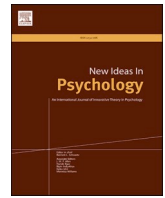




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Examining the impact of reinforcement sensitivity theory on compulsive internet use through difficulty in emotion regulation

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ABSTRACT

Reinforcement Sensitivity Theory, encompassing Behavioural Inhibition and Activation Systems (BIS/BAS), may help us understand the modern-day phenomenon of compulsive Internet use. BAS, a neurologically appetitive system is sensitive to positive cues (e.g., rewards), and traditionally linked with addictive behaviours, whereas BIS is sensitive to negative cues (e.g., punishment), and inhibits behaviour. Analysing data on a sample of 209 young people attending university, BIS is found to be related to compulsive Internet use, not BAS. Furthermore, BIS is revealed to have a significant indirect effect on compulsive Internet use through difficulties in emotion regulation. The findings can be employed by practitioners, who work with compulsive Internet users, to try to weaken the patients' inhibitory behaviours that may improve their emotion regulation skills, which in turn could help individuals reduce their need to be online. Longitudinal research is required to provide more reliable results and confirm the directionality of the effects.

1. Introduction

The use of the Internet is a dominant feature of contemporary society. However, where using the Internet becomes a compulsive action that interferes with a user's daily life, it may become regarded as an addiction (Bener et al. 2019). The phenomenon of Internet misuse has been referred to by various names, including compulsive Internet use, Problematic Internet use, computer addiction, Internet mania, and Internet addiction (Davis, 2001; Ko et al., 2012; Laconi et al., 2018; Meerkerk et al., 2009; O'Reilly & Mohan, 2023; Pan et al., 2020; Young & Rogers, 1998). We note that while Internet dependency has not yet been recognised as a mental disorder due to a lack of consensus over its clinical validity, the potential negative effects of excessive Internet use on an individual's functioning has attracted the concern of the World Health Organization (World Health Organization, 2015) and the European Parliament (European Parliament, 2019, 2023).

Compulsive Internet use among young people merits immediate attention for variety of reasons. First, young people may be especially vulnerable to compulsive Internet use as the Internet can provide a forum for which they exercise greater autonomy (Borca), and develop their identity (Beard, 2011). Activities and interactions on the Internet can offer short-term rewards and, excessive Internet usage can be

reinforced by a need for immediate gratification (Al-Samarraie et al., 2022). This is particularly acute where the use of the Internet stimulates reward regions in the brain that generate dopamine (which are also activated by non-behavioural addictions such as opioids (Yuan et al., 2011).

Second, compulsive Internet use and Internet addiction have been associated with a range of harmful effects on young people, including physical and mental health issues, and poorer academic performance (Arzani-Birgani et al., 2021; Javaeed et al., 2020; Jiang, 2014). The reasons for this may include the potential detrimental effects that compulsive Internet use has on an individual's quality of life (Noroozi), their emotional stability (Dalton & Cassidy, 2020), and interpersonal relationships (Hao). Likewise, research suggests that compulsive Internet use may increase preoccupation with details and nervousness (Kayiç; Ko et al., 2012), a suggestion supported by an association reported between obsessive-compulsive symptoms and the levels of compulsive Internet use (Zamboni et al., 2020).

A final reason which underscores the need to robustly study compulsive Internet use among people is the continuing growth and universal integration of the digital world and Internet in all aspects of young people's lives. For instance, 100 % of young people between the ages of 16 and 24 years old reported they used the Internet daily in Great

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Britain (Office for National Statistics, 2018). In parallel with this, the rate of *dependency* on the Internet has increased, where young people have been found to be the most vulnerable group in this regard (Global Connectivity Report, 2022), and it is feared that more and more youth are at risk of developing negative psychological consequences arising from Internet overuse. The demand for prevention and treatment of Internet addiction is also mounting (Rowicka). As such, there is a need to understand whether people with particular types of personality are more vulnerable to compulsive Internet use than others. This is of particular importance given that there is a scarcity of research that explores motivators associated with compulsive Internet use. Little is known if, and how, both positive (activation) and negative (inhibition) motivations could influence an individual's propensity to engage excessively with the Internet. To respond to this knowledge gap, this study aims to investigate whether concepts from Reinforcement Sensitivity Theory, namely Behavioural Inhibition and Activation Systems have impacts on compulsive Internet use, through emotion dysregulation. An objective of this work was to examine these phenomena in a non-clinical setting, since the National Institute of Mental Health's research domain criteria recommends that psychological constructs are studied among community populations as supplementary for clinical research (Insel et al., 2010; Cuthbert, 2022).

1.1. Reinforcement sensitivity theory and compulsive internet use

According to Gray's Reinforcement Sensitivity Theory (RST) people differ in their degree of sensitivity to reward and punishment which effect motivation, and such neurobiological-based variations determine personality. Two primary motivational systems, which underlie a person's behavioural activity, are believed to influence personality: the Behavioural Inhibition System (BIS) and the Behavioural Activation Systems (BAS) (Corr). BIS is related to aversive motives i.e., the motivation to avoid unpleasant stimuli such as behaviours that lead to punishment or the loss of a reward. BIS has been associated with anxiety and avoidance-related behaviours (Olino et al., 2018), and internalizing problems (Oguchi & Takahashi, 2019). On the other hand, BAS, is related to appetitive behavioural motives, where the motive is to strive towards desired stimuli e.g., pursuing a reward. BAS is theorised as being made up of three subsystems of responses: fun-seeking, drive, and reward (Carver & White, 1994). BAS has been associated with approaching behaviours and with externalising problems (Taubitzet al.). High BAS reactivity has been linked to orientation towards reward, impulsivity, and positive effect (Merchán-clavellino et al.), which may encourage addictive behaviours.

A growing body of literature has examined the link between RST and compulsive Internet use, finding inconsistent results on the association between BIS, BAS, and excessive Internet use. Several researchers find that BIS and BAS were related to compulsive Internet use (Li et al., 2019; Nam et al., 2018). A positive association between BIS and Internet use was uncovered by Zhang et al., (2022), while different patterns of associations between compulsive Internet use and the three BAS-subcales have been found (Gao et al., 2022); where the *Fun-Seeking* (BAS-F) component was positively correlated to Compulsive Internet Use, whereas no associations were found for the *Reward* (BAS-R) and the *Drive* (BAS-D) components of the BAS. In addition to apparent inconsistencies in the BIS/BAS-compulsive Internet use association across studies, little is known about *how* they may relate to each other. The research of the present paper aims to fill this gap by analysing a mediator that may potentially link the effects of BIS and BAS on compulsive Internet use. One possible mechanism may be Difficulty in Emotion Regulation (DER), given that DER is suggested to mediate the relationship between personality and psychopathology (Cassello). More specifically, it has been suggested that DER may mediate the effects of BIS/BAS on psychopathology (Bijttebier et al., 2009). To the best of the author's knowledge, the extant literature on this topic has not examined whether DER provides a specific mechanism underlying the BIS/BAS

contribution to compulsive use of Internet.

1.2. Difficulty in emotion regulation (DER)

Emotion regulation concerns the capacity of a person to modulate their emotional experiences, their degree of understanding and acceptance of emotions, and whether the person can behave in accordance with desired goals despite their emotional state (Gratz & Roemer, 2004). An individual's difficulty in processing emotions can lead to what is known as Difficulty in Emotion Regulation (DER). The theoretical foundation of the DER is based on "third wave" cognitive behavioural therapy models, which emphasize the pivotal role of experiential avoidance in the development and persistence of various emotional disorders. Experiential avoidance refers to an inability to tolerate (typically negative) emotional experiences, as well as maladaptive attempts to escape such experiences (Niles et al., 2014). In this model, emotion regulation is considered effective when an individual can act in ways that support achieving predetermined goals, even though they may be experiencing negative emotions or intense emotional states.

Recent evidence has suggested that variations in BIS/BAS can impact an individual's ability to regulate their emotions (Khosravani et al., 2019), where a positive link between DER and BIS sensitivity has been uncovered (Izadpanah et al., 2016), while different subscales of BAS sensitivity have been linked the DER in different ways. Specifically, BAS-Fun Seeking (BAS-F) has been positively related to DER, while BAS-Reward (BAS-R) has been negatively associated with DER, and no association between BAS-Drive (BAS-D) and DER has been documented (Wu et al., 2021).

Several recent studies have also suggested that DER itself may also contribute to Internet addiction (Lin et al., 2023). In addition to substance-use addictions, DER has been purported to be linked with non-substance related addictive behaviours such as video gaming and gambling addictions, as well as problematic Internet use (Amendola et al., 2019). People with emotional dysregulation problems may have difficulty in developing and managing meaningful relationships with others. They may use Internet-based activities as a means to cope with negative emotions such as loneliness and depression (Gioia et al., 2021). The Internet can offer alternative opportunities for people to create positive emotions e.g., excitement, pleasure, and satisfaction. As such, heavier engagement in a virtual world may be representative of attempts to avoid the reality of everyday life, as well as an effort to cope with negative emotions and produce positive emotions (Quaglieri et al., 2021). The association between emotion dysregulation and excessive Internet use has also been supported by emerging longitudinal research, which has indicated that a lower level of maladaptive emotion regulation strategies in the baseline time period predicted spontaneous remission of Internet addiction among youth in the follow up time period (Wartberg & Lindenbergh, 2020).

1.3. Present study

In light of the findings of the current body of research on this important topic, and remaining gaps in understanding, the aim of the present work is to empirically test the application of RST on compulsive Internet use, to provide insights on such associations, and how they interact with each other. Informed by the documented literature, we hypothesise that greater levels of BIS sensitivity is associated with compulsive Internet use, and there are indirect effects of BIS on compulsive Internet use through DER. We also hypothesise that higher levels of BAS sensitivity are positively associated with compulsive Internet use across all three BAS subscales (BAS-R, BAS-F, and BAS-D), and there are indirect effects of BAS on compulsive Internet use through DER. These hypotheses are empirically scrutinised using data on over 200 study participants from a community setting, to provide a first exploration of these phenomena, upon which it is intended that other scholars can build and improve upon in future studies in clinical

and non-clinical settings.

2. Methods

2.1. Participants and procedure

To explore the research aims and hypotheses posited, a non-clinical, community-based sample of student participants were recruited for this research, employing a non-probability sampling method. A primary survey was conducted to inform this research, where an online questionnaire was administered via a survey link in an email to undergraduate students registered as attending courses under the Faculty of Science and Health at Dublin City University (DCU), Ireland. The link brought volunteers to a website that contained a participant information sheet (PIS), which outlined eligibility criteria and information relating to the purpose of study. The information outlined a brief overview of the aim of the study, the researchers involved, the data collection process and that approximately 20 min was required for completion of the survey. The participants were presented with a consent form, which stated that by clicking “Yes” they accepted the terms and conditions of the survey, and that they could proceed to fill in the survey. The survey was open for respondents over a two-month period in February to March 2021. Ethics approval for the study was granted by DCU Research Ethics Committee (DCUREC/2020/280). Two hundred and eleven students provided responses to the survey, though two outliers were dropped, leaving a sample of 209 for the inquiry of this research (156 female). The age of the participants ranged from 18 to 25 years old ($mean = 20.4$ years, $SD = 1.8$ years). The majority of participants ($n = 207$) reported they were single/never married. The data is cross sectional collected at a single point in time, and thus the research of this paper can only demonstrate associations among variables. As such, the researchers do not propose that the work can offer evidence of causal relationships, though the findings of this preliminary exploration could provide a basis for further investigation of such connections.

2.2. Measures

2.2.1. Compulsive internet use

Compulsive Internet use was measured using a compulsive Internet use scale (CIUS) (Meerkerket al.). The CIUS comprises of 14-items concerned with the frequency of one’s use of the Internet for private purposes, for example, ‘How often do you find it difficult to stop using the Internet when you are online?’. Responses are rated on a 5-point Likert scale, ranging from ‘never’ (0), to ‘very often’ (4). The Cronbach’s alpha, measuring the reliability of this scale for the analytical sample data was 0.86, indicating good internal consistency.

2.2.2. BIS/BAS scale

The behavioural inhibition and activation systems were measured using the BIS/BAS scale (Carver & White, 1994). The BIS/BAS scale consists of twenty items, where responses to the items are given on a four-point Likert scale, from ‘strong agreement’ (1), to ‘strong disagreement’ (4), with no neutral response option. The BIS scale is unidimensional and made up of seven items, which measure differences across individuals in relation to how they respond to bad occurrences or punishment cues; for example: ‘I feel worried when I think I have done poorly at something’. By contrast, the BAS scale is divided into three subscales: and the BAS-Fun-Seeking scale, the BAS-Drive scale, and the BAS-Reward Responsiveness scale. The Fun-Seeking scale is made up of four items concerned with the desire for rewarding events, as well as willingness to do such on the spur of the moment; the Drive scale comprises of four items concerned with the pursuit of desired goals; and the Reward Responsiveness scale contains five items which have positive responses to the anticipation or realisation of a reward. Cronbach’s alpha coefficients for the current sample were as follows: 0.80 for BIS, 0.77 for BAS-F, 0.85 for BAS-D, and 0.70 for BAS-R.

2.2.3. Difficulty in emotion regulation

To measure emotion regulation problems, the short form Difficulty in Emotion Regulation Scale (DERS-SF) (Kaufman et al., 2016) was employed. The scale encompasses eighteen items, for example, ‘When I am upset, I (i) become embarrassed; (ii) feel guilty; (iii) become irritated at myself ... for feeling that way.’ Responses are captured using a five-point Likert scale, ranging from ‘almost never’ (1) to ‘almost always’ (5). A higher total score of the DERS-SF indicates greater problems with emotion regulation. The Cronbach’s alpha coefficient for DER was 0.88.

2.3. Statistical analysis

Statistical analysis was conducted using SPSS version 27. A preliminary descriptive analysis of all study variables was conducted, and Pearson correlations, which measure the extent of the linear association between the variables of interest were calculated. A mediation analysis was estimated using SPSS PROCESS macro – specifically Model 4 (Hayes, 2013). The mediation analysis is graphically illustrated in Fig. 1: the outcome variable, compulsive Internet use, is modelled as predicted by BIS, and mediated by DER. Also, the three BAS-subcales are modelled as predictors, specifically, BAS-F, BAS-D, and BAS-R; DER is modelled as a mediator for each of these. We also used Model 7-SPSS PROCESS macro to test whether indirect effects of BIS on compulsive Internet use are moderated by sex. A bootstrap re-sampling procedure from the sample is employed for the mediation analysis models to correct for potential bias (set to 5000 reiterations), where a mediation effect is considered significant where the estimated 95 % Confidence Interval (CI) does not contain zero.

3. Results

3.1. Summary statistics

Table 1 presents the means and standard deviations of the study variables, as well as the bivariate correlations between these (and 95 % confidence intervals). From the correlation analysis, a positive statistical association between CIU and BIS is evident. No significant correlation is displayed for the BAS subscales and CIU. DER is significantly positively correlated with CIU and BIS.

A histogram displaying the distribution of the CIUS is presented as Fig. 1, with a mean of 40.4 [95 % Confidence Interval: 39.1, 41.7], a minimum score of 16 and maximum of 60. The small skewness value of the distribution of -0.204 , and the kurtosis value of -0.336 , are not outside the range of normality (± 1.0), and therefore the distribution can be considered normal, as exemplified in the fitting of the normal distribution curve in Fig. 1. Furthermore, the Shapiro-Wilk test of normality statistic for CIUS is 0.990, carries a significance value of $p = 0.135$, and thus the null hypothesis that the sample stems from a normal distribution cannot be rejected; confirming the CIUS variable is normally distributed in this sample.

3.2. Mediation analysis

The results of the mediation models are presented using a graphical depiction in Fig. 2. BIS is considered as the predictor variable (X) of the outcome, compulsive Internet use (Y), which estimates a significant indirect effect of BIS on Compulsive Internet Use through DER. The estimated indirect and direct effects, documented in Table 2, estimate the indirect effect of BIS on compulsive Internet use as 0.188 (Standard error (SE) = 0.90, 95 % CI [0.037, 0.387]). The subtypes of BAS, BAS-Reward, BAS-Drive and BAS-Fun-seeking are predictors, X. As shown in Table 2, DER did not demonstrate a statistically significant association between BAS scores and compulsive Internet use, nor was this evidenced for the three BAS subtypes of Reward, Drive, and Fun-seeking.

Where moderation analysis, using sex as the moderator, was

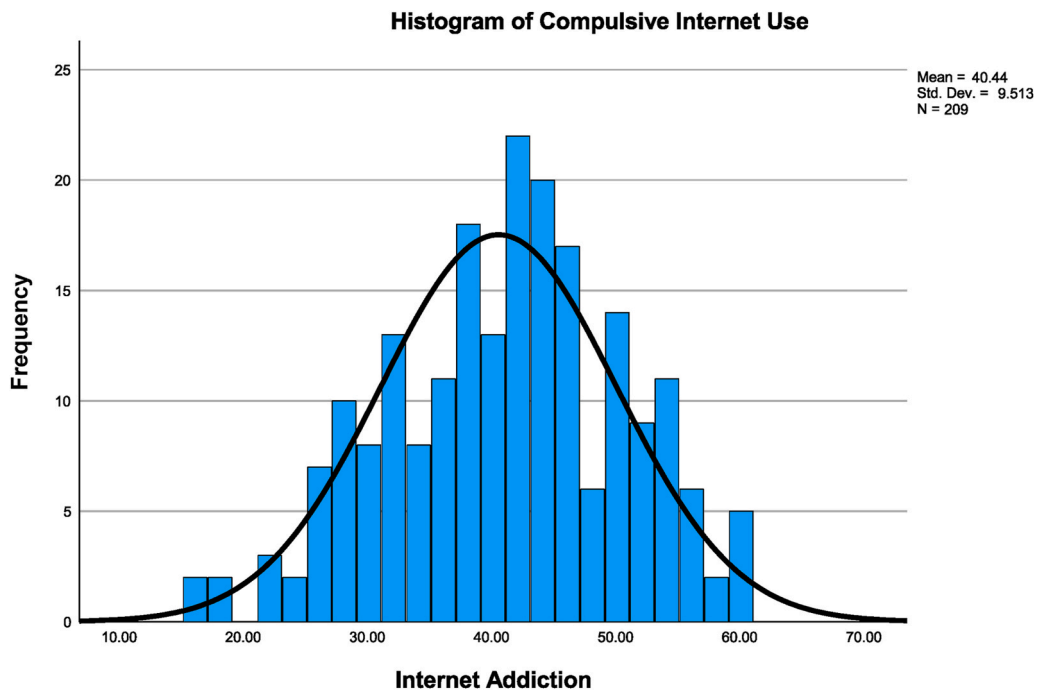


Fig. 1. Histogram of CIUS.

Table 1
Descriptive statistics and correlations between study variables.

	Mean	SD	Correlations				
			BIS	BAS-R	BAS-D	BAS-F	DER
BIS	22.43	3.83					
BAS-R	17.46	2.12	0.050 [-0.08, 0.18]				
BAS-D	10.96	2.64	-0.07 [-0.20, 0.06]	0.52** [0.42, 0.61]			
BAS-F	12.06	2.62	-0.14* [-0.17, -0.00]	0.39** [0.27, 0.50]	0.31** [0.18, 0.43]		
DER	46.36	12.50	0.40** [0.28, 0.51]	-0.08 [-0.21, 0.5]	0.013 [-0.12, 0.14]	0.002 [-0.13, 0.13]	
CIU	40.44	9.51	0.19** [0.05, 0.31]	-0.019 [-0.15, 0.11]	-0.092 [-0.22, 0.04]	0.12 [-0.01, 0.25]	0.23** [0.10, 0.35]

Level of statistical significance indicated by p-values: *p < 0.05. **p < 0.01.
Values in square brackets indicate 95 % Confidence Intervals.

executed, no differences in the results were uncovered. For transparency, the results from additional statistical tests have been included in Appendix, including Confirmatory Factor Analysis (CFA) (Table A-1) and a test of Multicollinearity (Table A-2).

4. Discussion

This research analysed the role of DER on compulsive Internet use as an indirect effect of BIS/BAS, in a community setting. The analysis, designed as a preliminary investigation of these phenomena, suggested that BIS activity is related to an increase in compulsive Internet use, and DER is positively associated with BIS. The mediation analysis results revealed that the indirect effects of BIS on compulsive Internet use was through DER, however, no significant relationship was uncovered for the BAS subscales (either for the outcome, compulsive Internet use, or the mediator, DER). The estimation results generated from this empirical analysis are therefore supportive of the second hypothesis that BIS has a role in compulsive Internet use, indirectly affected by DER, though the empirical findings do not find support for the first hypothesis, where an effect of BAS on compulsive Internet use is not found.

The findings estimated here in relation to BIS and compulsive Internet use are in accordance with those obtained by other researchers (Meerkerket al.; Nam et al., 2018). It is not surprising to find that BIS and compulsive Internet use are related, given that people with high levels of

BIS and high sensitivity to punishment are vulnerable towards and overestimate any cues of threat, which leads them to prioritize personal safety over other goals that results them in employing avoidance strategies such as overuse of Internet (Marciano et al., 2022). This finding is also supported by a recent meta-analysis (Marciano et al., 2020), and a systematic review (Bowden-Green et al., 2021), indicating that people with higher levels of neuroticism, which is conceptually close to BIS, struggle with expanding their social connections and tend to create a false self in an online world where, as opposed to real social situations, distress is reduced.

This research indicated indirect effects of BIS on compulsive Internet use through DER, and as such the findings contribute to the debate on the nature of the relationship between Compulsive Internet Use and BIS, identifying DER as a mechanism through which they are related. This can be understood by the concept of “Compensatory Internet Use” (Kardefelt-Winther, 2014), that posits excessive use of the Internet is a coping strategy that people use to escape from reality and negative emotions. BIS is positively associated with emotion dysregulation (i.e., people with higher levels of BIS activation have more difficulty in emotion regulation) (Tull et al. 2010), and there is evidence that people struggling with emotion regulation are prone to addictive behaviours such as compulsive Internet use (Kun & Demetrovics, 2010; Schreiber et al., 2012). It is plausible that compulsive Internet use could be a mechanism through which people deal with difficult emotions, as

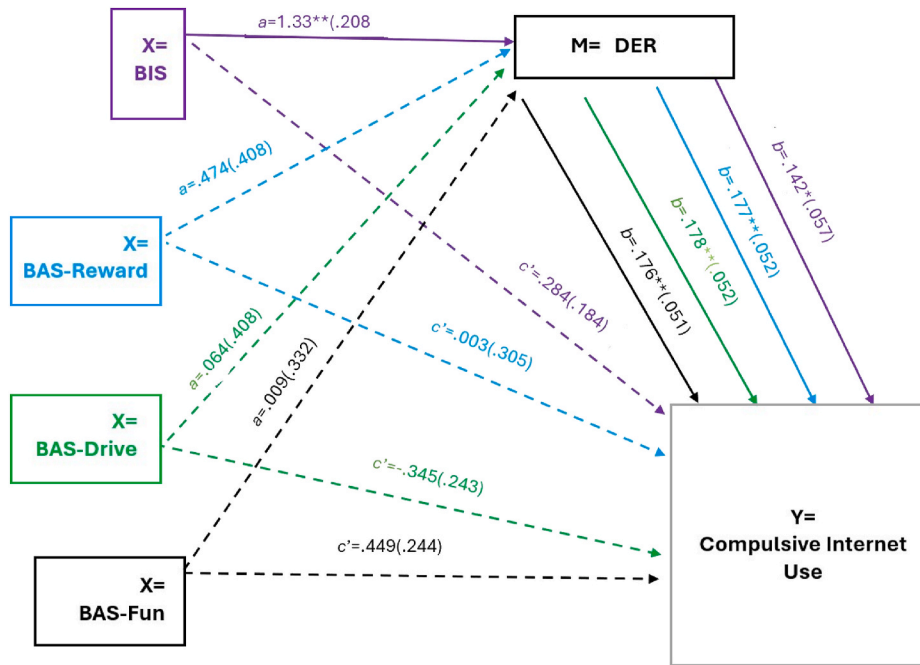


Fig. 2. Visual summary of mediation results.

Table 2
The indirect effects and effect sizes of study variables on Compulsive Internet Use.

Outcome: Compulsive Internet Use	Effects	SE	95 % CI		CSIE
			Lower	Upper	
Indirect effects of BIS via DER	0.188*	0.090	0.037	0.387	0.076
Indirect effects of BAS-R via DER	-0.084	0.089	-0.292	0.067	-0.019
Indirect effects of BAS-D via DER	0.012	0.064	-0.128	0.135	0.004
Indirect effects of BAS-F via DER	0.002	0.061	-0.122	0.124	0.0004

Statistical significance denoted as * $p < 0.05$.

CSIE: completely standardised indirect effects – represents effect sizes.

demonstrated by the indirect effects of BIS on Internet addiction through DER.

Our analysis demonstrated that BAS subscales were not associated with DER, as the mediator variable. The association between the two concepts has been generally weak (Tull et al. 2010). When the effect size is small, the sampling may make a large difference in the results which presents challenges in terms of the reliability of the replication of findings (Tsypes et al. 2019). Heterogenous samples may explain some of the inconsistency in the literature regarding the BAS-DER link where some research reported a relationship between BAS and DER (Azadi et al. 2020), while other studies failed to uncover such an association (Khoshfetrat et al. 2022).

Contrary to our expectations, the results of this research study did not find strong evidence of a relationship between BAS and the outcome of compulsive Internet use. Knyazev, (2004) found evidence linking BAS sensitivity to various types of addiction, though in other studies people with compulsive and unhealthy use of the Internet were found to have had lower scores in BAS (Zhang et al., 2022). Perhaps compulsive Internet users' tendency for activation and approach differs from the traditional sense that considers activation to be mainly physical, such as undertaking risky activities and adventures. Unlike the traditional concept of activation which implies some initiation of physical-based

activity, Internet users appear to be non-physical in their pleasure and sensation seeking. This may be understandable given that people with compulsive Internet use may experience greater levels of loneliness and have fewer social connections, and thus look for non-physical actions such as Internet use to compensate. This reasoning may be plausible in the context of the findings of the current study since the scale employed to measure BAS is more focused on physical than non-physical activations. Another possible explanation for a lack of association between BAS and compulsive Internet use found in the present research may relate to the sex composition of study participants, where the preponderance of participants in this study were female; recently published empirical work has indicated that BAS and Internet addiction was not significant for females, though this was related for males (Zhang et al., 2022).

The research and findings of this paper offers a unique contribution to the existing body of personality-addiction literature. The association between personality traits and substance-based addiction is well-documented (Dash et al., 2023; Kroencke et al., 2021), whereas the relationship between personality and non-substance addiction and addictive behaviours has not gained the same level of attention (Hussain & Pontes, 2018). The current research suggests a possible mechanism through which personality may contribute to the development of Internet addiction. Certain personality traits may increase an individual's propensity to experience negative emotions (Hussain & Pontes, 2018), where the BIS is employed in the current research, and emotion dysregulation is shown to be a key pathway through which BIS can contribute to compulsive Internet use.

4.1. Strengths and limitations

This paper provides an exploration of relationships between RST, compulsive Internet use and DER, hitherto unexplored in a growing body of literature concerned with Internet addiction. A strength of the study was to investigate *if and how* certain personality traits namely BIS and BAS relate to compulsive Internet use. Moreover, compulsive Internet use was explored in a community setting among a group of people i.e., those of emerging adulthood, who are deemed to be more vulnerable to excessive Internet use than other age groups (Global Connectivity Report, 2022). The study provides a novel preliminary

basis for investigating the links explored, to which other scholars can build and improve upon.

Despite its strengths, the study has several limitations that must be acknowledged. The limitations are both methodological and theoretical. One methodological limitation was the reliance on a cross-sectional design of the study that prevents causal inferences. Future studies could use a longitudinal panel of participants to provide more reliable conclusions about the directionality of effects (Maxwell et al., 2011). Although the sample size was appropriate, this study is also limited by the sampling method and the sampling bias (i.e., the extent to which the students who attended the study represented those not attending) cannot be ruled out. To improve the generalizability of the results, it is recommended that future research employs more effective sampling methods such as cluster-stratified sampling by which young adult participants can be invited and recruited from different parts of the country. The data collection method is also a further limitation of the study, relying on subjective measures and self-reported scales for which biases such as social desirability bias cannot be entirely ruled out. A potentially more objective approach could include reports from multiple sources such as acquaintances or include objective methods e.g., observation. This could help us gain a more comprehensive understanding about factors which contribute to compulsive Internet use. The influence of only one mediator, DER, is examined, though future research could examine if and how social anxiety for example could play a role in the contribution of BIS/BAS to the development of compulsive Internet use; there is evidence that social anxiety is related to BIS and BAS (Morgan et al., 2009), and Internet addiction (Weinstein, 2015, pp. 3–26). Studies which benefit from larger sample sizes could also better explore whether there are differential influences of the specific types of DER (e.g. the six sub-scales of DER) on CIUS (reliable statistical inference could not be fully executed on such sub-scales in the current study due to the relatively small sample size employed in this exploratory study). Finally, the results from this research are limited by the three-factor model of the BAS not fitting the data, as indicated by a significant Chi-square value and several correlation residuals $> .10$ (Kline, 2023). This issue is fully acknowledged here, and replication of the results by which a three-factor model of the BAS yields a non-significant Chi-square test statistic and correlation residuals $< .10$ would produce more reliable and valid results.

The study was also conducted among a sample of non-clinical participants. It could be argued that the study variables might interact in different ways among people who meet psychiatric diagnostic criteria. Thus, the study findings cannot be generalized to a clinical group of people. Furthermore, our study found no relationship between BAS and compulsive Internet use, which may be due to the measure of BAS employed - other scales measuring more non-physical than physical aspects of sensation seeking could yield different results. Finally, future studies with larger sample sizes could better consider the potential for mixtures and latent classes within samples (Borsboom et al.; Clark et al., 2013; Miettunen et al., 2016). For example, Tiego et al. (2019) found different patterns of endorsement of symptoms within the Internet addiction test they employed, where two subtypes emerged (a lower severity “impulsive” subtype, linked with attention-deficit hyperactivity disorder, and a higher severity “compulsive” subtype, linked with obsessive-compulsive personality traits). On the other hand, a recent paper which explicitly explores heterogeneity in the symptoms of pathological internet use found that predictors were only related to the ‘Pathological’ internet use class, and not for the two less severe classes of ‘Normal’ and ‘Problematic’ Internet users (Eşkisuet al.).

In relation to the theoretical limitations of the study, compulsive

Internet use is a multidimensional concept (Peris). Research is recommended to explore certain aspects of this concept that are salient particularly among young adults such as using social media for virtual interactions and geek behaviours that are characterised by an intense interest in online activities such as gaming or sexuality. Also, we considered compulsive Internet use as an outcome, though we caution that it should not be deemed as a final outcome because it can potentially cause, or worsen, already present psychological difficulties (Marciano et al., 2022). Future studies can use compulsive Internet use as a factor that can potentially mediate psychological problems.

4.2. Implications

The findings from this study could have implications for practice in the treatment of excessive Internet use since BIS and DER are found to contribute to the development of compulsive use of the Internet. Educational and prevention programs designed to help people experiencing pathological use of Internet should take into account strategies that would encourage people to be more active and confident, which could lessen emotion dysregulation. The findings of this empirical research suggest that a potentially effective treatment for compulsive use of Internet could be one which lessens BIS sensitivity and DER. Acceptance and Commitment Therapy (ACT), which is focused on psychological flexibility, and is intended to weaken avoidance and inhibitory strategies (Hayes, 2004; Viskovich & Pakenham, 2020), may be of particular relevance. It could be suggested that reducing BIS could decrease emotion dysregulation, which in turn could lead to a reduction in the need to compulsively use the Internet as a mechanism to cope with and escape unpleasant emotions.

5. Conclusion

In sum, this study makes a novel contribution to understanding the processes underpinning motivational systems (BIS/BAS) and compulsive Internet use. While BAS was not found to be associated with DER and compulsive Internet use, this study found a novel result in that BIS is linked to compulsive Internet use through difficulties in emotion regulation. The study offers greater insight on individual differences in terms of tendencies to compulsively engage with the Internet. The findings from this work demonstrate several possible directions for future research and may have potential implications for clinical practice in managing cases of excessive Internet use.

CRedit authorship contribution statement

Ali Khoshfetrat: Writing – review & editing, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Gretta Mohan:** Conceptualization, Investigation, Methodology, Writing – review & editing.

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Appendix. Presentation of additional statistical analyses

Table A-1
Confirmatory Factor Analysis

Factor Loadings							
Factor	Indicator	Estimate	SE	95 % Confidence Interval		Z	p
				Lower	Upper		
Factor 1	Q1_BIS1	0.439	0.0543	0.333	0.546	8.09	<0.001
	Q1_BIS2	0.538	0.0502	0.440	0.637	10.72	<0.001
	Q1_BIS3	0.530	0.0602	0.412	0.648	8.80	<0.001
	Q1_BIS4	0.462	0.0568	0.351	0.573	8.14	<0.001
	Q1_BIS5	0.455	0.0555	0.347	0.564	8.20	<0.001
	Q1_BIS6	0.447	0.0505	0.348	0.546	8.85	<0.001
	Q1_BIS7	0.553	0.0638	0.428	0.678	8.67	<0.001
Factor 2	Q1_BAS_Reward1	0.313	0.0398	0.236	0.391	7.88	<0.001
	Q1_BAS_Reward2	0.208	0.0379	0.134	0.282	5.50	<0.001
	Q1_BAS_Reward3	0.366	0.0433	0.281	0.451	8.46	<0.001
	Q1_BAS_Reward4	0.338	0.0465	0.247	0.430	7.27	<0.001
	Q1_BAS_Reward5	0.574	0.0524	0.471	0.677	10.95	<0.001
Factor 3	Q1_BAS_Drive4	0.419	0.0474	0.326	0.512	8.82	<0.001
	Q1_BAS_Drive3	0.599	0.0471	0.506	0.691	12.70	<0.001
	Q1_BAS_Drive2	0.715	0.0491	0.618	0.811	14.56	<0.001
	Q1_BAS_Drive1	0.715	0.0475	0.622	0.808	15.07	<0.001
Factor 4	Q1_BAS_Fun_Seeking1	0.568	0.0590	0.452	0.684	9.62	<0.001
	Q1_BAS_Fun_Seeking2	0.609	0.0550	0.501	0.717	11.08	<0.001
	Q1_BAS_Fun_Seeking3	0.495	0.0547	0.388	0.602	9.05	<0.001
	Q1_BAS_Fun_Seeking4	0.637	0.0639	0.512	0.763	9.97	<0.001

Table A-2
Multicollinearity tests

Collinearity Statistics		
	VIF	Tolerance
BISscore	1.04	0.957
BASRewar	1.54	0.650
BASDrive	1.42	0.703
BASFunSe	1.24	0.805

Table A-3

st-Hoc Model Performance

Residuals for Observed Correlation Matrix

	BIS1	BIS2	BIS3	BIS4	BIS5	BIS6	BIS7	BASReward1	BASReward2	BASReward3	BASReward4	BASReward5	BASDrive4	BASDrive3	BASDrive2	BASDrive1	BAS_Fun1	BAS_Fun2	BAS_Fun3	BAS_Fun4
BIS1		0.007	0.023	0.006	0.026	-0.043	-0.000	0.042	0.020	0.116	0.093	0.075	0.060	0.016	0.185	0.115	0.073	0.120	0.020	0.063
BIS2			0.007	-0.057	-0.042	0.089	-0.022	-0.059	-0.011	-0.044	-0.123	-0.042	-0.038	-0.117	-0.009	-0.046	-0.005	0.032	-0.104	-0.149
BIS3				0.146	-0.075	-0.068	-0.020	0.009	-0.091	-0.059	-0.005	0.033	0.055	-0.017	0.013	-0.073	0.050	0.053	-0.039	0.002
BIS4					-0.013	-0.035	-0.016	-0.048	-0.010	0.163	0.019	0.065	0.033	0.039	0.062	-0.010	0.072	0.085	0.032	0.021
BIS5						0.036	0.109	0.016	-0.057	0.067	-0.006	0.003	0.035	-0.043	0.095	0.036	0.075	0.056	-0.019	0.024
BIS6							-0.045	0.012	0.033	-0.039	0.059	0.053	0.052	-0.037	0.041	0.095	-0.019	0.042	-0.101	-0.143
BIS7								-0.158	-0.096	-0.013	0.008	-0.037	-0.110	-0.177	-0.066	-0.111	-0.014	-0.032	-0.059	-0.092
BASReward1									0.110	0.025	0.023	-0.001	-0.053	-0.063	-0.101	-0.086	0.080	0.003	0.056	0.042
BASReward2										0.010	-0.084	-0.037	-0.073	-0.005	-0.051	0.098	0.033	0.032	0.122	-0.093
BASReward3											0.046	-0.043	-0.038	-0.074	0.042	-0.020	0.059	0.003	0.069	-0.003
BASReward4												0.011	0.010	-0.071	-0.043	-0.064	0.044	0.070	0.060	-0.014
BASReward5													0.079	0.064	0.050	0.081	-0.061	-0.037	0.018	-0.153
BASDrive4														0.060	0.012	-0.051	0.188	0.214	0.127	0.085
BASDrive3															-0.019	0.002	0.025	0.036	0.117	-0.033
BASDrive2																0.012	0.004	0.069	-0.058	-0.102
BASDrive1																	0.006	-0.017	-0.039	-0.142
BAS_Fun1																		0.030	-0.021	-0.026
BAS_Fun2																			-0.045	0.016
BAS_Fun3																				0.037
BAS_Fun4																				

Data availability

Data will be made available on request.

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