s (ASHA) (2022) definition, social communication is composed of pragmatics (including non-linguistic contextual comprehension), social understanding (including social inference and empathizing), social interaction and language processing. In this paper, we focus on domains of non-linguistic pragmatic comprehension, social inference and empathizing skills. Non-linguistic pragmatic comprehension encompasses interpreting meanings according to communicative context through non-verbal (e.g., gestures, facial expressions, prosodic cues) expressions. The ability to infer the intentions, dispositions and beliefs of others has been labelled the theory of mind (ToM), which is also considered part of the broader concept of social cognition, often defined as a set of the mental operations that underlie social interactions, including perceiving, interpreting and generating responses to the intentions, dispositions and behaviours of others (Tirassa & Bosco, 2008). In everyday conversations, contextual comprehension is closely connected with social inference skills, which enables mutual understanding of intentions and mental states when engaging in communicative interaction. In addition, emotional empathy is needed to readily understand other people’s emotions. This helps to respond to others appropriately in various communicative situations. Different domains of social communication interact with each other in a complex way (Perkins, 2007) although the topic is still quite debated in the literature (Bosco & Gabbatore, 2017; Matthews et al., 2018). For example, Bosco and Gabbatore (2017) found that in typically developing children ToM was able to explain only some of the variance in the pragmatic skills detected.

Diagnosis of autism spectrum disorder (ASD) is characterized by impairments in the development of communication and social skills and the presence of stereotyped behaviour, interests and activities (World Health Organization (WHO), 2019). The population prevalence

of ASD diagnosis has varied over time and currently it is reported to be even 1.5% in developed countries with recent increases primarily among those whose cognitive abilities are within normal range (e.g., Lyall et al., 2017).

Current evidence places autistic traits on a continuum in the general population where autistic persons¹ represent the end of this continuous distribution (e.g., Focquaert & Vanneste, 2015). Often in clinical assessment, it has been recognized that a person has some autistic-like traits, but not sufficient for a diagnosis. In the general population, higher autistic traits have been connected with challenges in social and pragmatic functioning, such as difficulties in interpreting non-verbal communication (Ingersoll, 2010; Jobe & White, 2007). At the moment, we do not know precisely whether a child with autistic-like traits will ‘grow out’ of these features or whether these features will be present in adulthood. At the moment, there are very few studies that compare a group of persons with autistic traits (but no diagnosis) to autistic persons who meet the criteria for an ASD diagnosis (Yang et al., 2022).

Studies have shown that there are both similarities and differences in autistic persons’ processing of social communication situations (e.g., Deliens et al., 2018; Dindar et al., 2022; Kotila et al., 2020; Lönnqvist et al., 2017). The challenges in social communication vary individually from mild to severe and may include difficulties in inferring a meaning from context (Baixauli-Fortea et al., 2019; Dindar et al., 2022; Jolliffe & Baron-Cohen, 2000), understanding mental states in ironic utterances (Deliens et al., 2018) or providing novel and relevant information in conversation (Sng et al., 2018). During the last decades, different reasons to the social communication features of autistic persons have been suggested. One of the suggestions is that autistic persons prefer systemizing over empathizing (e.g., Baron-Cohen & Wheelwright, 2004a). Empathizing includes both cognitive component of empathy (identifying with someone else’s or one’s own mental states, that is, ToM) and affective empathy (an emotional reaction to others’ thoughts and feelings).

There is a high degree of interrelatedness among different social communication components. For instance, in

Happé (1993), a connection between ToM ability and ironic understanding was found in autistic persons suggesting that in the autistic person the ability to understand other's belief states is essential to pragmatic comprehension. Later the connection between pragmatic skills and ToM in autistic children was also found by Baixauli-Fortea et al. (2019). Since pragmatics refers to the social aspect of language it is not surprising that significant relationship has also been found between pragmatic language and social information processing skills in autistic and non-autistic persons (Russo-Ponsaran et al., 2015). However, the existing studies about the interplay between different components of social communication seem not sufficient to disentangle the nature of this relationship. It is not known whether the relationship is similar in the broad autism phenotype varying from non-autistic persons to persons who have autistic traits to autistic persons. Studying the interplay between different social communication components is also methodologically challenging since for example when assessing high-level processing of pragmatic language or ToM, these skills are often difficult to separate from each other and for example many advanced ToM tasks demand also pragmatic processing, and vice versa (see also Loukusa & Moilanen, 2009).

Despite increasing numbers of studies focusing on the nature of social communication in autistic people (e.g., Angeleri et al., 2016; Loukusa et al., 2014; Thiébaud et al., 2016) a better understanding of variability in people's social communicative skills is needed. In addition, often studies have investigated social and communication abilities of children, while less is known of these abilities across adulthood and how these abilities are interrelated in different populations. This study examines how young adults who have received an ASD diagnosis in their childhood, young adults who have been identified having autistic traits in their childhood (without fulfilling the criteria for the ASD diagnosis) and young adults without autistic traits in their childhood: (1) interpret contextually complex situations where intentions are conveyed using non-linguistic expressions; (2) make social inference when answering questions that focus on Faux Pas and social-pragmatic inferencing; (3) assess their own empathizing skills; and (4) whether and how the understanding of non-linguistic expressions, social inference and empathizing skills are interrelated.

METHOD

Participants

In this study, good scientific practice and the guidelines of the National Advisory Board on Research Ethics were followed in order to perform an ethically acceptable study

with reliable results. Participants were part of an ongoing multidisciplinary study 'Autism Spectrum Disorder—A Follow-up Study from Childhood to Young Adulthood' in northern Finland. A total of 34 young adults were diagnosed with ASD in their childhood (26 males and eight females; mean age = 23.7 years, SD = 3.2; 'autistic group'), 19 adults who had noticeable autistic traits in their childhood as assessed using Autism Spectrum Screening Questionnaire (ASSQ) (18 males and one female; mean age = 22.4 years, SD = 0.5; 'autistic traits group') but did not fulfil the diagnostic criteria for ASD diagnosis as assessed by ICD-10 criteria in their childhood and 36 participants without autistic traits (25 males and 11 females; mean age = 22.8 years, SD = 1.8, 'control group') participated in this study. The age of the participants in different groups did not differ significantly from each other either [$F(2, 88) = 2.23, p = 0.114$]. All participants were native Finnish speakers, born and raised in Finland, and they had no hearing impairment.

Participants of the autistic group and autistic traits group originally participated either in an epidemiological study in the Northern Ostrobothnia Hospital District area (Mattila, 2013) or in a clinic-based ASD study conducted at Oulu University Hospital (Kuusikko-Gauffin, 2011) between 2000 and 2003. Clinical ASD diagnoses according to the ICD-10 criteria were then determined based on all gathered information using consensus among a paediatrician and a child psychiatrist and/or by a psychologist who consulted, if necessary, the paediatrician, using the results from the Autism Diagnostic Interview—Revised (ADI-R) (Lord et al., 1995) and Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 2000), school day observations and patient records. The group of the persons with autistic traits consisted of participants whose diagnostic criteria (ICD-10) did not fulfil although the ASSQs had yielded medium or high scores (for more detail, see Mattila, 2013). Control participants without ASD diagnosis or autistic traits were randomly selected from the epidemiological study (Mattila, 2013) or from the participants who participated in the earlier studies by Kuusikko-Gauffin (2011) or Jansson-Verkasalo et al. (2005). In addition, two control participants were recruited outside the earlier studies in order to better match gender between the control and autistic groups [$F(2, 88) = 2.32, p = 0.102$].

During the re-recruiting in young adulthood, the autistic traits of 73 of the participants were assessed by the Finnish version of autism quotient (AQ) questionnaire whereas 16 of the participants did not return the AQ questionnaire or there were so many missing values that we could not score the AQ. In the sample of 73 participants there was a significant difference in AQ scores between groups [$F(2, 72) = 17.60, p < 0.001$] (autistic group: $M = 22.2, SD = 8.5, n = 30$; autistic traits group: $M = 15.3, SD = 7.2, n = 12$; control

group: $M = 11.7$, $SD = 5.1$, $n = 31$).² Post-hoc comparisons by Tukey HSD showed that the difference between the autistic group and the control group ($p < 0.001$) and the autistic group and the autistic traits group ($p = 0.014$) was significant.

Since language processing has a role in social communication (e.g., ASHA, 2022; Perkins, 2007), we considered whether verbal comprehension or other cognitive skills of different groups differed significantly from each other. In the present study participants' General Ability Index (GAI) was measured using Wechsler Adult Intelligence Scale—IV (WAIS-IV; Wechsler, 2008) showing that groups performed quite similarly [$F(2, 88) = 0.388$, $p = 0.679$] (autistic group: $M = 104.9$, $SD = 21.5$; autistic traits group: $M = 99.5$, $SD = 19.9$; control group: $M = 104.3$, $SD = 12.9$). When looking at language performance closer, no significant group differences were found in the Verbal Comprehension Index (VCI) [$F(2, 88) = 0.984$, $p = 0.378$] (autistic group: $M = 104.9$, $SD = 22.2$; autistic traits group: $M = 99.0$, $SD = 19.2$; control group: $M = 106.2$, $SD = 14.4$). No significant differences were found in any of the subtests either: Similarities [$F(2, 88) = 1.597$, $p = 0.208$] (autistic group: $M = 11.8$, $SD = 3.8$; autistic traits group: $M = 10.3$, $SD = 4.1$; control group: $M = 11.0$, $SD = 2.6$), Vocabulary [$F(2, 88) = 0.669$, $p = 0.515$] (autistic group: $M = 10.5$, $SD = 4.8$; autistic traits group: $M = 10.2$, $SD = 4.0$; control group: $M = 11.3$, $SD = 2.7$) or Information [$F(2, 88) = 0.1447$, $p = 0.241$] (autistic group: $M = 10.0$, $SD = 4.1$; autistic traits group: $M = 9.1$, $SD = 2.9$; control group: $M = 10.8$, $SD = 3.4$). Furthermore, there were no significant differences between groups in the Perceptual Reasoning Index (PRI) [$F(2, 88) = 0.307$, $p = 0.737$] (autistic group: $M = 103.9$, $SD = 22.1$; autistic traits group: $M = 100.3$, $SD = 19.4$; control group: $M = 101.5$, $SD = 13.9$).

Assessment material

Non-linguistic comprehension: Assessment battery for communication

Understanding of non-linguistic expressions was measured using fourteen items belonging to the extralinguistic (e.g., gestures, body movements and facial expressions) and paralinguistic (e.g., prosodic cues) scales of the Finnish version (Gabbatore et al., 2019) of the Assessment Battery for Communication (ABaCo, Form A; Bosco et al., 2012). Specifically, when looking at items on the extralinguistic scale the focus is on basic speech acts, sincere, deceitful and ironic communicative acts and when looking at items on the paralinguistic scale the focus is on basic speech acts and emotion. The items are presented as video clips where the participant is required to understand an actor's communicative–pragmatic meaning

expressed in the form of a gesture/facial expression on the extralinguistic scale and in the form of a prosodic cue on the paralinguistic scale. The ABaCo contains both open questions and multiple-choice questions (see Appendix A). During the scoring procedure each task can be assigned 1 point, when the participant correctly comprehends the actor's communicative intention or 0 when no comprehension is evident. The participants' answers are coded offline, based on video recordings of the tasks' administration and according to the manual's guidelines.

Social inference skills: The Faux Pas Recognition Test and Social-Pragmatic Questions

Social inference skills were examined using two measures. The Faux Pas Recognition Test (Stone et al., 1998) measures the ability to recognize whether someone has mistakenly said something they should not have been said or something hurtful with respect to the surrounding contextual factors in which the communicative interaction is taking place. The test consists of short stories containing Faux Pas instances which are read out loud by the examiner. A written copy of each story is also placed in front of the person, one at a time, in order to reduce memory load. At the end of each story, the participant is asked questions to determine whether or not they recognized the Faux Pas (see Appendix A for examples of the tasks). In this study, we used shortened version of the test which contains eight stories translated into Finnish by Saarenketo and Hämäläinen (Stone & Baron-Cohen, 1998). Questions of the stories were scored according to instructions based on the transcriptions of the video recordings.

We examined social inference skills also by using Social-Pragmatic Questions (SoPra) by showing the participants six video clips of complex social scenes involving multiple interlocutors and asking targeted questions about the scenes. These film scenes contain different kinds of everyday social communication situations. Each of these scenes require complex processing of meaning, intention and feeling by connecting different multimodal information, such as paralinguistic indicators, world knowledge, physical contextual cues and characters' shared knowledge. In order to interpret these contextually demanding social situations, complex simultaneous and temporal processing is required. Thus, the participants are required to put multiple pieces of information together to answer the questions. In this study, sum scores were used. These consisted of the answers to the different types of question measuring ability to (1) manage to derive conclusions, (2) explain answers and (3) have the ability to make predictions on the basis of earlier context (see Appendix A). Prior studies suggest that

the SoPra questions are useful in bringing out differences between autistic adults and control adults (Dindar et al., 2022; Lönnqvist et al., 2017).

The film scenes contain different kinds of everyday social communication situations. Each of these scenes includes complex hidden meanings, intentions and feelings which are possible to interpret by connecting different kinds of multimodal information, for example, paralinguistic indicators, world knowledge, physical contextual cues and characters' shared knowledge. In order to interpret these contextually complex social situations many kinds of simultaneous and temporal processing are needed.

Empathizing skills: Empathy Quotient (EQ)

Empathizing skills were assessed using the EQ which is a self-assessment questionnaire (Baron-Cohen & Wheelwright, 2004a), translated into Finnish by Roine (Baron-Cohen & Wheelwright, 2004b; Salmi et al., 2013), designed to assess cognitive and affective empathy in adults, and specifically to evaluate the level of social impairment in certain diagnostic groups such as ASD. The EQ is composed of 60–40 items relating to empathy (e.g., *I can easily tell if someone else wants to enter a conversation*) and 20 control items (e.g., *I am at my best first thing in the morning*)—that the person has to rate as either 'strongly agree', 'slightly agree', 'slightly disagree' or 'strongly disagree'. The items are randomized and worded to produce a 'disagree' in half of the items and an 'agree' response for the other half. On each item interviewees can score 2, 1 or 0, depending on how (strongly, mildly and never, respectively) they record a specific empathic behaviour (scores range = 0–80, control items do not give any points).

Interrater reliability of measurements

Interrater reliability (intraclass correlation coefficient (ICC), two-way mixed model) was calculated between two raters in order to evaluate the reliability of scoring of ABaCo, Faux Pas and SoPra in the sample of scores of 18 persons (six autistic persons, six persons with autistic traits and six control persons). The ICC was 0.986 (95% CI = [0.963, 0.995]) for ABaCo scores, 0.988 (95% CI = [0.967, 0.995]) for Faux Pas scores and 0.991 (95% CI = [0.976, 0.997]) for SoPra scores. The ICC values indicated that the scoring of answers was reliable. Since EQ is a self-assessment tool, the ICC between two raters was not calculated.

Statistical analysis

One-way between-groups analysis of variance (ANOVA) was used to explore differences between the experimental groups and post-hoc tests were conducted with the Tukey HSD test. The effect sizes of group comparisons were calculated using Partial eta squared (small $\eta^2 = 0.01$, medium $\eta^2 = 0.06$ and large $\eta^2 = 0.14$). Correlation among tasks scores were calculated with the Pearson's correlation coefficient. The statistical package for social sciences (SPSS) version 25.0 for Windows was used for data analysis.

RESULTS

Group comparisons

Non-linguistic comprehension

In the ABaCo there was a significant effect of the group on total scores [$F(2, 87) = 7.84, p = 0.001, \eta^2 = 0.156$]. Further analysis showed that difference between groups was significant in extralinguistic subscale scores [$F(2, 87) = 10.13, p < 0.001, \eta^2 = 0.192$] but not in paralinguistic subscale score [$F(2, 87) = 0.74, p = 0.508, \eta^2 = 0.016$]. Post-hoc comparisons using the Tukey HSD test indicated control group differed from the autistic group in the total score ($p = 0.001$) and extralinguistic subscale score ($p < 0.001$) and the autistic traits group differed from the autistic group in the extralinguistic subscale score ($p = 0.046$). Taken together, these results suggest that control group performed better than the other two groups, and that the performance of the autistic traits group fell in between control group and autistic group (Figure 1). When looking at performance within groups in relation to standard deviation (SD) of the control group, 13 out of 34 (38%) participants of the autistic group, 2 out of 19 (11%) in autistic traits group and 2 out of 36 (6%) in control group performed equal or below -2 SD.

Social inference skills

There was not a significant effect of group on the answer scores in the social inference ability as assessed by the Faux Pas Recognition Test [$F(2, 87) = 0.80, p = 0.923, \eta^2 = 0.002$]. High scores showed that participants in all the three groups tended to succeed in answering questions and reasoning about justifications. Only three out of 34 participants (9%) of the autistic group and two out of 36 (6%) in control group performed equal or below -2 SD of control group (Figure 2).

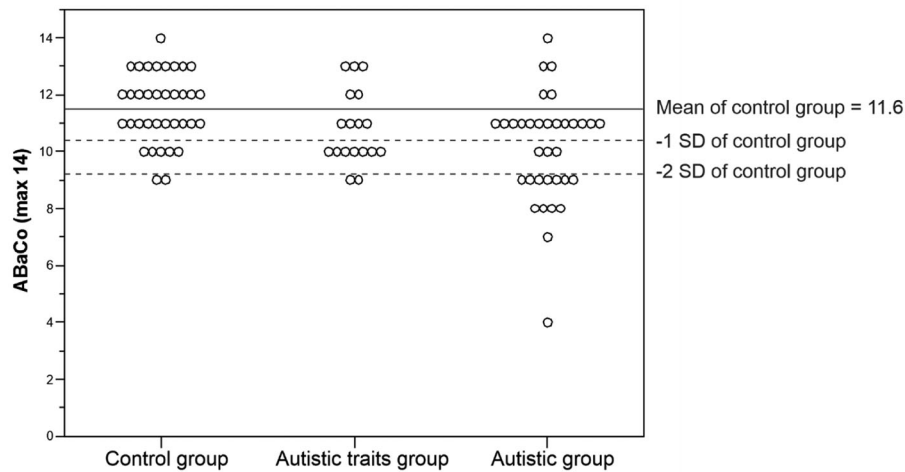


FIGURE 1 Participants' non-linguistic comprehension (ABaCo) scores

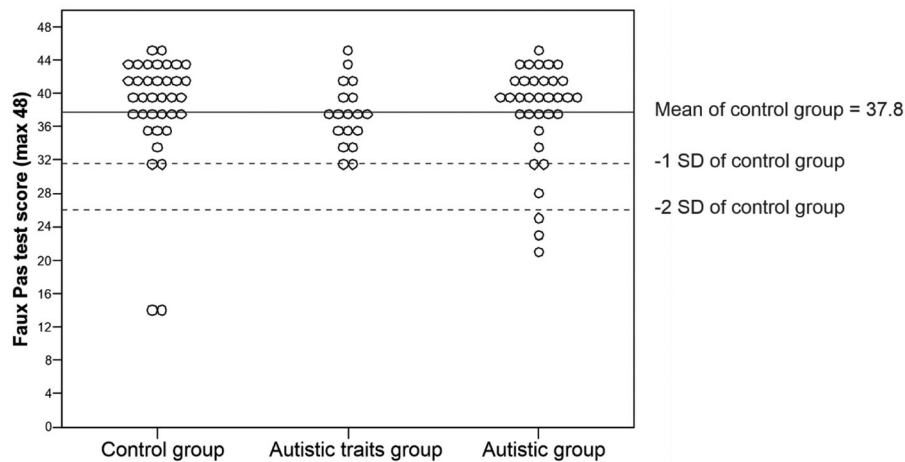


FIGURE 2 Participants' Faux Pas Test scores

There was a statistically significant effect of the group on the scores of the SoPra questions [$F(2, 88) = 15.60, p < 0.001, \eta^2 = 0.266$]. Post-hoc comparisons using the Tukey HSD test showed that there was a significant difference between the control group and the autistic group ($p < 0.001$), as well as between the control group and the autistic traits group ($p = 0.003$). The autistic traits group did not differ from the autistic group. In relation to -2 SD of control group, 13 out of 34 participants of the autistic group (38%), five out of 19 in autistic traits group (26%), and two out of 36 (6%) in control group performed equal or below borderline (Figure 3).

Empathizing quotient

Effect of the group was also significant on the total scores of EQ [$F(2, 85) = 24.14, p < 0.001, \eta^2 = 0.368$]. The Tukey

HSD post-hoc comparisons showed that there was a significant difference between the performance of the control group and the autistic group ($p < 0.001$), control and autistic traits group ($p = 0.001$). Taken together, these results suggest that control group performed higher and the performance of the autistic traits group fell in between control group and autistic group (Figure 4). In relation to -2 SD of control group, 10 out of 34 participants of the autistic group (30%), two out of 19 in autistic traits group (11%), and one out of 36 in control group (3%) performed equal or below borderline.

Correlation between the assessment methods' outcomes

In the control group, there was a large and statistically significant correlation between EQ and SoPra question

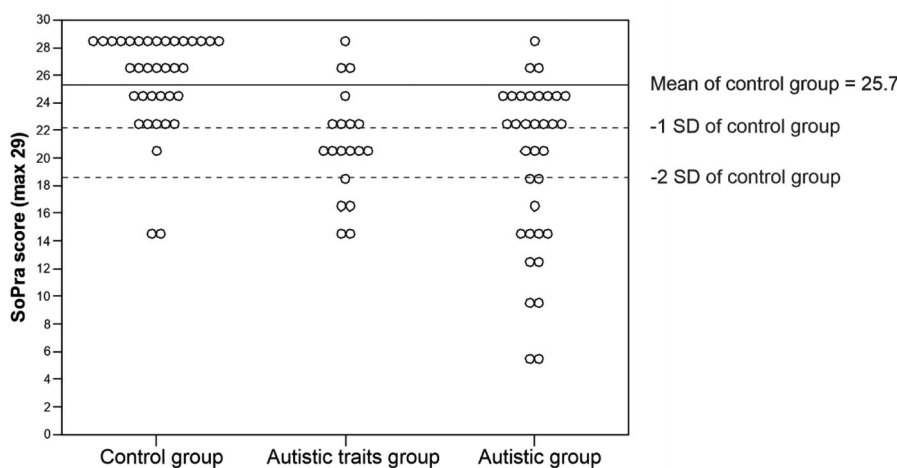


FIGURE 3 Participants' Social-Pragmatic Questions (SoPra) scores

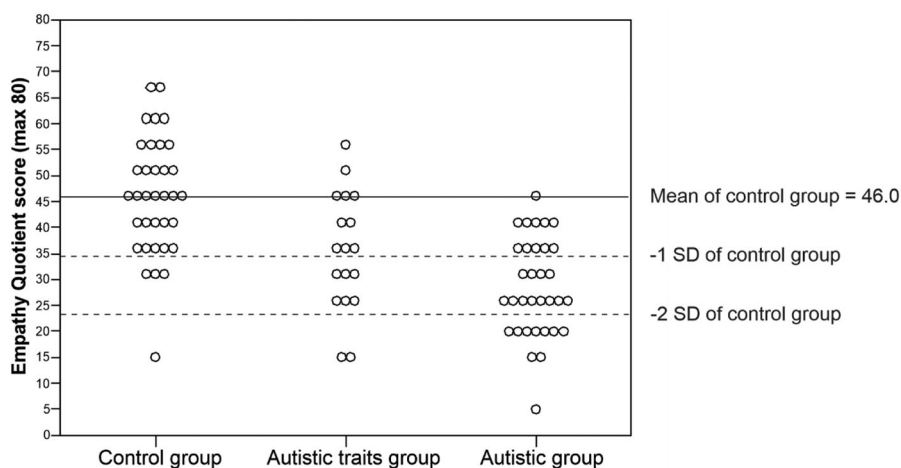


FIGURE 4 Participants' Empathy Quotient (EQ) scores

scores ($r = 0.61, p < 0.001$) and a medium and statistically significant correlation between Faux Pas and SoPra question scores ($r = 0.42, p = 0.01$). Small but not significant correlations were found between Faux Pas and EQ scores ($r = 0.28, p = 0.09$), Faux Pas and ABAco scores ($r = 0.17, p = 0.33$) and ABAco and SoPra question scores ($r = 0.16, p = 0.36$). There was no correlation between ABAco and EQ scores (Figure 5).

In the autistic traits group, there was no statistically significant correlations between test results. A small but not statistically significant correlation was found between EQ and SoPra question scores ($r = 0.32, p = 0.19$), ABAco and SoPra question scores ($r = 0.26, p = 0.29$), Faux Pas test and SoPra question scores ($r = 0.24, p = 0.34$), Faux Pas test and ABAco scores ($r = 0.19, p = 0.45$), Faux Pas test and EQ scores ($r = 0.15, p = 0.58$). No correlation was found between ABAco and EQ scores (Figure 6).

In the autistic group, a large and significant correlation was found between Faux Pas and SoPra scores ($r = 0.62, p < 0.001$). A medium correlation was found between ABAco test and EQ scores but the correlation fell just short of significance ($r = 0.33, p = 0.06$). A medium correlation was also found between Faux Pas test and EQ scores but again here, the correlation did not reach significance ($r = 0.31, p = 0.08$). Small but not significant correlations were found between EQ and SoPra scores ($r = 0.27, p = 0.13$) and between ABAco test and SoPra scores ($r = 0.21, p = 0.23$) (Figure 7).

DISCUSSION

The current study examined non-linguistic comprehension, social inference and empathizing skills in autistic

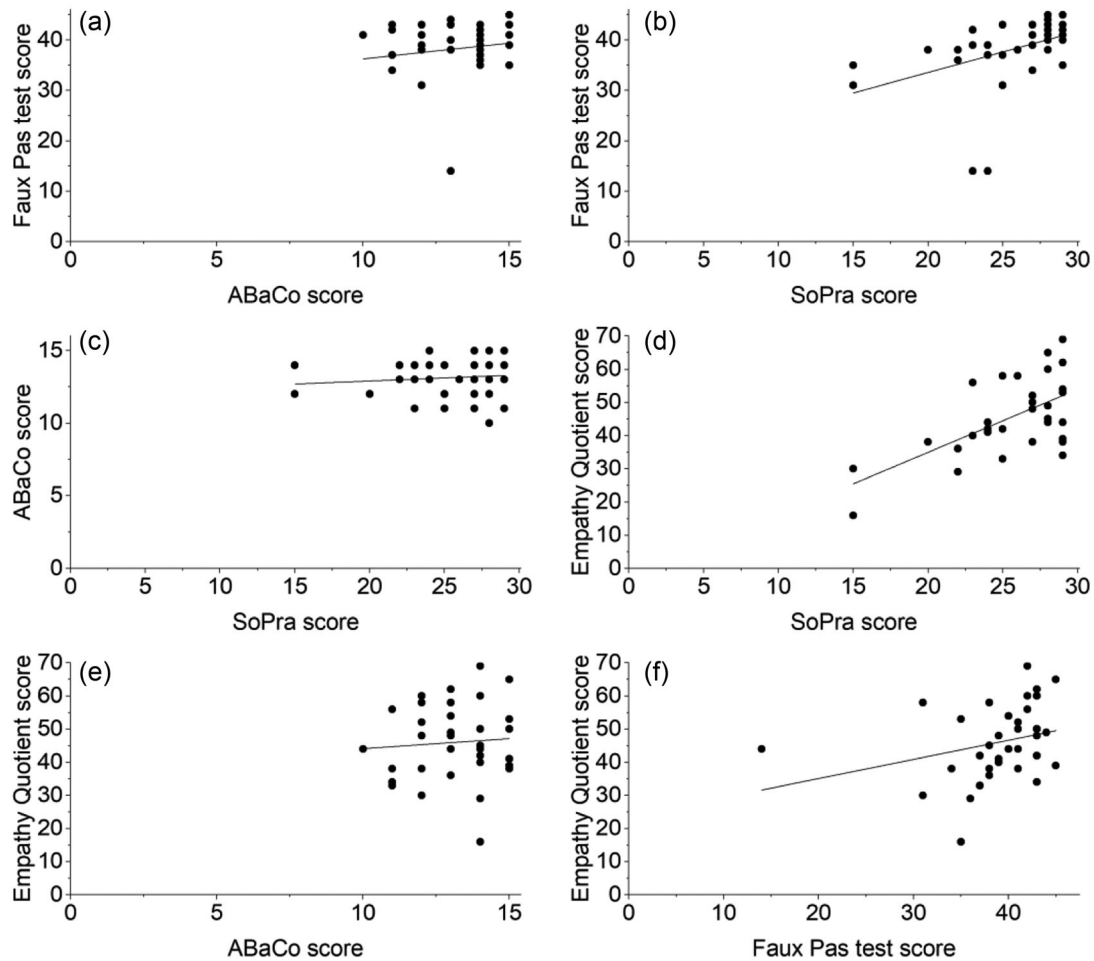


FIGURE 5 Correlations between Faux Pas, ABAco, EQ and SoPra question scores in the control group

young adults, young adults who have been identified having autistic traits in their childhood and control young adults. The present study highlighted the presence of a continuum in terms of autism related social communication traits (see also Focquaert & Vanneste, 2015). Although this study found group differences, many autistic young adults performed well in structured instruments which measured different aspects of social communication skills. When looking at performance in different social communication assessments, the groups were found to overlap with each other. Since only a few significant correlations were found between the test scores, the findings highlight that conclusions about social communication abilities should be based on wide-ranging assessments using methods focusing on different aspects of social communication skills. There is still a need to understand better the complex interplay of different components of social communication.

This study found that the autistic young adults differed from control young adults in extralinguistic subscale scores in the ABAco emphasizing the importance of taking into consideration non-linguistic ability when assessing

social communication skills. Non-linguistic expressions have a crucial role in human communicative interactions, not only because they interact with language expressions in meaning creation but also because they have an autonomous communicative role (Bara, 2010).

Counter to the findings of Thiébaud et al. (2016), in this study all groups performed equally in the tasks where there was a need to detect a Faux Pas, showing the participants' ability to recognize whether someone had mistakenly said something they shouldn't have with respect to the surrounding contextual factors. Since the test was originally developed to measure advanced ToM, this finding also lends support to the current discussion that ToM is not impaired in all autistic individuals (Gernsbacher & Yergeau, 2019) or cognitively able autistic individuals may have used compensatory cognitive strategies for task requiring cognitive ToM skills (Livingston et al., 2019).

In this study, social inference was measured using SoPra based on film scenes containing pragmatically complex social scenes involving multiple interlocutors. Compared with control group both autistic group and the autistic traits group received lower scores in these questions. These

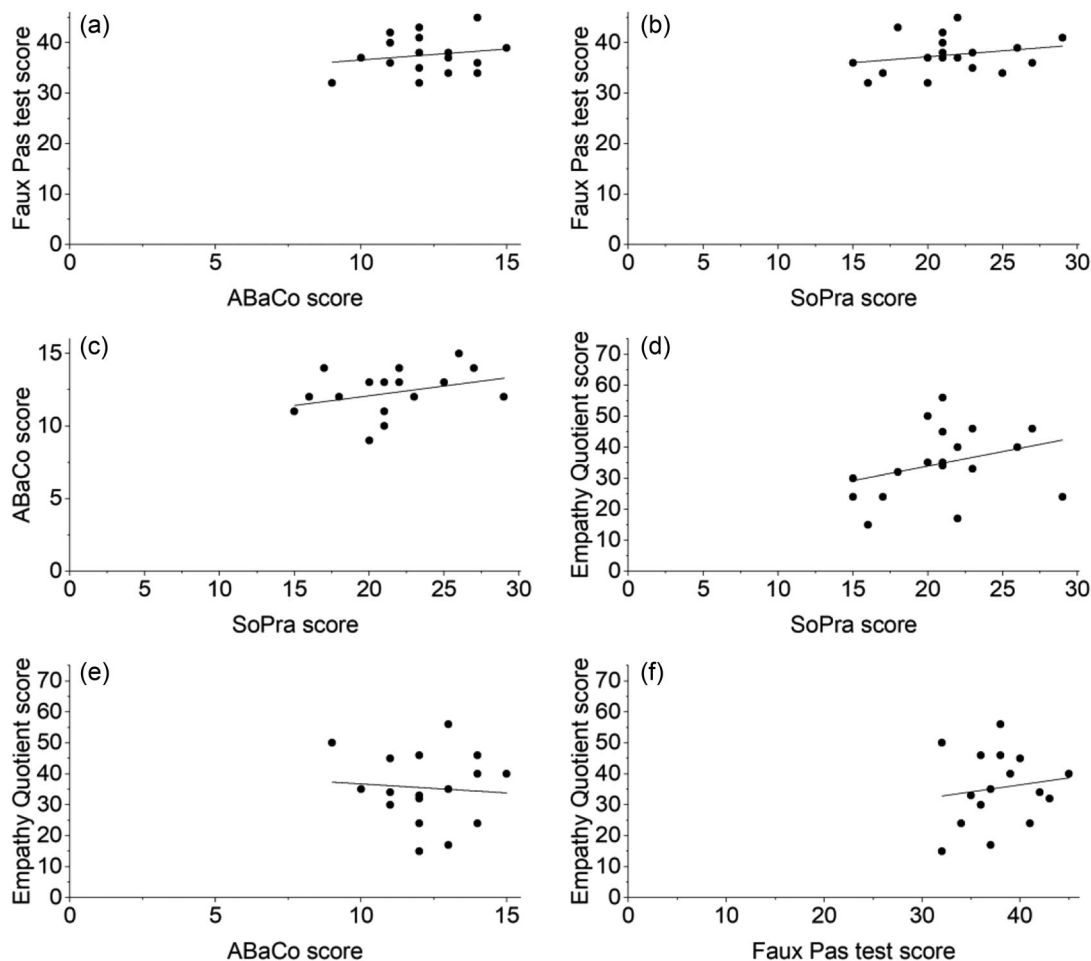


FIGURE 6 Correlations between Faux Pas, ABAco, EQ and SoPra question scores in the autistic traits group

scenes included complex meanings, intentions and feelings which were only possible to interpret by connecting different multimodal information as part of simultaneous and temporal processing. Compared with processing literally and verbally presented Faux Pas, processing of social communication content of video clips demanded more rapid simultaneous multilevel processing. Indeed, previous studies have shown between-group differences in visual attention allocation, physiological reactivity and neural-level processing in attending to these pragmatically complex social scenes (Dindar et al., 2022; Kotila et al., 2020; Lönnqvist et al., 2017). There is evidence that simultaneous processing of concurrent multimodal communication situations is altered in autistic persons (Kotila et al., 2020).

Many autistic young adults described themselves as having lower empathy skills than the control group (see also Baron-Cohen & Wheelwright, 2004a), while the autistic traits group performed between the control and autistic group. However, although there was a clear continuum in empathy traits between groups, again, there was also a clear overlapping between the groups

since some of the autistic young adults had empathy skills similar to control young adults. In general, this study showed that self-reports, such as the EQ used here, may be very useful in identifying and screening individuals with challenges in situations involving social communication and that autistic persons have good awareness of objectively assessing their challenges (Gernsbacher et al., 2017). It is possible that these individuals compensate their difficulties, at least up to a certain extent, when they are in structured test situations (Livingston et al., 2019).

This study showed that the interrelatedness between different aspects of social communication are not clear and the interaction of different skills needs to be understood better. In this study, in the control group, there was a significant correlation between EQ and SoPra scores and between the Faux Pas and SoPra scores. In the autistic group, a significant correlation was found between Faux Pas and SoPra scores. In addition to these, other medium or small correlations were found. The non-linguistic comprehension skills were not strongly connected with the scores in the Faux Pas Test, SoPra or in the EQ. This result appears to be in line with Bosco and Gabbatore (2017)

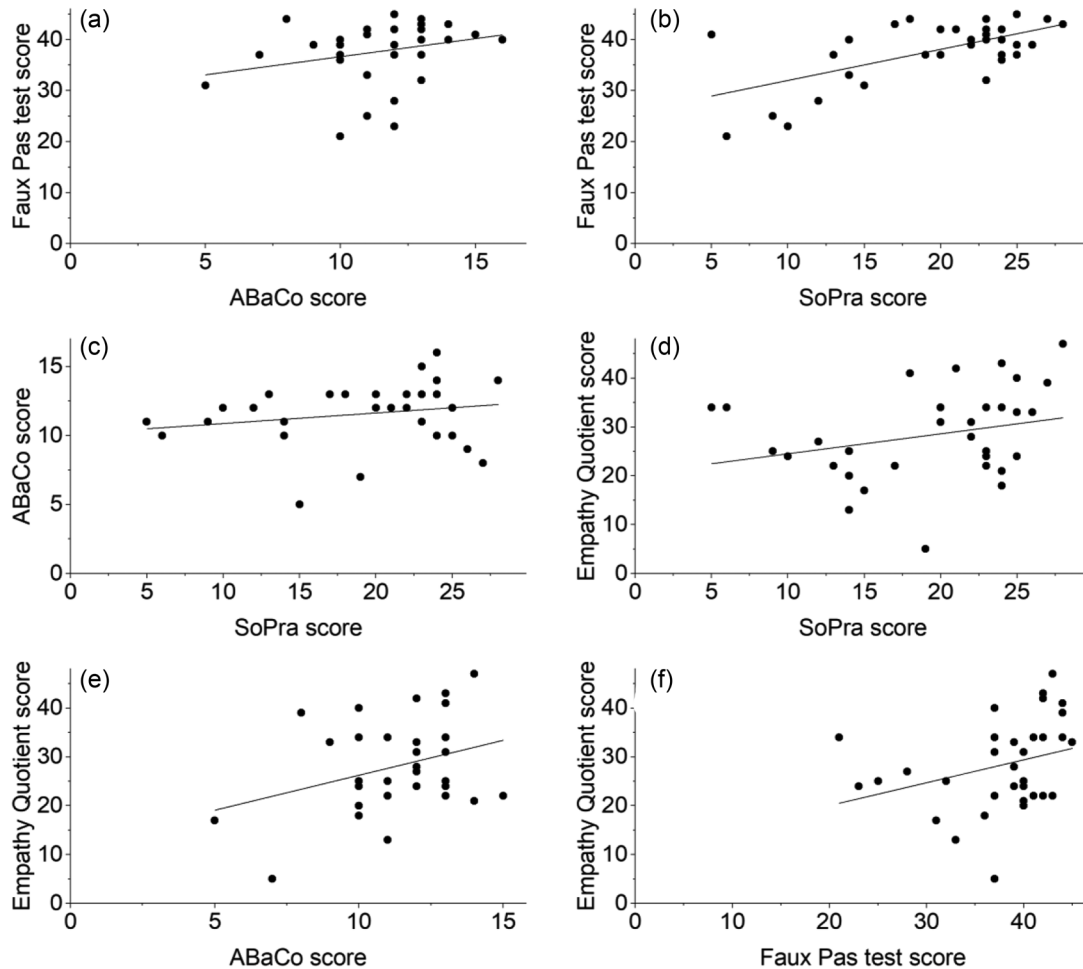


FIGURE 7 Correlations between Faux Pas, ABaCo, EQ and SoPra question scores in the autistic group

proposing that non-linguistic comprehension and ToM may be domains that only partially overlap. It is known that different social communication skills demand a variety of social cognitive, neuropsychological and structural language skills which interact with each other in a complex way (e.g., Perkins, 2007). This complex interplay needs to be better understood in typical and clinical populations in order to better understand humans' unique social communication processing and functioning. Although we found differences at the group level, we also found that many autistic young adults performed approximately similarly or even better to than the controls (see also Jolliffe & Baron-Cohen, 2000). In the future, it is important to assess whether there is a subgroup of autistic children who will have a positive outcome as young adults and what are the facilitative factors for a good adulthood prognosis.

It is obvious that compared with structured test situations, real-life communication situations are more multidimensional, requiring rapid, complex and sophisticated multimodal processing. Therefore, in such interactive situations, sometimes even subtle difficulties

may cause compounded challenges or overload to the person. On the basis of this study, we suggest that in the clinical practice, it is important to connect data from different assessment methods focusing on different aspects of social communication skills. It is also possible that qualitative analysis of a person's answers might show different types of differences than the quantitative analysis used in this study. The earlier study by Loukusa et al. (2007) has shown that when comparing incorrect explanations of typical and autistic children, overgeneralization of their own world knowledge and tautological explanations were more typical in autistic children. A multidimensional approach would allow us to not only carefully map what autistic people have challenges with, but also what they are competent in and, crucially, in what kind of communicative contexts they function best and whether they have some specific capacities which should also be taken into consideration when assessing social communication skills. Such understanding could be highly beneficial in developing support strategies to strengthen existing communicative skills. When interpreting the results of this study it is also

good to bear in mind that when examining social communication skills via structured tests, it is possible that autistic adults respond according to how they have learned to respond rather than what they would 'actually' say in a real social situation. Thus, observational assessment might better reflect real performance as opposed to the person's capacity being measured using structured tests.

Since the results of different assessment methods in this study were not totally associated with each other, it is obvious that if the assessment is too narrow it is possible that subtle weaknesses and strengths are not being identified. Our findings suggest that in the assessment of social communication, self-report and clinical assessment can be used effectively together and their results complement each other. The results support earlier findings that self-reports are a reliable way to collect information from autistic persons (e.g., Boulton & Guastella, 2021).

In this study, some methods which used video clips depicting social communicative situations are closer to real life compared to the picture- or text-based methods. Technology gives us new possibilities to develop better video and virtual reality-based environments in order to assess social communication processing in multidimensional real-life type structured test situations. The findings of this and other earlier studies (e.g., Dindar et al., 2022; Jolliffe & Baron-Cohen, 2000; Kotila et al., 2020; Lönnqvist et al., 2017) gives us a good basis to continue to develop more realistic and sensitive methods which can be used in clinical practice.

It is also worth noting that the participants in this study did not have cognitive deficits, so we cannot make conclusions about the social communication skills of autistic people with cognitive disabilities. It is also important to consider cross-cultural differences when assessing social-communicative skills (e.g., Gabbatore et al., 2019) as cultural differences influences how typical or problematic behaviours are defined and perceived.

SUMMARY

The findings of this study highlight that social communication skills are multidimensional and exist on a continuum across the population. Our study has shown that the assessment of these skills needs to further be considered as well as their individual contributions to the whole. This study has shown there is a relationship between the EQ and SoPra and between the SoPra and Faux pas scores. This likely reflects the similarities of the phenomenon being measured. EQ and SoPra both look at the individual's ability to interpret the mental states and emotions of others and respond accordingly although the other is self-assessment measure and the other done in structured test

situation. Both are assessed using the medium of language. Similarly, SoPra and Faux Pas both test social inferencing. It will be important for future research to try to disentangle the elements of these tasks further.

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CONFLICT OF INTEREST

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

DATA AVAILABILITY STATEMENT

Research data are not shared because the permission of the study does not allow data sharing.

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ENDNOTES

¹In this study, when referring to autistic persons we use terminology that is reportedly preferred by persons on the autism spectrum (e.g., Bury et al., 2020).

²Based on a total of 52 young adults on the autism spectrum and 1686 controls, the mean AQ score in Finnish ASD individuals is 22.5 (8.3) and in controls 13.1 (6.4) (for more details, see Loukusa et al. 2021).

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APPENDIX A

TABLE 1 Examples from the assessment tools

Assessment tool	An example or a description of an item	Example test questions
Assessment Battery for Communication (extralinguistic scale)	The following video is shown to a participant. <u>Deceit</u> : Nadia and Sergio are arguing—having a pillow fight—in their bedroom. In all the confusion, Nadia hits the lamp on the bedside table and it falls onto the floor. Having heard the noise, their father comes to their room, puts his hands on his hips and, with a questioning air, at the same time assuming a cross expression as if to say ‘What’s going on?’ he points with his finger to the lamp on the floor. Nadia immediately picks up a book and shows it to her father, as if to say ‘I was reading’.	The participant is asked: 1. What did the girl want to say to her father? 2. Was she speaking seriously?
Assessment Battery for Communication (paralinguistic scale)	The following video is shown to a participant. <u>Emotion understanding—Amused</u> : The actor laughs while he speaks.	The participant is asked to choose among the following options: 1. Amused (Target) 2. Surprise (Liable to be confused) 3. Angry (Opposite) 4. Disgusted
Faux Pas Recognition Test	The following story is read out loud to a participant. Helen’s husband was throwing a surprise party for her birthday. He invited Sarah, a friend of Helen’s, and said, ‘Don’t tell anyone, especially Helen.’ The day before the party, Helen was over at Sarah’s and Sarah spilled some coffee on a new dress that was hanging over her chair. ‘Oh!’ said Sarah, ‘I was going to wear this to your party!’ ‘What party?’ said Helen. ‘Come on,’ said Sarah, ‘Let’s go see if we can get the stain out.’	The participant is asked: 1. Did anyone say something they shouldn’t have said or something awkward? If yes, ask: 2. Who said something they shouldn’t have said or something awkward? 3. Why shouldn’t he/she have said it or why was it awkward? 4. Why do you think he/she said it? 5. Did Sarah remember that the party was a surprise party? 6. How do you think Helen felt? Control question: 7. In the story, who was the surprise party for? 8. What got spilled on the dress?
SoPra questions	The following video is shown to a participant. Two young women are sitting on a sofa. One of them begins to talk about a course that she has recently joined. The other (dark-haired) woman listens to her and asks questions about the course, appearing to be interested. They talk for a moment before the woman attending the course explains that she needs to leave for a bus. After she has left, the dark-haired woman talks to herself saying ‘I need to Google that’ and walks to a computer.	The participant is asked: 1. What is the dark-haired person searching for using Google? 2a. What is the dark-haired person thinking about? 2b. How do you know that? 3. What do think will happen next? 4. What were the people on the video discussing? (control question)
EQ	A participant reads a statement and rates how strongly she/he agrees or disagrees with it by selecting one of the options: ‘strongly agree’, ‘slightly agree’, ‘slightly disagree’ or ‘strongly disagree’.	The participant is asked to rate, e.g., the following statement: I find it hard to know what to do in a social situation.

Note: See more examples in Bosco (2012) from the ABaCo, Form A; in Stone and Baron-Cohen (1998) from the Faux Pas Recognition Test; in Dindar et al. (2022) from the SoPra questions; and in Baron-Cohen and Wheelwright (2004) from EQ statements.