Alexithymia, impulsivity and negative mood in relation to internet addiction symptoms in female university students

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Published in:
Australian Journal of Psychology

DOI:
10.1080/00049530.2021.1942985

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Author Disclosure Statement: All authors hereby declare that no competing financial interests exist concerning the research reported in this manuscript.

Word Count: 6057

Abstract

Objective. The personality trait alexithymia has been implicated as a risk factor for problematic substance use and other excessive behaviors including excessive use of the internet, often referred to as internet addiction when it entails problems for the user. Trait impulsiveness has also been identified as a likely predisposing factor for excessive behaviors. However, as impulsivity is often elevated in alexithymia, and both traits are often associated with negative affect, the degree of independence of these factors in relation to excessive internet use is unclear. **Method.** The present study assessed the contributions of alexithymia, impulsivity, and negative affect to variance in internet addiction symptoms in 116 internet-using female university students. Participants completed the following instruments online: demographics, Toronto Alexithymia Scale-20 (TAS-20), Barratt Impulsiveness Scale-11 (BIS-11), Internet Addiction Test (IAT), and the Depression Anxiety Stress Scales-21 (DASS-21). **Results.** The TAS-20, BIS-11, IAT, and DASS-21 were significantly intercorrelated in expected directions. Hierarchical regression indicated that although both alexithymia and impulsivity were highly significant predictors of internet addiction symptoms after controlling for demographic covariates, the contribution of alexithymia became nonsignificant after adding impulsivity to the model. The final model explained 37% of variance in internet addiction symptoms; impulsivity, negative mood, and age were significant predictors. Multiple mediation modelling indicated that both impulsivity and negative affect fully mediated the association of alexithymia with internet addiction symptoms. **Conclusions.** High impulsivity and negative affect appear to account for the link between alexithymia and internet addiction symptoms in young women at university. Potential clinical implications are discussed.

Keywords: internet addiction; personality; impulsivity; alexithymia

Alexithymia, a personality trait defined by difficulties identifying and describing feelings and externally oriented thinking (Luminet et al., 2018), has been implicated as a risk factor for excessive behaviors including problematic substance use (Cruise & Becerra, 2018; Lyvers, Hinton et al., 2014; Thorberg et al., 2009, 2016), compulsive buying (Rose & Segrist, 2012), pathological gambling (Marchetti et al., 2019; Toneatto et al., 2009), and eating disorders (Marsero et al., 2011). Alexithymia has also been linked to excessive use of the internet (De Berardis et al., 2009; Kandri et al., 2014; Lyvers et al., 2016; Mahapatra & Sharma, 2018), which is often referred to as internet addiction (IA) when such use causes problems for the user. Another personality trait, impulsivity, has been similarly linked to various excessive behaviors (Littlefield & Sher, 2010; Lyvers et al., 2014; MacKillop et al., 2011), and is regarded as a manifestation of executive dyscontrol given its associations with neuropsychological and brain imaging indices of prefrontal cortex dysfunction (Lyvers, 2000; Lyvers et al., 2015; Spinella, 2004; Turel et al., 2014; Vermeulen et al., 2018). Like alexithymia, impulsivity has been linked to IA (Cao et al., 2007; Dalbudak et al., 2013; De Berardis et al., 2009; Mottram & Fleming, 2009), with the relationship reportedly paralleling that for pathological gambling (Lee et al., 2012; Lumley & Roby, 1995).

Alexithymia, a deficit in emotional self-awareness, and impulsivity, the tendency to act rashly without due consideration of consequences, are defined very differently. However, people with higher alexithymia also tend to be more impulsive (Lyvers, Hinton et al., 2014; Lyvers, Makin et al., 2014; Shishido et al., 2013). Findings have thus been mixed regarding the degree to which alexithymia and impulsivity may be regarded as independent risk factors for excessive behaviors. For alcohol use disorder, much evidence suggests that they are largely independent risk factors (see Cruise & Becerra, 2018), whereas in other research the risk associated with alexithymia was attributed to impulsivity (Shishido et al., 2013). One recent study (Lyvers, Narayanan et al., 2018) compared traits associated with alcohol-related

risk to those associated with disordered social media use in young adults, finding that both alexithymia and impulsivity predicted alcohol-related risk whereas only impulsivity predicted disordered social media use. This suggests that impulsivity may be a more relevant trait than alexithymia in excessive online behaviors, at least in the case of disordered social media use.

IA refers to excessive internet use that leads to negative consequences in life domains such as employment, education, and relationships (Young, 1998, 2017). The concept was based on DSM criteria for pathological gambling, currently included under Substance-Related and Addictive Disorders in the DSM-5 (American Psychiatric Association, 2013). The only internet-related disorder in the DSM-5 (albeit tentatively) is internet gaming disorder. Given the many uses of the internet, the IA concept has been criticized as too heterogenous (Starcevic & Aboujaoude, 2017). Nevertheless, the high worldwide prevalence of IA symptoms (Cheng & Li, 2014; Durkee et al., 2012; Moreno et al., 2011) has stimulated research on this apparent phenomenon. A recent study in Australia (Borg & Smith, 2018) indicated that of the 93% of a large sample of people contacted by telephone who had internet access, 84% used the internet daily; the heaviest users were young adults, the age group most likely to use the internet excessively (Chakraborty et al., 2010). Although IA symptoms have been reported to be more prevalent in males than in females overall (Durkee et al., 2012; Wang et al., 2017), the gender difference may be narrowing (Dufour et al., 2016). Results of a large-scale study in university students indicated that the role of personality traits in IA may be stronger for women than for men (Yen et al., 2009). Further, women at university tend to report higher levels of stress and other negative moods than male students do (Rickwood et al., 2016), and negative affect has been identified as a proximate factor driving IA (Whang et al., 2003). The present study thus assessed trait and mood variables in relation to IA symptoms in a sample of female university students, based on the notion that such variables are especially likely to influence

IA symptoms among women attending university given those previous findings.

The present study assessed IA symptoms among internet-using university student women in relation to their levels of impulsivity, alexithymia, and negative affect. The goal was to assess whether the reported link of alexithymia to IA symptoms might be explained by impulsiveness and/or negative affect, both of which are commonly associated with alexithymia, in female university students. This hypothesis was tested by regression and multiple mediation modelling.

Method

Participants

Recruitment was from two universities in southeast Queensland, Australia, via campus-wide email at one university and an online research participation notice board at the other, yielding an initial sample of 132. Those recruited from the former university were offered the incentive of entry into a random draw for one of two $50 gift vouchers; those recruited from the other were offered an undergraduate psychology credit point. To meet inclusion criteria, participants had to be female and report using the internet at least twice a week for the past two years, no use of illicit drugs more than once per month on average, high English proficiency, no current psychiatric medication, and no previous brain injury. After removal of multivariate outliers and those who did not meet inclusion criteria, the final sample consisted of 116 female undergraduates aged 18 to 30 years (M = 21.39, SD = 3.52).

Measures

Demographic Questionnaire. Information was requested on age, gender, student status, years of education, use of alcohol and illicit drugs, previous brain injury, and English proficiency.

Toronto Alexithymia Scale (TAS-20). The TAS-20 (Bagby, Parker et al., 1994; Bagby,

Taylor et al., 1994) is the most widely used self-report index of alexithymia. The 20 items encompass three facets of alexithymia, difficulty identifying feelings (DIF), difficulty describing feelings (DDF), and externally oriented thinking (EOT). Items are rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree); total scores range from 20 to 100, with higher scores indicating higher alexithymia. Psychometric studies have generally supported the reliability and validity of the TAS-20 (Bagby et al., 2004; Sekely et al., 2018; Thorberg et al. 2010), although alternative models of alexithymia have been suggested (Preece et al., 2017). Gignac et al. (2007) supported a five factor model of the TAS-20, however their interpretation was subsequently disputed (Bagby et al., 2007). Meganck et al. (2008) found support for the three-factor model, but low internal consistency was noted for the externally oriented thinking factor. On the other hand, use of the alpha index of internal consistency is questionable when the number of items is small, as is the case for the TAS-20 subscales (Tavakol & Dennick, 2011). Convergent validity of the TAS-20 has been indicated by expected correlations with other indices of alexithymia such as the Bermond-Vorst Alexithymia Questionnaire (Zech et al., 1999) and the Toronto Structured Interview for Alexithymia (Bagby et al., 2006). The total scale score was utilized in this study as recommended by the authors of the original measure (see Sekely et al., 2018). The alpha index of internal consistency for the total TAS-20 was acceptable in the present sample (α = .83).

Barratt Impulsiveness Scale (BIS-11). The BIS-11 (Patton et al., 1995) is a widely used 30-item self-report instrument designed to measure trait impulsivity in adults. Questions encompass attentional, motor, and non-planning impulsiveness. Items are rated on a four-point Likert scale ranging from 1 (rarely/never) to 4 (almost always/always). Total scores range from 30 to 120, with higher scores indicating higher impulsivity. The BIS-11 has been reported to have good psychometric properties (Spinella, 2004, 2007), with alpha reliability

coefficients of .79 - .83 and test-retest stability over one year of .60 (Luengo et al., 1991). Convergent validity was established with neuropsychological measures that have demonstrated sensitivity to prefrontal cortex dysfunction (Lyvers et al., 2015; Spinella, 2004). Internal consistency was acceptable at α = .80 in the current sample.

Depression Anxiety Stress Scales (DASS-21). The DASS-21 (Lovibond & Lovibond, 1995) is a 21-item self-report instrument assessing negative moods experienced over the previous week. There are three subscales of seven items each: depression, anxiety, and stress. Items are scored on a four-point Likert scale from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time). Total scores can range from 0 to 63, with higher scores indicating more negative mood symptoms experienced during the past week. The DASS-21 has been reported to have excellent psychometric properties (Brown et al., 1997), and showed correlations of .72-.85 with other measures of depression and anxiety (Antony et al, 1998). The total score was used in the present study as an overall index of negative affect. Internal consistency of the total DASS-21 was excellent at α = .92 in the present sample.

Internet Addiction Test (IAT). The IAT (Young, 1998, 2017) is a 20-item self-report index of IA symptoms based on DSM criteria for pathological gambling. Items consist of statements rated on the degree to which they describe the respondent via a five-point Likert scale from 0 (does not apply) to 5 (always). The total score is the sum of ratings. Items include questions such as "How often do you find that you stay online longer than you intended?" Possible scores range from 0 to 100, with higher scores indicating more excessive or problematic internet use. Validity and reliability have been consistently supported across languages and cultures (Young, 2017). Internal consistency was excellent at α = .89 in the present sample.

Procedure

After obtaining approval from the ethics committees of both universities, recruitment was initiated for research on personality and internet use. Respondent anonymity, voluntary nature of participation, time required, and incentives were described. Those interested accessed a link to the online questionnaire battery via Qualtrics, a web-based survey hosting company. After completing the demographics questionnaire, instruments were presented in a uniquely randomized order per participant. Upon completion, a final screen reminded participants to email a screenshot to the researchers to receive their incentive. A random draw determined the two participants who received a $50 electronic gift voucher.

Results

The DASS-21 index of negative affect was positively skewed, as expected for a nonclinical sample; this was corrected by square root transformation. Descriptive statistics and correlations for the measures are shown in Table 1. Total scores on BIS-11 and TAS-20 are shown in the table, as all three BIS-11 subscales showed similar significant correlations with IAT scores (r = .33 - .42), as did all three subscales of the TAS-20 (r = .20 - .31). As expected, scores on the IAT were significantly positively correlated with total TAS-20 alexithymia and BIS-11 impulsivity scores as well as with the transformed DASS-21 scores. Alexithymia, impulsivity, and negative mood were significantly positively correlated with each other. IAT scores were significantly negatively correlated with age and education, hence these demographic variables were included as covariates in the regression and mediation model.

Regression on Internet Addiction Test scores

Hierarchical multiple regression was conducted on IAT scores. At step 1, the covariates age and education were entered, accounting for a significant 9% of variance, $F(2, 113) = 5.59$, $p = .005$. Age was the only significant (and negative) predictor. Alexithymia was

entered at step 2 and accounted for a further 9.1% of variance, which was significant, $\Delta F(1, 112) = 12.38$, $p = .001$; alexithymia was the only significant (and positive) predictor at this step. Impulsivity was entered at step 3 and explained a significant 12.6% of additional variance as a positive predictor, $\Delta F(1, 111) = 20.27$, $p < .0001$, with impulsivity and age the only significant predictors. Alexithymia was no longer significant; Sobel Test indicated full mediation by impulsivity, $z = 3.56$, $p = .0004$. The transformed DASS-21 index of negative mood was entered at the last step based on evidence that negative mood is a proximate driver of excessive internet use (Whang et al., 2003); DASS-21 accounted for a significant 6.1% of additional variance as a positive predictor, $\Delta F(1, 110) = 10.53$, $p = .002$. Impulsivity remained the strongest predictor in the final model, followed by negative mood and age. The final model accounted for 37% of variance in IAT scores, $F(5, 110) = 12.79$, $p < .0001$. Table 2 shows the regression statistics.

As discussed in a recent review by Luminet et al. (2021), a number of alexithymia studies have indicated differential behavioral, cognitive, or psychopathological correlates of the EOT component versus the DIF and/or DDF components. Although not a planned analysis, in the present sample, regression results were similar when TAS-20 subscales were used instead of the total score, with the exception of DDF – the shortest subscale with only 5 items. Both DIF and EOT subscales were significant predictors until impulsivity was added to the model, as was the case for the total TAS-20.

Multiple Mediation Analysis

Although the hierarchical regression model indicated that the variance in IAT scores explained by TAS-20 alexithymia scores was fully mediated by BIS-11 impulsivity scores before the DASS-21 index of negative affect was entered at the last step, the possibility of dual mediation by both impulsivity and negative affect was tested by multiple mediation modelling via JASP 0.14.1. Mediation was tested using bootstrapping with 1000 bias-

corrected replications, controlling for age and education as covariates. As can be seen in Table 3, the 95% confidence interval for the indirect effects of alexithymia through impulsivity and negative affect did not include zero, whereas the 95% confidence interval for the direct effect did include zero. This result indicated full mediation; that is, the association between alexithymia and excessive internet use was fully accounted for by impulsivity. The model is depicted in Figure 1 showing significant paths.

Given the evidence cited by Luminet et al. (2021) noted earlier, although not a planned analysis the multiple mediation analysis was run again with the TAS-20 subscales as predictors instead of the total score. The results indicated that the relationships of DIF and EOT with excessive internet use were fully mediated by impulsivity, whereas there was neither a direct nor indirect effect of DDF. A second exploratory mediation analysis indicated that the BIS-11 subscales of attentional and motor impulsiveness, but not planning impulsiveness, showed mediation of the relationship between total TAS-20 and excessive internet use.

Discussion

Indices of alexithymia, impulsivity, and negative affect were significantly positively correlated with excessive internet use, as indexed by IAT scores, as well as with each other. Alexithymia, impulsivity, and negative affect have all been implicated as risk factors for excessive or problematic substance use (Cruise & Becerra, 2018; Littlefield & Sher, 2010; Lyvers, Hinton et al., 2014; Thorberg et al., 2009) as well as IA (De Berardis et al., 2009; Kandri et al., 2014; Lyvers et al., 2016; Mahapatra & Sharma, 2018) in previous work. However, in the present study the contribution of alexithymia to variance in IA symptoms became nonsignificant after adding impulsivity to the regression model, suggesting that the contribution of alexithymia reflected high impulsiveness associated with alexithymia. Multiple mediation modelling further indicated that the relationship between alexithymia and

internet addiction symptoms was fully mediated by both impulsivity and negative affect. As noted earlier, previous work has been somewhat mixed regarding the degree of independence of alexithymia from other risk factors such as impulsivity or depression in relation to excessive substance use, although much evidence does appear to support alexithymia as an independent risk factor for problematic drinking (Cruise & Becerra, 2018). Present findings however suggest that both impulsivity and negative affect may account for the relationship of alexithymia to excessive internet use as indexed by the IAT, presumably reflecting an alexithymic preference for impulsive action over introspection in response to the negative affect often associated with alexithymia and related difficulties with emotional self-regulation.

High impulsivity is considered a behavioral manifestation of deficient executive self-regulation processes mediated by prefrontal cortex (Lyvers, 2000; Lyvers et al., 2012; Qiu et al., 2013; Turel et al., 2014). Alexithymia is also linked to impaired self-regulation, as evidenced by positive relationships of alexithymia indices such as TAS-20 with neuropsychological indices of executive function deficits associated with frontal lobe injury (Lyvers, Makin et al., 2014; Vermeulen et al., 2018), as well as brain imaging research showing deficient frontal activation in alexithymia (Chester et al., 2015). Both impulsivity and alexithymia appear to reflect dysfunctionality of brain systems mediating executive control, including self-regulation of negative affect, hence their importance as potential markers of risk for excessive behaviors. However, as emphasized earlier, impulsivity and alexithymia are defined very differently and may contribute to excessive behaviors in different ways. For example, in excessive or problematic drinking, deficient impulse control may drive ongoing alcohol use despite adverse consequences (Dawe & Loxton, 2004), whereas the role of alexithymia has been attributed to a deficiency of interoception (Brewer et al., 2016) that impedes recognition of internal cues of overconsumption. Independent

contributions of both traits to excessive drinking thus seem plausible, as they may promote the disordered behavior in different ways. By contrast, interoceptive cues of overconsumption are not relevant to self-regulation of internet use. This difference might explain why, in regression models, impulsivity and alexithymia are often found to be independent predictors of excessive drinking (Cruise & Becerra, 2018), whereas only impulsivity showed such a role in one form of excessive internet use, social media addiction, in a recent study (Lyvers, Narayanan et al., 2018).

Although the present study was undertaken in a non-clinical sample of young women at university, the key finding that both impulsivity and negative affect mediated the relationship of alexithymia with symptoms of internet addiction may have potential implications for clinical practice. If negative affect and impulsivity are underlying mechanisms of how alexithymia is related to internet addiction (and perhaps some other excessive behaviors), then targeting negative affect and impulsivity would be essential. One approach might be to utilize cognitive behavioral therapy to address dysfunctional thought patterns that induce or maintain negative mood states. By identifying dichotomous thinking patterns and applying cognitive restructuring to address and replace such cognitions, a client may over time be able to upregulate depressive moods and downregulate stress and anxiety, reducing dependence on the maladaptive coping strategy of engaging in an excessive behavior such as IA. Training in relaxation exercises as well as promoting distress tolerance may help alexithymic clients learn to "sit with" as well as cope with negative feelings and moods, instead of trying to escape distress via compulsive behavior. The tendency to impulsive action may be addressed by learning to do the opposite of what impulsiveness is and focus on "slowing down" to be more open to experiences and get in touch with emotional feelings and somatic sensations. This in turn may assist in gaining access to emotions and

being able to better describe, identify, and self-regulate feelings, reducing the reliance on excessive internet use or other excessive behavior for affect regulation.

The present study had several limitations. Although potential influences of age and education were controlled as covariates in the regression model, the sample consisted of female university students given evidence of potentially stronger influences of trait and mood factors on IA symptoms among females at university (Yen et al., 2009); thus the findings cannot be generalized to the wider population of young adults including nonstudents and males. Further, although the IAT assesses symptoms of excessive internet use on a continuum, results in a nonclinical sample may not apply to clinical cases of IA. On the other hand, 19% of the present sample had IAT scores indicative of moderate to severe IA according to suggested cut-off scores (Young, 1998, 2017). This seems high based on overall population estimates (Durkee et al., 2012), however for youth and university students, estimates of IA prevalence have ranged as high as 26% (Moreno et al., 2011). Finally, the present findings were cross-sectional and therefore cannot be taken to reflect causal relationships among variables. Although longitudinal research has indicated that alexithymia and impulsivity are relatively stable traits that begin to manifest early in life and predict onset of, and/or relapse to, problematic alcohol use (Littlefield & Sher, 2010; Lyvers, Jones et al., 2018; Thorberg et al., 2009, 2016), such longitudinal relationships have not been established for problematic internet use. The role of negative affect is even less clear, as it could promote excessive internet use or represent an outcome of problems related to such use. A longitudinal approach is thus recommended for future research on these issues.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.).* Arlington, VA: American Psychiatric Publishing.

Antony, M. M., Bieling, P. J., Cox, B. J., Enns, M. W., & Swinson, R. P. (1998). Psychometric properties of the 42-item and 21-item versions of the Depression Anxiety Stress Scales in clinical groups and a community sample. *Psychological Assessment, 10*, 176-181. doi:10.1037/1040-3590.10.2.176

Bagby, R. M., Parker, J. D. A., & Taylor, G. J. (1994). The twenty-item Toronto Alexithymia Scale I: Item selection and cross-validation of the factor structure. *Journal of Psychosomatic Research, 38,* 23-32. doi:10.1016/0022-3999(94)90005-1

Bagby, R., Taylor, G. J., & Parker, J. D. (1994). The twenty-item Toronto Alexithymia scale—II. Convergent, discriminant, and concurrent validity. *Journal of Psychosomatic Research, 38,* 33-40. doi:10.1016/0022-3999(94)90006-x

Bagby, R. M., Taylor, G. J., Parker, J. D., & Dickens, S. E. (2006). The development of the Toronto Structured Interview for Alexithymia: Item selection, factor structure, reliability and concurrent validity. *Psychotherapy and Psychosomatics*, *75*, 25-39. doi:10.1159/000089224

Bagby, R.M., Taylor, G.J., Quilty, L.C., & Parker, J.D.A. (2007). Reexamining the factor structure of the 20-item Toronto Alexithymia Scale: Commentary on Gignac, Palmer, and Stough. *Journal of Personality Assessment*, *89*, 258–264. doi: 10.1080/00223890701629771

Borg, K., & Smith, L. (2018). Digital inclusion and online behaviour: Five typologies of Australian internet users. *Behavior & Information Technology*, *37*, 367-380. doi: 10.1080/0144929x.2018.1436593

Brewer, R., Cook, R., & Bird, G. (2016). Alexithymia: A general deficit of interoception.

Royal Society Open Science, 3. doi:10.1098/rsos.150664

Brown, T. A., Chorpita, B. F., Korotitsch, W., & Barlow, D. H. (1997). Psychometric properties of the Depression Anxiety Stress Scales (DASS) in clinical samples. *Behavior Research and Therapy, 35,* 79-89. doi:10.1016/S0005-7967(96)00068-X

Cao, F., Su, L., Liu, T., & Gao, X. (2007). The relationship between impulsivity and internet addiction in a sample of Chinese adolescents. *European Psychiatry, 22,* 466-471. doi: 10.1016/j.eurpsy.2007.05.004

Chakraborty, K., Basu, D., & Kumar, K. G. V. (2010). Internet addiction: Consensus, controversies, and the way ahead. *East Asian Archives of Psychiatry, 20,* 123–132. Available: www.easap.asia/index.php/component/k2/item/113-1003-v20n3-p123

Chang, M.K., & Law, S.P.M. (2008). Factor structure for Young's Internet Addiction Test: A confirmatory study. *Computers in Human Behavior, 24,* 2597-2619. doi: 10.1016/j.chb.2008.03.001

Cheng, C., & Li, A. Y. (2014). Internet addiction prevalence and quality of (real) life: A meta-analysis of 31 nations across seven world regions. *Cyberpsychology, Behavior, & Social Networking, 17,* 755-760. doi: 10.1089/cyber.2014.0317

Chester, D. S., Pond, R. S., Jr., & DeWall, N. C. (2015). Alexithymia is associated with blunted anterior cingulate response to social rejection: Implications for daily rejection. *Social Cognitive & Affective Neuroscience, 10,* 517-522. doi:10.1093/scan/nsu082

Chin, F., & Leung, C.H. (2018). The concurrent validity of the Internet Addiction Test (IAT) and the Mobile Phone Dependence Questionnaire (MPDQ). *PLoS One, 13,* e0197562. doi: 10.1371/journal.pone.0197562

Cruise, K., & Becerra, R. (2018). Alexithymia and problematic alcohol use: A critical update. *Addictive Behaviors, 77,* 232-246. doi: 10.1016/j.addbeh.2017.09.025

Dalbudak, E., Evren, C., Aldemir, S., Coskun, K.S., et al. (2013). Relationship of internet addiction severity with depression, anxiety, and alexithymia, temperament and character in university students. *CyberPsychology, Behavior & Social Networking, 16*, 272-278. doi: 10.1089/cyber.2012.0390

Dawe, S., & Loxton, N. J. (2004). The role of impulsivity in the development of substance use and eating disorders. *Neuroscience & Biobehavioral Reviews, 28,* 343–351. doi: 10.1016/j.neubiorev.2004.03.007

De Berardis, D., D'Albenzio, A., Gambi, F., Sepede, G., et al. (2009). Alexithymia and its relationships with dissociative experiences and Internet addiction in a nonclinical sample. *CyberPsychology & Behavior, 12,* 67-69. doi: 10.1089/cpb.2008.0108

Dufour, M., Brunelle, N., Tremblay, J., LeClerc, D., et al. (2016). Gender difference in internet use and internet problems among Quebec high school students. *Canadian Journal of Psychiatry, 61*, 663–668. doi: 10.1177/0706743716640755

Durkee, T., Kaess, M., Carli, V., Parzer, P., et al. (2012). Prevalence of pathological internet use among adolescents in Europe: Demographic and social factors. *Addiction*, *107*, 2210-2222. doi:10.1111/j.1360-0443.2012.03946.x

Gignac, G.E., Palmer, B.R., & Stough, C. (2007). A confirmatory factor analytic investigation of the TAS–20: Corroboration of a five-factor model and suggestions for improvement. *Journal of Personality Assessment, 89*, 247-257. doi: 10.1080/00223890701629730

Kandri, T. A., Bonotis, K. S., Floros, G. D., & Zafiropoulou, M. M. (2014). Alexithymia components in excessive internet users: A multi-factorial analysis. *Psychiatry Research, 220,* 348–355. doi:10.1016/j.psychres.2014.07.066.

Lee, H.W., Choi, J.S., Shin, Y.C., Lee, J.Y., et al. (2012). Impulsivity in

internet addiction: A comparison with pathological gambling. *Cyberpsychology, Behavior, & Social Networking, 15,* 373-337. doi:10.1089/cyber.2012.0063

Littlefield, A. K., & Sher, K. J. (2010). The multiple, distinct ways that personality contributes to alcohol use disorders. *Social & Personality Psychology Compass, 4,* 767–782. doi:10.1111/j.1751-9004.2010.00296.x

Lovibond, S. H., & Lovibond, P. F. (1995). *Manual for the Depression Anxiety Stress Scales.* Sydney (Australia): Psychology Foundation.

Luengo, M. A., Carrillo-de-la-Pena, M. T., & Otero, J. M. (1991). The components of impulsiveness: A comparison of the I.7 Impulsiveness Questionnaire and the Barratt Impulsiveness Scale. *Personality and Individual Differences, 12,* 657-667. doi: 10.1016/0191-8869(91)90220-6

Luminet, O., Bagby, R. M., & Taylor, G. J. (2018). *Alexithymia: Advances in research, theory, and clinical practice.* Cambridge: University Press.

Luminet, O., Nielson, K.A., & Ridout, N. (2021). Cognitive-emotional processing in alexithymia: An integrative review. *Cognition and Emotion, 35,* 449-487. doi: 10.1080/02699931.2021.1908231

Lumley, M. A., & Roby, K. J. (1995). Alexithymia and pathological gambling. *Psychotherapy & Psychosomatics, 63,* 201-206. doi: 10.1159/000288960

Lyvers, M. (2000). "Loss of control" in alcoholism and drug addiction: A neuroscientific interpretation. *Experimental & Clinical Psychopharmacology, 8,* 225-249. doi: 10.1037//1064-1297.8.2.225

Lyvers, M., Basch, V., Duff, H., & Edwards, M.S. (2015). Self-reported impulsivity predicts D-KEFS Tower Test performance in university students. *Applied Neuropsychology: Adult, 22,* 88-93. doi: 10.1080/23279095.2013.850693

Lyvers, M., Duff, H., Basch, V., & Edwards, M. (2012). Influences of rash impulsiveness and

reward sensitivity on risky drinking in university students: Evidence of mediation by frontal systems. *Addictive Behaviors, 37,* 940-946. doi: 10.1016/j.addbeh.2012.03.028

Lyvers, M., Hinton, R., Gotsis, S., Roddy, M., et al. (2014). Traits linked to executive and reward systems functioning in clients undergoing residential treatment for substance dependence. *Personality & Individual Differences, 70,* 194-199. doi: 10.1016/j.paid.2014.07.004

Lyvers, M., Jones, V., Edwards, M.S., Wood, K., et al. (2018). Personality and neurocognitive traits associated with treatment retention in a therapeutic community for substance dependence. *Therapeutic Communities, 39,* 137-147. doi: 10.1108/TC-10-2016-0020

Lyvers, M., Makin, C., Toms, E., Thorberg, F.A., et al. (2014). Trait mindfulness in relation to alexithymia, emotion regulation, mood and everyday executive functioning. *Mindfulness, 5,* 619-625. doi: 10.1007/s12671-013-0213-y

Lyvers, M., Narayanan, S.S., & Thorberg, F.T. (2018). Disordered social media use and risky drinking in young adults: Differential associations with addiction-linked traits. *Australian Journal of Psychology, 71,* 223-231. doi: 10.1111/ajpy.12236

MacKillop, J., Amlung, M. T., Few, L. R., Ray, L. A., et al. (2011). Delayed reward discounting and addictive behavior: A metanalysis. *Psychopharmacology, 216,* 305-321. doi:10.1007/s00213-011-2229-0

Mahapatra, A., & Sharma, P. (2018). Association of internet addiction and alexithymia: A scoping review. *Addictive Behaviors, 81,* 175-182. doi: 10.1016/j.addbeh.2018.02.004

Marchetti, D., Verrocchio, M., & Porcelli, P. (2019). Gambling problems and alexithymia: A systematic review. *Brain Sciences, 9,* 191. https://doi.org/10.3390/brainsci9080191

Marsero, S., Ruggiero, G., Scarone, S., Bertelli, S., & Sassaroli, S. (2011). The relationship between alexithymia and maladaptive perfectionism in eating disorders: A mediation moderation analysis methodology. *Eating and Weight Disorders*, *16*, 182-187. https://doi.org/10.1007/bf03325130

Meganck, R., Vanheule, S., & Desmet, M. (2008). Factorial validity and measurement invariance of the 20-item Toronto Alexithymia Scale in clinical and nonclinical samples. *Assessment, 15*, 36-47. doi: 10.1177/1073191107306140

Moreno, M.A., Jelenchick, L., Cox, E., Young, H., et al. (2011). Problematic internet use among US youth: A systematic review. *Archives of Pediatric and Adolescent Medicine, 165*, 797-805. doi:10.1001/archpediatrics.2011.58

Mottram, A. J., & Fleming, M. J. (2009). Extraversion, impulsivity, and online group membership as predictors of problematic internet use. *Cyberpsychology & Behavior, 12*, 319-321. doi:10.1089/cpb.2007.0170

Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt Impulsiveness Scale. *Journal of Clinical Psychology, 51,* 768-764. doi:10.1002/1097-4679(199511)51:6<768::aid-jclp2270510607>3.0.co;2-1

Preece, D., Becerra, R., Allan, A., Robinson, K., & Dandy, J. (2017). Establishing the theoretical components of alexithymia via factor analysis: Introduction and validation of the attention-appraisal model of alexithymia. *Personality and Individual Differences, 119,* 341-352. doi: 10.1016/j.paid.2017.08.003

Qiu, Y., Jiang, G., Su, H., Lv, X., et al. (2013). The impulsivity behavior is correlated with prefrontal cortex gray matter volume reduction in heroin-dependent individuals. *Neuroscience Letters, 538,* 43-48. doi: 10.1016/j.neulet.2013.01.019

Rickwood, D., Telford, N., O'Sullivan, S., Crisp, D., et al. (2016). *Headspace:*

National tertiary student wellbeing survey 2016. Retrieved from https://headspace.org.au/assets/Uploads/headspace-NUS-Publication-Digital.pdf

Rose, P., & Segrist, D. (2012). Difficulty identifying feelings, distress tolerance and compulsive buying: Analyzing the associations to inform therapeutic strategies. *International Journal of Mental Health and Addiction*, *10*, 927-935. https://doi.org/10.1007/s11469-012-9389-y

Sekely, A., Bagby, R. M., & Porcelli, P. (2018). Assessment of the alexithymia construct. In O. Luminet, R. M. Bagby & G. J. Taylor (Eds.), *Alexithymia: Advances in research, theory, and clinical practice* (pp. 17-32). Cambridge, UK: Cambridge University Press. doi: 10.1017/9781108241595.004

Shishido, H., Gaher, R. M., & Simons, J. S. (2013). I don't know how I feel; therefore, I act: Alexithymia, urgency, and alcohol problems. *Addictive Behaviors*, *38,* 2014-2017. doi:10.1016/j.addbeh.2012.12.014

Starcevic, V., & Aboujaoude, E. (2017). Internet addiction: Reappraisal of an increasingly inadequate concept. *CNS Spectrums, 22,* 7-13. doi:10.1017/S1092852915000863

Spinella, M. (2004). Neurobehavioral correlates of impulsivity: Evidence of prefrontal involvement. *International Journal of Neuroscience, 114,* 95-104. doi: 10.1080/00207450490249347

Spinella, M. (2007). Normative data and a short form of the Barratt Impulsiveness Scale. *International Journal of Neuroscience, 117,* 359-368. doi: 10.1080/00207450600588881

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2,* 53–55. doi: 10.5116/ijme.4dfb.8dfd

Thorberg, F. A., Young, R. M., Sullivan, K. A., & Lyvers, M. (2009). Alexithymia and alcohol use disorders: A critical review. *Addictive Behaviors, 34,* 237-245. doi:

10.1016/j.addbeh.2008.10.016

Thorberg, F. A., Young, R. McD., Sullivan, K. A., Lyvers, M., Connor, J. P., & Feeney, GFX. (2010). A psychometric comparison of the Toronto Alexithymia Scale (TAS-20) and the Observer Alexithymia Scale (OAS) in an alcohol dependent sample. *Personality & Individual Differences, 49,* 119-123. doi: 10.1016/j.paid.2010.03.018

Thorberg, F. A., Young, R., Sullivan, K. A., Lyvers, M., et al. (2016). A prospective mediational study on the stability of alexithymia among alcohol-dependent outpatients in Cognitive-Behavioral Therapy. *Psychology of Addictive Behaviors, 30,* 64– 72. doi: 10.1037/adb0000135

Toneatto, T., Lecce, J., & Bagby, M. (2009). Alexithymia and pathological gambling. *Journal of Addictive Diseases, 28,* 193-198. https://doi.org/10.1080/10550880903014775

Turel, O., He, Q., Xue, G., Xiao, L., et al. (2014). Examination of neural systems sub-serving Facebook "addiction." *Psychological Reports, 115,* 675–695. doi: 10.2466/18.PR0.115c31z8

Van den Eijnden, R. J., Lemmens, J. S., & Valkenburg, P. M. (2016). Social Media Disorder Scale: Validity and psychometric properties. *Computers in Human Behavior, 61,* 478-487. doi:10.1037/t53980-000

Vermeulen, N., Domachowska, I., & Nielson, K. (2018). Memory and executive functions in alexithymia. In O. Luminet, R. Bagby, & G. Taylor (Eds.), *Alexithymia: Advances in research, theory, and clinical practice* (pp. 78-89). Cambridge: Cambridge University Press. doi:10.1017/9781108241595.007

Wang, B., Yao, N., Zhou, X., Liu, J., et al. (2017). The association between attention deficit/hyperactivity disorder and internet addiction: A systematic review and meta-analysis. *BMC Psychiatry, 17*. doi: 10.1186/s12888-017-1408-x

Whang, L. S., Lee, S., & Chang, G. (2003). Internet over- users' psychological profiles: A

behavior sampling analysis on internet addiction. *Cyberpsychology & Behavior*, *6*, 143-150. doi:10.1089/109493103321640338

Yen, J.Y., Yen, C.F., Chen, C.S., Tang, T.C., et al. (2009). The association between adult ADHD symptoms and internet addiction among college students: The gender difference. *CyberPsychology & Behavior*, *12*, 187-191. doi: 10.1089/cpb.2008.0113

Young, K. S. (1998). Internet addiction: The emergence of a new clinical disorder. *Cyberpsychology & Behavior*, *1*, 237-244. doi:10.1089/cpb.1998.1.237

Young, K.S. (2017). *IAT manual.* Bradford, PA: Center for Internet Addiction Recovery. Available: netaddiction.com/wp-content/uploads/2015/11/IAT-Manual.doc

Zech, E., Luminet, B. Rime, & H. Wagner (1999). Alexithymia and its measurement: Confirmatory factor analyses of the 20-item Toronto Alexithymia Scale and the Bermond–Vorst Alexithymia Questionnaire. *European Journal of Personality*, *13*, 511–532. doi: 10.1002/(SICI)1099-0984(199911/12)13:6<51

Table 1

Means, Standard Deviations and Intercorrelations of Study Variables (N = 116)

Variable	*M (SD)*	1	2	3	4	5	6
1. IAT score	37.05 (12.39)	-					
2. Alexithymia	47.59 (11.71)	.34***	-				
3. Impulsivity	60.62 (10.03)	.47***	.47***	-			
4. Negative Mood	30.34 (22.40)	.47***	.56***	.46***	-		
5. Age (years)	21.39 (3.52)	-.30**	-.17	-.04	-.09	-	
6. Education level	2.49 (.61)	-.22*	-.08	-.09	-.06	.61***	-

*$p < .05$. **$p < .01$. ***$p < .001$. IAT = Internet Addiction Test.

Table 2

Hierarchical Multiple Regression on Internet Addiction Test Scores (N = 116)

Predictor	ΔR^2	β	*B*	*SE B*	95% CI for *B*
Step 1	.09**				
Age		-.26*	-.92	.40	[-1.70, -.13]
Education		-.06	-1.20	2.28	[-5.73, 3.33]
Step 2	.09***				
Age		-.20	-.72	.38	[-1.47, .04]
Education		-.07	-1.43	2.18	[-5.74, 2.89]
Alexithymia		.31***	.32	.09	[.14, .51]
Step 3	.13***				
Age		-.25*	-.87	.36	[-1.57, .-.16]
Education		-.02	-.48	2.02	[-4.49, 3.53]
Alexithymia		.11	.12	.10	[-.07, .31]
Impulsivity		.41***	.50	.11	[.28, .72]
Step 4	.06**				
Age		-.25*	-.86	.34	[-1.54, -.19]
Education		-.02	-.49	1.94	[-4.34, 3.36]
Alexithymia		-.02	-.02	.10	[-.23, .18]
Impulsivity		.33***	.40	.11	[.18, .62]
Negative Mood		.31**	1.87	.58	[.73, 3.01]

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

Table 3

Mediation of the Relationship of TAS-20 Alexithymia Scores with IAT Internet Addiction Scores by both BIS-11 Impulsivity Scores and DASS-21 Negative Affect, Controlling for Age and Education.

Direct effects

							95% Confidence Interval	
			Estimate	Std. Error	z-value	p	Lower	Upper
overall_TAS	→	overall_IAT	-0.005	0.095	-0.055	0.956	-0.192	0.184

Note. Delta method standard errors, bias-corrected percentile bootstrap confidence intervals, ML estimator.

Indirect effects

							95% Confidence Interval	
			Estimate	Std. Error	z-value	p	Lower	Upper
overall_TAS → overall_BIS	→	overall_IAT	0.162	0.051	3.188	0.001	0.076	0.258
overall_TAS → overall_DASS_Total	→	overall_IAT	0.149	0.056	2.661	0.008	0.035	0.269

Note. Delta method standard errors, bias-corrected percentile bootstrap confidence intervals, ML estimator.

Total effects

							95% Confidence Interval	
			Estimate	Std. Error	z-value	p	Lower	Upper
overall_TAS	→	overall_IAT	0.305	0.085	3.581	< .001	0.130	0.466

Note. Delta method standard errors, bias-corrected percentile bootstrap confidence intervals, ML estimator.

Total indirect effects

							95% Confidence Interval	
			Estimate	Std. Error	z-value	p	Lower	Upper
overall_TAS	→	overall_IAT	0.311	0.069	4.469	< .001	0.174	0.481

Note. Delta method standard errors, bias-corrected percentile bootstrap confidence intervals, ML estimator.

Figure 1. Mediation model showing significant paths after controlling for age and education. The direct effect without mediators is shown in parentheses.

***$p < .001$