Original Article

Gaming Disorder and Computer-Mediated Communication in Children and Adolescents with Autism Spectrum Disorder

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Abstract: *Background:* This study investigates how children and adolescents with autism spectrum disorder (ASD) make use of computer gaming and computer-mediated communication (CMC) in comparison to their nonautistic peers. *Method:* Parents filled out a standardized questionnaire on media use, gaming disorder (GD), and CMC. Sixty-two boys with a diagnosis of ASD aged 4 to 17 years (mean = 11.5; *SD* = 3.2) were compared to 31 healthy control boys (mean = 11.5; *SD* = 3.7). *Results:* Children and adolescents with ASD used CMC less frequently than their nonautistic peers but played video games for longer times than the controls. They preferred playing alone rather than in company of others and less frequently in multiplayer mode. Levels of GD symptoms were higher in boys with ASD. *Conclusions:* Children and adolescents with ASD seem to be an especially vulnerable subpopulation for GD. For them, the gaming situation (alone and in single-player mode) and CMC behavior seem to correspond to social patterns in real life. Our findings also provide support for the inclusion of offline gaming in the GD definition.

Keywords: autism spectrum disorder, gaming disorder, computer-mediated communication, children, adolescents

Zusammenfassung: *Fragestellung:* Die Studie untersucht, wie Kinder und Jugendliche mit Autismus-Spektrum-Störung (ASS) im Vergleich zu ihren nichtautistischen Altersgenossen Computerspiele und Internetbasierte Kommunikationsmöglichkeiten (IBK) nutzen. *Methodik:* Die Eltern füllten einen standardisierten Fragebogen über Mediennutzung, Computerspielabhängigkeit und IBK aus. 62 Jungen mit der Diagnose ASS im Alter von 4 bis 17 Jahren (Mittelwert = 11.5; *SD* = 3.2) wurden mit 31 unbeeinträchtigten Jungen als Kontrollgruppe (Mittelwert = 11.5; *SD* = 3.7) verglichen. *Ergebnisse:* Kinder und Jugendliche mit ASS benutzten IBK weniger häufig und spielten Computerspiele länger als die Kinder in der Kontrollgruppe. Bei gegebener Diagnose ASS spielten sie eher allein, nicht in Gesellschaft anderer und seltener im Mehrspielermodus. Das Niveau der Computerspielabhängigkeit war bei Jungen mit ASS höher. *Schlussfolgerung:* Kinder und Jugendliche mit ASS scheinen eine besonders gefährdete Gruppe für die Entwicklung einer Computerspielabhängigkeit zu sein. Die Spielsituation (allein und im Einzelspieler-Modus) und das IBK-Verhalten entspricht den sozialen Mustern im realen Leben. Unsere Ergebnisse unterstützen auch den Einbezug von Offline-Spielen in die Definition von Computerspielabhängigkeit.

Schlüsselwörter: Autismus-Spektrum-Störung, Computerspielabhängigkeit, Internetbasierte Kommunikation, Kinder, Jugendliche

Introduction

Anecdotal data on autism spectrum disorder (ASD) and computer use has apparently led IT companies to look specifically for autistic employees (Florentine, 2015; Jones, 2016). Why are people on the autistic spectrum so valuable for the IT sector?

ASD is a lifelong neurodevelopmental condition (Joseph, Soorya, & Thurm, 2015). Diagnostic criteria in the 5th edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; American Psychological Association, 2013) include social-communicative and interactional deficits as well as restricted repetitive behaviors. Epidemiological rates of ASD range from 1% (Fombonne, 2003) to 6% (Newschaffer et al., 2007). Psychiatric comorbidities are frequent in children with ASD (Simonoff et al., 2008), but gaming disorder (GD) as a new ASD comorbidity and the impact of ASD on computer-mediated communication (CMC) have not been studied in detail.

Social and verbal activities appear to lead to a reduction of the social impairments (Orsmond & Kuo, 2011), highlighting the importance of the type of leisure time. Leisure

time as well as educational and working environments are increasingly being influenced by new mass media, including computers, video games, the internet, smartphones, and social media. Electronic screen media could facilitate the perception and understanding of individuals with ASD thus appealing to them particularly (Mineo, Ziegler, Gill, & Salkin, 2009).

In addition, the use of CMC is especially important regarding autistic core symptoms (e.g., Thurlow, Lengel, & Tomic, 2004). CMC can be defined as the use of electronic devices for communication purposes; examples include emails, text messaging, social networks like Facebook or Instagram, and instant messengers like WhatsApp or Skype. There are limited empirical data available on CMC use and social adaptation in real life (Mikami, Swedo, Allen, Evans, & Hare, 2010) and their implications for individuals with ASD. On the one hand, based on the social compensation hypothesis (Valkenburg & Peter, 2007), they are drawn to CMC because it allows interactions from a safe distance with higher control and with fewer contextual, auditory, and visual distractions (Finkenauer, Pollmann, Begeer, & Kerkhof, 2012). Further, typical autistic problems of face-to-face communication are reduced (Mazurek, 2013; Van Schalkwyk et al., 2017), such as the recognition of facial expressions (Rump, Giovannelli, Minshew, & Strauss, 2009) and deficits in verbal and nonverbal communication (Tager-Flusberg, Paul, & Lord, 2003). The opposing rich-get-richer hypothesis (Valkenburg & Peter, 2007) suggests that young people display a cross-situational continuity of social interaction which transfers to CMC. Thus, the socially competent use CMC to extend social networks, whereas those with communicational difficulties in real life also have difficulties with CMC (virtually "poor-get-poorer"). Preliminary empirical studies support the latter theory, showing below-average CMC usage times for individuals with ASD (Mazurek et al., 2012; Mazurek & Wenstrup, 2013).

Another important aspect of new mass media is video gaming. Video games encompass a wide range of different genres (e.g., action, adventure, role-playing, strategy) for various electronic devices in different social settings (e.g., online, offline, alone, or with others). Video gaming could be especially rewarding for autistic youth (Mazurek & Wenstrup, 2013), as they have enhanced general visual abilities (Mottron, Dawson, Soulières, Hubert, & Burack, 2006). Because of their extraordinary attention to details and their visual abilities (O'Riordan & Plaisted, 2001), individuals with ASD are exceptionally adept at video games that require fast visual scanning for stimuli in a complex environment, such as in shooter or construction games (Orsmond & Kuo, 2011). Studies have shown that young people with ASD use video games excessively (Liu et al., 2017; Mazurek & Engelhard, 2013a; Mazurek & Wenstrup, 2013).

Video games can also have positive potentials (Green & Bavelier, 2006; Li & Atkins, 2004), such as creating new cognitive challenges and providing relaxation. They can be used in the treatment of persons with ASD (Bernard-Opitz, Sriram, & Nakhoda-Sapuan, 2001; Hetzroni & Tannous, 2004). While electronic media do not lead to social isolation and addictive behavior in healthy young people (Lenhart et al., 2008; Olson, 2010; Olson, Kutner, & Warner, 2008), children and youth with ASD are at risk for social difficulties and isolation (Bölte, 2009; Mazurek & Wenstrup, 2013).

DSM-5 (American Psychological Association, 2013) introduced the concept of internet gaming disorder (IGD) and defined it as "the persistent and recurrent use of the internet in order to play games, that leads to clinically significant impairment." Diagnostic criteria further encompass five of nine symptoms, for example, an exceeding preoccupation with the games, increasing time spent gaming before feeling satisfied, withdrawal symptoms, risks toward relationships, job or education, and others. The Beta Draft of the WHO ICD-11(International Classification of Diseases, 11th revision) proposes the diagnostic category of gaming disorder (GD) (WHO, 2018), including persistent online *and* offline gaming patterns with impaired control over gaming, increasing priority of gaming and the continuation of gaming despite negative consequences.

Instruments to measure GD are lacking or of low quality (King, Haagsma, Delfabbro, Gradisar, & Griffiths, 2013; Petry et al., 2014) and cannot provide accurate prevalence rates for GD (King et al., 2013).

The etiology of video gaming and internet addiction is "complex and multicausal," including classical and operant conditioning as well as neurobiological processes (Koepp et. al., 1998; Vousooghi, Zeinolabedin, Sadat-Shirazi, Eghbali, & Zarrindast, 2015; Weinstein & Lejoyeux, 2015). Psychosocial risks encompass male sex, impulsiveness, low social skills, loneliness, and an increased amount of time spent gaming (Chen, Chen, & Gau, 2015; Gentile et al., 2011; Lemmens, Valkenburg, & Peter, 2011; Paulus, Ohmann, von Gontard, & Popow, 2018), as well as attentional difficulties and hyperactivity (Bioulac, Arfi, & Bouvard, 2008; Carli et al., 2013; Gentile, 2009; Paulus et al., 2018) and online role-playing, shooter, action-adventure and strategy video games (Elliott, Golub, Ream, & Dunlap, 2012; Rehbein, Kleimann, & Mößle, 2010).

Children and youth with ASD are at special risk for GD symptoms (Liu et al., 2017; Mazurek & Wenstrup, 2013; Mazurek & Engelhardt, 2013a, So et al., 2017) with a higher rate of males (Fombonne, 2003), increased playing times (Mazurek & Wenstrup, 2013; Mazurek & Engelhardt, 2013a) and preference of video games with increased addictive qualities (Elliot et al., 2012; Mazurek & Engelhardt, 2013a; Mazurek & Engelhardt, 2013b; Rehbein et al., 2010). In addition, decreased social skills (Gentile et al., 2011; Lem-

mens et al., 2011; Mazurek & Engelhardt, 2013a), certain qualities of screen-based media (Mineo et al., 2009; Mazurek & Wenstrup, 2013), and internet addiction are further risks (Finkenauer et al., 2012; Romano, Truzoli, Osborne, & Reed, 2014). Previous studies found that young patients with ASD spend less time with CMC and more with gaming, mirroring their social difficulties in their gaming behavior (Mazurek et al., 2012; Mazurek & Engelhard, 2013a; Mazurek & Wenstrup, 2013). However, replications of these findings with controls and with standardized assessment tools are outstanding.

Therefore, this study investigates the associations between ASD, CMC, and video gaming in young patients with ASD and in a control group. We hypothesized the following concerning video gaming:

1. Patients with ASD prefer to play alone rather than in company of others and to play less frequently in multiplayer mode.
2. Patients with ASD play video games more often and for longer times than the controls.
3. The levels of GD symptoms are higher in the patients with ASD than in control children

Concerning CMC, there were two main hypotheses:

1. ASD patients spend less time using CMC and use it less frequently than their nonautistic peers.
2. CMC applications were explored descriptively.

Methods

Participation in the study was voluntary, and there was no financial compensation. All participants and their parents gave informed consent. The local ethics committee approved the study. Participants with ASD were recruited at two locations in Southwest Germany: at the specialized outpatient clinic for autistic disorders at a tertiary university hospital for child and adolescent psychiatry and at a center for autism therapy (ATZ Saar).

All patients with confirmed ASD diagnoses, aged between 4 years and 17 years and 11 months attending the outpatient clinic and the center from January to July 2015 who were willing to participate were included in the sample ($N = 68$, 62 boys, 6 girls).

Data of 85 controls was collected via word-of-mouth recruitment as well as in several sports clubs. Eighteen control children had to be excluded because of missing data (1 case), because the child was too young (1 case), and because of total scores below 1 on the CBCL/4-18 (Achenbach, 1991; Arbeitsgruppe Deutsche Child Behavior Checklist, 1998; Döpfner, Plück, & Kinnen, 2014), suggesting unclear statements (16 cases). Because of large differences in the gender distribution between the ASD and control group, it was decided to only include male participants. Thus, 31 (33.3 %) control boys without a documented psychiatric diagnosis, mean age 11.5 years ($SD = 3.7$, range 4 to 17.8 years), and 62 (66.7 %) boys with a confirmed autistic diagnosis, mean age 12 years ($SD = 3.2$, range 4.5 to 17.7 years) took part in the study. The two groups did not differ in age. The final total sample consisted of $N = 93$ boys.

A notable difference, however, was found in the type of school: Whereas most control boys attended elementary (35.5 %, $n = 11$) or secondary schools (46.5 %, $n = 15$), boys with ASD most likely attended special schools (29 %, $n = 18$). The mean intelligence score of the ASD group, as reported by the parents, was in the average range with 87.6 ($SD = 23.8$), ranging from 50 to 143, although comparability of the scores is limited: Because of the large age range, the scores stem from several different intelligence tests. 22 % ($n = 14$) of the boys had a reported IQ below 70 and 14 % ($n = 9$) had a reported IQ above 114. Approximately one-third of the ASD boys were taking one or more medications, with methylphenidate being the most frequently used substance (18 %, $n = 11$), followed by melatonin (6 %, $n = 4$), amphetamine (5 %, $n = 3$), atomoxetine (3 %, $n = 2$), pipamperone (3 %, $n = 2$), and aripiprazole (1 %, $n = 1$). 61 % of the autistic boys had two or more comorbid diagnoses, most frequently developmental disorders (language disorders, motor disorders, specific learning disorders) and attention deficit hyperactivity disorder (ADHD).

Parents of all participants were given general information regarding the study and two questionnaires to fill in. Video game and CMC use as well as GD symptoms (online and offline gaming) were assessed with a parent questionnaire specifically compiled for this study, based on a questionnaire developed for a former study (Paulus, Sinzig, Mayer, Weber, & von Gontard, 2018). To the knowledge of the authors, no established questionnaire met the specific requirements of this study (sufficient psychometric evaluation, parents as informants, age range of 4 to 17 years, and German language).

The questionnaire comprised four sections. The first part covered basic information about the child or adolescent. Parents of ASD patients additionally answered questions concerning the primary diagnosis, comorbid disorders, and the IQ of their sons. The second part, labeled "video game use," started with an introductory definition of the study's concept of video games. This was followed by items relating to the number and types of devices owned by or being accessible to the child and the frequency as well as usage time of video gaming. Usage time was assessed by single choice question (0 min, 30 min, 60 min, 2 h, 5 h, 7 h, more than 7 h) as well as by an open-ended question (free format indication: hours/minutes). Additionally, there were questions about social aspects of video gaming (play-

ing in multiplayer mode, by oneself or with others, online or offline). The third section (Table 1), labeled "video gaming behavior," assessed the degree of GD symptoms.

The 16 items were composed in accordance with the symptom criteria of the internet gaming disorder of DSM-5, with supplementary items on sleeping and eating behavior. They were rated on a 4-point scale ranging from 0 (*never*) to 3 (*always*). A total score and mean values were calculated by adding up the 16 items. Missing items were replaced by mean values. Reliability was high with Cronbach's $\alpha = .93$. As confirmed by a reliability analysis, total reliability did not increase by eliminating any of the 16 items. Additionally, discriminatory power analyses ensured a value of $r > .3$ for every item. Thus, all 16 items remained in the scale for the calculations. Because a sufficient psychometric evaluation is still lacking, no cut-off value could be set to determine pathological cases of gaming disorder.

Patterns of CMC use were determined in the fourth and last section of the questionnaire. If the answer to the first item concerning whether the child has online access to CMC was answered with "no," parents could directly continue with the next questionnaire. If the answer was "yes," six more items followed, relating to frequency and duration of media usage and the three most frequently used applications.

To increase the external validity of autism spectrum diagnoses and to validate the control group, we used all 11 syndrome scales of the Child Behavior Checklist, CBCL/4-18, (Achenbach, 1991; Arbeitsgruppe Deutsche Child Behavior Checklist, 1998; Döpfner et al., 2014). All parametric and nonparametric data analyses (*t*-tests, Mann Whitney U-tests, chi-square tests) were conducted with the IBM SPSS Statistics program, version 23.

Results

CBCL Scales

Boys with ASD scored significantly higher in all CBCL scales than the controls (Table 2). They scored highest on "social problems," "thought problems," and "attention

Table 1. Items of gaming disorder symptoms: third section of the questionnaire.

1.	Do you think that your child's usage time of the computer or the game console has increased over the last months?
2.	Are other leisure activities of your child (e.g., sports, music, meeting friends) affected by gaming with the computer or game consoles?
3.	Have there been conflicts with you as the parent or legal guardian when you have limited or forbid the use of the computer/game console?
4.	Does your child become nervous, aggressive, or irritable if he/she doesn't have the opportunity to play with the computer/game console?
5.	How often does your child show an urgent desire to play with the computer/game console?
6.	Does your child become moody or sad if he/she doesn't have the opportunity to play with the computer/game console?
7.	If your child doesn't have the opportunity to play with the computer/game console, can he/she come up with an alternative activity? Does he/she become bored?
8.	Does your child play with the computer/game console for a longer period of time than was agreed on with you?
9.	Has your family life been impaired by your child's using the computer/game console to play with?
10.	Once your child has started playing with the computer/game console, is it very difficult for him or her to stop playing and must he/she continue?
11.	Has your child hidden his/her computer/game console playing activities or has deceived you about them?
12.	Has your child's eating behavior changed because of the increased occupation with the computer/game console?
13.	Has your child's sleeping behavior changed because of the increased occupation with the computer/game console?
14.	Does your child use video games in order to get distracted from negative thoughts and/or feelings?
15.	Do you think that your child spends a lot of time thinking about video games or fantasizing about them even when he/she is not playing?
16.	Are there serious negative consequences of the video gaming on the child's academic performance or social relationships (e.g., family and friends)?

problems," which agrees with the typical CBCL profile of children with ASD (Bölte, Dickhut, & Poustka, 1999). A detailed analysis of the control group's CBCL syndrome scales' outliers showed no ASD typical profiles, validating the group membership.

Access to and Possession of Media Devices

More than two thirds of the ASD boys had access to a computer or a home video game console, and about half of them had access to a handheld video game console, a tablet computer, and a smartphone (Figure 1). Overall, more ASD boys had access to technical devices than the control group, although the differences mostly didn´t reach statistical significance (see Figure 1). A notable exception was the access to smartphones: The proportion of the control boys with access to a smartphone was about 20 % higher, though this difference also failed to reach statistical significance ($\chi^2(1) = 2.61$; *ns*). In return, the proportion of ASD boys who had access to another kind of mobile phone (not web-enabled) was significantly larger, $\chi^2(1) = 5.66$, $p = .017$ (Figure 1). ASD boys also had significantly greater access to a children's computer for educational purposes, $\chi^2(1) = 3.875$, $p = .049$ (Figure 1).

The number of media devices owned by the children was largely comparable between groups (Figure 2). But here the difference concerning the possession of smartphones was statistically significant: Only a quarter of the ASD boys but half of the control boys owned a smartphone, $\chi^2(1) = 6.09$, $p = .014$ (Figure 2). Again, more ASD boys possessed another kind of mobile phone, $\chi^2(1) = 5.589$, $p = .018$.

Video Gaming

About two-thirds of the ASD boys (65.5 %, $n = 36$) and the controls (65.5 %, $n = 19$) usually played video games offline. About one-tenth (11 %) of the ASD boys and one-quarter (24 %) of the controls reported using video games usually online. There were similarly considerable differences between the groups: 84 % of ASD boys usually played by themselves, but only 66 % of the controls. Subsequently, frequencies of playing in the company of parents, siblings, and friends were all lower for the ASD boys than for the control group. The biggest difference emerged in the frequency of playing usually in the company of friends (ASD boys: 24 %, controls: 48 %). ASD boys ($n = 54$, mean rank = 38.67, Mdn = 0.0) were also less likely than the control group ($n = 29$, mean rank = 46.67, Mdn = 0.0) to play video games in multiplayer mode, Mann-Whitney U = 618.5, $z = -1.75$, $p = .044$, $r = -.19$, 1-β = .54. Furthermore, a chi-square test revealed a significant interaction between group and playing video games alone or in company of others, $\chi^2(1) = 7.35$, $p = .006$. ASD boys were 4.29 times more likely (OR) to play video games on their own (Hypothesis 1).

As expected, the mean daily video gaming time of ASD boys (85 min, $SD = 11.4$) was significantly higher than that

Table 2. CBCL scales for boys with ASD and controls: Means and standard deviations of *T*-values (based on German norms, Arbeitsgruppe Deutsche Child Behavior Checklist, 1998).

	Boys with ASD	Controls		
Scale	*M* (*SD*)	*M* (*SD*)	*t*	Cohen's *d*
Social withdrawal	64.08 (8.74)	53.23 (4.46)	–7.93**	1.43
Somatic complaints	59.37 (9.21)	53.19 (4.75)	–4.27**	0.77
Anxiety/depression	61.73 (7.90)	52.00 (3.22)	–8.40**	1.45
Social problems	67.94 (9.70)	53.32 (6.54)	–8.59**	1.67
Thought problems	67.13 (10.45)	50.84 (3.41)	–11.14**	1.86
Attention problems	67.85 (7.67)	51.84 (3.66)	–13.63**	2.42
Delinquent behavior	58.26 (6.94)	51.35 (2.82)	–6.79**	1.17
Aggressive behavior	61.37 (8.87)	51.58 (2.86)	–7.91**	1.32
Internalizing problems	63.82 (8.13)	48.87 (7.57)	–8.55**	1.88
Externalizing problems	59.97 (8.65)	47.16 (6.20)	–7.34**	1.62
Total problems	66.60 (7.07)	47.87 (5.75)	–12.77**	2.81

Note. $^{**}p < .01$.

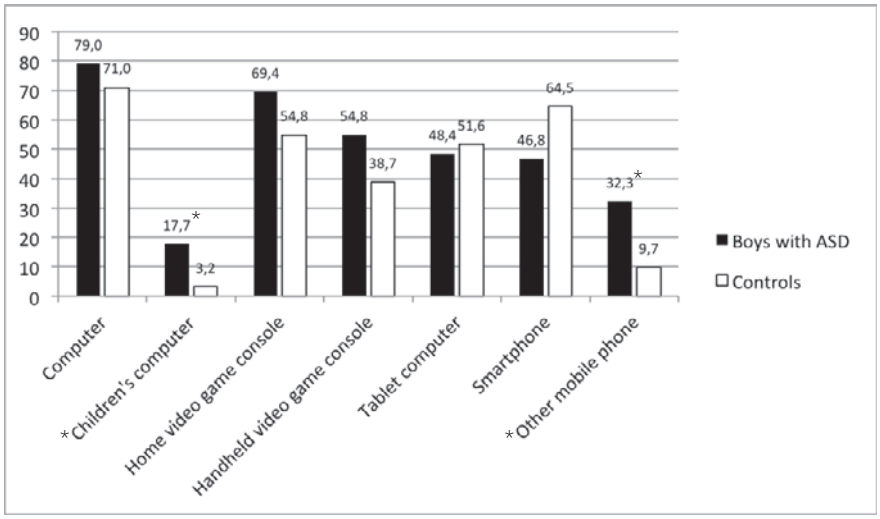

Figure 1. Distribution of access to screen media devices in boys with ASD and controls (in %).
Note. *Significant difference chi-square test ($p < .05$).

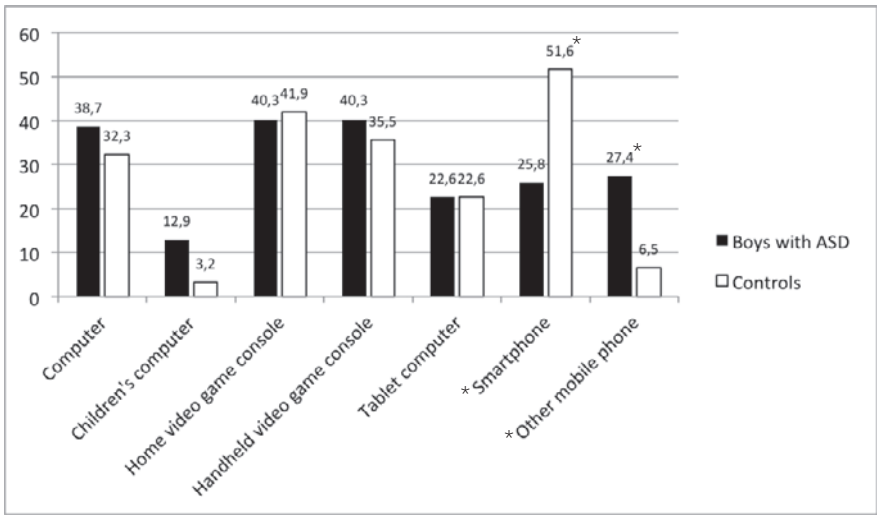

Figure 2. Distribution of screen media devices possessed by boys with ASD and controls (in %).
Note. *Significant difference chi-square test ($p < .05$).

of the controls (M = 50.1 min, SD = 8.1), $t(80) = -2.46$, $p = .008$, $d = .48$ (see Table 3).

There was a nonsignificant difference between groups in the frequency of video gaming, Mann-Whitney U = 878.0, $p = ns$, $r = -.07$. Power was very low with 1-β = .17 (Hypothesis 2).

Lastly, as hypothesized, ASD boys (M = 0.71, SD = 0.62) were revealed to have comparably higher rates of GD symptoms than the control boys (M = 0.38, SD = 0.30), $t(90) = -3.52$, $p < .001$, $d = .62$) (Hypothesis 3).

In an open-ended format parents reported the three most commonly played video games. Minecraft was reported most often as the favorite video game for ASD boys (18.5%, n = 10), followed by racing games (9.3%). Minecraft also was the most often reported favorite game in 20% of the the controls, although the football game FIFA was equally popular. Racing games were not among the favorite games of the control boys.

CMC

Boys with no access to CMC were excluded for subsequent analyses, 79% (n = 49) of ASD boys and all control boys used CMC at least sometimes. As expected, ASD boys (n = 30, mean rank = 18.41, Mdn = 2.5) used CMC significantly less frequently than the controls (n = 15, mean rank = 28.7, Mdn = 4.0), Mann-Whitney U = 109.5, $p = .003$, $r = -.41$). Interestingly, as can be seen in Table 3, a considerable number of ASD boys (21%) did not use CMC at all despite its potential accessibility (Figure 1). In the open-ended answering format, boys with ASD used

Table 3. Percentage distribution of frequency of computer-mediated communication (CMC) use and video gaming.

	Boys with ASD		Controls	
	CMC (*N* = 28) *N* (%)	Video gaming (*N* = 62) *N* (%)	CMC (*N* = 15) *N* (%)	Video gaming (*N* = 31) *N* (%)
Never	6 (21.4)	7 (11.3)	0 (00.0)	2 (06.5)
Less often than once a week	7 (25.0)	6 (09.7)	1 (06.7)	6 (19.4)
Once a week	1 (02.3)	4 (06.5)	0 (00.0)	1 (03.2)
Several times a week	6 (21.4)	22 (35.5)	5 (33.3)	14 (45.2)
Daily	8 (28.6)	23 (37.1)	9 (60.0)	8 (25.8)

Note. Boys with no access to CMC were excluded from the CMC analyses.

CMC on average for 29 minutes/day and controls for 51 minutes/day, but the difference did not reach statistical significance, probably because of low power, $t(38) = 1.22$, $p = .12$., $d = -.4$ (Hypothesis 4).

In an open-ended format parents reported the three most commonly used CMC applications. The instant messengers WhatsApp (65%) and Skype as well as the webpage Youtube (both 20%) were the most frequently used applications by ASD boys. Controls showed a similar pattern of preferred programs with one exception: Youtube was not the most frequently used program for any of them (Hypothesis 5).

Discussion

The results suggest that children and adolescents with ASD (at least boys) differ from their nonautistic peers in specific patterns of media use as well as the severity of GD symptoms.

Access to and Possession of Media Devices

A reduced accessibility to and possession of a smartphone in ASD boys was the most intriguing finding in the descriptive analysis. One possible explanation might be that ASD children have less interest in smartphones and thus do not ask their parents to buy them one because of their lack of concern about the social status associated with a smartphone. Because social recognition and standing are less important to ASD patients (Izuma, Matsumoto, Camerer, & Adolps, 2011), they might be satisfied with a less expensive, less technically and visually sophisticated mobile phone. This would explain the higher number of ASD patients using another kind of mobile phone. The use of smartphones in individuals with ASD could be an interesting topic for future research.

Video Gaming

As hypothesized, the autistic boys played video games for longer periods of time (85 min vs. 51 min). This finding successfully replicates data of US studies by Mazurek and colleagues (Mazurek & Engelhard, 2013a; Mazurek & Wenstrup, 2013) as well as Asian studies (Liu et al., 2017; So et al., 2017). However, contrary to our hypotheses, there was no significant difference in the frequency of gaming. This, again, might be explained by the small sample size. It could also indicate that boys with ASD don't necessarily play more often, yet if they do play, they continue to do so for longer times than their peers. Video games may be of such great appeal to boys with ASD that it is even harder for them to stop playing. Fittingly, the data in this study supports the preexisting evidence of a heightened level of GD symptoms in ASD boys compared to controls. Again, US data by Mazurek and colleagues were replicated in Germany, even though we used a different measurement procedure. Young patients with ASD do in fact seem to be an especially vulnerable subpopulation for GD.

On the other hand, computer gaming symptoms in individuals with ASD can be difficult to isolate from restricted interests and repetitive behaviors, which are common in persons diagnosed with ASD (e.g., Mazurek et al., 2012). If computer gaming occurs as part of an addictive disorder, it is a pathological symptom; but if computer gaming is a restrictive interest of an individual with ASD, it should not automatically be considered pathological. This distinction has vital implications for therapy: If an individual with ASD has developed a GD, it should be treated as comorbid diagnosis. But if the gaming activity is a restricted interest,

it might be a useful aspect to implement into the therapy of the autistic core symptoms (Winter-Messiers, 2007).

Furthermore, our findings suggest differences concerning the social aspects of video gaming. Boys with ASD were shown to play video games significantly less often in multiplayer mode and were more likely to play them exclusively by themselves. As with CMC, social patterns in real life seem to be reflected in the gaming situation. Whilst several social aspects play a crucial role when typically developed children play video games (Lenhart et al., 2008; Olson, 2010; Olson, Kutner, & Warner, 2008), ASD boys are apparently less able to use the opportunities for social interaction that video games can offer.

With regard to the ongoing scientific debate on the classification and nosology of a possible IGD versus GD, it could be argued that the findings in this study provide support for the inclusion of offline gaming (and not only online gaming) in the definition: Young patients with ASD exhibited addictive patterns of gaming that in a way were more "isolated" (less multiplayer mode, more gaming exclusively on their own, less use of CMC). The DSM-5 definition of IGD includes only online gaming and would thus probably not allow for a diagnosis in many cases of patients from the autistic spectrum. Another group of patients whose addictive gaming behavior might also be difficult to describe with the DSM-5 IDG criteria are preschool children (Paulus, Sinzig, Mayer, Weber, & von Gontard, 2018).

CMC

Regarding CMC, we identified a significant difference in use patterns between boys with and without ASD. As expected, autistic boys used CMC less frequently, supporting the rich-get-richer hypothesis. These findings agree with the preliminary findings by Mazurek and Wenstrup (2013), enabling further generalization because of our independent control group. It appears that children and youth with social deficits use the internet less than their socially more competent peers to communicate. The assumption of a cross-situational continuity of individual communicational features apparently applies to the internet as well. In our study, there was a notable difference between usage times of CMC (29 vs. 51 min), which probably didn´t reach statistical significance due to low power and the small sample size. But there might also be another explanation: More than one-fifth of the ASD boys who had access to CMC devices and apps never used CMC, and one-fourth used it less than once a week. Taken together, these findings could mean that a subgroup of ASD boys hardly uses CMC at all, whereas another subgroup uses CMC even longer than socially competent boys. The social compensation hypothesis may apply to this latter group, in that they recognize and make use of the potential inherent in this form of communication to improve their social skills. Nonclinical studies show CMC to lead to an increase in social integration (Kraut et al., 2002) and a decrease in loneliness and depression (Shaw & Gant, 2002). Such an ASD subgroup and positive effects of CMC need to be investigated further. The identification of this subgroup could help to develop therapeutic approaches for social skills in children and adolescents with ASD.

Strengths and Limitations

A major strength of this study is that it investigates two large and relevant fields of new mass media and their meaning in the daily life of autistic children and adolescents. To our knowledge, this study is the first to investigate the association between children and adolescents with ASD from 4 to 17 years of age with CMC and GD compared to an independent control group. It also replicates findings of American studies in a German sample with different measurements, thus enabling a broader theoretical generalization. GD symptoms were determined using a questionnaire that covers all nine DSM-5 dimensions of IGD. Ecological validity of our findings is high, given the quasiexperimental design of the study.

One major limit is the cross-sectional design of this study, so that no causal associations can be identified. Further limitations are the partially low power, and that only parent reports were used for most information. Because of the recruitment process, the intelligence scores of the control boys were not assessed, but in light of the types of school they attended, intelligence can be expected to be normally distributed. Also, the questionnaire on computer and internet use has not been psychometrically evaluated and normed. Lastly, because of lacking data, only boys were included for the investigations, which reduces generalizability of the findings to girls.

In summary, young male patients with ASD used CMC less frequently than their peers. They played video games for longer times, played alone rather than in company of others, and played less frequently in multiplayer mode. Levels of GD symptoms were higher in boys with ASD, which makes patients with ASD very likely to be a specifically vulnerable population for GD. The gaming situation (without company and in single-player mode) as well as the CMC behavior seem to mirror real-life social patterns.

Some of the exact characteristics that make a person with ASD special can be of help not only to IT companies but perhaps also to those with ASD themselves. It remains open whether the distinctive features of ASD youth regarding the use of electronic media identified in this study should be seen as a part of the pathology or whether they

in fact demonstrate how digital media can be of special benefit to ASD patients. The success of training programs using computer technology, such as The Transporters (Golan et al., 2009), FEFA (Bölte et al., 2002) and Mind Reading (Golan & Baron-Cohen, 2006), supports the latter conclusion. A very recent study by Sundberg (2018) even suggests that online games might help individuals with ASD to build and sustain friendships and feel less lonely.

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