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**The relationship between autism quotient, anxiety, and internet
addiction**

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Abstract

This study investigated internet addiction across the broad autism phenotype, and assessed the degree to which internet addiction in individuals with higher autism quotient scores may be mediated by co-morbid depression and anxiety. Ninety participants were given a range of psychometric assessments to determine their level of problematic internet usage (Internet Addiction Test), autism traits (Autism Quotient Scale), depression (Beck Depression Inventory), and anxiety (Spielberger Trait Anxiety Scale). Significant associations were found between both autism, and anxiety, and internet addiction. However, the association between autism traits and internet addiction was moderated by high level for anxiety, such that individuals with high numbers of autism traits showed less evidence of internet addiction if they also displayed high levels of anxiety. It is suggested that the presence of anxiety in these individuals alters the function that internet behavior serves, and makes internet addiction less likely.

Key words: internet addiction, autism, depression, anxiety.

There is a growing weight of evidence that suggests the notion of an Internet Addiction Disorder (IAD) has some construct validity (Block, 2008; Byun, Ruffini, Mills, Douglas, Niang, Stepchenkova, & Blanton, 2009). The notion of an IAD is based on observations that some individuals display signs of problematic internet-related behaviors similar to those observed for other behavioral addictions, such as gambling (Block, 2008; Young, 1998). In particular, excessive use of the internet has been shown to produce severe disruption to the affected individual's everyday functioning, especially in terms of their social and work commitment (Bozoglan, Demirer, & Sahin, 2013; Lin, Tsai, Chen, Koo, 2013; Shaw & Black, 2008). Individuals who display signs of IAD also show a need to engage in greater amounts of internet-related activities over time (Griffiths, 2000). Finally, individuals who score highly on psychometrically-measured tests of internet addiction, such as the Internet Addiction Test (IAT; Young, 1998), show signs of withdrawal when they stop using the internet – manifest in reduced mood (Romano, Osborne, Truzoli, & Reed, 2013), and increased levels of depression (Kross, Verduyn, Demiralp, Park, Lee, Lin, & Ybarra, 2013).

A number of psychological problems and personality traits have been documented as having associations with problematic internet behaviors. In particular, individuals with problematic internet behaviors show a lack of inhibition (Dong, DeVito, Du, & Cui, 2012; Dong, Lu, Zhou, & Zhao, 2010), and problems in making self-controlled choices (Reed, Osborne, Romano, & Truzoli, 2014) in behavioral experiments. In addition, individuals scoring highly on the IAT also score highly in terms of psychometrically-measured depression (Gundogar, Bakim, Ozer, & Karamustafalioglu, 2012; Morrison, & Gore, 2010), as well as anxiety (Mehroof, &

Griffiths, 2010), and clinical presentations of these latter disorders are co-morbid with high levels of internet use (Bernardi, & Pallanti, 2009).

A further group of individuals who have been shown to display high levels of internet usage are those who are socially-isolated (Byuan et al., 2009; Weinstein, & Lejoyeux, 2010), and/or those who report social-anxiety (Du, Jiang, & Vance, 2010). These latter issues are related to the characteristics of ASD, and it has been shown that those with ASD (Mazurek & Engelhardt, 2013) engage in internet usage to a high extent. In fact, Romano et al. (2013) demonstrated that psychometrically-measured levels of autism traits were related to higher levels of internet-related problems. Given that there appears to be a strong relationship between use of the internet and those with ASD (e.g., Mazurek & Engelhardt, 2013), and also with those with greater levels of sub-clinical ASD traits (Romano et al., 2013), this group represents an important one to study in regard to internet-related problems.

The existence of autism-related traits in a non-clinical population has been referred to as the broad autistic phenotype (Micali, Chakrabarti, & Fombonne, 2004; Piven & Palmer, 1999; Wheelwright, Auyeung, Allison, & Baron-Cohen, 2010). That is, these ASD-related traits have been suggested to be distributed along a continuum in the population, with ASD at one end, and a milder variant, often found in relatives of people with ASD, at the other (see Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001; Bishop, Maybery, Maley, Wong, Hill, & Hallmayer, 2004; Happé, Briskman, & Frith, 2001; Murphy, Bolton, Pickles, Fombonne, Piven, & Rutter, 2000; Wheelwright et al., 2010). Thus, the concept of the broader autistic phenotype implies that behaviors associated with ASD can be present at a subclinical level for all individuals (Bishop et al., 2004; Happé et al., 2001; Reed, Lowe, & Everett, 2011; Wheelwright et al., 2010). Such ASD-related traits are often measured in the non-

clinical population using psychometrically-validated scales, such as the Autism Quotient scale (Baron-Cohen et al., 2001).

However, it has been argued that the internet is a very important tool for individuals with the broad autistic phenotype, in that it may help them to engage in social interactions that they would not otherwise engage upon if they had to employ traditional social means (Benford, & Standen, 2009; Burke, Kraut, & Williams, 2010; Mazurek, Shattuck, Wagner, & Cooper, 2012). This argument might be taken to suggest that their usage of the internet may differ from individuals with fewer ASD characteristics, and that this difference in function may somehow protect those higher on the ASD spectrum from developing IAD. Certainly, it has been suggested that the precise function of the internet use may be important in determining whether an IAD develops (Weinstein, & Lejoyeux, 2010; Yang, & Brown, 2013).

Thus, it may be that a combination of high levels of autism traits, and the existence of depression and/or anxiety, provokes a difference in the uses made of the net, and that this combination of problems actually offers protection from IAD. For example, if somebody has high levels of autism traits and is also anxious, they may find face-to-face interaction with other people difficult (Benford, & Standen, 2009; Mazurek et al., 2012), and use the net to maintain a form of social contact. Their high use of the net would then be serving a distinct function, with its own sets of reinforcers, which may serve to overshadow the development of an addiction to the internet per se, or, even if the internet became a major factor in their life, would not be perceived as problematic.

The current study investigated the relationship between internet and autism-traits in those individuals who also had lower- or higher-levels of anxiety and depression. It was hoped to establish whether the joint occurrence of high levels of

autism-traits and either anxiety and/or depression produced a different pattern of relationship between these variables and problematic internet usage.

Method

Participants

Ninety participants (48 males and 42 female) were recruited from the University campus at Swansea University. This sampling strategy was employed as it was thought that younger people may use the internet more often (Anderson, 2001; Morahan-Martin & Schumacher, 2000). The participants has a mean age of 24.48 (\pm 2.58, range 20 – 30) years old. The self-reported ethnicity of the participants, according to the classifications recommended by the UK Office National Statistics, were: 58 (64%) White; 2 (2% Mixed / Multiple Ethnic Groups; 21 (23%) Asian / Asian British; 7 (8%) Black / African / Caribbean / Black British; and 2 (2%) Other Ethnic Group. The marital status of sample was: 60 (67%) single, 8 (9%) married or in a civil partnership; 21 (23%) in other forms of relationship; and 1 (1%) divorced or widowed. None of the participants reported any history of psychiatric problems. The study received approval from the Department of Psychology Ethics Committee.

Materials

Internet Addiction Test (IAT; Young, 1998) is a 20-item scale covering the degree to which use of internet disrupts everyday life (work, sleep, relationships, etc.). Each item is scored on a 1-4 scale, and the overall score ranges from 20 to 100. The factor structure of the IAT is currently debated (cf. Chang & Man Law, 2008; Widyanto & McMurrin, 2004), but Young (1998) has suggested that employing a cut-off score of 40 or more for the total score of the IAT represents some level of

problematic internet usage (see also Hardie & Tee, 2005; Romano et al., 2013; Widyanto & McMurrin, 2004). The internal reliability (Cronbach, α) of the scale has been found to be between .90 (Widyanto & McMurrin, 2004) and .93 (Young, 1998).

Autistic Spectrum Quotient Questionnaire (AQ; Baron-Cohen et al., 2001) measures the level of autistic traits that an individual lacking an ASD diagnosis may possess. This questionnaire consists of 50 questions, with a score of 32 generally being suggested as indicating Asperger's syndrome or high functioning autism. The test-retest reliability of the scale is 0.70 (Baron-Cohen et al., 2001), and the internal consistency (Cronbach alpha) of the AQ is 0.82 (Austin, 2005). There are sub-scales to the AQ, however, there is some debate about the appropriate factor solution for the AQ, and the reliabilities of the sub-scales are uncertain (see Austin, 2005; Hurst, Mitchell, Kimbrel, Kwapil, & Nelson-Gray, 2007). Given these concerns, only the overall AQ score was employed.

Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961) is a 21-item questionnaire that assesses the clinical symptoms of depression through asking about feelings over the past week. The score is a sum of the answers, ranging from 0 to 63, and it is suggested that scores of 10 or greater reflect the presence of some level of depression. The internal reliability (Cronbach α) of the scale is between .73 and .92, and a concurrent validity of between .55 and .73 for non-psychiatric subjects (Beck, Steer, & Garbin, 1988).

Spielberger Trait Anxiety Inventory (STAI-T; Spielberger, 1983) rates the affective, cognitive, and physiological manifestations of anxiety in terms of long-standing patterns (i.e., trait anxiety). Scores for each question range from 1 = never, to 4 = almost always, and the total score can range from 20 to 80. A score of greater

than 40 is recommended as showing some signs of anxiety. The internal reliability (Cronbach α) of the scale is .93, and a concurrent validity = .52 to .80.

Procedure

The participants were seated alone in a quiet room, and were tested individually. A brief introduction to the study was given, in which the participants were told that this was a study regarding personality and behavior, and the participants gave their consent to participate. Following this, they were asked to complete the above battery of psychological tests (i.e., IAT, AQ, BDI, and STAI). The tests were given to the participants by one of the experimenters (a psychology graduate student) in a random order. Participants usually took about 30 min to complete the assessment battery.

Results

Table 1 about here

Table 1 shows the means (standard deviations) for the four measures employed, as well as the Pearson correlation values between these measures. Inspection of these data shows that the mean IAT score for the sample was below the cut-off point for problematic usage, but that there was some degree of variability in these values. In fact, 27 (30%) of the sample reported a score of 40 or greater, which suggests some level of problematic use. The mean score of autism quotient was well below the cut off for a diagnosis of ASD, and, in fact, only 1 individual scored higher than this cut-off. The mean depression score was also below the cut off for signs of

clinical depression, although 29 (32%) did score in the range indicating some level of depression. The anxiety mean score for the sample was actually quite high, over the cut off for some sign of anxiety, and 55 (61%) of the participants reported some level of anxiety. The correlations between these variables indicated that there were statistically significant and moderately-sized relationships (based on the criterion of a correlation of .000-0.299 being weak, .300-.699 being moderate, and over .700 being strong; Cohen, 1988) between scores of problematic internet use (IAT) and both autism traits (AQ) and anxiety levels (STAI), and there were also statistically significant correlations (with a moderate effect size) between autism traits (AQ) and both anxiety (STAI) and depression (BDI), which were themselves significantly correlated with one another.

Table 2 about here

Table 2 shows the correlations between the participants' ages (Pearson), genders and relationship-statuses (Point Biserial) with the IAT, AQ, BDI, and STAI scores. There were no statistically significant correlations between the participants' ages and any of the variables measured. Neither were there any relationships between the participants' genders and the variables. However, there was a statistically significant (but weak-sized) correlation between the participants' relationship status and their internet addiction score, indicating that higher IAT scores were associated with being single.

Table 3 about here

Table 3 shows the numbers of participants scoring above the cut-off for problematic internet behavior, classified by those with scores above the cut offs for depression and anxiety. The table also shows the chi-square conducted on these data, and the strength of association between these variables (i.e. phi coefficient). These data suggest that there was a statistically significant, but weak, correlation between depression (BDI) and the presence of an internet problem (IAT). There was a significant and moderately-sized association between IAT and anxiety.

The sample was split into lower and higher autism traits based on their AQ score, using the mean AQ score for the sample. This created a lower-AQ (N = 41; mean AQ= 10.83 + 3.46; range 3 – 15) and higher-AQ (N = 49; mean AQ= 19.65 + 3.44; range 16 – 29) group. Correlations were performed between both the depression (BDI) and the anxiety (STAI) scores and the internet-problems (IAT) scores for the lower- and higher-AQ groups, separately. These analyses revealed that, for the low-scoring AQ group, there was a strong correlation between anxiety and internet addiction scores, $r = .549$, $p < .001$, but not between depression and internet addiction, $r = .100$, $p > .50$. However, for the higher-scoring AQ group, there was no significant relationship between anxiety and internet addiction, $r = .250$, $p > .08$, or between depression and internet addiction, $r = .080$, $p > .50$.

The sample was split into lower- and higher-anxiety groups, based on the mean score on the STAI, and also into lower- and higher-autism trait groups, using the mean AQ score for the sample. This created four groups: lower-anxiety lower-AQ (N = 25; mean STAI = 33.88; mean AQ = 10.72); lower-anxiety higher-AQ (N = 15; mean STAI = 33.27; mean AQ = 19.00); higher-anxiety lower-AQ (N = 16; mean STAI = 48.25; mean AQ = 11.00); and higher-anxiety higher-AQ (N = 34; mean IAT = 49.71; mean AQ = 19.94).

The sample was also split into lower- and higher-depression groups, based on the mean BDI score, and into lower- and higher-autism groups, based on the mean AQ score. This created four groups: lower-depression lower-AQ (N = 32; mean BDI = 3.44; mean AQ = 10.56); lower-depression higher-AQ (N = 26; mean BDI = 4.04; mean AQ = 17.92); higher-depression lower-AQ (N = 9; mean BDI = 14.00; mean AQ = 11.78); and higher-depression higher-AQ (N = 23; mean BDI = 15.09; mean AQ = 21.61).

 Figure 1 about here

The left panel of Figure 1 shows the group-mean internet addiction scores (IAT) for the four groups created in terms of lower-and higher anxiety (STAI) and autism (AQ). Inspection of these data for the anxiety-autism groups shows that the higher-anxiety and the higher-autism groups displayed greater levels of internet addiction than the lower-anxiety and autism groups. However, the difference between the lower- and higher-AQ groups was numerically more pronounced for the lower-anxiety groups than it was for the higher-anxiety groups.

A two-factor between-subject analysis of covariance (ANCOVA), with anxiety (lower versus higher) and autism (lower versus higher) as factors, and depression (BDI) as a covariate, was conducted on these data. This analysis revealed statistically significant main effects of anxiety, $F(1,85) = 17.01, p < .001, partial\ eta^2 = .167$, and autism, $F(1,85) = 5.92, p < .05, partial\ eta^2 = .065$, however there was no statistically significant interaction between the factors, $F < 1, partial\ eta^2 = .005$. Although the interaction was not statistically significant, there was numerical difference between levels of IAT score in the autism groups for the lower- and higher-

scoring anxiety groups. To explore this difference, simple effect analysis were conducted between the lower- and higher autism groups, for the lower and higher anxiety groups (the conduct of simple effects is not constrained by the existence of a significant interaction, Howell, 1998). These analyses revealed a statistically significant simple effect of autism, $F(1,37) = 4.21, p < .05, \text{partial } \eta^2 = .102$, for the lower-anxiety groups, but no significant simple effect of autism for the higher-anxiety group, $F(1,47) = 1.98, p > .15, \text{partial } \eta^2 = .040$

The right panel of Figure 1 shows the mean IAT score for the four groups created in terms of lower- and higher- depression (BDI) and autism (AQ). These data show that the higher-autism groups displayed greater levels of internet addiction than the lower-autism groups, but there was little impact of depression on the IAT scores. A two-factor between-subject ANCOVA (depression x autism), with anxiety (STAI) as a covariate, was conducted on these data, and revealed a statistically significant main effect of autism, $F(1,85) = 5.52, p < .05, \text{partial } \eta^2 = .061$, but neither the main effect of depression, $F < 1, \text{partial } \eta^2 = .002$, nor the interaction between the two factors, $F < 1, \text{partial } \eta^2 = .001$, were significant.

Discussion

The current research aimed to investigate whether the association between autism traits in the general population and internet addiction was mediated by the presence of depression and anxiety. The findings demonstrated that there were associations between autism traits and both anxiety and depression, which corroborates previous reports of these associations (Ghaziuddin, Ghaziuddin, & Greden, 2002; Romano et al., 2013; Stewart, Barnard, Pearson, Hasan, & O'Brien, 2006). Furthermore, there were significant relationships between both autism traits

and levels of anxiety with internet addiction, such that the higher was the autism or anxiety score, the more likely the participant was to report higher levels of problematic internet usage.

These findings replicate several previous demonstrations of both of these associations: autism (Romano et al., 2013) and anxiety (Bernardi, & Pallanti, 2009; Mehroof, & Griffiths, 2010). However, there was no strong relationship between levels of depression and problematic internet usage noted in the current data. This finding stands in contrast to a number of previous reports concerning this relationship (Gundogar et al., 2012 Morrison, & Gore, 2010). It must be noted that these latter reports all included larger numbers of individuals with clinically-significant levels of depression, whereas the current sample did not show such high levels of depression, and this may explain the difference between the results.

The relationship between autism and internet usage was also partly suppressed by the existence of anxiety. In particular, the part of the sample with greater levels of autism traits did not show a relationship between anxiety and problematic internet usage, whereas this anxiety-internet addiction association was noted for the lower-AQ scoring participants. This pattern of findings was also numerically noted in that there was little difference in IAT scores between lower- and higher-scoring AQ groups who had lower anxiety scores, whereas IAT scores did differ more between lower- and higher-AQ groups who had higher anxiety scores. Thus, the presence of anxiety appears to produce a different relationship between internet addiction and autism traits. Although higher levels of autism traits are associated with greater levels of problematic internet usage for both lower- and higher anxious individuals, the relationship is much more pronounced for lower-anxious individuals than for individuals with higher levels of anxiety.

These findings suggest that the factors that dispose individuals to develop internet addiction problems are complex, and consideration of individual trait characteristics in isolation may not give a full picture of the probability of an internet addiction developing. In the case of autism traits, as measured by the AQ (Baron-Cohen et al., 2001), it appears that individuals with co-morbid anxiety may be less likely to display internet addiction as their level of autism phenotype increases, relative to individuals without co-morbid anxiety.

On the face of it, this finding is somewhat counter-intuitive; as both autism (Romano et al., 2013), and anxiety (Bernardi, & Pallanti, 2009; Mehroof, & Griffiths, 2010), individually predict levels of internet usage. Given this, it might be expected that those who report both problems would exhibit much higher levels of IAD than individuals reporting either problem on their own. However, the presence of a co-morbid problem such as anxiety may alter the behaviors and needs of an individual with ASD, or high-AQ scores, and, thus, alter the likelihood of an IAD developing. For example, high anxiety may dispose those with a higher autism phenotype to express their social interactions virtually, and this may be satisfactory or preferable for those individuals – meaning that high-levels of internet use are not problematic for them. However, these same high levels of internet behavior in a lower anxious individual, who is happy to engage in face-to-face interactions, may be problematic. This is admittedly speculative, but remains a possible explanation for these findings. Certainly, at base, these findings develop understanding of the relationship of AQ to IAD, and suggest that these relationships are somewhat more complex than previously suggested.

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Figure Captions

Figure 1. Group mean internet problem groups (IAT) for lower and higher autism trait (AQ) groups, categorized as lower- and higher-scoring in terms of depression and anxiety.

Figure 1

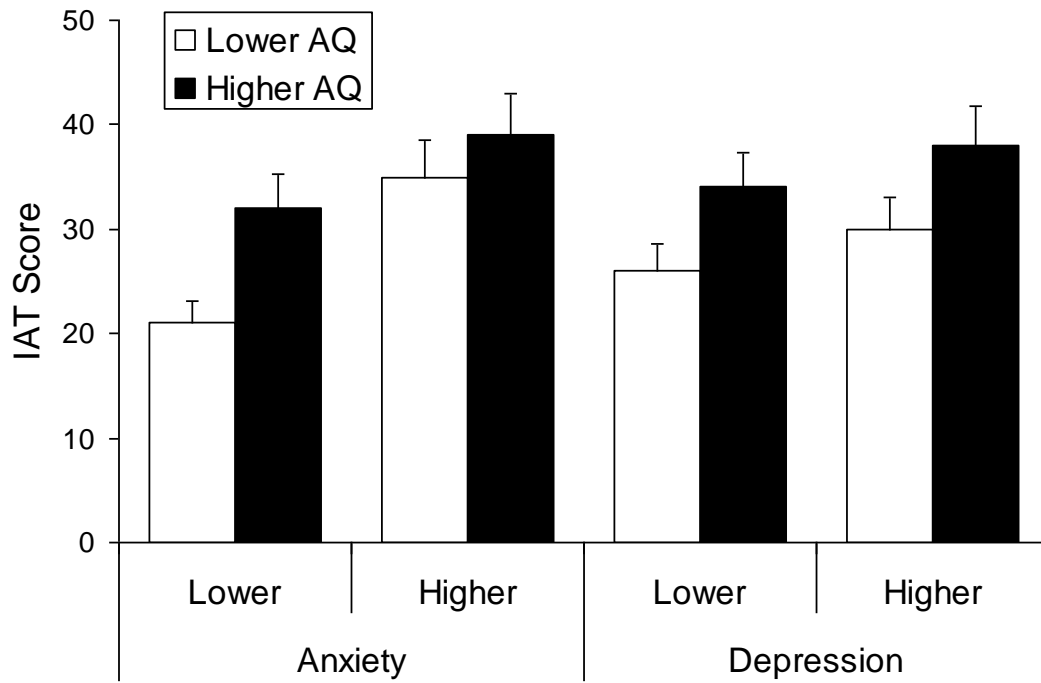


Table 1: Means (standard deviations) for internet addiction (IAT), autism (AQ), depression (BDI), and anxiety (STAI), and the Pearson correlations between these measures.

Scale	Mean (SD)	AQ	BDI	STAI
IAT	32.12 (14.72)	.365***	.174	.430***
AQ	15.63 (5.60)		.444***	.273**
BDI	7.64 (6.37)			.477***
STAI	42.31 (9.34)			

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

Table 2: Correlations between the participants' ages (Pearson), genders (0 = female, 1 = male) and relationship-statuses (0 = relationship, 1 = single) (Point Biserial) with the internet addiction (IAT) autism (AQ), depression (BDI), and anxiety (STAI) scores.

Scale	IAT	AQ	BDI	STAI
Age	.111	-.002	-.085	-.020
Gender	.003	.042	.018	.041
Relationship	.275**	.172	.168	.113

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

Table 3: Numbers of participants scoring higher than cut off points for depression (BDI > 9), anxiety (STAI > 39), who also scored above the cut off for internet problems (IAD > 39), and the chi-square and phi-correlations.

		No IAD	IAD	Chi-square	Phi
BDI	No	48	13	6.81	.275**
	Yes	15	14		
STAI	No	32	3	12.52	.373***
	Yes	31	24		