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Social impairment in the autistic spectrum: real-life versus online perceived social skills

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Abstract

Objectives:

While socio-communicative difficulties are identified as a core diagnostic criterion for Autism Spectrum Disorder (ASD), there is growing evidence that social difficulties could be context-dependent and could be overcome by the use of online communication. Beyond the spectrum, the symptoms of ASD can be met in the general population at a milder scale, leading researchers to extend their work to subjects with high autistic traits, also called the broader autism phenotype. The present study explored online versus real life social skills in the general population according to the level of autistic traits.

Method:

Seventy-one adults without ASD (from 18 to 55 years old) reporting using social networks completed a questionnaire assessing their real-life and online social skills. Their autistic traits were assessed using the autistic quotient (AQ).

Results:

Results showed a direct influence of the level of autistic traits on real-life and online social skills: participants having high autistic traits demonstrated a lower level of real-life social skills ($r=-0.26$, $p<.05$) and conversely higher online social skills ($r=0.28$, $p<.05$), suggesting that social difficulties might be context-dependent.

Conclusions:

While further studies are needed in a population with ASD, our results report preliminary evidence of the potential benefit of online social interactions within the autistic spectrum. Further studies in ASD could consider the potential for using an electronic mediator within social remediations.

Keywords:

Autistic traits, Perceived social skills, online communication

When meeting a person with Autism Spectrum Disorder (ASD), one typically notices differences in their social behavior: an unusual eye gaze (which may be reduced or over-extended), and when present, atypical speech with a lack of nonverbal gestures and facial expressions, as well as an unusual voice rhythm that sounds slightly stilted (Asperger, 1944; Attwood, 1998; Kanner, 1943). Socio-communicative difficulties are indeed considered as a major dysfunctional element in ASD and constitute the first axis of diagnosis, the second being repetitive and restricted behaviors (APA, 2013). Research has provided evidence that individuals closely related to individuals with ASD display autistic characteristics, albeit to a milder extent (Piven et al., 1994). This discovery has catalyzed the emergence of the “broader autism phenotype” (Constantino & Todd, 2003, p. 529) as a conceptual framework. Furthermore, these distinct characteristics are not limited to family members but are also observable within the broader population (for a review, Ruzich et al., 2015). In order to assess the degree of autistic traits in any individual adult, psychometric tools were developed, such as the “Autism spectrum Quotient” (AQ; Baron-Cohen et al., 2001, p. 6). The impaired responses to social information typically observed in ASD are also found in people without ASD but with high autistic traits. More precisely, many social difficulties in common between ASD subjects and subjects with high autistic traits have been highlighted and concern, for example, difficulties in the attribution of mental states (e.g., Baksh et al., 2018; Stewart et al., 2020), a gaze orientation preference towards blurred images rather than faces (e.g., Bayliss & Tipper, 2005), socio-communicative difficulties and social reciprocity (e.g., Bezemer et al., 2021; Constantino et al., 2000) as well as cerebral hypoactivity in social contact (Voos et al., 2013).

The internet is a vehicle of communication used by a large number of people. In the general population, various studies have found that internet use fosters and facilitates social interaction by decreasing social isolation and loneliness, as well as increasing social connectivity (e.g., Adams & Stevenson, 2004; Bradley & Poppen, 2003; Ellison et al., 2007; Erickson & Johnson, 2011; Subrahmanyam et al., 2008; White et al., 1999).

Some studies of the last decade suggested a preference among ASD people for communicating online (Gillespie-Lynch et al., 2014; Van der Aa et al., 2016; Westerberg et al., 2021). The review by Hassrick et al. (2021) highlighted that online communication offers multiple opportunities for ASD regarding the learning of social rules, the creation of relationships based on social media, and the enhancement of mental health by reducing anxiety and feelings of loneliness. More precisely, the primary reason for the preference for online interactions among individuals with ASD, is believed to be the slower pace of the online environment. This preference can be attributed to reduced information processing demands (van der Aa et al., 2016). Additionally, written computer-mediated communication has the potential to alleviate social stress associated with social conventions such as body language, eye contact, and tone of voice, which can be particularly distressing for individuals with ASD (Westerberg et al., 2021). Consequently, ASD subjects reported higher satisfaction with their online social life than with their social life and life in general (van der Aa et al., 2016), a feeling of greater understanding and control over communication, and the opportunity to express their true selves in computer-mediated communication (Gillespie-Lynch et al., 2014). Moreover, heightened depressive symptoms, reduced overall life satisfaction, and diminished self-esteem have been consistently linked to experiences of loneliness in individuals with ASD (Mazurek, 2014). Interestingly, Mazurek (2014) showed that the intensity of loneliness tends to wane in the presence of a more substantial number and higher-quality of friendships. Therefore, considering the potential of online communication to facilitate satisfying social interactions in ASD, online communication tools could significantly enhance their mental well-being.

However, so far, no studies have investigated online social skills in the autistic spectrum, while an easy-to-administer tool has recently been developed to specifically assess communicative and online socio-emotional skills (Mantzouranis et al., 2019). The purpose of this study was to examine global social skills both online and in real life according to autistic traits, in order to better characterize social functioning in everyday life situations within the autistic spectrum.

Method

Participants

In the present study, seventy-one participants (8 males) from the general population participated (Mean age=35.23; SD=11.46; Range=18-55). G*Power software was used to test the power analysis of our sample size. We rejected the null hypothesis if we observed a sample correlation coefficient outside the interval [-0.2287052, 0.2287052]. The total sample size required to ensure a power $(1 - \beta) > 0.80$ was 74. Therefore, the inclusion of seventy-one participants in the current study can be considered correct. All participants reported using social networks to communication in everyday life. They had normal or corrected-to-normal vision and had no history of neurological or psychiatric illness. No information about ethnic background, socio-economic status or sexual orientation was available. Note that the use of the Real and Electronic Communication Skills questionnaire (RECS) did not reveal any gender effect in the original study (Mantzouranis et al., 2019), conversely to the AQ (Baron-Cohen et al., 2001).

Procedure

The participants were recruited through calls for volunteers that were posted on social networks and university websites. These recruitment methods allowed for a broad reach and potential engagement of individuals active on social media platforms. Participants completed surveys that were conducted in French using an online survey tool in the following order: AQ-RCS-ECS.

Measures

Autistic traits and social profile

The Autism-Spectrum Quotient (AQ) is a validated 50-items self-report questionnaire for identifying the degree to which an adult presents autistic traits. The instrument measures five dimensions (10 items each): Social skill (e.g., “I find it hard to make new friends”), Attention switching (e.g., “I frequently get so strongly absorbed in one thing that I lose sight of other things”), Attention to detail (e.g., “I often notice small sounds when others do not”), Communication (e.g., “I enjoy social chit-chat”) and Imagination (e.g., “I find making up stories easy”) (Baron-Cohen et al., 2001, p. 15-16). Each response is scored 0 or 1, a higher score indicates higher levels of autistic behavior. Previous studies found a high internal consistency for the overall AQ score with a Cronbach’s alpha between .72 and .79 (Hoekstra et al., 2008; Ruzich et al., 2015; Stevenson & Hart, 2017). Autism-Spectrum Quotient global score was used as an indicator of autistic traits. Furthermore, Baron-Cohen et al. (2001) suggested that a score exceeding 32 on the AQ can be used as a valuable threshold for discerning individuals exhibiting clinically significant levels of autistic traits. However, it is worth noting

that none of the participants in our study reached such a high score on the AQ global scale. We used the French version of the AQ (Kempnaers et al., 2017).

In order to obtain an assessment of the social abilities of the participants, a validated questionnaire in French, the Real and Electronic Communication Skills questionnaire (RECS; Mantzouranis et al., 2019) was administered. This instrument includes two self-reported questionnaires, one assessing social abilities in real life (Real Communication Skills; RCS) and the other assessing online social abilities (Electronic Communication Skills; ECS). Each of these questionnaires includes 18 items that are scored with a 5-point Likert scale and are composed of four dimensions: Sociability (e.g., RCS: “I really like meeting new people”; ECS: “I really like to increase my circle of friends online”), Disclosure (e.g., RCS: “I sometimes cry in front of others”; ECS: “When I chat online with a close friend, I can easily tell him things that make me feel ashamed”), Emotion Decoding (e.g., RCS: “When someone is sad, I see it immediately, even if they try to hide it”; ECS: “When I am online, I can easily identify the emotions of other Internet users”) and Assertiveness. (e.g., RCS: “In general, my friends see me as someone who knows how to assert themselves”; ECS: “If I disagree with someone online, I say so”) (Mantzouranis et al., 2019, p. 25-26). Mantzouranis et al. (2019) found a high internal consistency for the RCS and ECS scores with a Cronbach’s alpha of .75 and .78, respectively, and a high scale reliability with a McDonald’s omega of .81 and .84, respectively and confirm the external validity using the subscales of the Social Skills Inventory (Riggio, 1992).

Data Analyses

The normality of the data was tested using the Shapiro-Wilk test on the global score of the AQ, the RCS, and the ECS questionnaires. In order to examine the relationship between autistic traits and the social abilities of participants, Pearson’s correlations were applied on the total and subscale scores for the AQ and the RCS, as well as for the AQ and the ECS. The relation between the online social skills (ECS) and real-life social skills (RCS) was also examined using similar tests. The effect of autistic traits on social abilities assessed with real-life situations has been commonly highlighted in non-ASD individuals; High autistic traits are associated with greater social difficulties (e.g., Stewart & Ota, 2008; Voos et al., 2013). However, the correlational analyses do not provide a sense of the relationship between variables. In this context, a Structural Equation Model (SEM) was used to test the influence of autistic traits (AQ) on online social skills (ECS). SEM is a multivariate statistical analysis technique that is used to analyze structural relationships by using path models that mathematically represent the causal influences on the variables of interest. In addition, an ANOVA analysis was calculated to further compare the models testing the direct and indirect effect of AQ on ECS.

Results

The global score of the AQ ranged from 7 to 32 with a mean of 17.91 (SD=6.04), which is in line with previous results in the general population reporting a mean of 16.08 (SD=5.53) with a range from 2 to 31 (e.g., Mayer et al., 2016). The mean score of the RCS was 61.09 (SD=7.66) with a range from 45 to 75. The ECS ranged from 33 to 71 and presented a mean of 47.26 (SD=7.61). Due to the novelty of the RCS, no descriptive results are available in the literature. Consequently, we were not able to compare our data with reference data. The means, standard deviations and ranges of total scores, and dimensions of the questionnaires are presented in Table 1.

Table 1
Means, SDs and ranges of the questionnaires

	AQ total (0-50)	Social skills (0-10)	Att. Switch. (0-10)	Att. to detail (0-10)	Comm. (0-10)	Imag. (0-10)
Mean (SD)	17.91 (6.04)	3.16 (2.43)	4.2 (1.79)	5.41 (2.39)	2.65 (1.52)	2.65 (1.52)
Range	7-32	0-10	1-9	0-10	0-6	0-7
	ECS total (0-90)	Sociability (0-25)	Disclosure (0-25)	Emo. Decod. (0-25)	Assertiv. (0-15)	
Mean (SD)	47.26 (7.61)	9.12 (3.6)	11.75 (3.5)	17.03 (3.25)	9.37 (2.48)	
Range	33-71	5-25	5-23	10-25	3-14	
	RCS total (0-90)	Sociability (0-25)	Disclosure (0-25)	Emo. Decod. (0-25)	Assertiv. (0-15)	
Mean (SD)	61.09 (7.66)	13.93 (4.03)	15.58 (4.47)	20.57 (2.45)	11.02 (2.07)	
Range	45-75	5-25	6-24	13-25	6-15	

Because the global scores of the RCS and ECS questionnaires did not follow a normal distribution ($W = 0.963$ $p < 0.05$), the questionnaires scores (global score and dimensions of the AQ, the RCS and the ECS) were transformed into a z-score for the statistical analyses.

The results of Pearson's correlation between total scores and dimensions of the questionnaires are presented in Table 2. In general, the results demonstrated a significant negative correlation between autistic traits (AQ) and social skills in real life (RCS), with higher levels of autistic traits related to lower social abilities in real life (see Fig. 1A). This is to be expected since the social dimensions of the AQ are based on real-life social scenes. In contrast, the autistic traits (AQ) correlated positively with online social skills (ECS), meaning that the more the participants had autistic traits, the more they reported online social skills (see Fig. 1B). Note that the correlations between the RCS and the ECS with the AQ do not concern the same dimensions of the questionnaires. Specifically, the correlation between the AQ and RCS was primarily driven by negative relationships between the dimensions assessing social skills on the questionnaires. The more social difficulties participants expressed (Social skills, AQ), the fewer social skills (Sociability, RCS) they reported. Similarly, the more they perceived difficulty communicating (Communication, AQ), the less they were able to socialize (Sociability, RCS). Other dimensions drove the positive correlation between the AQ and the ECS. The more subjects expressed difficulties imagining (Imagination, AQ), the more ease they reported in online social interactions (ECS total). In addition, the more difficulties subjects had in sustaining a conversation (Communication, AQ), the more intimate information they shared with others (disclosure, ECS). No significant correlation was found between real-life and online social skills.

Table 2
Pearson correlation matrix between the questionnaires

	AQ total	Social skills	Att. Switch.	Att. to detail	Comm.	Imag.
RCS total	-0.26* [-0.47, -0.028]	-0.35** [-0.5393, -0.1271]	-0.12 [-0.3427, 0.1166]	0.08 [-0.166, 0.2984]	-0.25* [-0.46, -0.018]	-0.14 [-0.361, 0.096]
Sociability	-0.31** [-0.51, -0.083]	-0.6*** [-0.731, -0.4264]	-0.11 [-0.3347, 0.1266]	0.27* [0.0391, 0.4735]	-0.37** [-0.554, -0.1496]	-0.1 [-0.3257, 0.1365]
Disclosure	-0.08 [-0.5067, -0.0826]	-0.006 [-0.239, 0.2276]	-0.09 [-0.3167, 0.1464]	-0.013 [-0.2456, 0.221]	-0.03 [-0.2615, 0.2047]	-0.04 [-0.2708, 0.1951]
Emo. Decod.	-0.02 [-0.2521, 0.2143]	-0.11 [-0.3347, 0.1266]	-0.02 [-0.2521, 0.2143]	0.17 [-0.0659, 0.3879]	-0.16 [-0.3792, 0.0761]	-0.03 [-0.2615, 0.2047]
Assertiv.	-0.18 [-0.3966, 0.0556]	-0.03 [-0.2615, 0.2047]	-0.06 [-0.2893, 0.1758]	-0.16 [-0.3792, 0.0761]	-0.08 [-0.3076, 0.1562]	-0.26* [-0.4651, -0.0284]
	AQ total	Social skills	Att. Switch.	Att. to detail	Comm.	Imag.
ECS total	0.28* [0.045, 0.49]	0.13 [-0.1166, 0.3437]	0.19 [-0.0453, 0.4053]	0.16 [-0.0761, 0.3792]	0.14 [-0.0964, 0.361]	0.29** [0.0608, 0.490]
Sociability	0.14 [-0.0964, 0.3615]	-0.1 [-0.3257, 0.1365]	0.21 [-0.0245, 0.4226]	0.2 [-0.0349, 0.414]	-0.02 [-0.2521, 0.2143]	0.16 [-0.0761, 0.3792]
Disclosure	0.32** [0.0936, 0.5149]	0.26* [0.0284, 0.4651]	0.13 [-0.1065, 0.3526]	0.05 [-0.1855, 0.28]	0.35** [0.1271, 0.5393]	0.24* [0.0071, 0.4482]
Emo. Decod.	0.09 [-0.1464, 0.3167]	0.02 [-0.2143, 0.2521]	-0.1 [-0.3257, 0.1365]	0.22 [-0.0140, 0.4312]	0.03 [-0.2047, 0.2615]	0.07 [-0.166, 0.2984]
Assertiv.	0.11 [-0.1266, 0.3347]	0.14 [-0.0964, 0.3615]	0.28* [0.0499, 0.4818]	-0.16 [-0.3792, 0.0761]	-0.1 [-0.3257, 0.1365]	0.25* [0.0177, 0.4567]
	ECS total	Sociability	Disclosure	Emo. Decod.	Assertiv.	
RCS total	0.18 [-0.0556, 0.3966]	0.12 [-0.1166, 0.3437]	0.1 [-0.1365, 0.3257]	0.11 [-0.1266, 0.3347]	0.12 [-0.1166, 0.3437]	
Sociability	0.15 [-0.0863, 0.3703]	0.43*** [0.2186, 0.6028]	-0.2 [-0.414, 0.0349]	0.1 [-0.1365, 0.3257]	-0.004 [-0.2371, 0.2295]	
Disclosure	0.08 [-0.1562, 0.3076]	-0.15 [-0.3703, 0.0863]	0.51*** [0.3141, 0.6643]	-0.21 [-0.4226, 0.0245]	-0.02 [-0.2521, 0.2143]	
Emo. Decod.	0.19 [-0.0453, 0.4053]	0.07 [-0.166, 0.2984]	-0.16 [-0.3792, 0.0761]	0.43*** [0.2186, 0.6028]	0.13 [-0.1065, 0.3526]	
Assertiv.	-0.02 [-0.2521, 0.2143]	-0.15 [-0.3703, 0.0863]	-0.19 [-0.4053, 0.0453]	0.11 [-0.1266, 0.3347]	0.22 [-0.0140, 0.4312]	

* $p < .05$; ** $p < .01$; *** $p < .001$

The 95% confidence intervals are detailed in parantheses

The application of a structural equation model showed significant regression coefficients between autistic traits and real-life social skills ($-0.26, p < .05$), between autistic traits and online social skills ($0.28, p < .05$), and between real-life social skills and online social skills ($0.27, p < .01$, see Fig. 1C). The significance of the indirect effect (the influence of AQ on ECS mediated by RCS) was tested using bootstrapping procedures. Unstandardized indirect effects were computed for each of 1 000 bootstrapped samples, and the 95% confidence interval was computed by determining the indirect effects at the 2.5th and 97.5th percentiles. The bootstrapped unstandardized indirect effect was -0.08 and the 95% confidence interval ranged from -1.13 to 0 ($p = .052$). Thus, autistic traits significantly influenced perceived online social skills and real-life ones. In addition, the influence of autistic traits on online social skills was not mediated by real-life social skills.

In addition, an ANOVA was computed to compare the models with and without the indirect effect and revealed a significant enhancement when the indirect effect was removed ($F(1,35) = 3.2, p > .05$), suggesting that the best model is the simple one that test the direct effect of the AQ on the ECS.

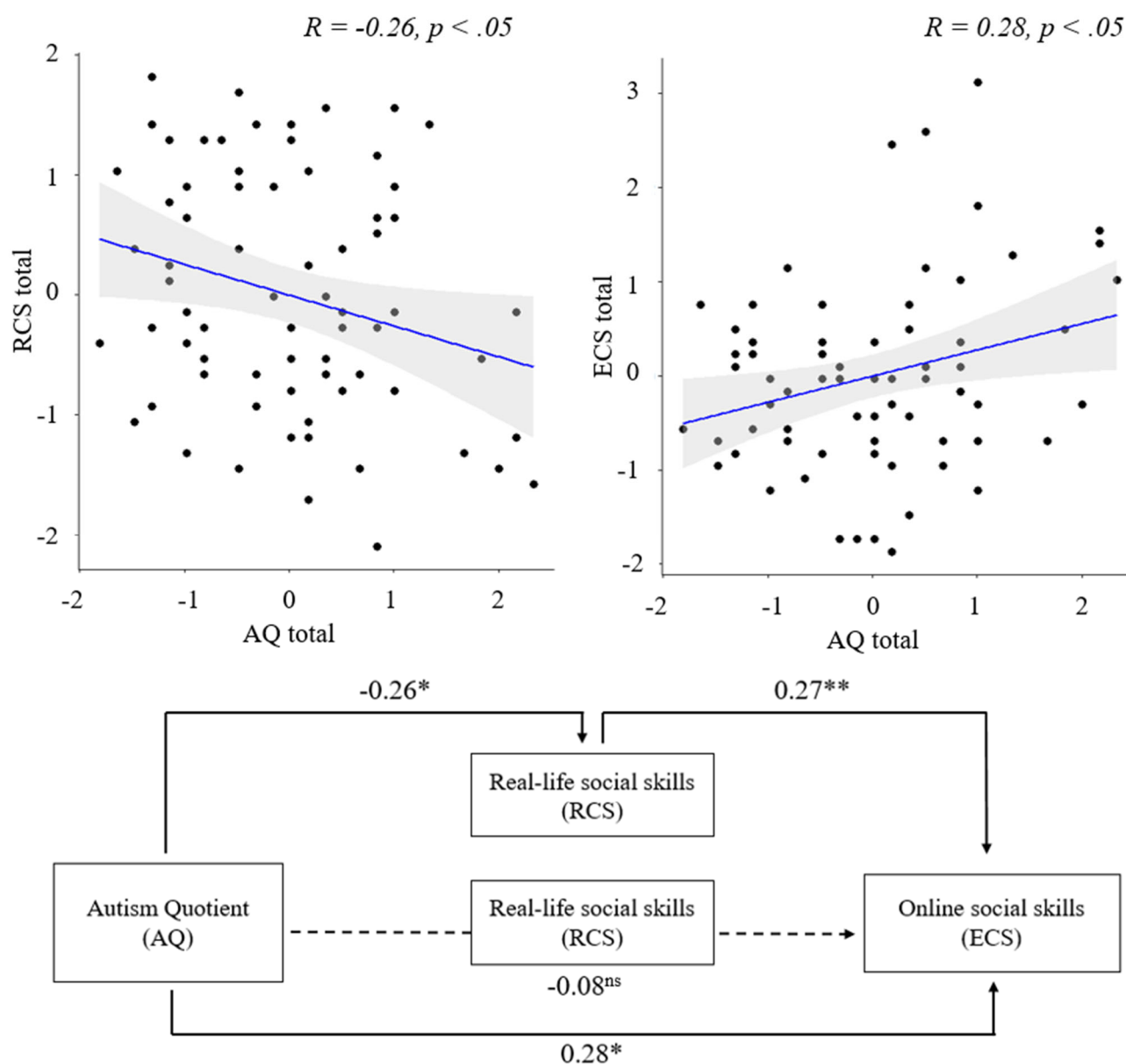


Fig. 1. Relation between autistic traits and social skills. Correlation between (A) the autistic traits (AQ) and the social skills in real life (RCS) and (B) the autistic traits (AQ) and online social skills (ECS). (C) Tested model regarding the relationship between autistic traits, and online and real-life social skills. Data were normalized by computing the z-score. $*p < .05$; $**p < .01$

Discussion

Within the autistic spectrum (ASD and autistic traits), social difficulties have commonly been explored using questionnaires or experimental paradigms focusing on real-life social situations. No study has yet explored social skills in an electronic context (i.e., online). However, such an investigation is crucial to characterize social functioning in everyday life situations to better understand socio-communicative difficulties, which are central within the autistic spectrum. We assessed the autistic traits of participants from the general population and highlighted that participants with high autistic traits presented lower social skills in real life and higher online social skills than participants with low autistic traits. These results, which reveal accentuated difficulties in real-life social interactions and facilities in online ones, suggest that the social difficulties commonly reported in the autistic spectrum could be context-dependent. Our results provide crucial preliminary evidence of the positive social capital that participants with high autistic traits gain by participating in online social interactions and may constitute an interesting avenue for the development of strengths-based interventions in ASD. Furthermore, identifying the factors responsible for the perception of higher online social skills could inform us on how to modify the environment to promote social interactions in the autistic spectrum.

Online communication: A way to foster social connection?

The results showed that autistic traits were associated with more perceived social skills when communicating online and, on the contrary, difficulties when communicating in real life. Previous research has already indicated that non-ASD individuals who exhibit self-reported social avoidance behaviors, such as aloofness, tend to experience a decrease in mental well-being (Stimpson et al., 2021). Furthermore, this association was partially explained by the level of social support perceived by the individuals. Another study by Stice and Lavner (2019) revealed that individuals with high autistic traits reported lower levels of social connectedness, which subsequently contributed to increased feelings of loneliness. As a result, these heightened feelings of loneliness were associated with elevated levels of anxiety and depressive symptoms. Considering our findings, online communication could have several social benefits for individuals having high autistic traits and consequently positively impact their mental well-being. The review by Hassrick et al. (2021) shed light on the multifaceted advantages of online communication in ASD. Their findings suggested benefits encompassing social skills development and cultivating positive social capital. Moreover, the study elucidated the potential of online communication as a tool for bolstering mental health outcomes in this population. Even if these results suggest the positive potential of online communication in enhancing the well-being and social integration of individuals with ASD, we cannot exclude that in our study, perception of enhanced social skills based on self-report questionnaires may reveal a higher comfort with online communication rather than a real improvement in social competencies. Further studies could explore the extension of previous results in ASD on individuals with high autistic traits by using more objective tools in assessing social abilities when using online communication and evaluating the impact on mental health. Additionally, investigating the underlying factors contributing to the increased sociability online would be particularly intriguing.

Online communication: A socially explicit and structured environment?

A tentative explanation of the lower level of real-life social skills and, conversely, higher online perceived social skills in participants having high autistic traits could be linked to the socially explicit and structured characteristics of online communication. In face-to-face

conversations, people with ASD often have difficulties interpreting non-verbal communication cues (body language, tone of voice, etc.), which are critical to understanding the speaker's intent (APA, 2013). In addition, people with ASD may feel the need to have more time than non-ASD subjects to interpret a conversation and formulate a response (Haigh et al., 2018). Instead, online interactions offer stable cues over time, visual signs of organization, and a presentation accompanying the written text that helps the user decipher the speaker's intentions, such as font features, punctuation, emoticons, etc., and allow participants to respond at their own pace. In this sense, online interactions potentially offer people with ASD the opportunity to communicate more comfortably and benefit from more easily interpretable cues (e.g., emoticons are always the same, whereas in real life, everyone expresses their emotions differently). Such a socially explicit online environment could also explain the link found in the present study between online social skills and difficulties in imagining. Participants with the most difficulty imagining may benefit more from supports that facilitate the representation of fictional scenes (pictures, videos, emoticons, descriptions, etc.). It would have been helpful to ask our subjects about their use of social networks, both in terms of frequency of use and content viewed to better understand the origin of such ease in online social communication.

Moreover, one of the specificities of online social communication is the highly structured communicative environment: since the design of social networks is stable, the appearance of conversations is similar from one person to another. Communicating online allows us to choose the people with whom to interact and who share common interests with us. All these elements are markedly reduced in real life, where interactions take place in different contexts, with a changing environment and are more random and unexpected. One of the particularities of ASD is the axis of high-intensity restricted interests as well as the excessive adherence to regular patterns (e.g. setting up routines or rituals) and the marked preference for predictable information (APA, 2013). Thus, it is possible that the regular and predictable environment of online communication as well as control over conversational topics and choices with whom to engage/respond foster engagement in social interactions in the autistic spectrum. In addition, such control of the social content could be at the origin of the internet addictions commonly highlighted in ASD (e.g., Murray et al., 2022) and in people without ASD but with high autistic traits (e.g., Finkenauer et al., 2012).

Online communication: a controlled sensory flow?

A higher sensory sensitivity has been well characterized all along the autistic spectrum (e.g., Markram & Markram, 2010; Mayer, 2017; Takayama et al., 2014) and the sensory profile is commonly associated with the severity of symptoms or the degree of autistic traits (Horder et al., 2014; Mayer, 2017). Thus, using electronic devices to communicate could reduce sensory inputs and increase social skills. More precisely, the intensity of sensory inputs is directly and instantly modular when using electronic tools (such as the auditory dB level or the light intensity), which is not the case in real-life contexts. In addition, this sensory sensitivity could lead to a saturation of the perceptual load in real life, generating social difficulties. Specifically, a recent study found a decrease in the severity of social difficulties in ASD when the number of surrounding items of information is diminished (Haskins et al., 2022). In this vein, since the amount of information is severely diminished online and focuses on the relevant information to be processed (e.g., the main information from a conversation with another person), this may favor adapted social behaviors.

Higher self-disclosure in online communication

Correlation analysis showed that the facilitation of online social skills concerned more particularly the states of self-disclosure in subjects with communication difficulties. The more

subjects exhibited high autistic traits, the more they opened up about their intimacy with others. Self-disclosure behaviors are particularly implicated in developing or maintaining intimate relationships (Brehm et al., 2002). The online environment could represent a defined and restricted place where ASD subjects or subjects with high autistic traits could direct interactions with their most intimate relatives, motivating self-disclosure behaviors. Nevertheless, despite the fact that revealing information about self can help people as they attempt to maintain close relationships with others, some authors (Miell & Duck, 1986) suggest that self-disclosure could generate problems for individuals and relationships. Individuals must learn to regulate their disclosures to avoid inappropriate self-disclosure in conversation with a stranger or to control revealing feelings with close friends that can be “cruel and destroy trust” (Hargie, 2006). Notably, because self-disclosure behaviors are linked to communication difficulties, it would be interesting to explore how and with whom subjects engage in self-disclosure behaviors within the autistic spectrum. Such an investigation would allow us to understand better whether online use promotes or hinders the appropriate use of self-disclosure in individuals with high communication difficulties.

Side effects of online communication

Finally, although online communication could have favorable effects on social communication, it is nevertheless crucial to mention the limits of using such a tool. Indeed, even if online communication offers several opportunities to create social connection, it also contains several risks, including cyberbullying and unwanted sexual solicitation, particularly in adolescents, with victimization rates being as high as 53% in some studies (for a review, Valkenburg & Peter, 2011). Within ASD, the study of Triantafyllopoulou et al. (2022) revealed a noteworthy association between elevated levels of social media usage and an amplified risk of cyber-victimization. Conversely, higher self-esteem exhibited positive correlations with feelings of belonging within online communities, while displaying negative correlations with feelings of being ignored on social network sites and chat rooms.

Limitations and Future Research

Our study has several limitations. Most importantly, the results of this study may not be generalizable to the overall autistic spectrum due to several factors, including the recruitment of participants without an ASD diagnosis, the overrepresentation of females, and the exclusion of individuals with intellectual delay. These limitations raise important considerations regarding the interpretation and applicability of the findings.

Firstly, our study focuses on the general population and not on ASD. While individuals with high autistic traits may share some similarities in social particularities with those diagnosed with ASD, it is essential to recognize that autistic traits are subclinical and do not interfere with quality of life. Since similarities have commonly been found between subjects with elevated autistic traits and ASD subjects, we might expect to replicate our results in a clinical population (e.g., Bezemer et al., 2021; Constantino et al., 2000; Voos et al., 2013). Furthermore, the concept of autistic traits should be interpreted cautiously because, although consensual, it remains hypothetical as no empirical evidence has confirmed the extension of autistic characteristics in the general population (Sasson & Bottema-Beutel, 2022). Questionnaires assessing autistic traits do not require clinical judgment, are not designed as diagnostic evaluations, rely on self-evaluation, and contain elements often interpreted differently by individuals with and without ASD (Gernsbacher et al., 2017). More specially, while self-report measures provide valuable insights into individuals' perceptions of their social abilities, they may be subject to biases, such as social desirability or limited self-awareness (Arnold & Feldman, 1981). Additionally, the absence of direct assessment limits the objective evaluation of participants' social skills in real-life and online contexts. A more comprehensive

assessment approach that includes direct observations or behavioral measures would have provided a more robust understanding of social skills in the autistic spectrum.

Secondly, the overrepresentation of females in our study sample is another factor that limits the generalizability of the results. Autism has traditionally been recognized as a condition that affects males more frequently than females (Zeidan et al., 2022). By recruiting a predominantly female sample, the study may have inadvertently skewed the findings and failed to capture the full range of social skills difficulties experienced by males on the autistic spectrum. Note that a gender effect on AQ in non-ASD subjects has been demonstrated and shows higher scores for men (Baron-Cohen et al., 2001). Such a difference in score could be linked to the use of compensation strategies (referred to as camouflaging strategies) by women, making their social difficulties invisible although present (Hull et al., 2017, 2020). Such strategies have also been proposed as the origin of the high male prevalence of ASD, with a male-to-female ratio of 3:1 (Hull et al., 2017, 2020; Loomes et al., 2017). Thus, because our study primarily included females, it may not adequately capture the experiences and characteristics of males and highlight the need for further studies to include a more gender-balanced sample.

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References

- Adams, R. G., & Stevenson, M. L. (2004). A Lifetime of Relationships Mediated by Technology. In *Growing Together : Personal Relationships across the Life Span*. Cambridge University Press.
- APA. (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)*. American Psychiatric Association, Washington, DC.
- Arnold, H. J., & Feldman, D. C. (1981). Social Desirability Response Bias in Self-Report Choice Situations. *The Academy of Management Journal*, 24(2), 377-385.
<https://doi.org/10.2307/255848>
- Asperger, H. (1944). *Die „Autistischen Psychopathen“ im Kindesalter* | SpringerLink.
<https://link.springer.com/article/10.1007/BF01837709>
- Attwood, T. (1998). *Asperger's syndrome*. London: Jessica Kingsley.
- Baksh, R. A., Abrahams, S., Auyeung, B., & MacPherson, S. E. (2018). The Edinburgh Social Cognition Test (ESCoT) : Examining the effects of age on a new measure of theory of mind and social norm understanding. *PLoS One*, 13(4), e0195818.
<https://doi.org/10.1371/journal.pone.0195818>
- Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-spectrum quotient (AQ) : Evidence from Asperger syndrome/high-functioning autism, males and

- females, scientists and mathematicians. *Journal of Autism and Developmental Disorders*, 31(1), 5-17. <https://doi.org/10.1023/A:1005653411471>
- Bayliss, A. P., & Tipper, S. P. (2005). Gaze and arrow cueing of attention reveals individual differences along the autism spectrum as a function of target context. *British Journal of Psychology*, 96(1), 95-114. <https://doi.org/10.1348/000712604X15626>
- Bezemer, M. L., Blijd-Hoogewys, E. M. A., & Meek-Heekelaar, M. (2021). The Predictive Value of the AQ and the SRS-A in the Diagnosis of ASD in Adults in Clinical Practice. *Journal of Autism and Developmental Disorders*, 51(7), 2402-2415. <https://doi.org/10.1007/s10803-020-04699-7>
- Bradley, N., & Poppen, W. (2003). Assistive technology, computers and Internet may decrease sense of isolation for homebound elderly and disabled persons. *Technology and Disability*, 15(1), 19-25. <https://doi.org/10.3233/TAD-2003-15104>
- Brehm, S. S., Miller, R. S., Perlman, D., & Campbell, S. M. (2002). *Intimate relationships* (4^e éd.). New York: McGraw-Hill.
- Brown, C., & Dunn, W. (2002). *Adolescent/Adult Sensory Profile manual*.
- Constantino, J. N., Przybeck, T., Friesen, D., & Todd, R. D. (2000). Reciprocal social behavior in children with and without pervasive developmental disorders. *Journal of Developmental and Behavioral Pediatrics: JDBP*, 21(1), 2-11. <https://doi.org/10.1097/00004703-200002000-00002>
- Constantino, J. N., & Todd, R. D. (2003). Autistic Traits in the General Population : A Twin Study. *Archives of General Psychiatry*, 60(5), 524. <https://doi.org/10.1001/archpsyc.60.5.524>
- Ellison, N. B., Steinfield, C., & Lampe, C. (2007). The benefits of Facebook « friends: » Social capital and college students' use of online social network sites. *Journal of Computer-Mediated Communication*, 12(4), 1143-1168. <https://doi.org/10.1111/j.1083-6101.2007.00367.x>
- Erickson, J., & Johnson, G. M. (2011). Internet use and psychological wellness during late adulthood. *Canadian Journal on Aging = La Revue Canadienne Du Vieillissement*, 30(2), 197-209. <https://doi.org/10.1017/S0714980811000109>
- Finkenauer, C., Pollmann, M. M. H., Begeer, S., & Kerkhof, P. (2012). Brief Report : Examining the Link Between Autistic Traits and Compulsive Internet Use in a Non-Clinical Sample. *Journal of Autism and Developmental Disorders*, 42(10), 2252-2256. <https://doi.org/10.1007/s10803-012-1465-4>
- Gernsbacher, M. A., Stevenson, J. L., & Dern, S. (2017). Specificity, contexts, and reference groups matter when assessing autistic traits. *PLOS ONE*, 12(2), e0171931. <https://doi.org/10.1371/journal.pone.0171931>
- Gillespie-Lynch, K., Kapp, S. K., Shane-Simpson, C., Smith, D. S., & Hutman, T. (2014). Intersections between the autism spectrum and the internet : Perceived benefits and preferred functions of computer-mediated communication. *Intellectual and Developmental Disabilities*, 52(6), 456-469. <https://doi.org/10.1352/1934-9556-52.6.456>
- Haigh, S. M., Walsh, J. A., Mazefsky, C. A., Minshew, N. J., & Eack, S. M. (2018). Processing Speed is Impaired in Adults with Autism Spectrum Disorder, and Relates to Social Communication Abilities. *Journal of autism and developmental disorders*, 48(8), 2653-2662. <https://doi.org/10.1007/s10803-018-3515-z>
- Hargie, O. (2006). *The handbook of communication skills* (3^e éd.). Routledge.
- Haskins, A. J., Mentch, J., Botch, T. L., Garcia, B. D., Burrows, A. L., & Robertson, C. E. (2022). Reduced social attention in autism is magnified by perceptual load in naturalistic environments. *Autism Research*, 15(12), 2310-2323. <https://doi.org/10.1002/aur.2829>
- Hassrick, E. M., Holmes, L. G., Sosnowy, C., Walton, J., & Carley, K. (2021). Benefits and Risks : A Systematic Review of Information and Communication Technology Use by Autistic People. *Autism in Adulthood*, 3(1), 72-84. <https://doi.org/10.1089/aut.2020.0048>
- Hoekstra, R. A., Bartels, M., Cath, D. C., & Boomsma, D. I. (2008). Factor Structure, Reliability and Criterion Validity of the Autism-Spectrum Quotient (AQ) : A Study in Dutch Population and Patient Groups. *Journal of Autism and Developmental Disorders*, 38(8), 1555-1566. <https://doi.org/10.1007/s10803-008-0538-x>

- Horder, J., Wilson, C. E., Mendez, M. A., & Murphy, D. G. (2014). Autistic Traits and Abnormal Sensory Experiences in Adults. *Journal of Autism and Developmental Disorders*, 44(6), 1461-1469. <https://doi.org/10.1007/s10803-013-2012-7>
- Hull, L., Petrides, K. V., Allison, C., Smith, P., Baron-Cohen, S., Lai, M.-C., & Mandy, W. (2017). "Putting on My Best Normal" : Social Camouflaging in Adults with Autism Spectrum Conditions. *Journal of Autism and Developmental Disorders*, 47(8), 2519-2534. <https://doi.org/10.1007/s10803-017-3166-5>
- Hull, L., Petrides, K. V., & Mandy, W. (2020). The Female Autism Phenotype and Camouflaging : A Narrative Review. *Review Journal of Autism and Developmental Disorders*, 7(4), 306-317. <https://doi.org/10.1007/s40489-020-00197-9>
- Kanner, L. (1943). *Autistic disturbances of affective contact*. 2, 217-250.
- Kempnaers, C., Braun, S., Delvaux, N., & Linkowski, P. (2017). The assessment of autistic traits with the Autism Spectrum Quotient : Contribution of the French version to its construct validity. *European Review of Applied Psychology*, 67(6), 299-306. <https://doi.org/10.1016/j.erap.2017.09.001>
- Loomes, R., Hull, L., & Mandy, W. P. L. (2017). What Is the Male-to-Female Ratio in Autism Spectrum Disorder? A Systematic Review and Meta-Analysis. *Journal of the American Academy of Child and Adolescent Psychiatry*, 56(6), 466-474. <https://doi.org/10.1016/j.jaac.2017.03.013>
- Mantzouranis, G., Baudat, S., & Zimmermann, G. (2019). Assessing Online and Offline Adolescent Social Skills : Development and Validation of the Real and Electronic Communication Skills Questionnaire. *Cyberpsychology, Behavior, and Social Networking*, 22(6), 404-411. <https://doi.org/10.1089/cyber.2018.0655>
- Markram, K., & Markram, H. (2010). The Intense World Theory – A Unifying Theory of the Neurobiology of Autism. *Frontiers in Human Neuroscience*, 4. <https://doi.org/10.3389/fnhum.2010.00224>
- Mayer, J. L. (2017). The Relationship Between Autistic Traits and Atypical Sensory Functioning in Neurotypical and ASD Adults : A Spectrum Approach. *Journal of Autism and Developmental Disorders*, 47(2), 316-327. <https://doi.org/10.1007/s10803-016-2948-5>
- Mazurek, M. O. (2014). Loneliness, friendship, and well-being in adults with autism spectrum disorders. *Autism: The International Journal of Research and Practice*, 18(3), 223-232. <https://doi.org/10.1177/1362361312474121>
- Miell, D., & Duck, S. (1986). Strategies in Developing Friendships. In V. J. Derlega & B. A. Winstead (Éds.), *Friendship and Social Interaction* (p. 129-143). Springer. https://doi.org/10.1007/978-1-4612-4880-4_7
- Murray, A., Koronczai, B., Király, O., Griffiths, M. D., Mannion, A., Leader, G., & Demetrovics, Z. (2022). Autism, Problematic Internet Use and Gaming Disorder : A Systematic Review. *Review Journal of Autism and Developmental Disorders*, 9(1), 120-140. <https://doi.org/10.1007/s40489-021-00243-0>
- Piven, J., Wzorek, M., Landa, R., Lainhart, J., Bolton, P., Chase, G. A., & Folstein, S. (1994). Personality characteristics of the parents of autistic individuals. *Psychological Medicine*, 24(3), 783-795. <https://doi.org/10.1017/s0033291700027938>
- Ruzich, E., Allison, C., Smith, P., Watson, P., Auyeung, B., Ring, H., & Baron-Cohen, S. (2015). Measuring autistic traits in the general population : A systematic review of the Autism-Spectrum Quotient (AQ) in a nonclinical population sample of 6,900 typical adult males and females. *Molecular Autism*, 6(1), 2. <https://doi.org/10.1186/2040-2392-6-2>
- Sasson, N. J., & Bottema-Beutel, K. (2022). Studies of autistic traits in the general population are not studies of autism. *Autism*, 26(4), 1007-1008. <https://doi.org/10.1177/13623613211058515>
- Stevenson, J. L., & Hart, K. R. (2017). Psychometric Properties of the Autism-Spectrum Quotient for Assessing Low and High Levels of Autistic Traits in College Students. *Journal of Autism and Developmental Disorders*, 47(6), 1838-1853. <https://doi.org/10.1007/s10803-017-3109-1>

- Stewart, G. R., Wallace, G. L., Cottam, M., & Charlton, R. A. (2020). Theory of mind performance in younger and older adults with elevated autistic traits. *Autism Research, 13*(5), 751-762. <https://doi.org/10.1002/aur.2206>
- Stewart, M. E., & Ota, M. (2008). Lexical effects on speech perception in individuals with “autistic” traits. *Cognition, 109*(1), 157-162. <https://doi.org/10.1016/j.cognition.2008.07.010>
- Stice, L. V., & Lavner, J. A. (2019). Social Connectedness and Loneliness Mediate the Association Between Autistic Traits and Internalizing Symptoms Among Young Adults. *Journal of Autism and Developmental Disorders, 49*(3), 1096-1110. <https://doi.org/10.1007/s10803-018-3812-6>
- Stimpson, N. J., Hull, L., & Mandy, W. (2021). The Association Between Autistic Traits and Mental Well-Being. *Journal of Happiness Studies, 22*(1), 287-304. <https://doi.org/10.1007/s10902-020-00229-5>
- Subrahmanyam, K., Reich, S. M., Waechter, N., & Espinoza, G. (2008). Online and offline social networks : Use of social networking sites by emerging adults. *Journal of Applied Developmental Psychology, 29*(6), 420-433. <https://doi.org/10.1016/j.appdev.2008.07.003>
- Takayama, Y., Hashimoto, R., Tani, M., Kanai, C., Yamada, T., Watanabe, H., Ono, T., Kato, N., & Iwanami, A. (2014). Standardization of the Japanese version of the Glasgow Sensory Questionnaire (GSQ). *Research in Autism Spectrum Disorders, 8*(4), 347-353. <https://doi.org/10.1016/j.rasd.2013.12.017>
- Triantafyllopoulou, P., Clark-Hughes, C., & Langdon, P. E. (2022). Social Media and Cyber-Bullying in Autistic Adults. *Journal of Autism and Developmental Disorders, 52*(11), 4966-4974. <https://doi.org/10.1007/s10803-021-05361-6>
- Valkenburg, P. M., & Peter, J. (2011). Online communication among adolescents : An integrated model of its attraction, opportunities, and risks. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine, 48*(2), 121-127. <https://doi.org/10.1016/j.jadohealth.2010.08.020>
- van der Aa, C., Pollmann, M. M. H., Plaat, A., & van der Gaag, R. J. (2016). Computer-mediated communication in adults with high-functioning autism spectrum disorders and controls. *Research in Autism Spectrum Disorders, 23*, 15-27. <https://doi.org/10.1016/j.rasd.2015.11.007>
- Voos, A. C., Pelphrey, K. A., & Kaiser, M. D. (2013). Autistic traits are associated with diminished neural response to affective touch. *Social Cognitive and Affective Neuroscience, 8*(4), 378-386. <https://doi.org/10.1093/scan/nss009>
- Westerberg, B., Bäärnhielm, S., Giles, C., Hylén, U., Holländare, F., & Bejerot, S. (2021). An Internet Based Intervention for Adults With Autism Spectrum Disorder—A Qualitative Study of Participants Experiences. *Frontiers in Psychiatry, 12*, 789663. <https://doi.org/10.3389/fpsy.2021.789663>
- White, H., McConnell, E., Clipp, E., Bynum, L., Teague, C., Navas, L., Craven, S., & Halbrecht, H. (1999). Surfing the Net in Later Life : A Review of the Literature and Pilot Study of Computer Use and Quality of Life. *Journal of Applied Gerontology, 18*(3), 358-378. <https://doi.org/10.1177/073346489901800306>
- Zeidan, J., Fombonne, E., Scolah, J., Ibrahim, A., Durkin, M. S., Saxena, S., Yusuf, A., Shih, A., & Elsabbagh, M. (2022). Global prevalence of autism : A systematic review update. *Autism Research: Official Journal of the International Society for Autism Research, 15*(5), 778-790. <https://doi.org/10.1002/aur.2696>