Research in Autism Spectrum Disorders 23 (2016) 15–27

Contents lists available at ScienceDirect

Research in Autism Spectrum Disorders

journal homepage: http://ees.elsevier.com/RASD/default.asp

Computer-mediated communication in adults with high-functioning autism spectrum disorders and controls

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ARTICLE INFO

Article history:
Received 16 February 2015
Received in revised form 17 November 2015
Accepted 24 November 2015
Available online xxx

Keywords:
Autism spectrum disorders
Autism spectrum conditions
Computer mediated communication
Internet use
Social life

ABSTRACT

It has been suggested that people with autism spectrum disorders (ASD) are attracted to computer-mediated communication (CMC). In this study, we compare CMC use in adults with high-functioning ASD ($N = 113$) and a control group ($N = 72$). We find that people with ASD spend more time on CMC than controls, are more positive about CMC, and report relatively high levels of online social life satisfaction. However, CMC use is negatively related to satisfaction with life for people with ASD. Our results indicate that the ASD subjects in this study use CMC at least as enthusiastically and successfully as controls but that there may also be negative sides to its use.

1. Introduction

Recently, more and more attention is paid to the impact of computer-mediated communication (CMC) on people with autism spectrum disorders (ASD), but it is rarely directly compared to the impact is has on people without ASD. The popularity of autism-related websites and mailing lists suggests high online activity by people with ASD[1] (Davidson, 2008). However, people with ASD typically have communication deficits (American Psychiatric Association, 2013; Hengeveld, Van Londen, & Van der Gaag, 2008). The current paper addresses three questions about CMC use of people with ASD by comparing it to a control group. (1) Do people with ASD use CMC in the same way as controls? (2) What aspects of CMC are valued by people with ASD and controls? (3) How is CMC use related to different life outcomes (e.g., satisfaction with social life, loneliness) for people with ASD and controls?

1.1. Computer-mediated communication

Computer-mediated communication is relatively consistent, predictable, and uni-modal; most CMC is text-based, takes place in a structured environment, is frequently asynchronous (giving users more time to process the information) and has

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[1] Of course these websites are also of interest and probably also consulted by family members of people with ASD. However, given that we were able to easily recruit ASD participants via these websites indicates that people with ASD also frequently use these sites.

http://dx.doi.org/10.1016/j.rasd.2015.11.007
1750-9467/

fewer distracting signals. Also, CMC often provides spatial and temporal distance between communication partners, and allows working at one's own convenience and pace, which fits the needs of people with ASD well. Several studies indicate that there is a special attraction to the Internet and computer-based tools for people with ASD (e.g., Cheng, Kimberly, & Orlich, 2002; Finkenauer, Pollmann, Begeer, & Kerkhof, 2012; Grynszpan, Martin, & Nadel, 2008; Ramdoss et al., 2011). The conclusion of these studies is that the text-based nature of CMC affords a reduced-cues method of communication, greatly reducing the sensory overload that many ASDs experience, and thereby leading to improved communication. Not surprisingly, 80% of adults with ASD report to use social media and they spend on average three hours a day using them (Mazurek, 2013). Additionally, a survey among 138 people with ASD showed that text-based, asynchronous communication channels were preferred to traditional forms of communication and that people with ASD report a high level of internet use in general (Benford, 2008). We therefore know that people with ASD use CMC, but we do not yet know whether they use it more than people without ASD. Thus, our first goal is to compare CMC use of people with ASD with a control group.

1.2. Characteristics of CMC

Our second goal is to investigate whether people with ASD value different aspects of CMC than controls. Benford (Benford, 2008; Benford & Standen, 2009) interviewed people with ASD and found that online communication provides them with a sense of liberation, afforded by specific characteristics of CMC. The first of these characteristics is control, both over the timing (communicating at a self-selected time) and pacing (immediacy of response) of a conversation, and over the way one can present oneself. Another main point was the clarity of written text; more structured, and with less social chit-chat than in real life. The absence of non-verbal cues was important for diminishing the stress brought about by real-life conversations. Burke, Kraut, and Williams (2010) found similar themes, describing the attractiveness of features such as CMC's slower pace and the absence of non-verbal signals and of the need for making eye contact. Furthermore, the possibilities to find like-minded people and to use predefined emoticons were named as benefits. A study by Davidson (2008) suggests that the emergence of an autistic culture online is supported greatly by special features of CMC such as its slower pace, the ability to communicate with like-minded people, and the absence of the demands of physical co-presence. In a case study on virtual world use, Stendal and Balandin (2015) found that their subject liked the virtual world because they feel more comfortable communicating. Recently, Gillespie-Lynch, Kapp, Shane-Simpson, Smith, and Hutman (2014) were the first to compare the preferred use of different internet functions and the perceived benefits of CMC use of adults with and without ASD. They found that adults with ASD value different aspects of the Internet than controls. For example, they value it more than controls that they can meet people with the same interests, but value it less than controls that they can easily stay close to friends and family. Additionally they found that adults with ASD appreciate several aspects of CMC more than controls, like the fact that they have more time to think and can more easily express their true self. Their study provides a first indication to the qualitative differences of Internet and CMC use of people with and without CMC. Our study provides an extension of their findings. Other than Gillespie-Lynch et al. (2014) we will not only ask people to what extent they value certain given categories but also include an open question, so that people can indicate themselves which features of CMC they value most. This approach enhances the validity of the research because it may be that people with ASD value aspect of CMC that people without ASD (including most researchers) do not think of.

1.3. CMC use and well-being

The third goal is to study how CMC use is related to well-being. Although some early studies on the link between CMC and well-being in the general population suggested that CMC can have a negative impact on people's social life (Kraut et al., 1998; Nie & Erbring, 2000), more recent studies link CMC use to various positive social outcomes (Amichai-Hamburger & Furnham, 2007). For example, Valkenburg & Peter (2007) find a positive relationship between instant messaging, and time spent with existing friends and the quality of those friendships. Additionally, researchers have noted how the Internet offers an additional set of tools for getting acquainted with people, and maintaining these contacts (Ellison, Steinfield, & Lampe, 2007; Orr et al., 2009; Steinfield, Ellison, & Lampe, 2008). Whether these advantages hold in the same way for people with ASD is not yet fully clear. There are only a few studies relating CMC use of people with ASD to life outcome variables, most of them without a control group. For example, Davidson (2008) and Mitchell (2003) studied autistic culture online and found that the ability to have meaningful communication without the need to respond immediately, and the slower pacing of CMC in general, could alleviate the stress that many ASDs encounter during real-life encounters. Benford and Standen (2009) surveyed people with Asperger's syndrome and high-functioning autism about their experiences and perceptions of CMC. Their subjects report that CMC has helped them expand their social networks and get more social support, decreasing feelings of loneliness. However, a recent study on social media use in adults with ASD found no link between frequency of use and feelings of loneliness (Mazurek, 2013).

The only study in this area with a control group is a study of word usage in blogs by Newton, Kramer, and McIntosh (2009). Interestingly, word usage was found to be almost identical in the two groups, except for the use of social words, which was more variable in ASDs than in controls. Their conclusion was that online there might be little differences in communication between the two groups, and that social-communicative deficits of ASDs could be induced by the proximal setting in which traditional social contact takes place, rather than being an impairment per se. Newton and colleagues suggest that in a more distal setting, as provided by CMC, the manifestation of these deficits may be diminished or even absent. This view is in

Table 1
Demographic variables for people with autism spectrum disorders and controls. Values denote number and (percentage) of respondents, except for AQ, age and working hours per week which are mean (SD) values.

Variable	ASD	Control
AQ total, 4-point scoring method (*N* = 182)	147.03 (19.09)	99.39(18.23)
AQ total, binary scoring method (*N* = 182)	34.68 (7.88)	13.59 (8.10)
Mean age (*N* = 183)	40.2 (12.3)	40.5 (12.1)
Sex (*N* = 183)		
Men	62 (55.9%)	28 (38.9%)
Women	49 (44.1%)	44 (61.1%)
Relational status (*N* = 181)		
Single	65 (59.6%)	20 (27.8%)
Partner	44 (40.4%)	52 (72.2%)
Living situation (*N* = 183)		
Independent	94 (84.7%)	69 (95.5%)
Non-independent (with parents, sheltered etc.)	17 (15.3%)	3 (4.2%)
Main daytime occupation (*N* = 181)		
Paid employment	42 (37.8%)	42 (58.3%)
Retired	2 (1.8%)	2 (2.8%)
Student	13 (11.7%)	19 (26.4%)
Disability allowance	32 (28.8%)	2 (2.8%)
Unemployed, actively seeking	6 (5.4%)	4 (5.6%)
Not employed otherwise	16 (14.4%)	3 (4.2%)
Working hours per week (*N* = 78)	32.00 (7.66)	30.53 (7.12)
Educational level (completed) (*N* = 183)		
Primary school	4 (3.6%)	0 (0.0%)
Lower vocational/intermediate secondary education	12 (10.8%)	3 (4.2%)
Intermediate vocational/higher secondary education	39 (35.1%)	12 (16.7%)
Higher vocational education	31 (27.9%)	31 (43.1%)
University	25 (22.5%)	26 (36.1%)
Highest educational level (including uncompleted) (*N* = 183)		
Primary school	1 (.9%)	0 (0.0%)
Lower vocational/intermediate secondary education	11 (9.9%)	1 (1.4%)
Intermediate vocational/higher secondary education	21 (18.9%)	10 (13.9%)
Higher vocational education	35 (31.5%)	29 (40.3%)
University	43 (38.7%)	32 (44.4%)

contrast to the common view that people with ASD lack interest in contact with others, as evidenced by some of the diagnostic and symptomatic criteria (American Psychiatric Association, 2013). In this view people with autism prefer numbers and things over people. Contrary to this view, the findings discussed above suggest that people with ASD may not lack interest in social contact, but lack social skills, as required in the everyday, proximal setting of face-to-face conversations. These studies imply that, contrary to the stereotype, high-functioning ASDs are interested in having relationships with other people (see, for example, Benford & Standen, 2009; Burke et al., 2010; Davidson, 2008; Newton et al., 2009). Given that CMC offers them the opportunity to have a social life which is easier to manage, we hypothesize that people with ASD can develop a satisfactory online social life.

What is more, CMC may be able to improve general well-being. ASD is related to higher levels of loneliness (Jobe and Williams White, 2007), but having a good support network is positively related to quality of life in people with ASD (Renty & Roeyers, 2006). If the online social life can function as a support network, CMC should be positively related to indicators of well-being in people with ASD. In the context of our third research goal we will therefore not only test whether people with ASD are satisfied with their online social life, but also whether CMC is related to more general indicators of well-being. We hypothesize that CMC can improve general well-being in people with ASD.

2. Method

2.1. Participants

Since this study focuses on people that use the Internet for computer-mediated communication, participant requests were primarily distributed via online channels. For the ASD group, a request to participate was posted on the LinkedIn discussion group “Autisme Ten Top” (Autism Par Excellence), the websites and newsletters from autism organizations NVA (“Nederlandse Vereniging voor Autisme” or Dutch Association for Autism, originally a parent organization) and PAS (“Personen uit het Autisme Spectrum”) and the autism discussion group “Autsider.” In addition, some recruiting was done

through one of the authors' personal network, and several health care organizations were asked to cooperate in finding candidates, for instance during an open house (April, 2010) and through e-mail and telephone requests.

For the non-ASD group recruitment was more complicated, because there is no online platform for the 'general' individual. We therefore asked students and acquaintances to invite people in their network to participate, and if possible to forward the request to others in their social network. We deliberately did not invite people from our own network to participate, but made sure that the invitation was sent at least one degree further to reduce the selection bias of middle-aged, highly educated individuals and collect a sample that is as similar as possible to the ASD group. To this end, we also explicitly asked to distribute the request over younger and older people, of different educational levels, and throughout the country. Another prerequisite for participation was that individuals were familiar with online communication, again to ensure similarity between the ASD and the control group.

We received data from 203 individuals, but in one case, the caregiver instead of the individual with ASD themselves completed the survey and two respondents did not meet the requirement that respondents needed to be at least 18 years old, so these responses were not included. Due to technical problems 20 questionnaires were incomplete and are not included in all analyses reported below. Information on gender was available from 183 respondents, with 90 men and 93 women in the sample. Respondents were asked whether they had a diagnosis in the autism spectrum. Respondents were considered to belong to the ASD group if they answered yes to this question (108 individuals), or if they self-identified as ASD in their comments (5 individuals). We included the self-identified ASD in the ASD group, since these individuals indicated that they are certain that they classify as ASD.[2] Based on these criteria, the ASD group counted 113 respondents, and the control group 72 respondents. Table 1 provides demographic statistics on the subjects.

The recruitment method resulted in a higher-than-average level of education in both the control and the ASD group. We included a question about the completed and the uncompleted level of education. Since ASDs tend to have more difficulties with the transition from school to college and face special challenges at college which make it harder for them to complete their education (Gelbar, Smith, Reichow, 2014; VanBergeijk, Klin, & Volkmar, 2008), the uncompleted level of education may give a better indication of their intellectual capabilities than the completed level of education. Most respondents had the Dutch nationality; some were Belgian. No information about ethnic background, socio-economic status or sexual orientation was available.

In comparison to the control group the ASD group has almost the same age (40 years), contains more men (55.9% vs. 38.9%), is more often single (59.6% vs. 27.8%), is living independently less often (84.7% vs. 95.5%), is more often unemployed or living on a disability allowance (53.2% vs. 7.0%), and both the completed and uncompleted level of education is lower. These results are in line with what we expected of a group of high-functioning ASDs vs. a control group recruited via students and acquaintances of researchers, and we have no evidence that the differences are of a quality that they can explain differences in perceptions of CMC.

2.2. Measures and procedure

The survey was held from May 25, 2010 to June 25, 2010. The survey was conducted in Dutch, using an online survey tool. Two € 15 book vouchers were raffled off among all respondents who had completed the survey and had entered their e-mail address for this goal. All persons gave their informed consent prior to their participation in the study. The study was approved by the local Research Ethics Committee.

2.2.1. Internet and CMC use

Internet use and *CMC use* were measured in hours per week, calculated from the number of days per week (1–7) or per month (1–3), and hours per day (0–10 h or more, in half hour blocks) that respondents spent online or on CMC. This way of measuring internet and CMC usage was based on the method used by Valkenburg and Peter (2007), except here no distinction was made between weekdays and weekends. To get a more specific picture of the channels used, we asked people to indicate for nine *different channels* how often they used this channel (see Table 3). Answers were scored on a 6-point scale, ranging from 0 (less than once per month) to 5 (more than 2 times per day). In addition, respondents were asked if they had *found friends or acquaintances* through CMC that they would not have known otherwise. If they indicated that they did, they were further asked to indicate *how many friends and acquaintances* they found through CMC. Finally, we measured *appreciation of CMC* with 5 items regarding the value a respondent places on different aspects of online communication. The items were scored on a 7-point Likert scale, ranging from 1 (totally disagree) to 7 (totally agree) and had a good internal consistency, $\alpha = .84$.

2.2.2. Characteristics of CMC

We assessed the perceived advantages and disadvantages of CMC with two types of questions. We first asked in two open questions to *list the advantages and disadvantages* of CMC as perceived by the respondent. The answers to these open-ended questions were categorized, based as much as possible on the categories found in the literature but allowing new categories to emerge from the answers. These fine-grained categories were collapsed into major clusters, 9 for advantages, and 8 for

[2] To be sure, we also inspected the scores on the AQ of these individuals. These scores are well above the scores of the control group (22, 27, 28, 34, 41).

Table 2
Means and standard deviations for different indices of internet use for people with ASD and controls.

	ASD		Controls	
	M	SD	*M*	SD
Hours of Internet use per week	23.20	16.07	16.46	13.96
Hours spent on CMC per week	13.95	14.41	9.01	11.25
Number of new friends through Internet	1.69	2.61	1.07	2.04
Number of new acquaintances through Internet	4.71	4.32	2.63	3.87
Appreciation of CMC	5.08	1.47	4.22	1.16

disadvantages. For example, all answers that included phrases like 'time to think' or 'no pressure' were put in the cluster 'pacing'.

Second, we presented respondents with a list of statements about CMC, which was created based on the advantages that had been reported in previous studies (e.g., Benford & Standen, 2009; Burke et al., 2010). These included: pacing of the conversation, absence of non-verbal communication, anonymity, ability to find like-minded people, etc. For each characteristic, respondents were asked to indicate on a visual analog scale (Ahearn, 1997) whether they saw this *characteristic as a disadvantage or an advantage* . The starting point of the slider was in the middle of the scale and respondents could move it to the left to indicate a disadvantage or move it to the right to indicate an advantage. The scale was labeled at the end points with the statement "To me this is a big (dis) advantage". No numbers were visible to the participant but the position of the slider was stored on a scale from 1 (disadvantage) to 100 (advantage). As described in the results section, we performed factor analyses to identify underlying clusters in these characteristics of CMC. Based on these analyses we created three subscales: *Time independence* with 15 items ($\alpha = .89$), *No co-presence* with 8 items ($\alpha = .87$), and *Relative ease to express oneself* with 5 items ($\alpha = .76$) (see Table 5 for the complete list).

2.2.3. Well-being scales

Well-being was measured for different aspects of life. The aspects ranged from concrete to abstract; with the most concrete being *satisfaction with one's online social life* ($\alpha = .82$), then *satisfaction with one's social life* ($\alpha = .95$), then *satisfaction with life* ($\alpha = .94$), and finally their general *loneliness* ($\alpha = .84$). The satisfaction scales each consisted of 5 items measured on a 7-point Likert scale following Diener's satisfaction with life scale (Diener, Emmons, Larsen, & Griffin, 1985). Scores could range from 1 (totally disagree) to 7 (totally agree). The loneliness scale consisted of 6 items based on the UCLA Loneliness Scale (Russell, Peplau, & Cutrona, 1980), for example 'Do you ever feel lonely?'. These items were measured on a 5-point Likert scale with answer categories ranging from 5 (never) to 1 (always). Answers were scored such that higher scores represent less loneliness.

2.2.4. Autism spectrum quotient (AQ)

As an additional check for the distinction between people with and without ASD, participants filled out the AQ, a self-report questionnaire, originally developed by Baron-Cohen, Wheelwright, Skinner, and Martin (2001). The translation used here was the Dutch Autism Spectrum Quotient (Hoekstra, Bartels, Cath, & Boomsma, 2008). The reliability of the scale was good $\alpha = .96$, and the ASD group scored significantly higher ($M = 34.68$, SD = 7.88) than the controls ($M = 13.59$, SD = 8.10), $t(179) = 17.29$, $p < .001$, $r^2 = .67$, see also Table 1. Seventy-four individuals from the ASD group (65%) scored above the commonly suggested threshold of 32. Three out of the 72 controls scored above the threshold, but we decided to still treat them as controls and not re-assign them to the ASD group as they were recruited as controls. The full questionnaire that was used is available online (https://askeplaat.files.wordpress.com/2013/01/do-you-read-me-5.pdf).

3. Results

3.1. Internet and CMC use

To test whether people with and without ASD use the Internet and CMC differently we performed a MANOVA with the different indicators of internet use as dependent variables. We included employment status as binary variable (paid employment or not) to control for the fact that people in the ASD group were more likely to be unemployed and therefore have more time to spend online. This analysis yielded a significant multivariate effect, $F(5, 166) = 2.96$, $p = .014$, $\eta_p^2 = .08$, indicating that there are systematic differences in the answers given by people with and without ASD. The means are provided in Table 2.

Specifically, marginally significant effects were found for time spent online and on CMC: people with ASD spent more hours per week online, $F(1, 170) = 3.53$, $p = .062$, $\eta_p^2 = .020$ and more hours per week on CMC, $F(1, 170) = 2.78$, $p = .097$, $\eta_p^2 = .016$. Note that, although being marginally significant, these are meaningful differences of several hours. People with ASD report to have made more acquaintances online than controls, $F(1, 170) = 7.80$, $p = .006$, $\eta_p^2 = .044$, but not to have made more friends online than controls, $F(1, 170) = 1.32$, $p = .252$, $\eta_p^2 = .008$. People with ASD further appreciate CMC much more than controls, $F(1, 170) = 11.53$, $p = .001$, $\eta_p^2 = .064$.

Table 3
Median and mean number of uses of different CMC channels for people with ASD and controls. Scale ranges from 0 (less than once per month) to 5 (more than 2 times per day).

	ASD		Controls	
	Mdn	*M*	Mdn	*M*
E-mail	5	4.40	5	4.33
Twitter	0	0.18	0	0.62
Text chat	0	1.25	0	1.28
Audiovisual chat	0	0.28	0	0.41
Social network sites	0	1.30	1	1.67
Professional network sites	0	0.67	0	0.65
Discussion sites and forums	1	1.89	0	0.64
Dating sites	0	0.17	0	0.01
Games	0	0.66	0	0.30

A chi-square test showed that people with ASD also answered significantly more often "yes" to the question whether they had found friends or acquaintances through CMC that they would not have known otherwise, than controls (67.9% of ASDs vs. 42.3% of controls, $\chi^2(1) = 11.58$, $p < .001$). The MANOVA reported above showed that this difference only manifested for acquaintances and not friends. For both groups we found that the number of new acquaintances was higher than the number of new friends, which is in line with earlier findings that CMC mostly fosters weak ties (Ellison et al., 2007; Turner, Grube, & Meyers, 2001). However, ASDs and controls might have different operational definitions of "friends" and "acquaintances," a point we address in the discussion section.

We further investigated which specific channels are used more often by people with ASD than controls. Because usage of channels was not normally distributed, we conducted Mann-Whitney tests. To control for multiple testing we set the significance level to .005 and found that the only channel used significantly more by people with ASD were discussion sites, $U = 2562$, $z = -4.08$ (median and mean number of use are given in Table 3).

However, this difference can be explained by the differences in recruitment for people with and without ASD, as recruitment for ASD relied more on requests posted on discussion sites than for controls. So, although people with ASD report spending more time using CMC, the difference cannot be found for most of the specific channels we investigated. It should be noted, however, that for most channels other than e-mail, ratings were very low, which restricts the possibility to find an effect.

In general, these results indicate that Internet use, CMC use, and number of acquaintances found online of respondents with ASD is greater than that of the control group and also that people with ASD value CMC more than controls. This is in line with our first hypothesis that people with ASD are especially attracted to CMC.

3.2. Characteristics of CMC

Having established that people with ASD make more use of CMC, we next investigated which aspects of CMC are seen as the most important advantages (again also comparing ASD to controls). We first analyzed the answers to the open questions. On average, people list 2.64 (SD = 1.75) advantages and 1.85 (SD = 1.17) disadvantages, with no differences between the two groups, $F(2, 181) = 1.40$, $p = .25$, $\eta_p^2 = .015$. As described in the methods section, we categorized the open answers into nine advantages and eight disadvantages. A MANOVA on the frequencies of the different advantages revealed that people with ASD and controls list different advantages $F(9, 174) = 7.40$, $p < .001$, $\eta_p^2 = .28$. For example, people with ASD list on average 0.8 advantages which relate to the slower pace in CMC whereas controls come up with only 0.35 of these kinds of advantages. On the other hand controls list on average one advantage relating to the convenience of CMC, whereas people with ASD only mention 0.3 of these kinds of advantages (see Table 4 for the categories and the comparisons). There was no difference between the groups for the disadvantages, $F(8, 175) = .75$, $p = .65$, $\eta_p^2 = .033$. So if asked to freely list advantages, people with ASD and controls differ substantially in the answers that come to their mind, with some categories being mentioned more than twice as often in one group than in the other.

Second, we analyzed the ratings given to the 40 characteristics we formulated beforehand. Many of these features are named as beneficial in general (e.g., "Online I don't have to react instantly"), but some are seen as specifically advantageous for ASDs (e.g., "Online I don't have to pay attention to someone's facial expression"). Therefore, ASDs were expected to endorse a higher number of these statements, and endorse them more intensely. We first performed factor analyses to identify the underlying constructs for the 40 characteristics to make further analyses more manageable. We followed recommendations from Costello & Osborne (2005) and used principal axis factors as extraction method because the scores on the individual items were not normally distributed. Based on the scree plot we decided how many factors to extract and we used direct oblimin rotation because we expected our factors to be correlated, given that they all measure aspects of CMC. We decided to exclude items with communalities lower than .40 because this indicates that the item is not related strong enough to other items in the analysis. After four rounds of excluding items three factors emerged which made theoretical sense, had at least five items, and had a good internal consistency, as described in the methods section. Factor loadings on the final three factors are presented in Table 5. We then performed a MANOVA with the scores on the three scales as dependent

Table 4
Answer categories for advantages and disadvantages of CMC as mentioned by ASDs and controls with mean frequencies (SD), and the comparison.

	ASD	Controls	*F*-value	*p*-value	Eta squared
Advantages					
Time independence: pacing	0.82 (0.90)	0.35 (0.66)	14.58	<.001	.074
Time independence: timing	0.29 (0.56)	0.62 (0.64)	13.30	<.001	.068
No co-presence: absence of non-verbal communication	0.25 (0.49)	0.07 (0.26)	7.87	.006	.041
No co-presence: anonymity/invisibility	0.11 (0.31)	0.04 (0.20)	2.39	.124	.013
Less sensory overload	0.19 (0.45)	0.06 (0.23)	4.95	.027	.026
Textual form	0.37 (0.62)	0.17 (0.48)	5.59	.019	.030
Enhanced contact, social skills	0.22 (0.59)	0.23 (0.74)	0.00	.967	<.001
Convenience	0.30 (0.65)	1.01 (1.02)	33.43	<.001	.155
Decreased stress	0.14 (0.38)	0.01 (0.12)	7.72	.006	.041
Disadvantages					
Time independence: too slow	0.20 (0.45)	0.23 (0.48)			
No co-presence: absence of non-verbal communication	0.35 (0.55)	0.41 (0.52)			
No co-presence: lack of direct contact	0.65 (2.05)	0.44 (0.69)			
Usage intensity	0.04 (0.19)	0.11 (0.36)			
Textual form	0.19 (0.41)	0.18 (0.43)			
Technique-related issues	0.20 (0.50)	0.24 (0.64)			
Friction	0.27 (0.45)	0.32 (0.50)			
Miscellaneous	0.05 (0.23)	0.06 (0.23)			

Note: because of multiple testing only *p*-values smaller than .005 should be regarded significant (Bonferroni correction).

variables and group (ASD or control) as fixed factor. It yielded a significant multivariate effect, $F(3, 176) = 26.31$, $p < .001$, $\eta_p^2 = .31$. Moreover, it revealed significant differences between the ratings given by people with ASD and controls on all three subscales. As can be seen in Table 5, people with ASD perceive the timing, the isolated communication context and the relative ease to express oneself as more of an advantage than controls.

In fact, controls don't perceive the isolated communication context as an advantage at all, as their rating is below 50, whereas ratings of people with ASD are well above 50, and significantly so ($t(108) = 11.89$, $p < .001$, $d = 1.14$).

In general, one can say that people with ASD ascribe more positive ratings to most characteristics of CMC than controls, as hypothesized. They see advantages in many characteristics of CMC, which is in line with their higher appreciation scores for CMC.

3.3. CMC and well-being

As a final step, we investigated whether CMC use in people with ASD affects satisfaction with different aspects of life. Whether people with ASD and controls differ on the three satisfaction with life scales was tested with a repeated measures ANOVA. We expected that people with ASD would have lower general life satisfaction, but we expected this difference to be less pronounced for their online social life, as the online social life should be easier for them to manage. There was a significant main effect for group, $F(1, 173) = 63.06$, $p < .001$, $\eta_p^2 = .27$, indicating that people with ASD report lower satisfaction than controls. There was also a significant main effect for type of outcome, $F(2, 346) = 18.85$, $p < .001$, $\eta_p^2 = .107$, indicating that scores for the three domains of satisfaction differ. Most importantly, and in line with our hypothesis, there was a significant interaction effect, $F(2, 346) = 30.29$, $p < .001$, $\eta_p^2 = .15$, indicating that the difference in satisfaction scores between the ASD group and the control group was not the same across the three domains. As can be seen in Fig. 1, the difference in satisfaction between the two groups is much smaller when asked about their online social life as compared to their social life and life in general.

Moreover, one-sample *t*-tests revealed that, whereas the mean satisfaction with their social life and their life is significantly lower than 4 (the mid-point of the scale), $t(109) = -4.27$, $p < .001$, $d = 0.41$, and $t(109) = -4.21$, $p < .001$, $d = .40$, satisfaction with their online social life for people with ASC is significantly *higher* than 4, $t(109) = 5.52$, $p < .001$, $d = .53$.

To test the idea that CMC is positively related to well-being, we performed four regression analyses with intensity of CMC-use as a predictor variable for *satisfaction with online social life*,*satisfaction with social life*, *satisfaction with life*, and *loneliness*. In these analyses we used the score on the AQ to differentiate between people with and without ASD, because a continuous predictor yields a much more detailed picture and a statistically more robust result than a dichotomous predictor.[3]

The overall model for satisfaction with online social life was significant, $F(3, 167) = 2.80$, $p = .042$, $R^2 = .05$. The only significant predictor was CMC use, $\beta = .21$, $p = .011$. The more people make use of CMC, the more satisfied they are with their online social life. Given that there was no significant interaction with AQ, this relationship works in the same way for people with or without ASD. We should immediately note here that, given the correlational nature of our study, we cannot say

[3] Using group as a dummy variable yielded almost the same result, with the exception that the interaction between group and CMC use on Satisfaction with life was only marginally significant, $\beta = -.253$, $p = .073$.

Table 5
Scores on statements regarding CMC qualities. Values denote means (SD) for each respondent group, and *t*-value. Scale ranges from 1 (big disadvantage) to 100 (big advantage).

	ASD	Controls		Comparison/factor loading
Scale: time independence	76.48	65.93	9.34	$F(1, 178) = 36.21$, $p < .001$, $\eta_p^2 = .169$
Online I can have a conversation in a quiet environment	82.49 (18.27)	70.85	17.70	.742
Online I don't have to react instantly	82.61 (18.91)	71.03	16.96	.658
Online I can communicate while being alone	85.39 (18.81)	74.94	17.96	.656
Online I can take the time to formulate correctly what I want to say	81.99 (15.52)	65.24	15.37	.642
Online I can choose at what time I want to communicate with others	83.84 (19.01)	85.41	12.82	.633
Online I can communicate while being in my own familiar surroundings	79.16 (19.27)	64.48	18.86	.611
Online I can take the time to process what the other person says	78.72 (17.08)	62.45	14.57	.564
Online I can write my responses when I want, regardless of whether my conversation partner is online simultaneously	80.42 (21.37)	70.42	17.58	.546
Online you can get to the point immediately	70.39 (20.10)	63.61	15.62	.511
Online I can better express myself	73.65 (21.08)	55.96	14.16	.491
Online there's less social chit-chat	72.55 (24.84)	56.30	16.58	.380
Online I can directly contact people that I would not be able to reach otherwise	74.28 (19.90)	68.23	18.00	.343
Scale: no co-presence	67.49 (15.35)	49.58	9.66	$F(1, 178) = 76.77$, $p < .001$, $\eta_p^2 = .301$
Online I don't have to watch my facial expression	69.41 (21.11)	49.58	15.69	.792
Online I don't have to make eye contact	72.07 (22.94)	47.58	14.33	.714
Online I don't have to pay attention to the other's facial expression	69.11 (23.76)	48.27	14.29	.660
Online nobody can see me	65.10 (21.27)	51.66	12.77	.629
Online I don't have to pay attention to the way someone sounds	61.62 (24.87)	48.27	14.30	.600
Online people express themselves more clearly	61.33 (17.96)	49.49	9.52	.438
Online I only have to pay attention to what is written	73.75 (20.71)	51.94	13.40	.432
Scale: relative ease to express oneself	61.39 (14.33)	53.90	9.13	$F(1, 178) = 15.32$, $p < .001$, $\eta_p^2 = .079$
Through my online experience I can have a real-life conversation more easily	56.42 (17.82)	52.00	10.35	.625
Online I can talk in a more personal way with others	61.20 (20.45)	51.82	12.31	.618
Online I can more easily bring up a difficult subject	64.74 (18.88)	54.80	12.59	.581
Online I can disclose more about myself	59.17 (21.00)	53.41	13.16	.468
Through my online experience I can have an online conversation more easily	65.40 (22.80)	57.46	16.58	.431
Items not in a scale				
Online I can remain anonymous	59.11 (23.77)	54.10	17.74	
I can combine online communication with other tasks	65.17 (24.53)	74.04	18.53	
I receive a lot of emails	52.69 (21.11)	53.20	17.65	
Online I can choose to contact someone based on their profile	59.17 (19.99)	53.45	11.19	
Keeping up with all my contacts takes much time	41.00 (17.18)	44.01	13.67	
Online people are often sloppy in their writing	36.55 (18.96)	40.96	17.75	
Online people can be rude or insulting	35.09 (18.56)	39.96	19.47	
Online many people can take part in a conversation or discussion simultaneously	45.83 (24.88)	57.46	18.04	
In chat programs conversations are often very high-paced	38.46 (22.96)	48.21	15.36	
I can illustrate my remarks with documents or links	65.70 (18.81)	61.24	16.86	
I don't know if I can trust my online conversation partners	36.55 (19.04)	41.52	12.78	
Online nobody can see that I have a disability	61.75 (23.04)	49.90	10.76	
What I write online has permanence	55.30 (28.31)	54.63	24.87	
An online conversation is usually slower than a real-life conversation	63.89 (24.02)	48.61	15.53	
Online I don't have to pay attention to the way I come across	66.83 (22.73)	53.70	14.53	
During online conversations I can always read back what exactly has been written	75.81 (20.95)	65.42	17.39	

anything about the direction of this effect. It can be the case that the more people make use of CMC, the more satisfied they get with their online social life, but also that people who are more satisfied with their online social life make more use of CMC. Also note that the AQ score was not a significant predictor of satisfaction with online social life, which is in line with the previous analysis, showing that satisfaction with one's online social life is independent of autistic traits.

The overall model for satisfaction with social life was significant, $F(3, 166) = 17.22$, $p < .001$, $R^2 = .24$. The only significant predictor was the AQ, $\beta = -.48$, $p < .001$. The higher someone scores on the AQ, the less satisfied they are with their social life. Given that there was no significant interaction with CMC use, this relationship is not influenced by how often people use CMC.

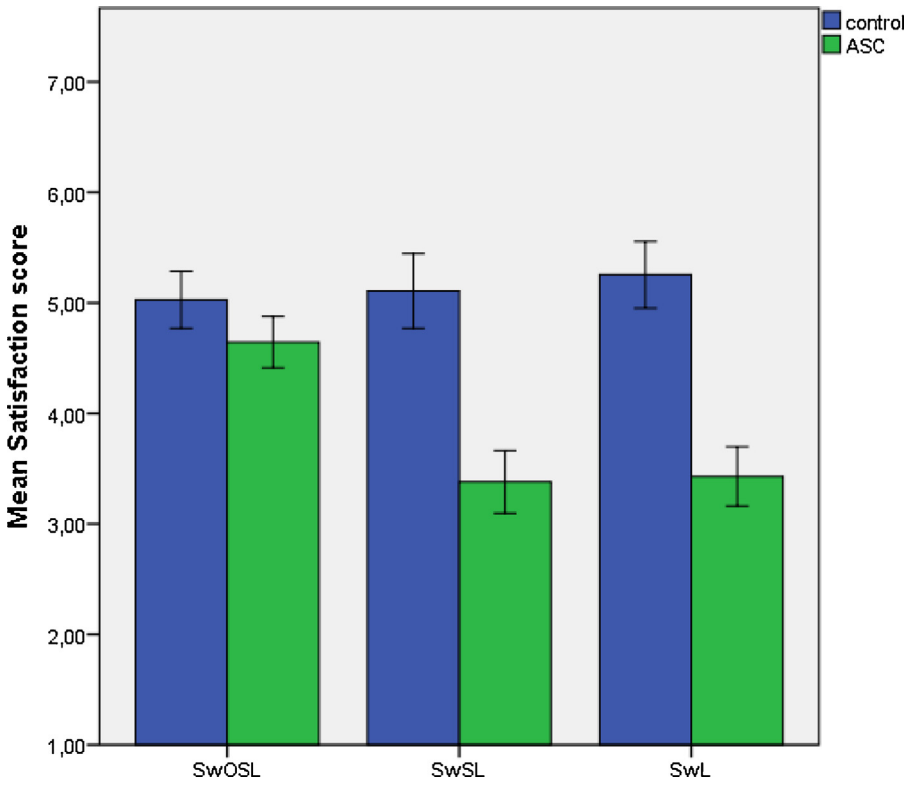

Fig. 1. Satisfaction scores for different aspects of life for people with ASD and controls. SwOSL: satisfaction with online social life; SwSL: satisfaction with social life; SwL: satisfaction with life. Error bars represent 95% confidence intervals.

The overall model for satisfaction with life was significant, $F(3, 166) = 26.02$, $p < .001$, $R^2 = .32$. The AQ was a significant predictor, $\beta = -.56$, $p < .001$. The higher someone scores on the AQ, the less satisfied they are with their life. For this outcome, there was also a significant interaction between AQ and CMC use, $\beta = -.14$, $p = .047$. To interpret this interaction we standardized all scores and plotted the regression lines for high, mean, and low levels of the predictors (see Fig. 2) and analyzed whether the simple slopes are significant for people who score high on the AQ (one SD above the mean) and people who score low on the AQ (one SD below the mean).

As can be seen, for people with low levels of AQ, use of CMC is slightly positively related to satisfaction with life, but this slope was not significant, $b = .124$, $t = 1.05$, $p = .30$. For people with high levels of AQ, CMC was significantly negatively related

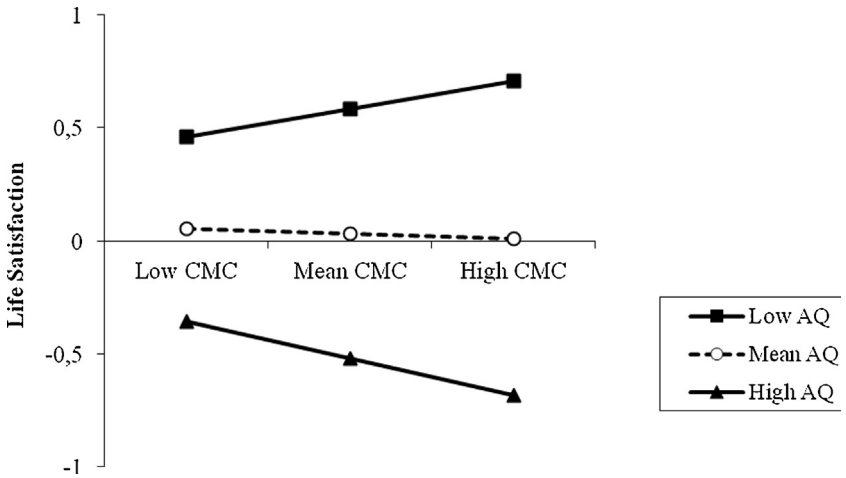

Fig. 2. Relationship between CMC use and satisfaction with life at different AQ scores. Low represents −1 SD, mean represents the mean value, and High represents +1 SD for both CMC use and AQ score.

to satisfaction with life, $b = -.164$, $t = -2.12$, $p = .036$. Again, we can only speculate about the causal direction of this effect. Either people with higher scores on the AQ who spend more time with CMC become less satisfied with their lives or people with higher scores on the AQ who are not very satisfied with their lives start to use more CMC (maybe to find like-minded people) or there is a third variable which relates to both.

Finally, the overall model for loneliness was significant, $F(3, 166) = 23.59$, $p < .001$, $R^2 = .30$. The only significant predictor was the AQ, $\beta = -.54$, $p < .001$. The higher someone scores on the AQ, the lonelier they feel. Given that there was no significant interaction with CMC use, this relationship is present in the same way for people regardless of how often they use CMC.

The analyses concerning the well-being scales show that people with ASD are relatively satisfied with their online social life, indicating that they feel good about CMC. At the same time, those with more autistic traits and who use CMC more frequently, are less satisfied with their life in general. Satisfaction with one's social life and feelings of loneliness are independent of CMC use. We will discuss the implications of these findings below.

4. Discussion

The current study is the first study to compare CMC use in people with and without ASD. It contributes to our knowledge on CMC use and ASD in several different ways. First, we find that the frequency of use of CMC and the number of online contacts of high-functioning ASDs is greater than or equal to the control group. Second, we find that people with high-functioning ASD appreciate the textual, self-paced communication aspects of CMC more than controls. Third, people with ASD are relatively satisfied with their online social life; more so than with their social life and their life in general. They still do not reach the level of satisfaction of controls, but the difference is smaller than in the other aspects of life and on average, they are on the positive side of the scale. Finally, high levels of autistic traits, combined with high levels of CMC use are associated with low levels of satisfaction with life. Together, these results may have important implications for our view of CMC-use by people with ASD, as we discuss below.

4.1. CMC use

Our results suggest that people with high-functioning ASD that use CMC are more active online than controls that use CMC and that they value CMC much more than controls. When investigating specific channels, we find that ASDs mainly use more discussion boards than controls. Although this difference may be explained by our recruitment method, it is consistent with other recent research on this topic (Gillespie-Lynch et al., 2014). As these authors noted, discussion boards may be especially attractive to people with ASD because they are more asynchronous than communication via chat and email. In general, we do find evidence to support our first hypothesis that people with ASD are especially attracted to CMC.

4.2. Characteristics of CMC

Both the ASD group and the control group see advantages in CMC, but there are differences in the type of advantages they see. Both among the open questions and the predefined characteristics, the slower pacing appears to be the most important advantage of CMC for people with ASD. This may be caused by decreased demands on information processing capabilities, reducing the need for an immediate response and providing more time to formulate an answer. Interestingly, the control group mentions the time independence as an advantage mainly because of convenience reasons (e.g., being able to answer at one's own time). For people with ASD the time independence is more important because it gives them more time to process the message.

The major difference between the two groups can be found in the characteristic 'absence of non-verbal communication'. This characteristic is listed as an advantage more often by people with ASD and listed as a disadvantage more often by controls. One might say that the fact that CMC offers reduced stimulus/single channel communication is evidence that CMC is a "poorer" kind of communication than face-to-face communication. However, for people with ASD it affords a mode of communication that suits them: no requirements for instant response/non-verbal communication, a single mode of communication, and a textual orientation. All in all, people with ASD name and value advantages that help to mitigate their autistic impairments, while for controls aspects of convenience seem more relevant.

4.3. CMC use and well-being

Our third goal was to investigate how CMC use relates to well-being in people with ASD. Computers, games and the Internet are often regarded as harmful for the social development of children and adults, depriving them of time spent establishing social contacts using more conventional ways of interaction (Barak & Sadovsky, 2008; Bargh & McKenna, 2004; Finkenauer et al., 2012; Kraut et al., 1998; McKenna & Bargh, 2000; Sheeks & Birchmeier, 2007). Indeed, we find that individuals who score high on autistic traits and spend a lot of time using CMC are actually less satisfied with their lives. However, we also find that people with ASD make new acquaintances and friends online, even more so than controls, and that people with ASD are relatively satisfied with their online social lives. Although there is a link between general life satisfaction, autistic traits and CMC use, the three indicators of interpersonal satisfaction (online social life, social life and loneliness) do not show this pattern of reduced satisfaction for those with more autistic traits who use CMC a lot. Our results

imply that people with high-functioning ASD who use CMC show no lack of interest in social contact, and that they are able to build a satisfying online social life. This supports the view by Newton et al. (2009), that social-communicative impairments may not be an intrinsic defect in people with ASD, but are compounded by conventional, rich, multi-modal, communication methods like face-to-face conversations. It seems that, in a different communication environment, autistic impairments in the conventional communicative domain may have less severe social repercussions.

4.4. Limitations

The current study is the first to compare CMC use and life outcomes of people with and without ASD. The use of a control group raises the question of whether the two groups are comparable, since we find significant differences on some demographic variables. Where possible, we controlled for these differences. For example, the fact that ASDs spend more time using CMC cannot be explained by the greater amount of time at hand given that respondents with ASD indicated being unemployed more often or having a disability allowance, because we controlled for that variable. Still there may be other differences that we could not control for. It will always be a challenge to find good controls because people with ASD tend to have lower levels of education given the same level of intelligence (Estes et al., 2011). Still, two main points for methodological improvement are (1) the recruitment method (participants self-selected into the study) and (2) the survey method (an online self-report survey was used). For example, both ASDs and controls were recruited through online social networks, personal contacts, patient group flyers, discussion forums, and email, but for the ASD group recruitment emphasized online forums and patient groups, whereas for the controls the personal and university network were the main recruitment channels. This may partly explain why we find that ASDs make more use of CMC, but it is unlikely that it influences the links between CMC use and well-being.

A possible further limitation lies in the fact that ASDs self-identified as ASD; we did not verify their diagnosis. Although not designed as a diagnostic tool, a score on the AQ above 32 is conventionally regarded as indicative of ASD, so individuals who self-identify as ASD and score higher than 32 on the AQ should be very likely to have an ASD. We re-ran our analyses with this subsample ($N = 74$) and found almost the exact same results, indicating the robustness of the findings.

The use of the AQ also has limitations because it meets with some resistance in the ASD community (e.g., AllieKat, 2011). Some of our participants stated in their comments that the questions are too stereotyped, and too much geared towards male autism. Also, the AQ is widely known, and freely available on the Internet. One respondent refused to fill out the AQ, because they were already acquainted with it and found it too biased towards autism stereotypes. Another disadvantage is that it is relatively easy to fill out the AQ in a way to avoid getting a high score. Still, we find scores that are very similar to those obtained in the original study by Baron-Cohen et al. (2001), when the AQ was not yet freely available. The ASD group's mean AQ in our study is 34.68 (SD = 7.88) compared to a mean AQ score of 35.8 (SD = 6.5) in the original study. Our control group scores 13.59 (SD = 8.10), compared to 16.4 (SD = 6.3) in the original study. We therefore do think that the AQ still serves as a good instrument to identify autistic traits.

Our sample is somewhat unrepresentative in terms of the male to female ratio for ASD's and their educational level. The male to female ratio in our study is 1.27:1, while most studies on the prevalence of ASD show higher ratios, with an average of 4.3:1 (Fombonne, 2005). However, our main focus lies in the communication area and a recent review on gender differences in ASD symptomatology found few differences in that area, and if any, females showed more impairments than men (Rivet & Matson, 2011). Given these numbers, our results may actually underestimate how successful people with ASD can communicate online, and a sample with more men may show even more satisfaction with their online social lives. Furthermore, our sample includes a larger proportion of ASD in higher education (50.4%) than in other studies. For instance in Renty and Roeyers' (2006) study 25% had a college or university degree. Maybe the phrasing of the invitation has contributed to this distribution, asking for "people of normal to high intelligence". Although this was meant only to exclude people with cognitive disabilities, it may have kept individuals of average intelligence from participating. Whatever the cause, this study may have benefited from this way of recruiting, as it has made the two study groups more comparable, at least regarding this variable.

We found that intensity of CMC use by high-functioning ASDs was slightly higher than in controls. However, our sample did not include people who do not use CMC. It could be that the proportion of non-users of CMC is larger among ASDs than among controls. In line with this reasoning, Mazurek and Wenstrup (2013) found that children with ASD spend more time than typically developing siblings watching television and playing video games (approximately 4 h a day), but less time than their siblings on social media (only .2 h a day). In the light of these findings it seems worthwhile to conduct further research among CMC use in adults with ASD with a more diverse sample, including non-high-functioning ASDs.

4.5. Conclusion

The traditional view of autistic individuals is that they are loners, not interested in other people, and incapable of initiating or maintaining mutual relationships. From the results of our survey a different picture arises. The subjects in this study use the communication options afforded by networked computers at least as enthusiastically as controls, and are proficient and successful in their use. Our results indicate that the absence of the instant response/non-verbal communication requirement attracts high-functioning ASDs to get online, to make friends, and to have an online social life that is satisfactory for them.

The point of view that computers and the Internet offer an alternative for creating meaningful social relationships for people with ASD is not undisputed. Our results confirm that the link is complex because people with ASD seem to have a satisfactory online social life, but at the same time, for those with more autistic traits an increase in CMC use goes along with a decrease in satisfaction with life. Given that we cannot be sure about the causal relationship of this link, it may be that people with more autistic traits who are unsatisfied with their life in general turn to CMC for support. Based on our findings there is hope that this may help them to establish a satisfying online social life.

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