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The role of trait and state fear of missing out on problematic social networking site use and problematic smartphone use severity

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ABSTRACT

Background: Previous research has reported mental health variables and maladaptive cognitive emotion processes to be associated with severity of problematic social networking site use (PSNSU) and problematic smartphone use (PSU). The present study examined trait and state fear of missing out (FOMO) dimensions and their potential mediating roles in explaining relations between PSNSU and PSU severity.
Method: A sample of 461 participants (mean age = 24.15, *SD* = 7.78) completed an online survey protocol measuring trait and state FOMO, PSU, and PSNSU.
Results: Structural equation modelling revealed that trait and state FOMO were significantly associated with PSNSU severity, and PSNSU severity was associated with PSU severity. State (but not trait) FOMO mediated relations between PSNSU and PSU severity.
Conclusions: The study demonstrates the role of FOMO, especially state FOMO, in association with PSNSU and PSU severity.

1. Introduction

Smartphones are now used almost constantly for communication, information sharing, and collaboration. These behaviours have been aided by a plethora of social networking sites (SNSs) such as Facebook, Instagram, Twitter, TikTok, and WhatsApp. Many daily activities are initiated, developed, and maintained using smartphones and SNSs offering many benefits to users all over the world. The positive impact of smartphones and SNSs on daily life can be hugely beneficial allowing for connections and interactions that were not possible before the inception of this technology. However, excessive use of these devices and applications can have a negative impact on health (Brailovskaia et al., 2021).

Researchers have used the term problematic smartphone use (PSU; Busch and McCarthy, 2021) and problematic social networking site use (PSNSU; Hussain and Starcevic, 2020) to describe these negative behaviours, given the fact that neither behaviour has been formally recognised as psychiatric disorders in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR; American Psychiatric Association, 2022) or International Classification of Diseases (ICD-11; World Health Organization (2018). Other terms are smartphone/social media addiction (Haug et al., 2015; Thomson et al., 2021) or smartphone use disorder/social networks use disorder (Montag et al., 2021). PSU and PSNSU occur when a user experiences difficulties in controlling their use, spending excessive amounts of time on a smartphone or SNS, leading to impaired daily functioning and adverse health consequences (Andreassen and Pallesen, 2014; Horwood and Anglim, 2019). Smartphones and SNSs are susceptible to problematic use because they provide access to pleasurable activities, might release chemicals in the brain such as dopamine, and thus encourage prolonged use (for a molecular framework to study PSU see Montag et al., 2016; see also recent work by Westbrook et al., 2021 showing links between dopamine system and social media use on smartphones). Furthermore, recent research reported an overlap in the underlying mechanisms between PSNSU and PSU because the smartphone is a common medium to access SNSs (Marino et al., 2021). See also work linking disordered use tendencies of apps such as WhatsApp, Instagram, Facebook, and Snapchat with

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disordered smartphone use tendencies (Rozgonjuk et al., 2020a, 2021a; Sha et al., 2019).

SNS use is now a common daily activity for millions of people, and this increased activity has raised concerns about the potential negative impact of SNS overuse. Research studies have reported PSNSU severity to be associated with a range of mental health variables. Boer et al. (2020) investigated PSNSU severity amongst adolescents in 29 countries ($n = 154, 981$), and results revealed that PSNSU severity was associated with lower mental, school, and social well-being. Wong et al. (2020) found that PSNSU severity was associated with depression, anxiety, stress, and poor sleep quality. Wartberg et al. (2020) found that PSNSU severity was associated with depressive symptoms, low interpersonal trust, and low family functioning. Other research studies have reported that PSNSU severity had a negative association with well-being (Zhao, 2021), and higher PSNSU severity was associated with mild depression symptoms (Saputri and Yumarni, 2021) and mental distress (Henzel and Hakansson, 2021; Huang, 2022). Altogether, research has shown that PSNSU severity is associated with worse health and well-being, and thus it is important to further study the underlying mechanisms of SNS use.

Research studies have consistently reported adverse associations with PSU. Edwards et al. (2022) reported that lower self-esteem was associated with greater nomophobia (fear of being without access to a smartphone) and PSU severity. Rathakrishnan et al. (2021) found that PSU severity was associated with poor sleep quality. Yang et al. (2021) found stress was associated with PSU severity, and in particular FOMO acted as a mediator between stress and PSU severity. Furthermore, research by Song et al. (2022) showed that PSU severity was associated with anxiety, and sleep disturbance mediated the relationship. Other studies have reported PSU severity to be associated with attachment anxiety and avoidance (Parent et al., 2022), stress and academic burnout (Hao et al., 2022), procrastination (Rozgonjuk et al., 2018a), levels of depression and obsessive-compulsive disorder (OCD; Wickford and Quaiser-Pohl, 2022). The research evidence overall suggests that PSU severity is associated with several variables (particularly psychopathological variables, see Busch and McCarthy, 2021; Elhai et al., 2019). Further research is needed to expand from these variables to examine other potential constructs related to PSU.

It is important to consider theories that help explain problematic internet behaviours and provide a theoretical framework. One such theory is the Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2019). This comprehensive model proposes several factors to understand the process and maintenance of problematic internet use. Firstly, predisposing variables that contribute to problematic use including genetic, biological, cognition, psychopathology, personality, and internet use motives. Secondly, the model proposes additional determinants that can influence decisions to use specific internet applications which in turn influence excessive use. The determinants involve affective and cognitive responses such as attentional bias, coping strategies, internet use expectancies, disinhibition, and craving. These additional determinants may interact with the predisposing variables or may mediate associations between the predisposing variables and outcomes such as loss of control when using a specific internet application such as an SNS. Several studies have found evidence to support the model (Guo et al., 2021; Mehmood et al., 2021; Rozgonjuk et al., 2021). The I-PACE model and other theoretical models of problematic internet use have been discussed by other researchers (see Sun and Zhang, 2021).

One important, additional determinant of PSU and PSNSU is the fear of missing out (FOMO). Many smartphone users utilise SNSs to observe the online behaviour of other users actively and passively. These media provide real-time information about activities, events, and conversations. There is a constant stream of information displayed on smartphones, and consequently, some users may experience FOMO – apprehension of missing rewarding experiences and the constant need to stay socially connected to avoid this feeling (Przybylski et al., 2013). Several studies have reported associations between FOMO, PSU severity, and PSNSU severity (Aygul and Akbay, 2019; Dempsey et al., 2019; Fabris et al., 2020; Fang et al., 2020; Li et al., 2020). FOMO has been associated with SNS use intensity (Beyens et al., 2016; Oberst et al., 2017; Rozgonjuk et al., 2020b), and higher levels of PSU severity (Chotpitayasunondh and Douglas, 2016; Yuan et al., 2021). FOMO has been associated with psychopathological variables including depression (Elhai et al., 2020; Sela et al., 2020; Yaun et al., 2021) and anxiety severity (Elhai et al., 2020; Wolniewicz et al., 2020). One study reported that FOMO significantly mediated relations between depression/anxiety with PSU severity (Vally et al., 2021). Rozgonjuk et al. (2021b) found no gender differences in FOMO, however, FOMO scores were associated with younger age. Individual differences in FOMO warrant further investigation.

Yet FOMO has largely been studied as a unitary construct, despite more recent evidence that it may encompass multiple latent dimensions. Balta et al. (2020) found that state FOMO was directly and indirectly associated with phubbing and PSNSU severity. Li et al. (2020) reported that both trait and state FOMO were positively associated with PSU. Wegmann et al. (2017) reported that in contrast to trait FOMO, state FOMO – here describing FOMO in the online realm, when an individual utilises internet communication applications – was more associated with excessive internet use. Also, a recent work by Montag et al. (2023) showed that state FoMO is more closely linked to PSNSU than trait FoMO (for further associations with meaning in life variables see this recent published work). Altogether, research findings show that FOMO plays a crucial role in smartphone and SNS usage and may prompt problematic use in some users (Elhai et al., 2021).

Considering previous research findings and the widespread use of smartphones and SNSs, it is important to investigate different aspects of FOMO in association with PSNSU and PSU severity. FOMO is an important variable accounting for why people with increased stress levels may overuse their smartphones (Yang et al., 2021). Few studies have examined effects of the different dimensions of FOMO (i.e., trait and state) on PSNSU and PSU. Investigating trait and state FOMO may provide a comprehensive understanding of how problematic internet behaviours develop. In the I-PACE model, FOMO has been conceptualised as a cognitive-related bias as underlying mechanisms of a problematic use such as PSNSU and PSU (Brand et al., 2019), and thus this research question needs to be investigated to further understand the complex mechanisms of this construct.

Guided by the I-PACE model, we hypothesised that trait and state FOMO will predict PSNSU and PSU severity. More specifically, we hypothesised that trait and state FOMO would differentially be associated with PSNSU and PSU severity. Furthermore, based on previous research (Li et al., 2020; Wegmann et al., 2017), it was hypothesised that state FOMO (in contrast to trait FOMO) should be more associated with PSNSU and PSU severity. It was also hypothesised that PSNSU severity would predict PSU severity, and this was based on previous work showing that the use of SNSs is associated with PSU severity, and that problematic use may begin with overuse of specific online channels (i.e., SNSs), with the smartphone becoming a learned cue related to the channels (Montag et al., 2021). Fig. 1 shows the hypothesised model; trait and state FOMO are conceptualised to predict PSNSU severity, and PSNSU severity is conceptualised to predict PSU severity (controlling for age and gender).

2. Methods

2.1. Participants

The study sample consisted of 461 participants (mean age = 24.15, $SD = 7.78$). There were 185 males (40.1%) and 276 females (59.9%). Ethnicity was mostly white ($n = 371$), with some representation amongst individuals identifying as Hispanic ($n = 27$, 5.9%), Asian ($n = 26$, 5.6%), and Black ($n = 18$, 3.9%).

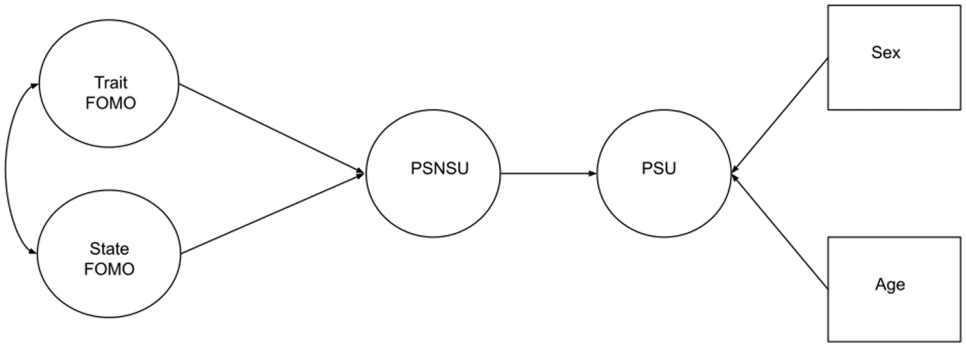

Fig. 1. Hypothesised model.
Note. FOMO=Fear of missing out; PSNSU=Problematic social networking site use; PSU=Problematic smartphone use. Round objects indicate latent variables, while rectangles indicate observed variables. For simplicity, relations between each latent factor and its associated observed indicator variables are not displayed.

2.2. Design and materials

An online survey design was utilised in the present study. The survey consisted of demographic questions and the following psychological scales in English.

2.3. Fear of missing out scale

FOMO was measured using an adaptation of the original FOMO scale (Przybylski et al., 2013). The original scale contained ten items, Wegmann et al. (2017) adapted the scale by adding two items. This scale contained 12 items assessing both trait and state FOMO. Items are rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). Example items include "I fear others have more rewarding experiences than me", "I get worried when I find out my friends are having fun without me", and "I am continuously online in order not to miss out on anything". Higher sum scores indicate higher state or trait FOMO (Wegmann et al., 2017). The scale reliability (Cronbach's alpha/McDonald's omega) in the current study was 0.87/0.91, including 0.80/0.88 for trait FOMO and 0.86/0.90 for state FOMO.

2.4. Smartphone addiction scale

The Smartphone Addiction Scale-Short Version (SAS-SV; Kwon et al., 2013) was used to measure PSU. The scale consists of 10 items. Response options range from 1 = strongly disagree to 6 = strongly agree. Sample items include "missing planned work due to smartphone use", "won't be able to stand not having a smartphone", and "the people around me tell me that I use my smartphone too much". Higher summed scores indicate increased PSU severity (Harris et al., 2020). Scale reliability (Cronbach's alpha/McDonald's omega) was 0.86/0.89.

2.5. Bergen social media addiction scale

PSNSU was assessed with the Bergen Social Media Addiction Scale (BSMAS, Andreassen et al., 2016). Six items assess the six core criteria of addiction outlined by Griffiths (2005), i.e., salience, conflict, mood modification, withdrawal, tolerance, and relapse. Responses are provided on a five-point Likert scale ranging from 1 (*very rarely*) to 5 (*very often*). Example items include "used social media in order to forget about personal problems", "tried to cut down on the use of social media without success", and "become restless or troubled if you are prohibited from using social media". Scores are summed with higher scores indicating higher PSNSU severity (Duradoni et al., 2020). Scale reliability (Cronbach's alpha/McDonald's omega) was 0.86/0.89.

2.6. Procedure

The researchers involved with this study advertised the online survey on their social media accounts which included Facebook, Twitter, and Instagram. Participants were also recruited via the Prolific.ac crowdsourcing site; these participants were awarded a nominal payment for participation. The survey was also advertised on a research participation website at a large university in the UK, and these participants were awarded course research credits. Participants were routed to a participant information page and consent form, and those consenting were then routed to the online survey followed by a debrief statement.

2.7. Ethics

The study was carried out in accordance with the Declaration of Helsinki and British Psychological Society ethical guidelines. The first author's university ethics committee approved the study. All participants were informed about the study, and all provided informed consent prior to participation.

2.8. Analytic strategy

We used R version 4.2.1 (R Core Team, 2022) for data cleaning, using the following packages: *careless* (for careless responding), *mice* (missing data), *pastecs* (descriptives), *fmsb* (internal consistency), and *sjstats* (analysis of variance, ANOVA). Before arriving at the current effective sample, we started with 560 participants rows of data. However, 85 rows were mostly blank, so we removed those participants due to substantial missing data, resulting in 475 participants. We further removed 14 participants for careless responding, as they entered the same consecutive response to at least 20 items, resulting in the final effective sample of 461 participants.

We next estimated and imputed missing item-level data for participants with nominal amounts of missing data (mostly just 1–2 items), using maximum likelihood procedures. We then summed scale scores, and conducted descriptive statistical analysis and bivariate Pearson

Table 1
Means, standard deviations, and Pearson correlations for the study's continuous variables.

Variable	*M*	*SD*	1	2	3	4
1. Age	24.15	7.78				
2. PSU	31.15	9.72	−0.26**			
3. PSNSU	14.57	5.36	−0.28**	.73**		
4. Trait FOMO	15.22	4.32	−0.24**	.40**	.37**	
5. State FOMO	16.49	5.92	−0.22**	.59**	.60**	.51**

Note. FOMO=Fear of missing out; PSNSU=Problematic social networking site use; PSU=Problematic smartphone use.

correlations for the study variables – trait and state FOMO, PSNSU, PSU, and age (Table 1), all of which were normally distributed. We tested for gender differences on scale scores using ANOVA (Table 2).

We used structural equation modelling in Mplus version 8.8. We first tested measurement models (confirmatory factor analysis, CFA) for FOMO (two factors: trait and state FOMO), PSNSU and PSU (one factor each). We treated items within a CFA as ordinal, using weighted least squares estimation with a mean- and variance-adjusted chi-square, and a polychoric covariance matrix with probit factor loadings (Lei and Shiverdecker, 2020). We specifically covaried FOMO residual error variances between items 1 and 2 (both about missing others' rewarding experiences) and between 10 and 11 (both about continuously missing out on "anything"). We covaried PSU residual error variances between items 1 and 2 (about missing school/work from smartphone use). We judged model fit based on the Tucker-Lewis index (TLI) > 0.94, Comparative Fit index (CFI) > 0.94, standardized root mean square residual (SRMR) <0.08, and root mean square error of approximation (RMSEA) < 0.06. We note, however, that RMSEA often rejects models that use ordinal data, and should therefore be less emphasized in fit determination here (Shi et al., 2020).

Next, we tested the model in Fig. 1 using the same estimation procedures as above. We also tested a model variation on Fig. 1, adding paths from trait and state FOMO to PSU severity. We tested mediation/indirect effects by computing cross-products of direct effects, using the Delta method and 1000 bootstrapped replications. Mediation tests assessed whether PSNSU mediated relations between trait/state FOMO and PSU severity.

3. Results

In Table 1, we display descriptive statistics and Pearson correlations for the study variables. Age was inversely related to the other variables; those other variables were all significantly positively correlated with each other. Using *t*-tests for dependent correlations, in comparison to trait FOMO, state FOMO was significantly more related to PSU severity, $t(458) = 5.06$, $p < .001$, and PSNSU severity, $t(458) = 6.15$, $p < .001$. Table 2 demonstrates that women scored significantly higher than men on PSU and PSNSU severity, with no differences on trait or state FOMO scores.

The measurement models (CFA) fit fairly well, with the exception of RMSEA as expected and discussed above. Fit indices are discussed next, and displayed in Table 3 for ease of comparison. The PSU CFA fit well, WLSMV $\chi^2(34, N = 461) = 170.09$, $p < .001$, CFI = 0.97, TLI = 0.95, SRMR = 0.04, RMSEA = 0.09 (90% CI: 0.08–.11). PSNSU fit well, WLSMV $\chi^2(9, N = 461) = 46.95$, $p < .001$, CFI = 0.99, TLI = 0.98, SRMR = 0.02, RMSEA = 0.10 (90% CI: 0.07–.12). The state/trait FOMO two-factor model fit well, WLSMV $\chi^2(51, N = 461) = 168.32$, $p < .001$, CFI = 0.99, TLI = 0.98, SRMR = 0.04, RMSEA = 0.07 (90% CI: 0.06–.08).

The SEM model from Fig. 1 had some evidence for adequate (but not excellent) fit, WLSMV $\chi^2(397, N = 461) = 1349.81$, $p < .001$, CFI = 0.93, TLI = 0.92, SRMR = 0.08, RMSEA = 0.07 (90% CI: 0.07–.08). Fig. 2 shows that when adjusting for trait FOMO, state FOMO was significantly associated with PSNSU severity; trait FOMO was not significant. PSNSU was associated with PSU severity, when controlling for age and gender. Younger age and female gender were associated with PSU severity.

We also tested a variation of the model from Fig. 1. Specifically, we added paths from trait and state FOMO to PSU severity, and this model fit well, WLSMV $\chi^2(395, N = 461) = 1326.43$, $p < .001$, CFI = 0.93, TLI = 0.92, SRMR = 0.08, RMSEA = 0.07 (90% CI: 0.07–.08). Although this model fit significantly better than the model from Fig. 1 (tested using Mplus' DIFFTEST command), WLSMV $\chi^2_{diff}(2, N = 461) = 22.01$, $p < .001$, the magnitude of difference was not meaningful, $CFI_{diff} = 0.002$ (Chen, 2007).

Finally, we tested PSNSU as a mediator in association between trait/state FOMO and PSU severity. PSNSU mediated relations between state FOMO and PSU severity, ($\beta = 0.66$, SE = 0.05, $p < .001$). However, PSNSU did not mediate relations between trait FOMO and PSU severity, ($\beta = -0.01$, SE = 0.06, $p = .91$).

Table 2
ANOVAs, comparing men and women on the scale scores.

Variable	Men ($n = 185$) M (SD)	Women ($n = 276$) M (SD)	F(1459)	P	η_p^2
PSU	28.82 (9.83)	32.71 (9.71)	18.43	<0.001	.04
PSNSU	13.01 (5.13)	15.63 (5.25)	28.08	<0.001	.06
Trait FOMO	14.94 (4.37)	15.41 (4.28)	1.34	.25	<0.01
State FOMO	16.29 (6.11)	16.62 (5.80)	.35	.55	<0.01

Note. FOMO=Fear of missing out; PSNSU=Problematic social networking site use; PSU=Problematic smartphone use.

Table 3
Confirmatory factor analytic and structural equation models tested, including fit indices.

Model	Goodness of fit WLSMV chi-square test	CFI	TLI	RMSEA (90% confident interval)	SRMR
PSU CFA	$\chi^2(34, N = 461) = 170.09$, $p < .001$	.97	.95	.09 (0.08–0.11)	.04
PSNSU CFA	$\chi^2(9, N = 461) = 46.95$, $p < .001$	.99	.98	.10 (0.07–0.12)	.02
State/Trait FOMO CFA	$\chi^2(51, N = 461) = 168.32$, $p < .001$	.99	.98	.07 (0.06–0.08)	.04
Fig. 1 SEM	$\chi^2(397, N = 461) = 1349.81$, $p < .001$	.93	.92	.07 (0.07–0.08)	.08
Fig. 1 SEM Variation	$\chi^2(395, N = 461) = 1326.43$, $p < .001$	.93	.92	.07 (0.07–0.08)	.08

Note. WLSMV=weighted least squares with a mean- and variance-adjustment; CFI=comparative fit index; TLI=Tucker-Lewis index; RMSEA=root mean square error of approximation; SRMR=standardized root mean square residual; PSU=problematic smartphone use; PSMSU=problematic social networking site use; FOMO=fear of missing out; CFA=confirmatory factor analysis; SEM=-structural equation model.

4. Discussion

The current study investigated trait and state FOMO and the potential associations with PSNSU and PSU severity. This study is one of few studies to examine the different dimensions of FOMO. The results revealed that state FOMO was significantly more related to PSU severity and PSNSU severity. This supports previous research reporting similar results (Balta et al., 2020; Li et al., 2020; Wegmann et al., 2017). Females scored significantly higher than men on PSU and PSNSU severity, with no differences on trait or state FOMO scores. Younger age and female gender were associated with PSU severity. These findings support previous research on younger individuals (Mitchell and Hussain, 2018; Rozgonjuk et al., 2021), and females having greater PSU severity (Lee et al., 2018; Mok et al., 2014). Gender differences, PSU, and PSNSU severity should be investigated in future research.

In the SEM analysis, state FOMO was significantly associated with PSNSU severity; trait FOMO was not significant. This finding supported previous research (Li et al., 2020; Wegmann et al., 2017). Potential reasons for this finding could be that state FOMO is experienced when individuals use SNSs and given the nature of this technology coupled with the application activities of viewing videos/photos, notifications, likes, and interactions that may bring on the feelings of state FOMO. Therefore, state FOMO could be associated with PSNSU severity more so than trait FOMO due to it being dependent on experiences. In terms of the I-PACE model, state FOMO may represent a specific cognitive-related bias (Li et al., 2020; Wegmann et al., 2017). Future research is needed to further investigate trait and state FOMO.

PSNSU was associated with PSU severity, when controlling for age

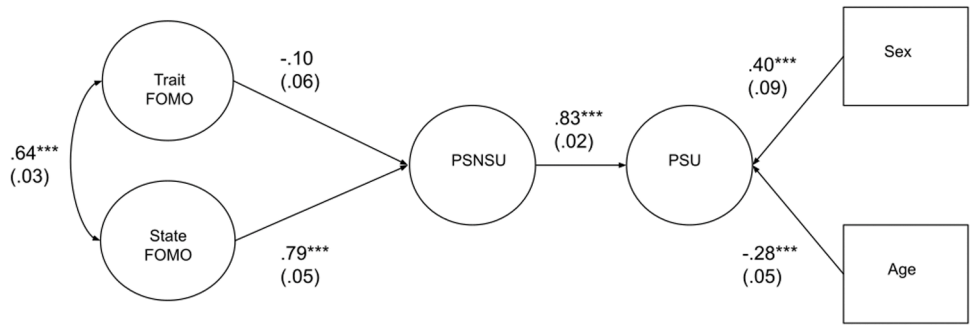

Fig. 2. Primary research model tested, with resulting standardized coefficients.
Note. Standardized coefficients are shown, with standard errors in parentheses. FOMO=Fear of missing out; PSNSU=Problematic social networking site use; PSU=Problematic smartphone use. Round objects indicate latent variables, while rectangles indicate observed variables. For simplicity, relations between each latent factor and its associated observed indicator variables are not displayed (but are available upon request). * $p < .05$, ** $p < .01$, *** $p < .001$

and gender. These findings support previous research that reported associations between PSNSU severity and PSU severity, and that the use of certain online channels, such as SNSs, may lead to PSU (Duke and Montag, 2017; Montag et al., 2021; Peterka-Bonetta et al., 2021). Mediation analysis revealed that PSNSU mediated relations between state FOMO and PSU severity, supporting previous research by Wegmann et al. (2017). These findings highlight the underlying mechanism of PSNSU and its role in the relationship between FOMO and PSU. PSNSU did not mediate relations between trait FOMO and PSU severity, and this supports previous research that has argued that the frequent use of online communication applications triggers the less stable state FOMO in contrast to the dispositional trait FOMO (Wegmann et al., 2017). Complex SNS algorithms deployed especially in more recent SNSs, such as TikTok, that work in collaboration with constant updates and notifications elicit feelings of state FOMO (Alshakhsi et al., 2023; Alutaybi et al., 2019). The present study findings support the I-PACE model (Brand et al., 2019), showing that FOMO may cognitively play a role in the development of problematic internet use behaviour. These results show that individuals who experience FOMO may engage with SNS use putting them at risk for developing PSNSU. This engagement with SNSs may consequently lead to PSU. It can be assumed that low sense of control might contribute to PSU and enhanced experiences of FOMO combined with increased levels of repetitive negative thinking could reinforce this relationship (Brailovskaia et al., 2021). The I-PACE model proposes that cognitive and affective responses to specific stimuli lead to the development of addictive behaviours. In the present study, state FOMO was associated with PSNSU, and PSNSU was in turn associated with PSU. This showed that FOMO may be an important mechanism in the development of PSNSU and PSU. Future research could further investigate the role of FOMO.

The implications of the study findings are that they will benefit users of all types of technology to understand their usage and to be aware of potential triggers that may lead to problematic use. User awareness and cognitions can help prevent maladaptive use of technology (Bickham, 2021). The findings may help in the development of interventions; psychological interventions may help to reduce problematic technology behaviours (Malinauskas and Malinauskiene, 2019). Furthermore, the findings will increase awareness amongst clinicians allowing them to identify the different dimensions of FOMO that are presented in patients which could lead to enhancements in treatment of behavioural addictions. Users of digital devices could potentially prevent problematic use by engaging in fulfilling activities such as physical and leisure activities that do not involve being online (Brailovskaia et al., 2018; Tomczyk and Selmanagic, 2018). One should also not forget that tech-companies designed their platforms to create FOMO (Alutaybi et al., 2019) and should take some responsibility for users spending too much time on the platforms (Montag et al., 2022). Hence, the investigation of how design elements of smartphone applications elicit FOMO and other relevant psychological processes is a highly relevant research field (Sindermann et al., 2022). FOMO is not necessarily a serious problem. Roberts and David (2020) found that FOMO can have a positive impact on well-being if it leads to SNS use that fosters social connection. Connected to this, observation and even tracking of users' activities can provide a sense of control, and for those who fear a loss of control, smartphone and SNS use may act as a coping strategy (Elhai et al., 2021).

The present study had several limitations. The cross-sectional nature of the current study design did not allow for causal inferences to be established. There were limitations associated with self-report data used in the current study (i.e., social desirability bias, accuracy of recall). Recent research has highlighted limitations relating to the BSMAS (Andreassen et al., 2016), and the findings have called for a renewed conceptualisation and assessment of behavioural addictions (Cataldo et al., 2022; Fournier et al., 2023). Future research could utilise longitudinal methods or more reliable measures, such as smartphone or SNS log data to allow for causal explanations to be made (Rozgonjuk et al., 2018b; see also a piece on mobile sensing and digital phenotyping by Montag and Rumpf, 2021). The analysed model examined only several of the many determinant factors from the I-PACE model that may influence problematic use. Future research could examine a more complex model of predisposing and determinant factors.

5. Conclusions

The study findings are important in increasing understanding of the different dimensions of FOMO and how they are associated with maladaptive online behaviours. Interesting insights into the role of trait and state FOMO have been presented which will be of benefit to prevention programmes. Future research should further examine FOMO and the relationships with cognitive/affective mechanisms.

CRediT authorship contribution statement

Zaheer Hussain: Conceptualization, Investigation, Methodology, Data curation, Writing – original draft, Writing – review & editing. **Jon D. Elhai:** Conceptualization, Investigation, Methodology, Formal analysis, Writing – original draft, Writing – review & editing. **Christian Montag:** Conceptualization, Investigation, Methodology, Writing – review & editing. **Elisa Wegmann:** Conceptualization, Investigation, Methodology. **Dmitri Rozgonjuk:** Conceptualization, Investigation, Methodology, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Alshakhsi, S., Babiker, A., Montag, C., Ali, R., 2023. On the association between personality, fear of missing out (FoMO) and problematic social media use tendencies in European and Arabian samples. Acta Psychol 240, 104026. https://doi.org/10.1016/j.actpsy.2023.104026.

Alutaybi, A., Arden-Close, E., McAlaney, J., Stefanidis, A., Phalp, K., Ali, R., 2019. How can social networks design trigger fear of missing out?. In: 2019 IEEE International Conference on Systems, Man and Cybernetics (SMC). IEEE, pp. 3758–3765. https://doi.org/10.1109/SMC.2019.8914672.

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. Psychol. Addict. Behav. 30 (2), 252–262. https://doi.org/10.1037/adb0000160.

Andreassen, C.S., Pallesen, S., 2014. Social network site addiction – an overview. Curr. Pharm. Des. 20, 4053–4061.

Aygul, T.A., Akbay, S.E., 2019. Smartphone addiction, fear of missing out, and perceived competence as predictors of social media addiction of adolescents. Eur. J. Educ. Res. 8 (2), 559–566. https://doi.org/10.12973/eu-jer.8.2.559.

American Psychiatric Association, 2022. *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision* (DSM-5-TR). American Psychiatric Association. https://doi.org/10.1176/appi.books.9780890425787.

Balta, S., Emirtekin, E., Kircaburun, K., Griffiths, M.D., 2020. Neuroticism, trait fear of missing out, and phubbing: the mediating role of state fear of missing out and problematic Instagram use. Int. J. Ment. Health Addict. 18 (3), 628–639. https://doi.org/10.1007/s11469-018-9959-8.

Beyens, I., Frison, E., Eggermont, S., 2016. I don't want to miss a thing": adolescents' fear of missing out and its relationship to adolescents' social needs, Facebook use, and Facebook related stress. Comput. Human Behav. 64, 1–8. https://doi.org/10.1016/j.chb.2016.05.083.

Boer, M., Van Den Eijnden, R.J., Boniel-Nissim, M., Wong, S.L., Inchley, J.C., Badura, P., Stevens, G.W., 2020. Adolescents' intense and problematic social media use and their well-being in 29 countries. J. Adolesc. Health 66 (6), S89–S99. https://doi.org/10.1016/j.jadohealth.2020.02.014.

Bickham, D.S., 2021. Current research and viewpoints on internet addiction in adolescents. Curr. Pediatr. Rep. 9 (1), 1–10. https://doi.org/10.1007/s40124-020-00236-3.

Brailovskaia, J., Stirnberg, J., Rozgonjuk, D., Margraf, J., Elhai, J.D., 2021. From low sense of control to problematic smartphone use severity during Covid-19 outbreak: the mediating role of fear of missing out and the moderating role of repetitive negative thinking. PLoS One 16 (12), e0261023. https://doi.org/10.1371/journal.pone.0261023.

Brailovskaia, J., Teismann, T., Margraf, J., 2018. Physical activity mediates the association between daily stress and Facebook addiction disorder (FAD)–a longitudinal approach among German students. Comput. Human Behav. 86, 199–204. https://doi.org/10.1016/j.chb.2018.04.045.

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. Neurosci. Biobehav. Rev. https://doi.org/10.1016/j.neubiorev.2019.06.032.

Busch, P.A., McCarthy, S., 2021. Antecedents and consequences of problematic smartphone use: a systematic literature review of an emerging research area. Comput. Human Behav. 114, 106414 https://doi.org/10.1016/j.chb.2020.106414.

Cataldo, I., Billieux, J., Esposito, G., Corazza, O., 2022. Assessing problematic use of social media: where do we stand and what can be improved? Curr. Opin. Behav. Sci. 45, 101145 https://doi.org/10.1016/j.cobeha.2022.101145.

Chen, F.F., 2007. Sensitivity of goodness of fit indexes to lack of measurement invariance. Struct. Eq. Model.: Multidiscipl. J. 14 (3), 464–504. https://doi.org/10.1080/10705510701301834.

Chotpitayasunondh, V., Douglas, K.M., 2016. How "phubbing" becomes the norm: the antecedents and consequences of snubbing via smartphone. Comput. Human Behav. 63, 9–18. https://doi.org/10.1016/j.chb.2016.05.018.

Dempsey, A.E., O'Brien, K.D., Tiamiyu, M.F., Elhai, J.D., 2019. Fear of missing out (FoMO) and rumination mediate relations between social anxiety and problematic Facebook use. Addict. Behav. Rep. 9, 100150 https://doi.org/10.1016/j.abrep.2018.100150.

Duke, É., Montag, C., 2017. Smartphone addiction and beyond: initial insights on an emerging research topic and its relationship to Internet addiction. In: Montag, C., Reuter, M. (Eds.), Internet addiction: Neuroscientific approaches and Therapeutical Implications Including Smartphone Addiction. Springer, pp. 359–372.

Duradoni, M., Innocenti, F., Guazzini, A., 2020. Well-being and social media: a systematic review of Bergen addiction scales. Future Internet 12 (2), 24. https://doi.org/10.3390/fi12020024.

Edwards, E.J., Taylor, C.S., Vaughan, R.S., 2022. Individual differences in self-esteem and social anxiety predict problem smartphone use in adolescents. Sch. Psychol. Int. 43 (5), 460–476. https://doi.org/10.1177/01430343221111061.

Elhai, J.D., Gallinari, E.F., Rozgonjuk, D., Yang, H., 2020. Depression, anxiety and fear of missing out as correlates of social, non-social and problematic smartphone use. Addict. Behav. 105, 106335 https://doi.org/10.1016/j.addbeh.2020.106335.

Elhai, J.D., Levine, J.C., Hall, B.J., 2019. The relationship between anxiety symptom severity and problematic smartphone use: a review of the literature and conceptual frameworks. J. Anxiety Disord. 62, 45–52. https://doi.org/10.1016/j.janxdis.2018.11.005.

Elhai, J.D., McKay, D., Yang, H., Minaya, C., Montag, C., Asmundson, G.J., 2021a. Health anxiety related to problematic smartphone use and gaming disorder severity during COVID-19: fear of missing out as a mediator. Human Behav. Emerg. Technol. 3 (1), 137–146. https://doi.org/10.1002/hbe2.227.

Elhai, J.D., Yang, H., Montag, C., 2021b. Fear of missing out (FOMO): overview, theoretical underpinnings, and literature review on relations with severity of negative affectivity and problematic technology use. Brazil. J. Psychiatry 43 (2), 203–209. https://doi.org/10.1590/1516-4446-2020-0870.

Fabris, M.A., Marengo, D., Longobardi, C., Settanni, M., 2020. Investigating the links between fear of missing out, social media addiction, and emotional symptoms in adolescence: the role of stress associated with neglect and negative reactions on social media. Addict. Behav. 106, 106364 https://doi.org/10.1016/j.addbeh.2020.106364.

Fang, J., Wang, X., Wen, Z., Zhou, J., 2020. Fear of missing out and problematic social media use as mediators between emotional support from social media and phubbing behavior. Addict. Behav. 107, 106430 https://doi.org/10.1016/j.addbeh.2020.106430.

Fournier, L., Schimmenti, A., Musetti, A., Boursier, V., Flayelle, M., Cataldo, I., Billieux, J., 2023. Deconstructing the components model of addiction: an illustration through "addictive" use of social media. Addict. Behav. 143, 107694 https://doi.org/10.1016/j.addbeh.2023.107694.

Griffiths, M., 2005. A 'components' model of addiction within a biopsychosocial framework. J. Subst. Use 10 (4), 191–197. https://doi.org/10.1080/14659890500114359.

Guo, N., Luk, T.T., Wang, M.P., Ho, S.Y., Fong, D.Y.T., Wan, A., Lam, T.H., 2021. Self-Reported screen time on social networking sites associated with problematic smartphone use in hinese adults: a population-based study. Front. Psychiatry 11, 614061. https://doi.org/10.3389/fpsyt.2020.614061.

Hao, Z., Jin, L., Huang, J., Wu, H., 2022. Stress, academic burnout, smartphone use types and problematic smartphone use: the moderation effects of resilience. J. Psychiatr. Res. 150, 324–331. https://doi.org/10.1016/j.jpsychires.2022.03.019.

Harris, B., Regan, T., Schueler, J., Fields, S.A., 2020. Problematic mobile phone and smartphone use scales: a systematic review. Front. Psychol. 11, 672. https://doi.org/10.3389/fpsyg.2020.00672.

Haug, S., Castro, R.P., Kwon, M., Filler, A., Kowatsch, T., Schaub, M.P., 2015. Smartphone use and smartphone addiction among young people in Switzerland. J. Behav. Addict. 4 (4), 299–307. https://doi.org/10.1556/2006.4.2015.037.

Henzel, V., Håkansson, A., 2021. Hooked on virtual social life. Problematic social media use and associations with mental distress and addictive disorders. PLoS One 16 (4), e0248406. https://doi.org/10.1371/journal.pone.0248406.

Horwood, S., Anglim, J., 2019. Problematic smartphone usage and subjective and psychological well-being. Comput. Human Behav. 97, 44–50. https://doi.org/10.1016/j.chb.2019.02.028.

Huang, C., 2022. A meta-analysis of the problematic social media use and mental health. Int. J. Soc. Psychiatry 68 (1), 12–33. https://doi.org/10.1177/0020764020978434.

Hussain, Z., Starcevic, V., 2020. Problematic social networking site use: a brief review of recent research methods and the way forward. Curr. Opin. Psychol. 36, 89–95. https://doi.org/10.1016/j.copsyc.2020.05.007.

Kwon, M., Lee, J.Y., Won, W.Y., Park, J.W., Min, J.A., Hahn, C., Gu, X., Choi, J.H., Kim, D.J., 2013. Development and validation of a smartphone addiction scale (SAS). PLoS One 8 (2), e56936. https://doi.org/10.1371/journal.pone.0056936.

Lee, S.Y., Lee, D., Nam, C.R., Kim, D.Y., Park, S., Kwon, J.G., Choi, J.S., 2018. Distinct patterns of Internet and smartphone-related problems among adolescents by gender: latent class analysis. J. Behav. Addict. 7 (2), 454–465. https://doi.org/10.1556/2006.7.2018.28.

Lei, P.W., Shiverdecker, L.K., 2020. Performance of estimators for confirmatory factor analysis of ordinal variables with missing data. Struct. Eq. Model.: Multidiscipl. J. 27 (4), 584–601. https://doi.org/10.1080/10705511.2019.1680292.

Li, L., Griffiths, M.D., Mei, S., Niu, Z., 2020. Fear of missing out and smartphone addiction mediates the relationship between positive and negative affect and sleep quality among Chinese university students. Front. Psychiatry 11, 877. https://doi.org/10.3389/fpsyt.2020.00877.

Malinauskas, R., Malinauskiene, V., 2019. A meta-analysis of psychological interventions for Internet/smartphone addiction among adolescents. J. Behav. Addict. 8 (4), 613–624. https://doi.org/10.1556/2006.8.2019.72.

Marino, C., Canale, N., Melodia, F., Spada, M.M., Vieno, A., 2021. The overlap between problematic smartphone use and problematic social media use: a systematic review. Curr. Addict. Rep 8 (4), 469–480. https://doi.org/10.1007/s40429-021-00398-0.

Mehmood, A., Bu, T., Zhao, E., Zelenina, V., Alexander, N., Wang, W., Yang, Y., 2021. Exploration of psychological mechanism of smartphone addiction among international students of china by selecting the framework of the I-PACE Model. Front. Psychol. 12, 758610 https://doi.org/10.3389/fpsyg.2021.758610.

Mitchell, L., Hussain, Z., 2018. Predictors of problematic smartphone use: an examination of the integrative pathways model and the role of age, gender, impulsiveness, excessive reassurance seeking, extraversion, and depression. Behav. Sci. 8 (8), 74. https://doi.org/10.3390/bs8080074.

Mok, J.Y., Choi, S.W., Kim, D.J., Choi, J.S., Lee, J., Ahn, H., Song, W.Y., 2014. Latent class analysis on internet and smartphone addiction in college students. Neuropsychiatr Dis. Treat. 10, 817. https://doi.org/10.2147/NDT.S59293.

Montag, C., Müller, M., Pontes, H.M., Elhai, J.D., 2023. On fear of missing out, social networks use disorder tendencies and meaning in life. BMC Psychol. 11 (1), 358. https://doi.org/10.1186/s40359-023-01342-9.

Montag, C., Thrul, J., van Rooij, A.J., 2022. Social media companies or their users—Which party needs to change to reduce online time? Addiction 117 (8), 2363–2364. https://doi.org/10.1111/add.15946.

Montag, C., Rumpf, H.J., 2021. The potential of digital phenotyping and mobile sensing for psycho-diagnostics of internet use disorders. Curr. Addict. Rep. 8, 422–430. https://doi.org/10.1007/s40429-021-00376-6.

Montag, C., Wegmann, E., Sariyska, R., Demetrovics, Z., Brand, M., 2021a. How to overcome taxonomical problems in the study of Internet use disorders and what to do with "smartphone addiction"? J. Behav. Addict. 9 (4), 908–914. https://doi.org/10.1556/2006.8.2019.59.

Montag, C., Sindermann, C., Becker, B., Panksepp, J., 2016. An affective neuroscience framework for the molecular study of Internet addiction. Front. Psychol. 7, 1906. https://doi.org/10.3389/fpsyg.2016.01906.

Montag, C., Sindermann, C., Rozgonjuk, D., Yang, S., Elhai, J.D., Yang, H., 2021b. Investigating links between fear of COVID-19, neuroticism, social networks use disorder, and smartphone use disorder tendencies. Front. Psychol. 12, 682837 https://doi.org/10.3389/fpsyg.2021.682837.

Oberst, U., Wegmann, E., Stodt, B., Brand, M., Chamarro, A., 2017. Negative consequences from heavy social networking in adolescents: the mediating role of fear of missing out. J. Adolesc. 55, 51–60. https://doi.org/10.1016/j.adolescence.2016.12.008.

Parent, N., Bond, T., Wu, A., Shapka, J., 2022. Predicting patterns of problematic smartphone use among university students: a latent class analysis. Human Behav. Emerg. Technol. 2022 https://doi.org/10.1155/2022/4287600.

Peterka-Bonetta, J., Sindermann, C., Elhai, J.D., Montag, C., 2021. How objectively measured Twitter and Instagram use relate to self-reported personality and tendencies toward Internet/Smartphone Use Disorder. Human Behav. Emerg. Technol. 3 (5), 898–911. https://doi.org/10.1002/hbe2.243.

Przybylski, A.K., Murayama, K., DeHaan, C.R., Gladwell, V., 2013. Motivational, emotional, and behavioral correlates of fear of missing out. Comput. Human. Behav. 29 (4), 1841–1848.

R Core Team, 2022. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Rathakrishnan, B., Bikar Singh, S.S., Kamaluddin, M.R., Yahaya, A., Mohd Nasir, M.A., Ibrahim, F., Ab Rahman, Z., 2021. Smartphone addiction and sleep quality on academic performance of university students: an exploratory research. Int. J. Environ. Res. Public Health 18 (16), 8291. https://doi.org/10.3390/ijerph18168291.

Roberts, J.A., David, M.E., 2020. The social media party: fear of missing out (FoMO), social media intensity, connection, and well-being. Int. J. Human–Comput. Interact. 36 (4), 386–392. https://doi.org/10.1080/10447318.2019.1646517.

Rozgonjuk, D., Kattago, M., Täht, K., 2018a. Social media use in lectures mediates the relationship between procrastination and problematic smartphone use. Comput. Human. Behav. 89, 191–198. https://doi.org/10.1016/j.chb.2018.08.003.

Rozgonjuk, D., Levine, J.C., Hall, B.J., Elhai, J.D., 2018b. The association between problematic smartphone use, depression and anxiety symptom severity, and objectively measured smartphone use over one week. Comput. Human. Behav. 87, 10–17. https://doi.org/10.1016/j.chb.2018.05.019.

Rozgonjuk, D., Schivinski, B., Pontes, H.M., Montag, C., 2021. Problematic online behaviors among gamers: the links between problematic gaming, gambling, shopping, pornography use, and social networking. Int. J. Ment. Health Addict. 1–18. https://doi.org/10.1007/s11469-021-00590-3.

Rozgonjuk, D., Sindermann, C., Elhai, J.D., Christensen, A.P., Montag, C., 2020a. Associations between symptoms of problematic smartphone, Facebook, WhatsApp, and Instagram use: an item-level exploratory graph analysis perspective. J. Behav. Addict. 9 (3), 686–697. https://doi.org/10.1556/2006.2020.00036.

Rozgonjuk, D., Sindermann, C., Elhai, J.D., Montag, C., 2020b. Fear of Missing Out (FoMO) and social media's impact on daily-life and productivity at work: do WhatsApp, Facebook, Instagram, and Snapchat Use Disorders mediate that association? Addict. Behav. 110, 106487 https://doi.org/10.1016/j.addbeh.2020.106487.

Rozgonjuk, D., Sindermann, C., Elhai, J.D., Montag, C., 2021a. Comparing smartphone, WhatsApp, Facebook, Instagram, and Snapchat: which platform elicits the greatest use disorder symptoms? Cyberpsychol., Behav., Social Network. 24 (2), 129–134. https://doi.org/10.1089/cyber.2020.0156.

Rozgonjuk, D., Sindermann, C., Elhai, J.D., Montag, C., 2021b. Individual differences in Fear of Missing Out (FoMO): age, gender, and the Big Five personality trait domains, facets, and items. Pers. Individ Dif. 171, 110546 https://doi.org/10.1016/j.paid.2020.110546.

Sela, Y., Zach, M., Amichay-Hamburger, Y., Mishali, M., Omer, H., 2020. Family environment and problematic internet use among adolescents: the mediating roles of depression and fear of missing out. Comput. Human. Behav. 106, 106226 https://doi.org/10.1016/j.chb.2019.106226.

Saputri, R.A.M., Yumarni, T., 2021. Social media addiction and mental health among university students during the COVID-19 pandemic in Indonesia. Int. J. Ment. Health Addict. 1–15. https://doi.org/10.1007/s11469-021-00582-3.

Sha, P., Sariyska, R., Riedl, R., Lachmann, B., Montag, C., 2019. Linking internet communication and smartphone use disorder by taking a closer look at the Facebook and WhatsApp applications. Addict. Behav. Rep. 9, 100148 https://doi.org/10.1016/j.abrep.2018.100148.

Shi, D., Maydeu-Olivares, A., Rosseel, Y., 2020. Assessing fit in ordinal factor analysis models: SRMR vs. RMSEA. Struct. Eq. Model.: A Multidiscipl. J. 27 (1), 1–15. https://doi.org/10.1080/10705511.2019.1611434.

Sindermann, C., Montag, C., Elhai, J.D., 2022. The design of social media platforms—initial evidence on relations between personality, fear of missing out, design element-driven increased social media use, and problematic social media use. Technol., Mind, Behavior 3 (4). https://tmb.apaopen.org/pub/m4nkfstp.

Song, Y., Sznajder, K., Cui, C., Yang, Y., Li, Y., Yang, X., 2022. Anxiety and its relationship with sleep disturbance and problematic smartphone use among Chinese medical students during COVID-19 home confinement – a structural equation model analysis. J. Affect. Disord. 296, 315–321. https://doi.org/10.1016/j.jad.2021.09.095.

Sun, Y., Zhang, Y., 2021. A review of theories and models applied in studies of social media addiction and implications for future research. Addict. Behav. 114, 106699 https://doi.org/10.1016/j.addbeh.2020.106699.

Tomczyk, Ł., Selmanagic-Lizde, E., 2018. Fear of Missing Out (FOMO) among youth in Bosnia and Herzegovina—scale and selected mechanisms. Child. Youth. Serv. Rev. 88, 541–549. https://doi.org/10.1016/j.childyouth.2018.03.048.

Thomson, K., Hunter, S.C., Butler, S.H., Robertson, D.J., 2021. Social media 'addiction': the absence of an attentional bias to social media stimuli. J. Behav. Addict. 10 (2), 302–313. https://doi.org/10.1556/2006.2021.00011.

Vally, Z., Alghraibeh, A.M., Elhai, J.D., 2021. Severity of depression and anxiety in relation to problematic smartphone use in the United Arab Emirates: the mediational roles of rumination and fear of missing out. Human Behav. Emerg. Technol. 3 (3), 423–431. https://doi.org/10.1002/hbe2.259.

Wartberg, L., Kriston, L., Thomasius, R., 2020. Internet gaming disorder and problematic social media use in a representative sample of German adolescents: prevalence estimates, comorbid depressive symptoms and related psychosocial aspects. Comput. Human. Behav. 103, 31–36. https://doi.org/10.1016/j.chb.2019.09.014.

Wegmann, E., Oberst, U., Stodt, B., Brand, M., 2017. Online-specific fear of missing out and Internet-use expectancies contribute to symptoms of Internet-communication disorder. Addict. Behav. Rep. 5, 33–42. https://doi.org/10.1016/j.abrep.2017.04.001.

Westbrook, A., Ghosh, A., van den Bosch, R., Määttä, J.I., Hofmans, L., Cools, R., 2021. Striatal dopamine synthesis capacity reflects smartphone social activity. iScience 24 (5), 102497. https://doi.org/10.1016/j.isci.2021.102497.

Wolniewicz, C.A., Rozgonjuk, D., Elhai, J.D., 2020. Boredom proneness and fear of missing out mediate relations between depression and anxiety with problematic smartphone use. Human Behav. Emerg. Technol. 2 (1), 61–70. https://doi.org/10.1002/hbe2.159.

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. Int. J. Environ. Res. Public Health 17 (6), 1879. https://doi.org/10.3390/ijerph17061879.

World Health Organization, 2018. *International Classification of Diseases For Mortality and Morbidity Statistics* 11th Revision). https://icd.who.int/browse11/l-m/en.

Wickord, L.C., Quaiser-Pohl, C., 2022. Psychopathological symptoms and personality traits as predictors of problematic smartphone use in different age groups. Behav. Sci. 12 (2), 20. https://doi.org/10.3390/bs12020020.

Yang, H., Liu, B., Fang, J., 2021. Stress and problematic smartphone use severity: smartphone use frequency and fear of missing out as mediators. Front. Psychiatry 12, 659288. https://doi.org/10.3389/fpsyt.2021.659288.

Yuan, G., Elhai, J.D., Hall, B.J., 2021. The influence of depressive symptoms and fear of missing out on severity of problematic smartphone use and Internet gaming disorder among Chinese young adults: a three-wave mediation model. Addict. Behav. 112, 106648 https://doi.org/10.1016/j.addbeh.2020.106648.

Zhao, L., 2021. The impact of social media use types and social media addiction on subjective well-being of college students: a comparative analysis of addicted and non-addicted students. Comput. Human Behav. Reports 4, 100122. https://doi.org/10.1016/j.chbr.2021.100122.