



Motor impulsivity and problematic online behaviours among university students: the potential mediating role of coping style

Magdalena Sánchez-Fernández¹ · Mercedes Borda-Mas¹

Accepted: 13 February 2024
© The Author(s) 2024

Abstract

Motor impulsivity may be a predictor for generalized and specific problematic Internet uses in university students. The possible mediating role of coping style needs to be further researched. Among a sample of 726 Spanish university students, the present study examined the direct and indirect associations of motor impulsivity with generalized problematic internet use (GPIU), problematic social media use (PSMU), and problematic online gaming (POG), and the potential mediational role of coping styles. Results reported that motor impulsivity was directly associated with GPIU, PSMU, and POG, and indirectly associated with these problematic behaviours via the disengagement coping style. However, the engagement coping style did not play a mediating role. These findings suggest that disengagement coping style may, in part, explain the association between motor impulsivity and university students' GPIU, PSMU, and POG, and provide empirical evidence for the theoretical hypothesis that different types of online problem behaviours share some aetiological mechanisms.

Keywords Problematic Internet use · Social media · Gaming · Motor impulsivity · Coping style

Introduction

The use of the Internet has increased exponentially since the turn of the century and is now a space where millions of people develop an important part of their lives (Van Schalkwyk et al., 2020). Among university students, Internet use is particularly relevant in academic, personal, and social domains (Adorjan et al., 2021). However, the exponential growth in online connectivity makes the dysfunctional use of the Internet and its functions (e.g., gaming and social media) increasingly worrying. Problematic online behaviours are especially relevant for emerging adults (Anderson et al., 2017), which are associated with several negative academic, psychological, and health effects on university students (e.g., Chang et al., 2022; Kwok et al., 2021; Wong et al., 2020).

The term “problematic internet use” (PIU) is used to refer to a spectrum of maladaptive uses of the Internet characterized by loss of control, occurrence of negative consequences, and obsessive thinking when the Internet is inaccessible (Van Rooij & Prause, 2014). In the first instance, this construct was classed PIU into generalized PIU—comprising many online activities—and specific PIU—problems of engagement with specific Internet functions, such as social media use, gaming, and gambling—(Davis, 2001). More recently, authors have advocated the study of specific activities mediated by the Internet and related with both common and unique characteristics and etiological factors (Starcevic & Aboujaoude, 2017). Instead, in order to investigate the similarities and differences between these behaviours, the present study focuses on generalized PIU (GPIU) and two specific PIU: problematic social media use (PSMU) and problematic online gaming (POG).

The Interaction of Person-Affect-Cognition-Execution (I-PACE) model, aiming to explain the mechanisms that lead to such problematic online behaviours, proposes that person's core characteristics, as impulsivity and coping styles, may act as important predisposing variables in the development of specific problematic online behaviours (Brand et al., 2019).

✉ Magdalena Sánchez-Fernández
magdalenasanchez@us.es

Mercedes Borda-Mas
mborda@us.es

¹ Department of Personality, Assessment and Psychological Treatment, Faculty of Psychology, University of Seville (Universidad de Sevilla), C. Camilo José Cela, s/n, 41018 Seville, Spain

Motor impulsivity and problematic online behaviours

Impulsivity was conceptualized by Patton et al. (1995) as a three-dimensional personality trait that includes motor, attentional, and non-planning dimensions. Motor impulsivity was defined as acting without thinking. Other authors have operationalized impulsivity in terms of the inability to retrain prepotent courses of action (Logan et al., 1997). From this perspective, people with high impulsivity would have problems inhibiting action due to cognitive difficulties in self-control.

The importance of impulsivity as a predictor of PIU is consistent with theoretical models proposing that "loss of control" was one of its central components (Van Rooij & Prause, 2014). In support of these models, recent studies have found impulsivity to be a risk factor for problematic online behaviours (Hussain & Starcevic, 2020; Kuss et al., 2021; Şalvarlı & Griffiths, 2022). In addition, previous longitudinal research has found that motor impulsivity predicted GPIU in university students (Chen et al., 2017). Similarly, previous research argues that "rash impulsivity" —a component of impulsivity proposed by Dawe et al. (2004) refers to the difficulty of restraining approach behavior despite the probable adverse outcomes, and within which impulsive action or motor impulsivity is found (Winstanley et al., 2010)— is an important factor in online addictions (Dawe et al., 2004; Fowler et al., 2020).

Therefore, the role of motor impulsivity should be further investigated to understand the many mechanisms that lead university students with high motor impulsivity to GPIU, PSMU, and POG. This kind of research is essential to inform a better understanding of how this psychological variable is related to PIU and design effective interventions to reduce PIU.

The mediating role of coping styles

The term "coping" refers to cognitive, emotional and behavioural strategies that people use to manage specific demands in stressful situations (Skinner et al., 2003). Some authors have distinguished between engagement coping -involving strategies that confront noxious stimuli- and disengagement (or avoidance) coping —involving strategies that reduce exposure to stressors— (Addison et al., 2007).

Research supports the role of disengagement coping as an important factor in problematic online behaviour among university students (Faghani et al., 2019; Li et al., 2016; Siah et al., 2021). Engagement coping may be a protective factor for online problem behaviours because

it acts opposite to disengagement coping (Addison et al., 2007) and is associated with psychological and physical well-being (Skinner et al., 2003). Previous longitudinal studies have demonstrated the antecedent nature of positive coping strategies, such as resilience (Hsieh et al., 2021), and negative coping strategies, including escapism or avoidance (Lin, 2022; Melodia et al., 2020), in relation to problematic online behaviors.

Some indirect evidence has suggested that coping styles mediate the relationships between motor impulsivity and PIU in university students. Trait self-control —characterized by low motor impulsivity— is associated with the use of more positive coping strategies and fewer negative coping strategies (Englert et al., 2011). Therefore, low self-control —high motor impulsivity— is likely related to less engagement coping style and more disengagement coping style. A previous study found that university students with high levels of impulsivity were more likely to use avoidant coping but less likely to engage in task coping (Lightsey Jr & Hulse, 2002). Some longitudinal studies showed the mediating role of coping strategies in the relationship between psychological factors and problematic online behaviours (Fowler et al., 2020; Gu, 2022; Li et al., 2019; Melodia et al., 2020). Specifically, Li et al. (2019) found the mediating role of coping styles in impulsivity and GPIU in adolescents. Fowler et al. (2020) showed that coping styles mediated the association between rash impulsiveness and Facebook addiction in young adults.

Therefore, considering these previous studies and the absence of research in the university student population in this area, it is considered pertinent to analyse the mediating role of coping styles in the relationship between motor impulsivity and different problematic online behaviours among university students. The results may have practical implications for developing strategies to prevent and intervene in problematic online behaviours within the university context.

The present study

Based on the previous literature, the aims of the current research were to: (a) examine the direct associations between motor impulsivity and each of the problematic online behaviour (GPIU, PSMU, and POG) among university students; and (b) to analyze the potential mediating role of coping styles in the relationship between motor impulsivity and problematic online behaviours, while adjusting for gender, age, and field of knowledge. With regard to these aims, the following two hypotheses were devised:

H1 *Motor impulsivity would be positively and directly associated with GPIU, PSMU, and POG.*

H2 Motor impulsivity would be positively associated with GPIU, PSMU, and POG through decreased engagement coping and increased disengagement coping.

Materials and methods

Participants and procedure

Between October 2022 and February 2023, a cross-sectional study was conducted at a university in Andalusia, Spain. A sample of 726 university students (58.0% female; Mage = 21.25 years, SDage = 3.74; range = 17 to 40 years) was recruited through convenience sampling. Questionnaires were administered via an online survey (i.e. *Google Forms*) distributed by teaching staff. Inclusion criteria were: over 17 years of age, enrolled in a degree program at this university, having any device with Internet access, and giving informed consent to participate. Participation was voluntary. The study was approved by the Ethics Committee of the authors' university and adhered to the tenets of the Declaration of Helsinki (Internal code: 1346-N-22; Date of approval: 28 September 2022).

The sociodemographic characteristics of the 726 participants are shown in Table 1.

Measures

In addition to sociodemographic data collection, the following instruments were applied:

Compulsive internet use scale (CIUS-14, Meerkerk et al., 2009)

The CIUS-14 was used to measure GPIU. The test consists of 14 items focusing on lack of control, intra- and interpersonal conflicts, cognitive and behavioural preoccupation, impaired mood, and withdrawal symptoms. All 14 items can be answered on a 5-point Likert scale ranging from 0 (never) to 4 (very frequently). The Spanish version confirmed the consistency, high quality of the construct, an excellent model fit, and measurement invariance (Sarmiento et al., 2021). In the present study, the Spanish CIUS-14 showed a high level of internal consistency ($\alpha = 0.88$, $\omega = 0.88$).

Bergen social media addiction scale (BSMAS, Andreassen et al., 2016)

The BSMAS was used to assess PSMU. The test contains six items that reflect core addiction elements (i.e., salience, mood modification, tolerance, withdrawal, conflict, and relapse) to measure social media addiction over the past year. All items can be answered on a 5-point Likert scale

Table 1 Sociodemographic characteristics of the study participants ($N = 726$)

Characteristics	Frequency	%
Gender		
Male	295	40.6
Female	421	58.0
Non-binary	10	1.4
Educational degree		
Bachelor	640	88.1
Master	58	8.0
Doctoral	28	3.9
Field of knowledge		
Sciences	130	17.9
Sciences Health sciences	115	15.9
Social sciences	157	21.6
Arts and humanities	85	11.7
Engineering and Architecture	239	32.9
Academic performance		
Below average	63	8.7
Average	570	78.4
Above average	93	12.9
Income level		
Low	159	21.9
Medium	349	48.1
High	218	30.0
Employment status		
Unemployed	436	60.1
Unemployed looking for a job	142	19.5
Part-time employed	109	15.0
Full-time employed	39	5.4
Residence		
With a family member	417	57.5
In a student residence/flat	66	34.9
With a couple/alone	55	7.6

ranging from 1 (very rarely) to 5 (very often). In the present study, Spanish translation was used by adapting the Spanish version of the Bergen Facebook Addiction Scale (Vallejos-Flores et al., 2018). In the present study, the Spanish BSMAS showed high level of internal consistency ($\alpha = 0.80$, $\omega = 0.80$).

Internet gaming disorder scale–short form (IGDS9-SF, Pontes & Griffiths, 2015)

The IGDS9-SF was used to measure POG. The test assesses the severity of POG and its detrimental effects to the gamer's life, by examining gaming activities that occurred in the last year. All items are rated on a 5-point Likert scale ranging from 1 (never) to 5 (very often). The Spanish IGDS9-SF has been shown to have robust psychometric properties (Beranuy et al., 2020). In the present study, the Spanish IGDS9-SF showed a high level of internal consistency ($\alpha = 0.83$, $\omega = 0.83$).

Barratt impulsiveness scale (BIS-11, Patton et al., 1995)

The BIS-11 is a 30-item questionnaire designed to assess impulsivity through three factors: attentional, motor, and non-planning. This study used the motor impulsivity factor of the abbreviated Spanish version (BIS-15S) of Orozco-Cabal et al. (2010). This factor consists of five items scored on a 5-point scale ranging from 0 (rarely) to 4 (always). In the present sample, the motor impulsivity factor of BIS-15S showed high levels of internal consistency ($\alpha = 0.86$, $\omega = 0.87$).

Coping strategies inventory (CSI-SF, Addison et al., 2007)

The CSI-SF was used to assess coping styles. The two first-tier subscales were used: Engagement (E, 7 items) and Disengagement (D, 7 items). All items can be answered on a 5-point Likert scale ranging from 1 (never) to 5 (almost always). The Spanish version showed high reliability for all scales, and a robust adjustment (Tous-Pallarés et al., 2022). In the present study, the CSI-SF showed acceptable levels of internal consistency in its subscales (E: $\alpha = 0.74$, $\omega = 0.73$; D: $\alpha = 0.70$, $\omega = 0.70$).

Statistical analysis

The collected data were analyzed using Jeffreys' Amazing Statistics Program (JASP) version 0.17.1 (Intel) statistical software (JASP Team, 2023). For the distribution of the variables, the absolute values of skewness ranged from 0.23 (Disengagement coping) to 2.69 (POG), and the absolute values of kurtosis ranged from 0.11 (Disengagement coping) to 9.69 (POG). Given the criteria of less than 2 for skewness and 7 for kurtosis for large sample sizes, the distribution can be considered normal for all variables except POG (Kim, 2013).

First, means, standard deviations, reliabilities (Cronbach's alpha and McDonald's omega), and correlations between the variables of the study were calculated. Pearson's correlation was used for all variables except POG, where Spearman's correlation due to non-normality of the POG.

Structural equation modeling (SEM) analysis was then used to test the hypothesized mediation models. Confirmatory factor analyses (CFA) were conducted to assess the goodness of fit of the measurement model. In addition, the discriminant validity of the output variables was tested using the Fornell-Lacker criterion, which states that the square root of the average variance extracted (AVE) must be higher than the correlation of the latent variable with others in the model (Ab Hamid et al., 2017).

Next, three competing structural models (SEM1, SEM2, and SEM3) were computed. Each of them was tested with GPIU and with PSMU and POG. In SEM1, engagement

coping and disengagement coping were predicted from GPIU or the set of both PSMU and POG, and motor impulsivity mediated the relationship between PIU variables and coping variables. In SEM2, engagement coping and disengagement coping were predicted from motor impulsivity, and PIU variables mediated the relationship between motor impulsivity and coping variables. In SEM3, which corresponds to the hypothesized model, GPIU or the set of both PSMU and POG were predicted from motor impulsivity, engagement coping, and disengagement coping variables, and engagement coping and disengagement coping variables mediated the relationship between motor impulsivity and PIU variables. In all competing models tested, gender, age, and field of knowledge were controlled as covariates. Non-binary gender was excluded from SEM analyses due to its low representation. ULS estimator and Satorra-Bentler model test were used. Missing data were imputed using pairwise.

Multiple criteria was used to assess the goodness of model fit: the comparative fit index (CFI) ≥ 0.90 , an incremental fit index (IFI) ≥ 0.90 , normed fit index (NFI) ≥ 0.90 , Tucker Lewis index (TLI) ≥ 0.90 , and the root-mean-square error of approximation (RMSEA) < 0.08 (Kline, 2015). As RMSEA is not recommended to compute for low *df* models, the interpretation of model fit was based on an overall assessment of the general pattern of all fit indices (Kenny et al., 2015). To test the study hypotheses, standardized estimates of the path coefficients of the direct effects were estimated. The indirect effects were examined using the bootstrapping method with 5000 samples from different bootstraps (Hayes, 2017).

To determine minimum sample size, Soper's (2015) calculator was used for an anticipated effect size of 0.15, an alpha level of 0.05, with a power of 0.80, and a total number of four latent variables and 26 observed variables (models for GPIU), and five latent variables and 27 observed variables (models for PSMU and POG). The program showed a minimum sample size of 630 (models for GPIU) and 693 (models for PSMU and POG), which was easily achieved.

Results

Descriptive analyses

Of the 726 participants, the majority were female, undergraduate students, from the fields of Engineering and Architecture, had a medium economic level, were unemployed and not looking for a job, and lived with a family member (Table 1).

Correlations were strong between GPIU and PSMU, moderate between GPIU and POG, and low between PSMU and POG. GPIU, PSMU, and POG were positively correlated

with motor impulsivity, with medium strength in the case of GPIU and PSMU and low strength in the case of POG. In addition, GPIU, PSMU, and POG were positively correlated with disengagement coping, with strong, medium, and low strength, respectively; and negatively correlated with engagement coping, with low strength in the three cases. On the other hand, motor impulsivity was positively correlated with disengagement coping, with low strength, and negatively correlated with engagement coping, with low strength. Finally, engagement coping and disengagement coping were negatively correlated with medium strength (Table 2).

Testing mediation by using SEM

The measurement model yielded an acceptable fit (CFI = 0.93, IFI = 0.93, NFI = 0.92, TLI = 0.92, RMSEA = 0.10). Evaluation of the Fornell-Lacker criterion for the three problematic use measures shows no issue with discriminant validity for GPIU ($\sqrt{AVE}=0.58$) and PSMU ($\sqrt{AVE}=0.62$). However, the standardised correlation between the latent construct of these two constructs ($r=0.72$) indicates that GPIU and PSMU may have a problem with discriminant validity. Therefore, structural

equation models were computed separately for GPIU and for PSMU and POG.

Three competing SEMs were tested to determine the best fit to the data (Table 3). SEM3, which corresponds to the hypothesised model, was selected because it had the best fit and made theoretical sense. The goodness-of-fit indices were CFI=0.94, IFI=0.94, NFI=0.92, TLI=0.93, RMSEA = 0.06 in SEM3 for GPIU, and CFI=0.97, IFI=0.97, NFI=0.94, TLI=0.96, RMSEA = 0.04 in SEM 3 for PSMU and POG.

The two select structural models are showed in Fig. 1 (for GPIU) and Fig. 2 (for PSMU and POG). They explained variance of 36% for GPIU ($R^2=0.36$), 23% for PSMU ($R^2=0.23$) and 21% for POG ($R^2=0.21$). Table 4 shows direct and indirect effect after controlling for age, gender, and field of knowledge.

In the case of SEM3 for GPIU, four models' paths were statistically significant, including the positive associations between motor impulsivity and GPIU, between motor impulsivity and disengagement coping style, between disengagement coping style and GPIU, and the negative associations between motor impulsivity and engagement coping style. The association between engagement coping style and

Table 2 Mean, standard deviations, range, reliabilities, and correlations of study variables ($N=726$)

Measures	1	2	3	4	5	6
1. Generalized problematic internet use	–					
2. Problematic social media use	0.72	–				
3. Problematic online gaming	0.36	0.21	–			
4. Motor impulsivity	0.26	0.26	0.15	–		
5. Engagement coping style	–0.18	–0.12	–0.15	–0.13	–	
6. Disengagement coping style	0.39	0.27	0.17	0.20	–0.27	–
<i>M</i>	17.56	11.64	11.66	4.29	23.79	19.04
<i>SD</i>	9.62	4.62	4.45	3.16	4.89	4.83
Range	0 – 56	0 – 30	9 – 45	0 – 20	7 – 35	7 – 35
α	0.88	0.80	0.83	0.86	0.74	0.70
ω	0.88	0.80	0.83	0.87	0.73	0.70

M mean, *SD* standard deviation. All correlations are statistically significant ($p < 0.001$)

Table 3 Goodness-of-fit measure

Fit indices	Obtained values						Criteria
	Models for GPIU			Models for PSMU and POG			
	SEM1	SEM2	SEM3	SEM1	SEM2	SEM3	
CFI	0.92	0.93	0.94	0.95	0.96	0.97	≥ 0.90
IFI	0.92	0.93	0.94	0.94	0.96	0.97	≥ 0.90
NFI	0.90	0.92	0.92	0.93	0.93	0.94	≥ 0.90
TLI	0.91	0.92	0.93	0.94	0.95	0.96	≥ 0.90
RMSEA	0.07	0.06	0.06	0.05	0.05	0.04	< 0.08

SEM structural equation model, *GPIU* generalized problematic internet use, *PSMU* problematic social media use, *POG* problematic online gaming, *CFI* Comparative Fit Index, *IFI* Incremental Fit Index, *NFI* Normalized Fit Index, *TLI* Tucker-Lewis Index, *RMSEA* Root Mean Squared Error of Approximation

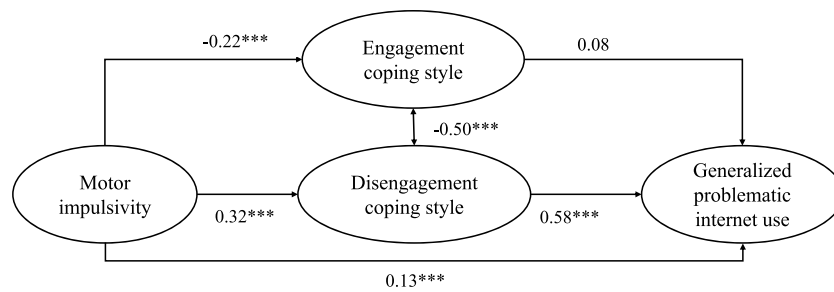
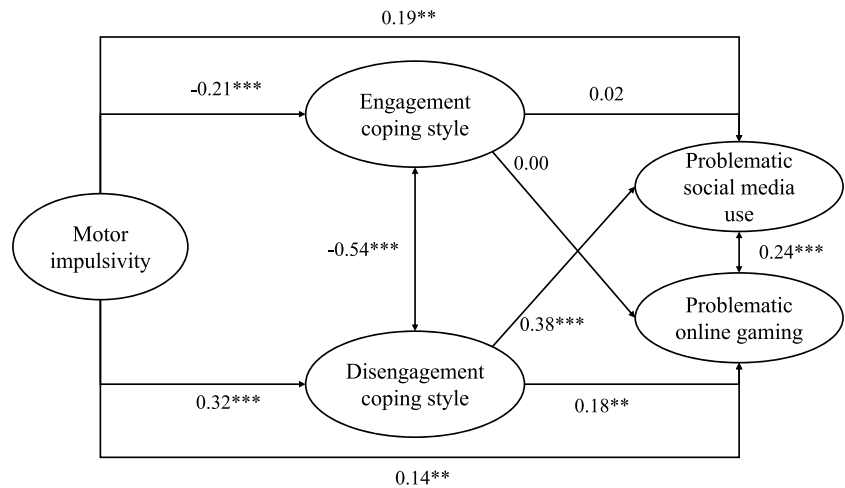


Fig. 1 Structural model of the associations between motor impulsivity, engagement coping style, disengagement coping style, and generalized problematic internet use. Standardized path coefficients were

shown. Gender, age and field of knowledge were controlled as covariates. *** $p < 0.001$. Observed indicators and error covariance not presented for clarity

Fig. 2 Structural model of the associations between motor impulsivity, engagement coping style, disengagement coping style, problematic social media use, and problematic online gaming. Standardized path coefficients were shown. Gender, age and field of knowledge were controlled as covariates. ** $p < 0.01$, *** $p < 0.001$. Observed indicators and error covariance not presented for clarity



GPIU was not significant. The indirect effect between motor impulsivity and GPIU via disengagement coping style was significant.

In the case of SEM3 for PSMU and POG, six models' paths were statistically significant, including the positive associations between motor impulsivity and PSMU, between motor impulsivity and POG, between motor impulsivity and disengagement coping style, between disengagement coping style and PSMU, between disengagement coping style and POG, and the negative associations between motor impulsivity and engagement coping style. The associations between engagement coping style and PSMU and between engagement coping style and POG were not significant. The indirect effects between motor impulsivity and PMSU, and between motor impulsivity and POG, via disengagement coping style, were significant.

Discussion and conclusions

According to the I-PACE model and previous evidence, motor impulsivity and coping strategies play an important role in the origin of the spectrum of problematic Internet

use. Coping strategies may partially explain the aetiological mechanism of impulsivity in these problematic behaviours. The current study examined the direct and indirect relationship of motor impulsivity with GPIU, PSMU, and POG via engagement and disengagement coping styles in a university student sample, controlling for gender, age, and field of knowledge. Structural equation modeling (SEM) was used to address the partial overlap between measures. Due to the high correlation between the latent variables of GPIU and PSMU, and considering the discriminant validity of the constructs, two models were required: one with GPIU as the outcome variable, and the other simultaneously including PSMU and POG as outcome variables.

As expected in Hypothesis 1, results revealed that GPIU and the two specific PIU, PSMU and POG, were directly related to motor impulsivity. This is consistent with the previous studies that have demonstrated the influence of motor impulsivity on problematic online behaviours in university students (Chen et al., 2017), and they provide empirical evidence to support theoretical models that propose that these behaviours are caused by loss of control problems in the use of Internet (Brand et al., 2019). In addition, it can be said to share mechanisms with addictive disorders in which

Table 4 Bootstrap analyses of the significance of mediation (controlling for age, gender and field of knowledge)

Model pathways	B	SE	β	95% CI of B		Percentage
				Lower	Upper	
SEM 3 for GPIU						
Direct effects						
MI → GPIU	0.12	0.03	0.13***	0.19	0.30	41.1%
MI → E	-0.21	0.03	-0.22***	-0.27	-0.15	–
MI → D	0.25	0.03	0.32***	0.06	0.17	–
E → GPIU	0.07	0.08	0.08	-0.09	0.23	–
D → GPIU	0.66	0.13	0.58***	0.41	0.91	–
Indirect effects						
MI → E → GPIU	-0.02	0.02	-0.02	-0.05	0.02	–
MI → D → GPIU	0.17	0.04	0.19***	0.10	0.24	58.9%
SEM 3 for PSMU and POG						
Direct effects						
MI → PSMU	0.14	0.02	0.19**	0.10	0.19	69.1%
MI → POG	0.14	0.03	0.14**	0.09	0.18	71.9%
MI → E	-0.16	0.03	-0.21***	-0.22	-0.12	–
MI → D	0.24	0.03	0.32***	0.19	0.30	–
E → PSMU	0.02	0.08	0.02	-0.13	0.17	–
D → PSMU	0.38	0.09	0.38***	0.20	0.56	–
E → POG	0.00	0.07	0.00	-0.14	0.15	–
D → POG	0.22	0.07	0.18**	0.07	0.37	–
Indirect effects						
MI → E → PSMU	-0.00	0.01	-0.01	-0.03	0.02	–
MI → D → PSMU	0.09	0.02	0.12***	0.05	0.14	30.9%
MI → E → POG	-0.00	0.01	-0.00	-0.02	0.02	–
MI → D → POG	0.05	0.02	0.06**	0.02	0.09	28.1%

^a Percentage of direct/indirect effect over total effect. ** $p < 0.01$ *** $p < 0.001$, $N = 726$, B Unstandardised coefficient, SE standard errors, β Standardised coefficient, SEM Structural equation model, $GPIU$ generalized problematic internet use, $PSMU$ problematic social media use, POG problematic online gaming, MI motor impulsivity, E engagement coping style, D disengagement coping style

impulsivity has been found to increase vulnerability. Specifically, motor impulsivity, as the propensity to react quickly to stimuli without considering the consequences, has been linked to substance and behavioural addictions (Chowdhury et al., 2017; Minhas et al., 2021). Thus, it can be concluded that motor impulsivity may be one of the characteristics of the psychopathology of addictive problems, which explains their poor inhibitory control over the problematic behaviour or substance.

It was second hypothesized that motor impulsivity would be positively associated with GPIU, PSMU, and POG through decreased engagement coping and increased disengagement coping (H2). H2 was partially supported. The study shows that the disengagement coping style could be a crucial mechanism through which motor impulsivity is related to the three online problem behaviours. It supports previous evidence for the role of disengagement coping style—or avoidance coping style—on GPIU, PSMU, or POG (Faghani et al., 2019; Li et al., 2016; Siah et al., 2021), and

the mediating role of maladaptive coping in the relationship between impulsivity and online addictions (Fowler et al., 2020). These results align with explanatory models of coping, which propose that high impulsivity diminishes the ability to regulate psychological distress in favour of automatic and maladaptive coping responses (Galla & Wood, 2015). In this way, individuals with high motor impulsivity may use a disengagement coping style in stressful situations that involve disconnection from the real world, avoidance of the problem, and passivity in problem-solving, which may perpetuate excessive use and inappropriate use of the Internet and specific online activities to cope with stressful situations. This approach would be in line with previous studies that find that maladaptive cognitive motivation related to Internet use as a form of stress coping predict GPIU in university students (Tian et al., 2017), and mediate the relationship between personality traits and GPIU (Tian et al., 2019), as well as the "distractibility" dimension as one of the dimensions of GPIU in the Online Cognition Scale (OCS)

(Davis et al., 2002). Future studies could examine whether, in this model, stress avoidance-related Internet use motivations mediate the relationship between disengagement coping style and problematic Internet uses.

However, the results suggest that, contrary to expectations, engagement coping style may not be as relevant as disengagement coping style in the association between motor impulsivity and problematic Internet behaviours. In this study, engagement coping style was measured by the Engagement scale of the CSI-SF (Addison et al., 2007), which reflects both emotion-focused and problem-focused engagement strategies. Given that emotion-focused style is positively associated with online problem behaviours (Fowler et al., 2020; Li et al., 2019), it is possible that, within the same engagement style dimension, problem-focused and emotion-focused strategies promote different outcomes, with the former protecting and the latter increasing risk of these problem online behaviours. Future research should examine whether problem-focused versus emotion-focused engagement strategies have specific effects on the three behaviours examined.

The present study has several limitations. First, due to its cross-sectional nature, this study does not allow to identify causal relationships between the variables. Therefore, future research should use longitudinal designs to help establish the causality and directionality of these effects. Second, the present study only used self-report questionnaires with limitations such as social desirability or memory recall biases. In addition, questionnaires for assessing problematic Internet use need to be updated, and the criteria may need to be updated due to rapid technological changes. Therefore, corroboration through qualitative tools might improve the completeness of assessments of these behaviours.

Despite these limitations, this study makes important contributions to the field of knowledge. On the one hand, the university where the data collection took place has several characteristics (i.e., public access, a high number of enrolled students, bilingual Spanish-English teaching, use of active teaching methodologies, and internationalization programs) that improve the representativeness of the sample and facilitate the generalizability of the results. On the other hand, although the relationship between impulsivity and PIU has been extensively studied in previous literature, this study has examined the relationship between a specific dimension of this psychological variable—which appears to be most closely related to these behaviours—and three problematic online behaviours within the same sample of university students. This approach enables the analysis of both similarities and differences in their impact. Additionally, it has helped to understand one of the mechanisms that explain this relationship, through coping strategies, being the only study to date to examine these mechanisms in a university student population. The

findings have provided empirical support for the hypothesis that PIU can be conceptualised within a spectrum of behaviours that are associated with both shared and specific aetiological factors (Brand et al., 2019; Starcevic & Billieux, 2017), such that the mechanism tested in this study would be shared to all three behaviours examined. Indeed, considering that the I-pace model for addictive behaviours (Brand et al., 2019), the theoretical framework employed to formulate the model under examination in this study, seeks to explain addictive behaviours beyond internet-use disorders, it can be inferred that the tested model may function as a common mechanism for other addictive behaviours. Therefore, it is advisable for future research to assess the applicability of this model to other addictive behaviours, such as alcoholism or problematic gambling.

From a practical perspective, our findings may help provide evidence-based prevention and interventions that, implemented from the early stages and as lifelong learning through the university stage, may reduce problematic online behaviours among university students. In particular, interventions that reduce motor impulsivity may have the potential to reduce all three of the problematic online behaviours examined. The aim would be to improve control over motor behaviour, which in turn would reduce the risk of non-adaptive Internet use. In addition, the finding that the disengagement coping style partially mediated the associations between motor impulsivity and the three behaviours provides important implications for practice. The purpose would be to reduce the use of the disengagement coping style by providing students with the knowledge and practical skills to cope appropriately with stressful situations, such as making an action plan and addressing the problem, to reduce the excessive use of the Internet and its services to deal with these situations.

Conclusions

In conclusion, this study demonstrated that motor impulsivity, which is a facet of impulsivity characterised by impulsive actions, is related to generalized problematic internet use, problematic social media use, and problematic online gaming among university students. Additionally, our results provide an explanation for how motor impulsivity increases the risk of these behaviours through an increased use of disengagement coping strategies. These findings are useful for the development of prevention and intervention strategies for PIU within a university context, paying special attention to the management of high levels of motor impulsivity and to the disengagement coping style. The ultimate purpose would be to contribute to the overall health and academic performance of these students.

Acknowledgements The authors thank all the participants and the teaching staff of the University of Seville. Besides, we thank Professor Francisco Rivera for his help with the data analysis.

Author contributions Magdalena Sánchez-Fernández and Mercedes Borda-Mas contributed equally. All authors read and approved the final manuscript.

Funding Funding for open access publishing: Universidad de Sevilla/CBUA This work was supported by a research grant awarded to the first author by the “VI Plan Propio de Investigación y Transferencia” of the Universidad de Sevilla (VI-PPTUS).

Data availability Data available on request due to privacy/ethical restrictions.

Declarations

Informed consent All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation of the University of Seville and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants for being included in the study.

Conflict of interest Magdalena Sánchez-Fernández and Mercedes Borda-Mas declare that they have no conflict of interest.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Ab Hamid, M. R., Sami, W., & Sidek, M. M. (2017). Discriminant validity assessment: Use of Fornell & Larcker criterion versus HTMT criterion. *Journal of Physics*, *890*(1), 012163. <https://doi.org/10.1088/1742-6596/890/1/012163>
- Addison, C. C., Campbell-Jenkins, B. W., Sarpong, D. F., Kibler, J., Singh, M., Dubbert, P., Wilson, G., Payne, T. J., & Taylor, H. (2007). Psychometric evaluation of a coping strategies inventory short-form (CSI-SF) in the Jackson heart study cohort. *International Journal of Environmental Research and Public Health*, *4*(4), 289–295. <https://doi.org/10.3390/ijerph200704040004>
- Adorjan, K., Langgartner, S., Maywald, M., Karch, S., & Pogarell, O. (2021). A cross-sectional survey of internet use among university students. *European Archives of Psychiatry and Clinical Neuroscience*, *271*(5), 975–986. <https://doi.org/10.1007/s00406-020-01211-1>
- Anderson, E. L., Steen, E., & Stavropoulos, V. (2017). Internet use and problematic internet use: A systematic review of longitudinal research trends in adolescence and emergent adulthood. *International Journal of Adolescence and Youth*, *22*(4), 430–454. <https://doi.org/10.1080/02673843.2016.1227716>
- Andreassen, C. S., Billieux, J., Griffiths, M. D., Kuss, D. J., Demetrovics, Z., Mazzoni, E., & Pallesen, S. (2016). The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study. *Psychology of Addictive Behaviors*, *30*(2), 252–262. <https://doi.org/10.1037/adb0000160>
- Beranuy, M., Machimbarrena, J. M., Vega-Osés, M. A., Carbonell, X., Griffiths, M. D., Pontes, H. M., & González-Cabrera, J. (2020). Spanish validation of the internet gaming disorder scale–short form (IGDS9-SF): Prevalence and relationship with online gambling and quality of life. *International Journal of Environmental Research and Public Health*, *17*(5), 1562. <https://doi.org/10.3390/ijerph17051562>
- Brand, M., Wegmann, E., Stark, R., Müller, A., Wölfling, K., Robbins, T. W., & Potenza, M. N. (2019). The Interaction of Person-Affect-Cognition-Execution (I-PACE) model for addictive behaviors: Update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. *Neuroscience & Biobehavioral Reviews*, *104*, 1–10. <https://doi.org/10.1016/j.neubiorev.2019.06.032>
- Chang, C. W., Huang, R. Y., Strong, C., Lin, Y. C., Tsai, M. C., Chen, I. H., ... & Griffiths, M. D. (2022). Reciprocal relationships between problematic social media use, problematic gaming, and psychological distress among university students: a 9-month longitudinal study. *Frontiers in Public Health*, *10*, 858482. <https://doi.org/10.3389/fpubh.2022.858482>
- Chen, S. K., Lo, M. T., & Lin, S. S. (2017). Impulsivity as a precedent factor for problematic Internet use: How can we be sure? *International Journal of Psychology*, *52*(5), 389–397. <https://doi.org/10.1002/ijop.12231>
- Chowdhury, N. S., Livesey, E. J., Blaszczynski, A., & Harris, J. A. (2017). Pathological gambling and motor impulsivity: A systematic review with meta-analysis. *Journal of Gambling Studies*, *33*, 1213–1239. <https://doi.org/10.1007/s10899-017-9683-5>
- Davis, R. A. (2001). A cognitive-behavioral model of pathological Internet use. *Computers in Human Behavior*, *17*(2), 187–195. [https://doi.org/10.1016/S0747-5632\(00\)00041-8](https://doi.org/10.1016/S0747-5632(00)00041-8)
- Davis, R. A., Flett, G. L., & Besser, A. (2002). Validation of a new scale for measuring problematic Internet use: Implications for pre-employment screening. *Cyberpsychology & Behavior*, *5*(4), 331–345. <https://doi.org/10.1089/109493102760275581>
- Dawe, S., Gullo, M. J., & Loxton, N. J. (2004). Reward drive and rash impulsiveness as dimensions of impulsivity: Implications for substance misuse. *Addictive Behaviors*, *29*(7), 1389–1405. <https://doi.org/10.1016/j.addbeh.2004.06.004>
- Englert, C., Bertrams, A., & Dickhäuser, O. (2011). Dispositional self-control capacity and trait anxiety as relates to coping styles. *Psychology*, *2*(6), 598–604. <https://doi.org/10.4236/psych.2011.26092>
- Faghani, N., Akbari, M., Hasani, J., & Marino, C. (2019). An emotional and cognitive model of problematic internet use among college students: The full mediating role of cognitive factors. *Addictive Behaviors*, *105*, 106252. <https://doi.org/10.1016/j.addbeh.2019.106252>
- Fowler, J., Gullo, M. J., & Elphinston, R. A. (2020). Impulsivity traits and Facebook addiction in young people and the potential mediating role of coping styles. *Personality and Individual Differences*, *161*, 109965. <https://doi.org/10.1016/j.paid.2020.109965>
- Galla, B. M., & Wood, J. J. (2015). Trait self-control predicts adolescents' exposure and reactivity to daily stressful events. *Journal of Personality*, *83*(1), 69–83. <https://doi.org/10.1111/jopy.12083>
- Gu, M. (2022). Understanding the relationship between distress intolerance and problematic Internet use: The mediating role of coping motives and the moderating role of need frustration. *Journal of Adolescence*, *94*(4), 497–512. <https://doi.org/10.1002/jad.12032>
- Hayes, A. F. (2017). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. Guilford publications.

- Hsieh, Y. P., Hwa, H. L., Shen, A. C. T., Wei, H. S., Feng, J. Y., & Huang, C. Y. (2021). Ecological predictors and trajectory of internet addiction from childhood through adolescence: A nationally representative longitudinal study. *International Journal of Environmental Research and Public Health*, *18*(12), 6253. <https://doi.org/10.3390/ijerph18126253>
- Hussain, Z., & Starcevic, V. (2020). Problematic social networking site use: A brief review of recent research methods and the way forward. *Current Opinion in Psychology*, *36*, 89–95. <https://doi.org/10.1016/j.copsyc.2020.05.007>
- JASP team. (2023). JASP (Version 0.17.1) [Computer software]. <https://jasp-stats.org/>. Accessed 28 Nov 2023
- Kenny, D. A., Kaniskan, B., & McCoach, D. B. (2015). The performance of RMSEA in models with small degrees of freedom. *Sociological Methods & Research*, *44*(3), 486–507. <https://doi.org/10.1177/0049124114543236>
- Kim, H. Y. (2013). Statistical notes for clinical researchers: Assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry & Endodontics*, *38*(1), 52–54. <https://doi.org/10.5395/rde.2013.38.1.52>
- Kline, R. B. (2015). *Principles and practice of structural equation modeling*. Guilford publications.
- Kuss, D. J., Kristensen, A. M., & Lopez-Fernandez, O. (2021). Internet addictions outside of Europe: A systematic literature review. *Computers in Human Behavior*, *115*, 106621. <https://doi.org/10.1016/j.chb.2020.106621>
- Kwok, C., Leung, P. Y., Poon, K. Y., & Fung, X. C. (2021). The effects of internet gaming and social media use on physical activity, sleep, quality of life, and academic performance among university students in Hong Kong: A preliminary study. *Asian Journal of Social Health and Behavior*, *4*(1), 36–44. https://doi.org/10.4103/shb.shb_81_20
- Li, H., Zou, Y., Wang, J., & Yang, X. (2016). Role of stressful life events, avoidant coping styles, and neuroticism in online game addiction among college students: A moderated mediation model. *Frontiers in Psychology*, *7*, 1794. <https://doi.org/10.3389/fpsyg.2016.01794>
- Li, Q., Dai, W., Zhong, Y., Wang, L., Dai, B., & Liu, X. (2019). The mediating role of coping styles on impulsivity, behavioral inhibition/approach system, and internet addiction in adolescents from a gender perspective. *Frontiers in Psychology*, *10*, 2402. <https://doi.org/10.3389/fpsyg.2019.02402>
- Lightsey, O. R., Jr., & Hulse, C. D. (2002). Impulsivity, coping, stress, and problem gambling among university students. *Journal of Counseling Psychology*, *49*(2), 202–211. <https://doi.org/10.1037/0022-0167.49.2.202>
- Lin, M. P. (2022). Avoidance/emotion-focused coping mediates the relationship between distress tolerance and problematic Internet use in a representative sample of adolescents in Taiwan: One-year follow-up. *Journal of Adolescence*, *94*(4), 600–610. <https://doi.org/10.1002/jad.12049>
- Logan, G. D., Schachar, R. J., & Tannock, R. (1997). Impulsivity and inhibitory control. *Psychological Science*, *8*(1), 60–64.
- Meerkerk, G. J., Van Den Eijnden, R. J., Vermulst, A. A., & Garretsen, H. F. (2009). The compulsive internet use scale (CIUS): Some psychometric properties. *Cyberpsychology & Behavior*, *12*(1), 1–6. <https://doi.org/10.1089/cpb.2008.0181>
- Melodia, F., Canale, N., & Griffiths, M. D. (2020). The role of avoidance coping and escape motives in problematic online gaming: A systematic literature review. *International Journal of Mental Health and Addiction*, 1–27. <https://doi.org/10.1007/s11469-020-00422-w>
- Minhas, M., Murphy, C. M., Balodis, I. M., Acuff, S. F., Buscemi, J., Murphy, J. G., & MacKillop, J. (2021). Multidimensional elements of impulsivity as shared and unique risk factors for food addiction and alcohol misuse. *Appetite*, *159*, 105052. <https://doi.org/10.1016/j.appet.2020.105052>
- Orozco-Cabal, L., Rodríguez, M., Herin, D. V., Gempeler, J., & Uribe, M. (2010). Validity and reliability of the abbreviated Barratt Impulsiveness Scale in Spanish (BIS-15S). *Revista Colombiana de Psiquiatría*, *39*(1), 93–109.
- Patton, J. H., Stanford, M. S., & Barratt, E. S. (1995). Factor structure of the Barratt Impulsiveness Scale. *Journal of Clinical Psychology*, *51*(6), 768–774. [https://doi.org/10.1002/1097-4679\(199511\)51:6%3c768::AID-JCLP2270510607%3e3.0.CO;2-1](https://doi.org/10.1002/1097-4679(199511)51:6%3c768::AID-JCLP2270510607%3e3.0.CO;2-1)
- Pontes, H. M., & Griffiths, M. D. (2015). Measuring DSM-5 internet gaming disorder: Development and validation of a short psychometric scale. *Computers in Human Behavior*, *45*, 137–143. <https://doi.org/10.1016/j.chb.2014.12.006>
- Şalvarlı, Şİ., & Griffiths, M. D. (2022). The association between internet gaming disorder and impulsivity: A systematic review of literature. *International Journal of Mental Health and Addiction*, *20*(1), 92–118. <https://doi.org/10.1007/s11469-019-00126-w>
- Sarmiento, A., Zych, I., Herrera-López, M., Delgado Sánchez, U., & Oksanen, A. (2021). Psychometric properties of the compulsive internet use scale in Spain, Colombia, and Mexico. *Cyberpsychology, Behavior, and Social Networking*, *24*(2), 108–116. <https://doi.org/10.1089/cyber.2020.0046>
- Siah, P. C., Hue, J. Y., Wong, B. Z. R., & Goh, S. J. (2021). Dark triad and social media addiction among undergraduates: Coping strategy as a mediator. *Contemporary Educational Technology*, *13*(4), ep320. <https://doi.org/10.30935/cedtech/111104>
- Skinner, E. A., Edge, K., Altman, J., & Sherwood, H. (2003). Searching for the structure of coping: A review and critique of category systems for classifying ways of coping. *Psychological Bulletin*, *129*(2), 216.
- Soper, D. (2015). *A-priori Sample Size Calculator for Structural Equation Models*. [Computer Software]. <https://www.danielsoper.com/statcalc>. Accessed 16 Jan 2023
- Starcevic, V., & Aboujaoude, E. (2017). Internet addiction: Reappraisal of an increasingly inadequate concept. *CNS Spectrums*, *22*(1), 7–13. <https://doi.org/10.1017/S1092852915000863Returntohref2017inarticle>
- Starcevic, V., & Billieux, J. (2017). Does the construct of Internet addiction reflect a single entity or a spectrum of disorders? *Clinical Neuropsychiatry: Journal of Treatment Evaluation*, *14*(1), 5–10.
- Tian, Y., Bian, Y., Han, P., Gao, F., & Wang, P. (2017). Associations between psychosocial factors and generalized pathological internet use in Chinese university students: A longitudinal cross-lagged analysis. *Computers in Human Behavior*, *72*, 178–188. <https://doi.org/10.1016/j.chb.2017.02.048>
- Tian, Y., Si, Y., Meng, W., Bian, Y., Han, P., Hu, J., ... & Gao, F. (2019). Mediating factors of the association between shyness and generalized pathological internet use in Chinese university students. *International Journal of Mental Health and Addiction*, *17*, 555–572. <https://doi.org/10.1007/s11469-018-9979-4>
- Tous-Pallarés, J., Espinoza-Díaz, I. M., Lucas-Mangas, S., Valdívieso-León, L., & Gómez-Romero, M. D. R. (2022). CSI-SF: Propiedades psicométricas de la versión española del inventario breve de estrategias de afrontamiento. *Anales de Psicología*, *38*(1), 85–92. <https://doi.org/10.6018/analesps.478671>
- Vallejos-Flores, M. Á., Copez-Lonzoy, A., & Capa-Luque, W. (2018). Is there anyone online?: Validity and reliability of the Spanish version of the Bergen Facebook addiction scale (BFAS) in university students. *Health and Addictions*, *18*(2), 175–184. <https://doi.org/10.21134/haaj.v18i2.394>
- Van Rooij, A., & Prause, N. (2014). A critical review of “Internet addiction” criteria with suggestions for the future. *Journal of Behavioral Addictions*, *3*(4), 203–213. <https://doi.org/10.1556/jba.3.2014.4.1>
- van Schalkwyk, G. I., Golt, J. D., & Silverman, W. K. (2020). Youth and technology: A developmental perspective on internet use. In M. N. Potenza, K. A. Faust, & D. Faust. (Eds.), *The Oxford Handbook of Digital Technologies and Mental Health*. <https://doi.org/10.1093/oxfordhb/9780190218058.013.3>. Accessed 23 Feb 2023
- Winstanley, C. A., Olausson, P., Taylor, J. R., & Jentsch, J. D. (2010). Insight into the relationship between impulsivity and substance abuse from studies using animal models. *Alcoholism: Clinical*

and Experimental Research, 34(8), 1306–1318. <https://doi.org/10.1111/j.1530-0277.2010.01215.x>

Wong, H. Y., Mo, H. Y., Potenza, M. N., Chan, M. N. M., Lau, W. M., Chui, T. K., ... & Lin, C. Y. (2020). Relationships between severity of internet gaming disorder, severity of problematic social media use, sleep quality and psychological distress. *International Journal of Environmental Research and Public Health*, 17(6), 1879. <https://doi.org/10.3390/ijerph17061879>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.