Behaviour & Information Technology

ISSN: 0144-929X (Print) 1362-3001 (Online) Journal homepage: https://www.tandfonline.com/loi/tbit20

Assessing the relationship between autistic traits and cyberdeviancy in a sample of college students

Kathryn C. Seigfried-Spellar, Casey L. O'Quinn & Kellin N. Treadway

To cite this article: Kathryn C. Seigfried-Spellar, Casey L. O'Quinn & Kellin N. Treadway (2015) Assessing the relationship between autistic traits and cyberdeviancy in a sample of college students, Behaviour & Information Technology, 34:5, 533-542, DOI: 10.1080/0144929X.2014.978377

To link to this article: https://doi.org/10.1080/0144929X.2014.978377

Behaviour & Information Technology, 2015
Vol. 34, No. 5, 533–542, http://dx.doi.org/10.1080/0144929X.2014.978377

Taylor & Francis
Taylor & Francis Group

Assessing the relationship between autistic traits and cyberdeviancy in a sample of college students

Kathryn C. Seigfried-Spellar*, Casey L. O'Quinn and Kellin N. Treadway

Department of Criminal Justice, The University of Alabama, 410 Farrah Hall, Box 870320 (mailing), Tuscaloosa, 35487 AL, USA

(*Received 11 October 2013; accepted 30 September 2014*)

Case studies suggest a relationship between Asperger syndrome (AS) and computer hacking. The current study examined whether characteristics associated with AS were significantly related to hacking, cyberbullying, identity theft, and virus writing. Two hundred and ninety-six university undergraduate students completed an Internet-based anonymous survey measuring self-reported computer deviant behaviour and characteristics associated with AS (autism-spectrum quotient; AQ). Of the 296 university students, 179 (60%) engaged in some form of computer deviant behaviour, but only 2 (0.01%) yielded clinically significant scores according to the AQ. Contrary to the authors' expectations, hackers did not score higher on the AQ compared to non-computer hackers. However, virus writers, identity thieves, and cyberbullies scored higher on the AQ compared to their computer non-deviant counterparts. In addition, individuals who engaged in hacking, identity theft, cyberbullying, and virus writing scored higher on the AQ and reported poorer social skills, poorer communication, and poorer imagination compared to all other individuals engaging in computer deviant behaviours. Considerations for future research and study limitations are discussed.

Keywords: hacking; Asperger syndrome; personality; cybercrime; autism; cyberbullying; computer crime

1. Introduction

As technology becomes more widespread and sophisticated, the prevalence and severity of cybercrime have evolved into an increasingly serious threat to society. In 2000, the National White Collar Crime Center's (NW3C) Internet Crime Complaint Center (IC3) noted 16,838 complaints of cybercrime, but this number increased substantially to 289,874 in 2012, with a total average financial loss of $525.4 million (IC3 2013). In 2011, security practitioners in the USA reported that 90% of their organisations had experienced one security breach in the past year, while 60% of these organisations reported they had been hacked numerous times during the year (Ponemon Institute 2011; Fishman 2012). Despite these figures, most work in this area is aimed at information security (Seigfried-Spellar, Rogers, and Lynam 2010). This traditional approach to cybercrime and digital forensics is changing, and society is realising that we need to understand *the people* involved in computer crime – essentially *who* and *why*.

Even with the globalisation of technology, only some individuals choose to engage in computer deviant behaviour. According to Bandura's Theory of Reciprocal Determinism, an individual's personality traits become extremely important in predicting human behaviour when environmental constraints are low (Bandura 1986). Environmental constraints for computer criminality are considered to be low due to the globalisation of technology (e.g. Internet and mobile devices). Since the globalisation of technology continues to make it easier for individuals to engage in criminal behaviours, it is important to understand the personality and cognitive characteristics associated with computer criminality. As stated by Loch and Conger (1996), 'individual characteristics all appear to be important in determining ethical computing decisions' (82).

Anecdotal cases suggest a potentially unique relationship between Asperger syndrome (AS) and computer deviance (cf., Zuckerman 2001; Dreyfus 2002; Campbell and Kennedy 2009; Hunter 2009; Seigfried-Spellar, Rogers, and Lynam 2010). In England, the hacker Wandii was acquitted of all charges by a jury who believed he could not be held responsible because his obsession with computers was a manifestation of his AS, which drove him to commit the criminal acts (Dreyfus 2002; Hunter 2009). In 2001, Gary McKinnon hacked the US Army's network causing approximately 2000 computers to be out of service for three days (Kushner 2011). McKinnon's lawyers argued that his criminal behaviour was a result of his disorder, AS. In 2009, Viacheslav Berkovich, who was sentenced to over four years in federal prison following a multimillion-dollar fraud scheme that involved hacking into a trucking company's computers, was given a reduced

*Corresponding author. Email: kseigspell@ua.edu

sentence because he was diagnosed with AS (Kushner 2011). These are just a few examples of high-profile hacker cases being 'linked' to AS.

The *Diagnostic and Statistical Manual of Mental Disorders* (DSM-IV-TR) defines autistic disorders as having an impairment in social interactions and communication, as well as restricted, repetitive, and stereotyped patterns of behaviour, interests, and activities (American Psychiatric Association [APA] 2000). Individuals diagnosed with AS have an autism spectrum disorder (ASD) diagnosis but are considered high functioning in that they have average to above-average language and academic ability, as well as adequate life skills (Baron-Cohen et al. 1998). Before the *Diagnostic and Statistical Manual of Mental Disorders – 5th edition* (DSM-5; APA 2013), AS was a specific diagnosis within the 'autism spectrum', where it fell on the lower end of the continuum as a milder form of autism. In the DSM-5, AS will be consolidated with the overarching category of ASD. However, the latest edition of the DSM-5 was not released when this study was conducted, so the authors concentrated on the DSM IV-TR's (APA 2000) account of AS.

Many of the characteristics associated with AS are similar to the characteristics of computer hackers, and one explanation for why individuals hack is the belief that this behaviour is a manifestation of AS (Dreyfus 2002). Firstly, AS is often associated with unusual obsessional interests and repetitive behaviours (Baron-Cohen 2000). According to Baron-Cohen, individuals with AS commonly become intensely absorbed in a narrow range of interests – particularly machines, objects, and physical systems (2000). Research suggests that individuals with a significant level of interest in hacking are more likely to seek out online environments, which facilitate networking and information sharing with other hackers (see Holt et al. 2012). This obsession with computers and technology has led to the creation of several offline resources (e.g. conventions) and online resources (e.g. blogs) for the hacking subculture (Holt 2010).

Secondly, individuals diagnosed with AS often have little empathy and show a distinct disinterest and inability to interact with others, as well as a lack of insight on when they may be imposing negatively on others (Baron-Cohen 2000). In addition, extensive computer usage among individuals with AS can be explained by their preference of controlled experiences as opposed to unpredictable experiences. Baron-Cohen (2000) explained that those with AS are likely to favour the technological world since it is more 'controllable' and predictable than the social world. In addition, other common traits of individuals with AS include the ability to focus intensively on a particular task and the tendency to over-collect unusual items, both of which tend to relate to technology or math (Baron-Cohen et al. 1999; Hunter 2009). In the case of computer hackers, some report an incredible amount of concentration due to the complexity of the tasks, such as coding, virus writing, and insider threats (Rogers 2010).

Finally, the DSM IV-TR (APA 2000) states that individuals diagnosed with As are often socially withdrawn and introverted. A small body of research also suggests that certain personality characteristics are predictive of computer deviance, specifically introversion. Shaw, Post, and Ruby (1999) found that information technology specialists who committed insider threats were more likely to be introverted, depend upon computers for social interactions, have a history of work and family problems, maintain flexible ethics, feel more entitled, and have a lessened sense of empathy and loyalty. In addition, Schwartau (2000) stated that computer hackers were more socially clumsy and severely introverted compared to non-computer criminals, and Rogers, Smoak, and Liu (2006) found lower scores of extraversion among self-reported computer criminals, meaning they were less likely to be outgoing and socially active.

Computer scientists are also stereotypically associated with having high mathematical skills and are regarded as poor communicators and introverts (Klawe 2001). By using the Myers–Briggs Type Indicator, Hunter (2009) further suggested a link between personality types in the computer industry and AS. According to Hunter (2009), the ISTJ (Introversion, Sensing, Thinking, and Judgement) personality type is found to be more predominant in the software engineering and computer science fields. The ISTJ personality type describes individuals who are more comfortable working with facts than they are reasoning with people. According to Hunter, this personality type is also seen in individuals with AS and could be associated with the characteristics of computer hackers (2009).

Recently, Schell and Melnychuk (2011) measured the autistic traits of 136 hacker conference attendees using the autism-spectrum quotient (AQ; Baron-Cohen et al. 2001), and the hacker conference attendees scored in the intermediate range (i.e. 17–34) of the autism spectrum (total, $M = 19.67$). This mean score on autistic traits was similar to that of the Baron-Cohen et al. (2001) study, which sampled students pursuing a career in the hard sciences. Schell and Melnychuk (2011) also reported that the highest mean score for the AQ subscales was for 'attention to detail (ATD)' and 'attention to switching (ATW)', meaning the hacker conference attendees reported exceptional ATD and focus of attention. However, only 6% of the hacker conference attendees scored in the higher spectrum range for autism (Schell and Melnychuk 2011).

Overall, if a link does exists between hacking and AS, it could 'alter sentencing … [by] assessing the degree of criminal intent' (Dreyfus 2002). Being diagnosed with a mental disorder could become a mitigating factor or defence for an individual being accused of computer hacking; however, few empirical research studies have attempted to assess the Hacker–AS link. Three primary

objectives were the focus of the current study. The authors' first aim was to determine whether there was an association between autistic-like traits[1] (e.g. poor social skills, poor imagination, poor communication, poor ATW, and exceptional ATD) and deviant computer behaviour among a sample of college students. The second aim of this study was to include other types of self-reported computer deviant behaviour, such as identity theft, cyberbullying, and virus writing, when assessing autistic-like traits. For example, are there autistic-like characteristics that distinguish between cyberbullies and non-cyberbullies as well as virus writers and non-virus writers? Finally, the third aim of this study was to determine whether these autistic-like traits distinguished between computer deviants. In other words, are there autistic-like traits that differentiate between individuals who self-reported engaging in one type of computer deviance (hacking) versus individuals who self-reported engaging in all computer deviant behaviours (hacking, identity theft, cyberbullying, and virus writing)?

Based on the previous research, the authors expected to find significant differences between computer deviants and computer non-deviants on measures of autistic-like traits. The following three hypotheses were tested in the current study:

H1. There are differences in the AQ total and subscale traits for self-reported computer deviants (hackers, virus writers, cyberbullies, and identity thieves) when compared to computer non-deviants.

H1.a. Self-reported hackers, virus writers, and identity thieves will report poor social skills, poor communication, poor imagination, poor ATW, and exceptional ATD compared to computer non-deviants.

H2. There are differences in the AQ total and subscale traits (social skills, ATW, ATD, communication, imagination) for individuals who engage in more or less computer deviance. (1 type, 2 types, 3 types, or all cybercrime types)

2. Methods

2.1. Participants

For two weeks, a convenience sample of approximately 600 undergraduate students was solicited from a large, Southern university. Of the approximate 600 undergraduate students, 398 voluntarily participated in the Internet-based research study, resulting in a response rate of approximately 66%. This response rate is approximated based on the number of students enrolled in the courses at the time the study was conducted (according to the University's online course registration system); however, this online system does not account for students who may have dropped out or withdrawn from the course prior to or during the two-week time period the study was conducted. Unfortunately, the authors are unable to report any demographic information on those students who did not participate in the study, though it may be assumed that some were not at least 19 years of age, a requirement for participation based on the State's statute concerning legal adulthood. However, the authors did sample from both lower-level (i.e. freshmen and sophomores; first year and second year) and upper-level (i.e. juniors and seniors; at least third year) courses from different colleges within the university in order to obtain a wide variety of majors and minors. All respondents were treated in accordance with the ethical standards set forth by the American Psychological Association (APA). Due to missing data, the final raw data set included 296 respondents.

As shown in Table 1, the sample of participants was evenly split between males and females. The majority of the participants were White (80%, $n = 236$), Christian (83.4%, $n = 247$), and below the age of 21 years (87%, $n = 257$). As part of the demographics questionnaire, respondents also self-reported their current major(s) and minor(s) as an open-ended question. Based on their responses, the students were classified into one of four categories: (1) Arts, (2) Sciences, (3) Business, or (4) 'Both'. As shown in Table 1, students majoring and minoring in the Arts made up the largest category with 35% ($n = 103$). In all, 21% ($n = 63$) of the students were Science majors, 20% ($n = 58$) were Business majors, and 19% ($n = 55$) reported a major/minor in at least two of the previous categories (Both). Of the 296 respondents, 179 (60%) self-reported some form of computer criminal behaviour.

2.2. Measures

The survey comprised questionnaires previously used or adapted from studies in the areas of computer deviant behaviour (Rogers, Seigfried, and Tidke 2006; Rogers, Smoak, and Liu 2006b; Seigfried, Lovely, and Rogers 2008; Seigfried-Spellar, Rogers, and Lynam 2010). These scales have consistently shown acceptable levels of reliability in research related to computer deviant behaviour. The current study comprised the following questionnaires/scales: demographics, Computer Crime Index – Revised (CCI-R) (Rogers, Seigfried, and Tidke 2006), and the AQ (Baron-Cohen et al. 2001). Firstly, the respondents' basic demographic information was self-reported via an online questionnaire, which included items such as gender, age, and college major/minor. The demographics survey appeared at the beginning of the study for all of the respondents and was advertised as assessing 'attitudes toward computer behaviour'. By placing the demographics questionnaire prior to the questions regarding computer criminal behaviour, this method increased the accuracy of self-reported demographics for this study (cf., Birnbaum 2000).

Roger's et al. (2006a) CCI-R measured the frequency and prevalence of self-reported deviant computer behaviour. Based on item response, respondents were classified as hackers, identity thieves, cyberbullies, and/or

Table 1. Demographics for computer deviants and computer non-deviants.

Variable		Computer		
		Deviant ($n = 179$)	Non-deviant ($n = 117$)	Total ($N = 296$)
Gender	Male	88 (49.2)	62 (53.0)	150 (50.7)
	Female	90 (50.3)	55 (47.0)	145 (49.0)
	Decline	1 (0.5)	0	1 (0.3)
Age (years)	19	85 (47.5)	56 (47.9)	141 (47.6)
	20	47 (26.3)	33 (28.2)	80 (27.0)
	21	22 (12.3)	14 (12.0)	36 (12.2)
	22	14 (7.8)	6 (5.1)	20 (6.8)
	≥ 23	11 (6.1)	8 (6.8)	19 (6.4)
College major/minor	Art	61 (34.1)	42 (35.9)	103 (34.8)
	Science	34 (19.0)	29 (24.8)	63 (21.3)
	Business	42 (23.5)	16 (13.7)	58 (19.6)
	Both	32 (17.9)	23 (19.7)	55 (18.6)
	Decline	10 (5.5)	7 (5.9)	17 (5.7)
Ethnicity	Caucasian/White	151 (84.4)	85 (72.6)	236 (79.7)
	Black	16 (8.9)	16 (13.7)	32 (10.8)
	Asian	5 (2.8)	9 (7.7)	14 (4.7)
	Hispanic/Latino	5 (2.8)	1 (0.9)	6 (2.1)
	Other	2 (0.6)	6 (5.1)	8 (2.7)
Religion	Christian	145 (81.0)	102 (87.2)	247 (83.4)
	No religion, secular	18 (10.0)	8 (6.8)	26 (8.7)
	Atheist/agnostic	9 (5.0)	2 (1.7)	11 (3.7)
	Other	7 (4.0)	4 (3.4)	11 (3.7)
	Decline	0	1 (0.9)	1 (0.5)

virus writers. Individuals who did not self-report computer deviant behaviour were classified as computer non-deviant. For example, an individual who engaged in hacking behaviours was classified as a hacker (1) and individuals who did not self-report computer hacking behaviours were classified as non-hackers (0). The following statements are examples from the CCI-R, which were used to classify the respondents' computer deviant behaviour:

(1) Hacking: knowingly accessing a computer system or network without authorisation
(2) Identity theft: knowingly electronically obtaining another person's credit card information without permission
(3) Cyberbullying: knowingly harassing, annoying, or stalking someone through the use of emails, social media, or other forms of technology
(4) Virus writing: knowingly writing or using a program that would infect a computer or network.

The AQ (Baron-Cohen et al. 2001) is a self-administered scale that measures 'the degree to which an adult has autistic traits' (6). This scale was designed for both scientific (e.g. comparisons between those 'affected' and those who are not) and clinical reasons (e.g. screening individuals for referral) for assessing the extent to which an adult may have AS (Baron-Cohen et al. 2001). However, the AQ is not a diagnostic instrument for high-functioning autism or AS. For the AQ, respondents endorsed their level of agreement on a scale of 1 (definitely agree) to 4 (definitely disagree) for 50 items divided into five subscales: social skills, communication, imagination, ATD, and ATW. For example, a statement assessing the social skills subscale was 'I find social situations easy'. In addition, the AQ assesses keen ATD and limited abilities of ATW, which is often seen in individuals diagnosed with high-functioning autism (Baron-Cohen et al. 2001). Also, individuals with autistic-like behaviours are more likely to report poor communication, imagination, and social skills but exceptional ATD and focus of attention (Baron-Cohen et al. 2001).

The overall score on the AQ (Total) represents a continuous scale from 0 (low) to 50 (high), with individuals who score 32+ being more likely to have clinically significant levels of high-functioning autism or AS (Baron-Cohen et al. 2001; Gardiner and Iarocci 2014). Although other cut-offs are used to indicate a greater likelihood of AS in clinical samples, Woodbury-Smith et al. (2005) suggest using scores of 32 and higher as the point of focus for autistic-like traits for a general population in order to reduce the possibility of false positives (see also Pisula et al. 2013). For each subscale (e.g. poor social skills), the minimum score is 0 (low) and the maximum is 10 (high). The AQ total score and subscales had the following reported Cronbach's alphas: total ($\alpha = 0.90$), social skills ($\alpha = 0.57$), communication ($\alpha = 0.70$), ATW ($\alpha = 0.70$), imagination ($\alpha = 0.66$), and ATD ($\alpha = 0.71$).

2.3. Procedure

Undergraduate students were recruited from all degree majors and minors at a large, Southern university through information sessions given on a class-by-class basis with permission from the instructor, as well as through emails and online postings. Classes were targeted from different colleges within the university in order to obtain a wide variety of majors and minors; for example, professors were contacted who taught courses in the College of Arts and Sciences as well as the College of Engineering. Research assistants received training from the Principal Investigator (author) via a three-hour workshop on participant solicitation and Internet-based research design, as well as the Collaborative Institutional Training Initiative Program online courses, Social and Behavioral Responsible Conduct of Research course, and Non-Medical Investigators Basic Course, as required by the University. In addition, the research assistants attended a human subjects research workshop that was provided by the University's Institutional Review Board (IRB). After the necessary training, the research assistants then recruited student participants for the survey during class by advertising the study as assessing 'attitudes towards computer behaviours'. Next, the professors emailed the link to their students and also posted it on the University's e-Education platform, Blackboard Learn. Participants did not receive any incentives from the researchers to complete the survey.

The study was conducted electronically using an Internet-based survey. Once the respondents accessed the website, the home page explained the study while acting as a consent form to which the respondents had to agree or decline to participate. In order to participate in the study, the individual had to also indicate that he/she was at least 19 years of age or older (based on the State's definition of a 'minor') and currently enrolled as a student at the University. The waiver of consent stressed the voluntary nature of the study, the confidentiality of the data collected, and the ability for respondents to quit the Internet survey at any time with no repercussions. If the prospective respondents met the study's requirements and agreed, they had to click on the 'I Agree' button in order to participate in the study, which took approximately 20 minutes to complete in total.

No identifying information (e.g. names and IP address) was recorded or collected in the survey or asked of the respondent at any time, so identification of the participants was impossible. Anonymity and confidentiality were important in order to increase the participants' confidence in self-disclosing criminally sanctioned behaviours (e.g. virus writing). All survey items were forced-choice, but the respondents were able to select 'decline to respond' to any item, as required by the IRB. At the end of the questionnaire, once participants had submitted their responses, they were directed to a page thanking them for their time and participation, and contact information for the research team was provided.

2.4. Statistical analyses

Two-tailed statistical significance was set at the alpha level of 0.05 prior to any analyses; however, due to the exploratory nature of this study, marginal significance levels of .10 were discussed in some cases. Firstly, a zero-order correlation was conducted to identify if any autistic-like traits (e.g. poor social skills) were significantly associated with the different cybercrime behaviours (hacking, identity theft, cyberbullying, and virus writing). In an attempt to minimise chance associations, findings from the zero-order correlation were further validated by using a one-way analysis of variance (ANOVA). Effect sizes were calculated using the omega squared (ω^2), rather than the eta squared (η^2) method, because it is slightly less biased since it is calculated using both the variance explained by the model and the error variance (see Field 2013). According to Kirk (1996), 0.01 is considered a small effect, 0.06 is considered a medium effect, and 0.14 represents a large effect size for ω^2. Finally, in order to determine significant mean group differences in the autistic traits of individuals who engage in various forms of cybercrime, *post hoc* analyses were conducted where appropriate.

3. Results

Of the 296 respondents, 179 (60%) self-reported engaging in some form of computer criminal behaviour. Of the 60% who self-reported engaging in some form of computer deviance, 57% ($n = 170$) self-reported engaging in hacking behaviours, 13% ($n = 38$) self-reported engaging in identity theft, 23% ($n = 66$) self-reported engaging in cyberbullying, and 8% ($n = 23$) engaged in virus writing. Due to missing data, only 275 students completed the AQ. Of these 275 students, only 2 (0.01%) produced an AQ total score at or above the suggested cut-off score of 32 (see Baron-Cohen et al. 2001). These two students will be referred to by their random ID#: 1 and 148. Both of these individuals self-reported engaging in computer deviant behaviour, which was 1% of the self-reported computer deviants who also completed the AQ ($n = 161$). Respondent #1 was a White female, 19 years of age, majoring in the Sciences, and reportedly only engaging in computer hacking. On the other hand, Respondent #148 was a White male, 20 years of age, majoring in the Arts, and reportedly engaging in all computer criminal behaviours (hacking, virus writing, cyberbullying, and identity theft). The final sample for analysis included 275 respondents; 161 were self-reported computer deviants and 114 were self-reported computer non-deviants.

3.1. Hypotheses

H1: There are differences in the AQ (total) and subscales (social skills, ATW, ATD, communication, imagination) between computer deviants (hackers, virus writers, cyberbullies, and identity thieves) and computer non-deviants.[2]

Table 2. Zero-order correlation between AQ total and subscales and self-reported computer deviance.

	AQ					
	Total	*S*	ATW	ATD	*C*	*I*
Hacking	−0.08	−0.10	0.03	−0.14**	−0.04	−0.02
Identity theft	0.24***	0.20***	0.02	0.02	0.24***	0.23***
Cyberbullying	0.12**	0.07	0.07	−0.03	0.11**	0.08
Virus writing	0.32***	0.21***	0.08	0.06	0.28***	0.22***

Notes: Listwise $N = 275$. *S*, social skills; *C*, communication; and *I*, imagination.
***$p < .01$.
**$p < .05$.
*$p < .10$.

Table 3. Means and standard deviations for AQ total and subscales by computer criminal behaviour.

	AQ					
Computer Behaviour	Total	*S*	ATW	ATD	*C*	*I*
Hacker	17.29 (5.40)	2.53 (1.83)	4.71 (1.79)	5.06 (1.94)**	2.39 (1.92)	2.75 (1.68)
Non-Hacker	18.18 (5.03)	2.91 (1.96)	4.62 (1.75)	5.59 (1.85)**	2.56 (2.14)	2.80 (1.49)
Identity thief	21.16 (5.51)***	3.74 (1.86)***	4.77 (1.50)	5.39 (1.65)	3.81 (2.07)***	3.81 (1.64)***
Non-identity thief	17.25 (5.06)***	2.57 (1.86)***	4.66 (1.80)	5.29 (1.95)	2.29 (1.95)***	2.64 (1.54)***
Cyberbully	18.86 (5.44)**	2.94 (1.97)	4.90 (1.68)	5.19 (1.93)	2.87 (1.98)*	3.02 (1.82)
Non-cyberbully	17.34 (5.15)**	2.61 (1.86)	4.55 (1.81)	5.26 (1.97)	2.30 (2.00)*	2.67 (1.54)
Virus writer	23.84 (4.75)***	4.10 (1.65)***	5.10 (1.33)	5.65 (1.14)	4.35 (2.13)***	3.76 (2.07)***
Non-virus writer	17.23 (5.00)***	2.57 (1.86)***	4.59 (1.81)	5.22 (2.00)	2.28 (1.93)***	2.65 (1.55)***

Notes: Values represent means with standard deviations in parentheses. AQ Total scale ranges from 0 (low) to 50 (high). AQ subscales measure the level of problems from 0 (low) to 10 (high) associated with *S*, social skills; *C*, communication; and *I*, imagination.
***$p < .01$.
**$p < .05$.
*$p < .10$.

Hacking. As shown in Table 2, hacking was significantly associated with ATD, $r_{pb}(275) = -0.14$ with $p < .05$. There were no significant associations between hacking and the following AQ scales: AQ total, social skills, ATW, communication, and imagination.

As shown in Table 3, the ANOVA suggested that significant group differences existed for the self-reported hackers ($M = 5.06$, SD = 1.94) and non-hackers ($M = 5.59$, SD = 1.85) regarding their scores on ATD, $F(1, 273) = 5.35$, $p = .02$ with a small effect size of $\omega^2 = 0.02$. In contrast to the authors' expectations, the non-hackers scored higher on the ATD subscale compared to the self-reported hackers in the current study.

Identity theft. Self-reported identity theft was significantly associated with the following AQ traits: AQ total, $r_{pb}(275) = 0.24$ with $p < .01$; social skills, $r_{pb}(275) = 0.20$ with $p < .05$; communication, $r_{pb}(275) = 0.24$ with $p < .01$; and imagination, $r_{pb}(275) = 0.23$ with $p < .01$ (Table 2). There were no significant associations between identity theft and ATW or ATD. As shown in Table 3, there were significant group differences between identity thieves and non-identity thieves for the following traits: AQ total, $F(1, 273) = 16.15$, $p < .01$, $\omega^2 = 0.05$; social skills, $F(1, 273) = 10.91$, $p < .01$, $\omega^2 = 0.03$; communication, $F(1, 273) = 16.34$, $p < .01$, $\omega^2 = 0.04$; and imagination, $F(1, 273) = 15.42$, $p < .01$, $\omega^2 = 0.04$. Overall, the identity thieves scored higher on the total score for the AQ compared to the non-identity thieves, and more specifically, higher on poor social skills, poor communication, and poor imagination.

Cyberbullying. As shown in Table 2, self-reported cyberbullying was significantly associated with AQ total, $r_{pb}(275) = 0.12$ with $p < .05$. In addition, there was a moderately significant association with communication, $r_{pb}(275) = 0.11$ with $p = .06$. However, there was no significant relationship between cyberbullying and the following autistic traits: social skills, ATW, ATD, and imagination. Consistent with the zero-order correlations, the ANOVA suggested group differences between cyberbullies and non-cyberbullies for AQ total, $F(1, 273) = 4.11$, $p < .05$, $\omega^2 = 0.01$; and communication, $F(1, 273) = 3.37$, $p = .06$, $\omega^2 = 0.01$. Compared to the non-cyberbullies, the cyberbullies scored higher on

the total score for the AQ as well as higher on poor communication skills (Table 3).

Virus writing. There was a statistically significant association between self-reported virus writing and the following AQ scales: AQ total, $r_{pb}(275) = 0.32$ with $p < .01$; social skills, $r_{pb}(275) = 0.21$ with $p < .01$; communication, $r_{pb}(275) = 0.28$ with $p < .01$; and imagination, $r_{pb}(275) = 0.22$ with $p < .01$ (Table 2). There was no significant relationship between virus writing and ATD or ATW. As shown in Table 3, there were significant group differences between the virus writers and non-virus writers for AQ total, $F(1, 273) = 31.15$, $p < .01$, $\omega^2 = 0.10$; social skills, $F(1, 273) = 12.56$, $p < .01$, $\omega^2 = 0.04$; communication, $F(1, 273) = 23.07$, $p < .01$, $\omega^2 = 0.07$; and imagination, $F(1, 273) = 13.74$, $p < .01$, $\omega^2 = 0.04$. Overall, the virus writers scored higher on the total score for the AQ compared to the non-virus writers, and specifically, reported poorer social skills, poorer communication, and poorer imagination.

H2: There are differences in the AQ (total) and subscale traits (social skills, ATW, ATD, communication, imagination) for individuals who self-report engaging in more or less computer deviance. (1 type, 2 types, 3 types, or all cybercrime types)

For this hypothesis, only those individuals who self-reported engaging in at least one computer deviant behaviour (hacking, identity theft, cyberbullying, and/or virus writing) were included for the statistical analyses ($N = 161$). For the 161 respondents, a one-way ANOVA was conducted to determine if there were significant group differences on the AQ for individuals who engaged in more or less computer deviance. If the ANOVA yielded significant group differences, *post hoc* pairwise comparisons were conducted; specifically, Bonferroni guarantees control over Type 1 error rate and is generally more conservative; Gabriel's pairwise test performs well if sample sizes are different; and the Games–Howell test copes well for cases where population variances may differ. For large differences in sample sizes, Hochberg's GT2 test was conducted in addition to the other *post hoc* analyses (see Field 2013).

Of the 161 computer deviants, 94 (58%) engaged in only one type of computer deviant behaviour, 44 (27%) engaged in two, 9 (6%) engaged in three, and 14 (9%) engaged in all four types of computer deviant behaviours. As shown in Table 4, the results suggested a significant mean difference in the level of self-reported computer deviance on the following AQ traits: AQ total, $F(3, 157) = 13.29$, $p < .01$, $\omega^2 = .19$; social skills, $F(3, 157) = 8.83$, $p < .01$, $\omega^2 = 0.13$; communication, $F(3, 157) = 13.97$, $p < .01$, $\omega^2 = 0.19$; and imagination, $F(3, 157) = 8.06$, $p < .01$, $\omega^2 = 0.12$.

However, there were no significant mean differences, on average, between the level of computer deviance and the following AQ subscales: ATD, $F(3, 157) = 0.90$ with $p = .44$; and ATW, $F(3, 157) = 0.50$, $p = .68$.

Firstly, individuals self-reporting all four computer deviant behaviours scored significantly higher on the AQ total than in all of the other categories (Bonferroni, $p < .01$; Gabriel, $p < .01$; Games–Howell, $p < .01$; and Hochberg GT2, $p < .01$). Secondly, individuals engaging in all four computer deviant behaviours reported more problems with social skills compared to all of the other categories (Bonferroni, $p < .05$; Gabriel, $p < .05$; Games–Howell, $p < .05$; and Hochberg GT2, $p < .05$). Thirdly, individuals self-reporting all four computer deviant behaviours reported more problems with communication compared to all of the other categories (Bonferroni, $p < .01$; Gabriel, $p < .01$; Games–Howell, $p < .01$; and Hochberg GT2, $p < .01$). Finally, individuals self-reporting all four computer deviant behaviours reported more problems with imagination than all of the other categories (Bonferroni, $p < .01$; Gabriel, $p < .01$; Games–Howell, $p < .05$; and Hochberg GT2, $p < .01$; Table 4).

Overall, the authors' expectations were supported in that there were significant group differences in the AQ total and subscales based on the individual's level of computer deviance. Specifically, those individuals who self-reported engaging in hacking, identity theft, cyberbullying, *and* virus writing scored higher on the AQ total score and scored higher on the subscales measuring poor social skills, poor communication, and poor imagination compared to all other individuals engaging in computer deviant behaviours (1 type, 2 types, and 3 types; Table 4). However, the AQ and subscales did not discriminate between the other levels of computer deviance (i.e. discriminating 1 type from 2 types).

4. Discussion

Prior research suggests that computer hackers share many of the same characteristics associated with AS, namely obsessional interests, poor communication and social skills, intense focus on a particular task, and introversion (Baron-Cohen et al. 1999; Shaw, Post, and Ruby 1999; Schwartau 2000; Klawe 2001; Dreyfus 2002; Rogers, Seigfried, and Tidke 2006; Hunter 2009). Therefore, the authors of the current study expected to find more autistic-like traits associated with self-reported computer deviants than computer non-deviants. Some support was found; however, it should be noted that the AQ does *not* diagnose AS or high-functioning autism. Therefore, the authors did not intend to diagnose respondents using the AQ; rather, the scale was used to identify 'the degree to which an adult has autistic traits' (Baron-Cohen et al. 2001, 6) for self-reported computer deviants and computer non-deviants.

Based on the responses to the AQ (Baron-Cohen et al. 2001), two participants (out of 275; .01%) in the current study scored in the range of clinical levels for traits associated with AS (i.e. having an AQ total score of 32

Table 4. Means and standard deviation for AQ total and subscales by computer deviance types.

	AQ					
	Total***	*S****	ATW	ATD	*C****	*I****
Computer deviance***						
1 Type	16.50 (5.26)	2.28 (1.73)	4.72 (1.93)	5.06 (2.00)	2.13 (1.87)	2.53 (1.50)
2 Types	16.75 (4.23)	2.43 (1.73)	4.57 (1.62)	4.84 (1.94)	2.18 (1.57)	2.93 (1.73)
3 Types	18.22 (4.29)	2.56 (2.07)	5.11 (1.62)	5.56 (2.07)	2.22 (1.39)	1.89 (0.93)
4 Types	25.42 (4.29)	4.79 (1.25)	5.14 (1.46)	5.71 (1.27)	5.29 (1.38)	4.57 (1.70)

Notes: $N = 161$. Values represent means with standard deviations in parentheses. AQ total scale ranges from 0 (low) to 50 (high). AQ subscales measure the level of problems from 0 (low) to 10 (high) associated with *S*, social skills; *C*, communication; and *I*, imagination.
***$p < .01$.
**$p < .05$.
*$p < .10$.

or higher). Both of these individuals self-reported engaging in computer deviant behaviour. In contrast, Schell and Melnychuk (2011) found that 6% of their sample scored clinically significant levels of autistic characteristics using the AQ. However, it should be noted that the respondents in Schell and Melnychuk's (2011) study were sampled from attendees of hacker conferences, and the authors did not differentiate between hackers and non-hackers in their sample. In other words, it is difficult to know the level of computer deviance for the hacker conference attendees with high autistic-like traits.

In Woodbury-Smith et al. (2005), the authors suggested using a cut-off score of +26 to limit false negatives when screening a non-general population (i.e. clinical sample). If the authors chose to use this cut-off score instead of +32, then 7% ($n = 8$ out of 114) of the computer non-deviants and 6% ($n = 10$ out of 116) of the computer deviants scored in the clinical range for AS. Based on these findings alone, there is no evidence of a significant link between *clinical* levels of AS and computer deviance in the current sample. However, the current study did find evidence for computer deviants reporting more autistic-like traits, according to the AQ, compared to computer non-deviants. Specifically, individuals who self-reported engaging in identity theft, cyberbullying, and virus writing scored higher on the AQ total scale compared to their non-deviant counterparts. In addition, self-reported virus writers expressed poorer social and communication skills as well as low levels of imagination compared to non-virus writers. Similar to the virus writers, the self-reported identity thieves scored significantly higher on the AQ total score, as well as on the subscales poor social skills, poor communication skills, and poor imagination, compared to non-identity thieves.

One of the most interesting findings was that the self-reported cyberbullies scored significantly higher on the AQ total score and communication subscale, meaning cyberbullies were more likely than non-cyberbullies to report autistic-like traits and poor communication skills. Because communication is largely influenced by the rise of technology and social networking, research suggests that the decline in face-to-face social interaction has led to poor communication skills and a decreased ability to handle conflict (Drussell 2012). One of the most powerful aspects of the Internet, and particularly with cyberbullying, is the ability to avoid face-to-face conflict while remaining anonymous (see Patchin and Hinduja 2006; Vandebosch and Van Cleemput 2008). According to Bamford (2004), cyberbullies are able to mask their true identity by 'masquerading' or posing as someone else. Overall, individuals with more autistic-like traits, specifically poor communication skills, may be more likely to engage in cyberbullying because they lack the ability to communicate their feelings and resolve conflict within the 'physical world'.

In contrast to expectations, self-reported hackers in the present study were found to be less detail oriented than non-hackers. However, Hoekstra et al. (2008) believe that ATD is an individual preference, rather than a significant factor of AS, as they found a strong correlation between only four of the five subscales, namely social skills, communication, ATW, and imagination. Specifically, Hoekstra et al. (2008) posit that these four subscales combine for an overall factor of degree of social interaction, while the fifth subscale, ATD, simply illustrates a preference for pattern identification. Still, ATD or ATW was not significantly related to the self-reported hackers, identity thieves, cyberbullies, or virus writers when compared to their non-deviant counterparts. In addition, these findings contradict Schell and Melnychuk (2011), who reported that the highest mean score for the AQ subscales was for ATD and ATW for the hacker conference attendees. However, the findings may be different due to the sampled population – undergraduate college students vs. hacker conference attendees. For instance, the mean age in the current study was 20 years compared to 34 years in the Schell and Melnychuk (2011) study. In addition, the majority of the hacker conference attendees were gainfully employed (Schell and Melnychuk 2011). Overall, exceptional ATD

and focus of attention may be traits that are more useful for those individuals who chose employment or careers in technology-driven fields, rather than it being a trait associated specifically with computer deviant behaviours.

In the current study, the authors also expected to find that individuals who self-reported engaging in more computer deviant behaviours (hacking, virus writing, cyberbullying, *and/or* identity theft) would score higher on the AQ. The results suggested that those individuals who self-reported engaging in all four types of computer deviant behaviour were significantly more likely to score high on the AQ total score, as well as express more problems with social skills, communication, and imagination compared to the participants who self-reported less computer deviancy. However, there were no discriminating factors between the other levels of computer deviancy, meaning participants who reported engaging in one type of computer deviant behaviour were not significantly different from those who reported engaging in two or three types.

Since the current study sampled undergraduate students from a large, Southern university, the findings may not be representative of the entire population of computer deviants. Still, the purpose of the current study was to determine whether there was an association between autistic-like traits (e.g. poor social skills, poor imagination, poor communication, poor ATW, and exceptional ATD) and deviant computer behaviour among a sample of college students. Besides pirating, computer hacking was the most prevalent form of computer deviance, and few to none reported only being an identity thief or virus writer. Thus, the current analyses included overlaps between categories where individuals who were engaging in virus writing were also engaging in other forms of computer deviance, such as computer hacking (Table 3). Due to this overlap, the authors were unable to compare the AQ and subscale scores of individuals who were solely engaging in certain forms of computer crime, such as sole virus writers versus sole computer hackers.

However, computer deviance is considered a Guttman-like progression, meaning individuals move from the least technical computer deviant behaviour to more technically challenging computer deviant behaviours (see Hollinger 1988). Thus, it may be difficult to compare the autistic-like traits of individuals who self-report only committing one type of computer deviant behaviour (e.g. identity thief vs. virus writer). However, by increasing the sample size and soliciting respondents from the 'general population of Internet users', the authors are confident that future research will contribute to the scientific literature on the relationship between AS and computer deviance.

5. Conclusion

Overall, the current study yielded mixed results regarding the relationship between the characteristics associated with AS and self-reported computer deviance. There was no evidence of a significant relationship between clinical levels of AS and self-reported computer deviance; however, individuals who engaged in computer deviancy did report more autistic-like traits compared to computer non-deviants. The current study's external validity is limited by the study's sample (university students), so future research should compare the autistic-like traits of computer deviants from different sample populations other than college students and hacker conference attendees (see Schell and Melnychuk 2011). In addition, since computer deviancy is a global problem, cross-cultural comparison samples should be utilised to gain a better understanding of the personality and cognitive differences. Future research should also include a measure of preoccupation or obsession associated with computer technology by including a computer or Internet addiction scale when assessing the relationship between cyberdeviancy and AS (see Finkenauer et al. 2012). Other factors should be examined as well, including personality characteristics, motivation, and level of computer technical skills (see McBrayer 2014). Finally, by having a better understanding of the relationship between poor communication, poor social skills, and computer deviancy (specifically with cyberbullying), preventative educational programmes may be implemented in schools to identify students who have problems with socially appropriate emotional responses and conflict resolution.

Conflict of interest

No potential conflict of interest was reported by the authors.

Notes

1. The authors may refer to 'characteristics associated with Asperger syndrome' as measured by the AQ as 'autistic-like' traits for conciseness (see Baron-Cohen et al. 2001).
2. Higher scores on the AQ subscales suggest 'abnormality' as defined by Baron-Cohen et al. (2001): poor social skills, poor ATW, poor imagination, poor communication, and exceptional ATD (6).

References

American Psychiatric Association. 2000. *Diagnostic and Statistical Manual of Mental Disorders*. 4th ed, text revision. Washington, DC: American Psychiatric Association.

American Psychiatric Association. 2013. *Autism Spectrum Disorder*. http://www.dsm5.org

Bamford, A. 2004. "Cyber-Bullying." Presented at the Association of Heads of Independent Schools of Australia Pastoral Care National Conference. Melbourne, Australia.

Bandura, A. 1986. *Social Foundations of Thought and Action: A Social Cognitive*. Englewood Cliffs, NJ: Prentice-Hall.

Baron-Cohen, S. 2000. "Is Asperger Syndrome/ High-Functioning Autism Necessarily a Disability?" *Development Psychopathology* 12 (3): 489–500.

Baron-Cohen, S., P. Bolton, S. Wheelwright, V. Scahill, L. Short, G. Mead, and A. Smith. 1998. "Autism Occurs More Often in Families of Physicists, Engineers, and Mathematicians." *Autism* 2: 296–301.

Baron-Cohen, S., S. Wheelwright, R. Skinner, J. Martin, and E. Clubley. 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.

Baron-Cohen, S., S. Wheelwright, V. Stone, and M. Rutherford. 1999. "A Mathematician, a Physicist, and a Computer Scientist with Asperger Syndrome: Performance on Folk Psychology and Folk Physics Tests." *Neurocase* 5 (6): 475–483.

Birnbaum, M. H. ed. 2000. *Psychological Experiments on the Internet*. San Diego, CA: Academic Press.

Campbell, Q., and D. Kennedy. 2009. "The Psychology of Computer Criminals." In *Computer Security Handbook* (4th ed.), edited by S. Bosworth and M. E. Kabay, 40–160. New York: John Wiley.

Dreyfus, S. 2002. "Cracking the Hackers Code." *The Age*, Melborne, August 20.

Drussell, J. 2012. "Social Networking and Interpersonal Communication and Conflict Resolution Among College Freshmen." Master of Social Work Clinical Research Papers, Paper 21, St. Catherine University, St. Paul, Minnesota.

Field, Andy. 2013. *Discovering Statistics using IBM SPSS Statistics*. 4th ed. Thousand Oaks, CA: SAGE Publications.

Finkenauer, C., M. M. H. Pollmann, S. Begeer, and P. Kerkhof. 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.

Fishman, P. 2012. "Blocking the Breach." *FTI Journal: Cybercrime* 7: 36–43.

Gardiner, E., and G. Iarocci. 2014. "Students with Autism Spectrum Disorder in the University Context: Peer Acceptance Predicts Intention to Volunteer." *Journal of Autism Developmental Disorders* 44 (5): 1008–1017.

Hoekstra, R. A., M. Bartels, D. C. Cath, and D. I. Boomsma. 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.

Hollinger, R. C. 1988. "Computer Hackers Follow a Guttman-Like Progression." *Sociology and Social Research* 72 (3): 199–200.

Holt, T. J. 2010. "Examining the Role of Technology in the Formation of Deviant Subcultures." *Social Sciences Computer Review* 28 (4): 466–481.

Holt, T. J., D. Strumsky, O. Smirnova, and M. Kilger. 2012. "Examining the Social Networks of Malware Writers and Hackers." *The International Journal of Cyber Criminology* 6 (1): 891–903.

Hunter, A. 2009. "High-Tech Rascality: Asperger Syndrome, Hackers, Geeks, and Personality Types in the ICT Industry." *New Zealand Sociology* 24 (2): 39–59.

Internet Crime Complaint Center. 2013. *2012 Internet Crime Report*. http://www.ic3.gov

Kirk, R. E. 1996. "Practical Significance: A Concept Whose Time has Come." *Educational and Psychological Measurement* 56 (5): 746–759.

Klawe, M. 2001. "Refreshing the Nerds." *Communications of the ACM* 44 (7): 67–68.

Kushner, D. 2011. The Autistic Hacker. *IEEE Spectrum*, June 27. Retrieved from http://spectrum.ieee.org

Loch, K. D., and S. Conger. 1996. "Evaluating Ethical Decision Making and Computer Use." *Communications of the ACM* 39 (7): 74–83.

McBrayer, J. 2014. "Exploiting the Digital Frontier: Hacker Typology and Motivation." Unpublished Master's Thesis, Department of Criminal Justice, The University of Alabama, Tuscaloosa, AL.

Patchin, J. W., and S. Hinduja. 2006. "Bullies Move Beyond the Schoolyard: A Preliminary Look at Cyberbullying." *Youth Violence and Juvenile Justice* 4 (2): 148–169.

Pisula, E., R. Kawa, L. Szostakiewicz, I. Lucka, M. Kawa, and A. Rynkiewicz. 2013. "Autistic Traits in Male and Female Students and Individuals with High Functioning Autism Spectrum Disorders Measured by the Polish Version of the Autism-Spectrum Quotient." *PloS ONE* 8 (9): 1–12.

Ponemon Institute. 2011. "Perceptions about Network Security: Survey of IT &IT Security Practitioners in the U.S." http://www.juniper.net/

Rogers, M. K. 2010. "The Psyche of Cybercriminals: A Psycho-Social Perspective." In *Cybercrimes: A Multidimensional Analysis Part V,* edited by S. Ghosh and E. Turrini, 217–235. Berlin: Springer.

Rogers, M. K., K. Seigfried, and K. Tidke. 2006. "Self-Reported Computer Criminal Behavior: A Psychological Analysis." *Digital Investigation* 3: 116–120.

Rogers, M. K., N. Smoak, and J. Liu. 2006. "Self-Reported Criminal Computer Behavior: A Big-5, Moral Choice, and Manipulative Exploitive Behavior Analysis." *Deviant Behaviour* 27: 1–24.

Schell, B. H., and J. Melnychuk. 2011. "Female and Male Hacker Conferences Attendees: Their Autism-Spectrum Quotient (AQ) Scores and Self-Reported Adulthood Experiences." In *Corporate Hacking and Technology-Driven Crime: Social Dynamics and Implications*, edited by T. J. Holt and B. Schell, 144–168. Hershey, PA: IGI Global.

Schwartau, W. 2000. *Cybershock: Surviving Hackers, Phreakers, Identity Thieves, Internet Terrorists and Weapons of Mass Disruption*. New York: Thunder Mouth Press.

Seigfried, K., R. Lovely, and M. Rogers. 2008. "Self-Reported Online Child Pornography Behavior: A Psychological Analysis." *International Journal of Cyber Criminology* 2 (1): 286–297.

Seigfried-Spellar, K., M. Rogers, and D. Lynam. 2010. *Psychological Analysis of Computer Criminal Behavior: Preliminary Findings*. Seattle, WA: American Academy of Forensic Sciences 62nd Annual Scientific Meeting.

Shaw, E. D., J. M. Post, and K. G. Ruby. 1999. "Inside the Mind of the Insider." *Security Management* 43 (12): 34–42.

Vandebosch, H., and K. Van Cleemput. 2008. "Defining Cyberbullying: A Qualitative Research into the Perceptions of Youngsters." *CyberPsychology and Behavior* 11 (4): 499–503.

Woodbury-Smith, M. R., J. Robinson, S. Wheelwright, and S. Baron-Cohen. 2005. "Screening Adults for Asperger Syndrome using the AQ: A Preliminary Study of its Diagnostic Validity in Clinical Practice." *Journal of Autism and Developmental Disorders* 35 (3): 331–335.

Zuckerman, M. J. 2001. "Hacker Reminds Some of Asperger Syndrome." *USA Today*, March 29. http://www.usatoday.com