Addictive Behaviors 143 (2023) 107708

Contents lists available at ScienceDirect

Addictive Behaviors

journal homepage: www.elsevier.com/locate/addictbeh

Emotion dysregulation factors associated with problematic smartphone use severity: The mediating role of fear of missing out

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ARTICLE INFO

Keywords:
Emotion dysregulation
Fear of missing out
Mediation analysis
Problematic smartphone use
Structural equation modeling

ABSTRACT

Based on current theoretical frameworks, there has been increasing research examining psychopathology leading to problematic smartphone use (PSU). However, less is known about the affective and cognitive processes linked to PSU. The present study aimed at analyzing the fear of missing out (FoMO) as a mediator in the association between emotion dysregulation and PSU severity. Participants were 343 U.S. undergraduate students (64.7 % female, *M*age = 19.3, *SD* = 2.51) who completed online measures of emotion dysregulation, FoMO and PSU. A fully latent structural equation model was analyzed. Results indicate greater impulse control dysregulation was associated with heightened PSU via increased FoMO. Our findings present evidence suggesting emotion dysregulation and FoMO as affective and cognitive mechanisms associated with PSU, with FoMO serving a mediating role between impulse control and PSU severity. Clinical implications are discussed.

1. Introduction

For some people, using smartphones excessively can lead to functional impairment and negative consequences. This pattern of usage is often referred to as problematic smartphone use (PSU; Billieux et al., 2015; Elhai et al., 2017), although other labels are used (for a discussion see Montag et al., 2021 and following commentaries). Global estimates suggest increased PSU prevalence rates after the COVID pandemic (Meng et al., 2022). Consequently, research about PSU's risk factors and associated mental health problems is imperative because of the various negative outcomes associated with this condition (Busch & McCarthy, 2021).

A consolidative approach to understanding excessive Internet use such as PSU is the Interaction Person-Affect-Cognition-Execution model (I-PACE; Brand et al., 2016, 2019). The model poses that the intersection between personal predisposing variables, affective and cognitive responses, and executive function difficulties can lead to problematic Internet use behaviors. I-PACE model has been paramount to understanding how psychopathology, a predisposing variable, influences PSU. For instance, the link between PSU and anxiety/depression symptoms is well-established in the research literature (Busch & McCarthy, 2021; Elhai et al., 2017). Although some evidence indicates that PSU leads to mental health problems (Coyne et al., 2019; Lapierre et al., 2019), most theoretical frameworks, like I-PACE, conceptualize psychopathology driving Internet overuse, such as PSU (Brand et al., 2019; Griffiths, 2019; Kardefelt-Winther, 2014).

There is current scientific interest in affective and cognitive processes explaining the development and maintenance of problematic Internet behaviors - components A and C in I-PACE (for a review of the state of the art see Elhai et al., 2019a; Wegmann & Brand, 2021). Furthermore, Elhai, Yang, and Montag (2019) stressed the importance of addressing these constructs/processes that are not disorders *per se* but can explain relations between psychopathology and PSU. The authors discussed several maladaptive coping responses linked to PSU, including emotional (*e.g.,* emotion dysregulation and distress intolerance) and cognitive (*e.g.,* rumination, proneness to boredom, worry, and fear of missing out (FoMO)) processes. We address two of these concepts: emotion dysregulation and FoMO.

Emotion dysregulation has at least two different conceptualizations (Gratz et al., 2020). The first one defines it as the combination of certain

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https://doi.org/10.1016/j.addbeh.2023.107708
Received 5 December 2022; Received in revised form 16 March 2023; Accepted 24 March 2023
Available online 25 March 2023

temperamental traits, such as emotional sensitivity, reactivity, intensity, and a slow return to baseline, with the understanding that these emotional responses are inherently dysregulated (Newhill et al., 2010, 2021). A second approach considers emotion dysregulation as maladaptive ways of reacting to emotions, including struggles in understanding, accepting, and modulating emotions regardless of their valence, intensity, or reactivity (Gratz & Roemer, 2004; Gratz et al., 2020). We focus on the latter conceptualization because it deems responses to emotions as more important than their quality, being malleable and subject to intervention, and because the questionnaire used in this study is based on this framework (Gratz et al., 2020).

Theoretical models indicate that emotion dysregulation is among the causes of mental disorders (Cludius et al., 2020; Sloan et al., 2017). Furthermore, emotion dysregulation has been associated with several problematic behaviors or behavioral addictions (Estévez et al., 2017; Marchica et al., 2019; Spada & Marino, 2017). Empirical research suggests that emotion dysregulation is related to greater PSU (Fırat et al., 2018; Gül et al., 2019; Horwood & Anglim, 2021; Squires et al., 2021) – in particular, aspects involving lack of emotional clarity and impulse control difficulties (Fırat et al., 2018; Horwood & Anglim, 2021).

Another important construct relevant to PSU is FoMO, which is conceptualized as a persistent concern that one is not present in the gratifying experiences of other people and is characterized by a need to stay connected to know what other people are doing (Przybylski et al., 2013; Tandon et al., 2021). Several studies empirically support the association between psychological distress/psychopathology and FoMO (Dempsey et al., 2019; Sette et al., 2020). Furthermore, extant scientific literature indicates that FoMO is associated with PSU severity (Elhai et al., 2021; Tandon et al., 2021). More specifically, FoMO is a significant mediator in the link between psychological distress and PSU severity (Elhai et al., 2020; Yang et al., 2021; Yuan et al., 2021).

Individuals suffering from emotion dysregulation might turn to maladaptive ways of coping with negative affectivity. Moreover, FoMO involves affective and cognitive processes and is associated with negative affect (Elhai et al., 2021). Thus, it makes intuitive sense that emotion dysregulation should be linked to heightened FoMO, and both variables have previously shown associations with PSU severity (*e.g.,* Elhai et al., 2021; Horwood & Anglim, 2021; Squires et al., 2021). Nonetheless, prior work has not examined FoMO as a mediator between emotion dysregulation and excessive Internet use/PSU.

1.1. The present study

Previous studies have addressed the gap between psychological distress (P component in the I-PACE model) and PSU, by testing emotion dysregulation (A component) (Squires et al., 2021) and FoMO (C component) (Elhai et al., 2020; Yang et al., 2021; Yuan et al., 2021) as mediators. The present study examined the middle part (A/C components) of I-PACE. The first objective was to test a model where emotion dysregulation would be associated with FoMO, and the latter would be linked to PSU. The second aim was to analyze FoMO as a potential mediator of this relationship. We postulated the following hypotheses:

H1: FoMO should be positively linked to PSU severity (Elhai et al., 2021).

H2: Emotion dysregulation factors should be significantly and positively related to FoMO (Elhai et al., 2018; Rozgonjuk & Elhai, 2021).

Finally, previous work has examined emotion dysregulation as a single variable (Quaglieri et al., 2022; Squires et al., 2021). Nonetheless, our best knowledge indicates that no prior studies have analyzed multiple emotion dysregulation facets in relation to FoMO and PSU. Because of the lack of sufficient background work, we do not pose specific hypotheses as to which indirect effects will be significant.

H3: A significant and positive indirect effect will be found from emotion dysregulation to PSU severity, through FoMO.

Fig. 1 presents our research model. This is a fully latent variable model (with the exception of the covariate) in which emotion dysregulation factors were expected to predict FoMO, specified to predict PSU severity. In addition, some studies found distinctions by sex in PSU severity (Fischer-Grote et al., 2019), and other types of excessive internet use (Chen et al., 2017; Su et al., 2020). Therefore, we added sex as a covariate in the path from FoMO to PSU to statistically control for these potential differences.

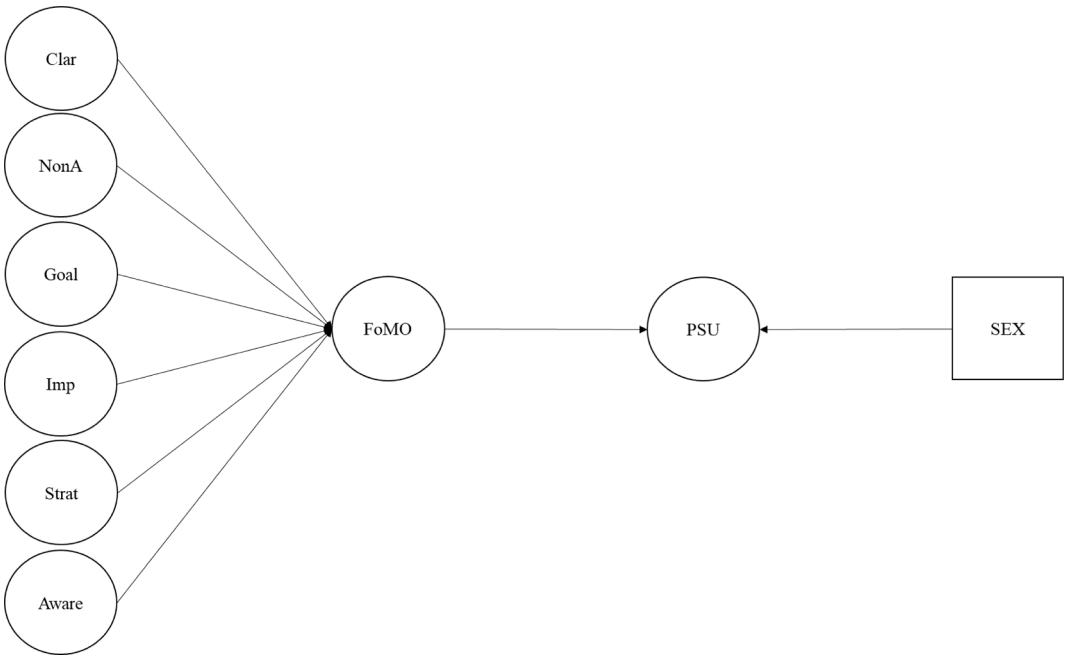

Fig. 1. Hypothesized SEM Model Note. Latent variables are represented in circles, while observed variables are presented in squares. DERS subscales: Clar = Lack of emotional clarity; NonA = Non-acceptance of emotion; Goal = Difficulties in adopting goal-directed behavior; Imp = Impulse control; Stra = Limited access to emotion regulation strategies; Aware = Lack of emotional awareness; FoMO = Fear of Missing Out; PSU = Problematic Smartphone Use.

2. Methods

2.1. Participants and procedure

A subset of measures was drawn from a larger project for this study, and the university's Institutional Review Board approved it. In 2021, an online survey was used to collect data through the PsychData web survey platform. Participants were recruited from the Psychology Department's undergraduate student research pool at a Midwestern U.S. university, using the university's Sona Systems web portal. Participants signing up for the study on Sona Systems were routed to an informed consent statement, and for those consenting, to the web survey. Participants were awarded course research points for completion. 379 participants consented. Based on survey timestamps, we removed 11 participants for duplicate survey entries and 6 students for only answering a few items. We deleted 4 participants for not owning a smartphone. Finally, we removed 15 participants for responding carelessly/inattentively (18+ identical responses consecutively) (Curran, 2016). The final sample consisted of 343 participants.

Most participants were female (64.7 %, n = 222); mean age was 19.3 years old (SD = 2.51; min = 18; max = 45). Racial breakdown was: 78.7 % White (n = 270), 12.8 % African American (n = 44), and 9.0 % Asian American (n = 31) (racial categories were non-mutually exclusive). Most participants were either unemployed (42.6 %, n = 146) or employed part-time (50.1 %, n = 172) with the remaining employed full-time (7.3 %, n = 26).

2.2. Instruments

Internal consistency for all scales is presented in Table 1.

2.2.1. Difficulties in Emotion Regulation Scale-Short Form (DERS-SF)

The DERS-SF (Kaufman et al., 2016) is composed of 18 items gauging 6 emotion dysregulation subscales regarding feeling distressed: (a) lack of emotional awareness, (b) lack of emotional clarity, (c) non-acceptance of emotional responses, (d) difficulties engaging in goal-directed behavior, (e) difficulties controlling impulsive behavior and (f) limited access to emotion regulation strategies. Items are answered on a 5-point Likert scale, from 1 = "almost never" to 5 = "almost always". The DERS-SF shows adequate psychometric properties (Kaufman et al., 2016).

2.2.2. Fear of Missing Out (FoMO) Scale

The FoMO Scale measures frequency of FoMO experiences using 10 items, answered on a Likert-type scale from 1 = "not at all true for me" to 5 = "extremely true for me". The scale has sound psychometric properties (Elhai et al., 2021).

2.2.3. Smartphone Addiction Scale-Short Version (SAS-SV)

The SAS-SV was used to assess PSU. It consists of 10 items measuring smartphone-related daily-life disturbances, overuse, withdrawal, cyberspace-oriented relationships, and tolerance. SAS-SV items use a Likert scale varying from 1 = "strongly disagree" to 6 = "strongly agree". The scale shows good validity and reliability (Harris et al., 2020; Kwon et al., 2013).

Table 1
Descriptive Statistics and Internal Consistency for Primary Variables.

Variables	*M*	*SD*	α
PSU	26.72	9.47	0.856
FOMO	22.68	8.43	0.887
DERS Full	45.50	13.32	0.904
Clarity	7.14	3.07	0.850
Nonacceptance	6.92	3.30	0.830
Goal-Directed Behaviors	8.82	3.62	0.920
Impulse control	5.52	3.19	0.920
Strategies	6.37	3.17	0.858
Emotional Awareness	10.72	2.87	0.813

M = Means; SD = Standard deviations; α = Cronbach's alpha.

2.3. Data analyses

Software R 4.2.0 (R Core Team, 2022) was used for data cleaning and pre-processing. For inattentive responding we used the *careless* R package, for data cleaning *dplyr,* to assess missing data *naniar,* to impute missing data *mice*, to conduct correlations *corrplot*, to assess internal consistency *fmsb*, and to analyze ANOVA effects *sjstats*. Only 0.75 % of sample data were missing. Data estimation and imputation were conducted using multiple imputation by chained equations. We estimated descriptive statistics, internal consistency, bivariate correlations between the continuous variables, and ANOVA to test relations between sex and the remaining variables.

Afterward, we used Mplus 8 (Muthén & Muthén, 2021) to conduct confirmatory factor analyses (CFA) and structural equation modeling (SEM). Scale items were treated as ordinal, using weighted least squares estimation with a mean- and variance-adjusted (WLSMV) chi-square, a polychoric covariance matrix and probit regression for factor loadings (Lei & Shiverdecker, 2020). We computed individual single-factor CFAs for the PSU and FoMO scales, and a six-factor model for the DERS. Residual error covariances were specified between items 1–2, and 4–5 of the PSU scale; and between items 1–2, and 9–10 of the FoMO scale because they were semantically related. All latent DERS factors were specified to correlate. In CFAs, the loading of the first item per latent factor was fixed to 1. Model fit was evaluated using standard conventions (CFI $\geq$ 0.95, TLI $\geq$ 0.95, RMSEA $<$ 0.06, SRMR $<$ 0.08) (Maydeu-Olivares, 2017). The same estimation approach was used in full SEM.

Using SEM, sex was added as a covariate of PSU. FoMO was expected to predict PSU, and the DERS six subscales were modeled to predict FoMO. Indirect effects of FoMO were tested by computing cross products of direct paths (Hayes, 2018). The delta method was used to calculate standard errors with 1000 non-parametric bootstrapped replications.

3. Results

3.1. Preliminary results

Table 1 presents general descriptive statistics, Fig. 2 shows intercorrelations, and Table 2 displays ANOVA results by sex. All scales had high internal consistency. Furthermore, all main study variables positively related to each other, except for age (with a negative association with FoMO), and lack of emotional awareness (only showing a positive association with the DERS total scale and a negative association with lack of emotional clarity). Finally, women scored significantly higher than men on all the DERS subscales, FoMO (small effect sizes), DERS total score, and PSU scores (medium effect sizes).

3.2. CFA results

The measurement model for the DERS-SF yielded good fit, WLSMV $\chi^2(120, 342) = 262.29$, $p < 0.001$, CFI = 0.99, TLI = 0.99, RMSEA = 0.05 (90 % CI[0.04, 0.06]), SRMR = 0.03. FoMO yielded adequate fit, WLSMV $\chi^2(33, 343) = 350.88$, $p < 0.001$, CFI = 0.96, TLI = 0.94, RMSEA = 0.16 (90 % CI[0.15, 0.18]), SRMR = 0.06. Finally, the SAS-SV also showed adequate fit, WLSMV $\chi^2(33, 343) = 149.30$, $p < 0.001$, CFI = 0.96, TLI = 0.94, RMSEA = 0.10 (90 % CI[0.08, 0.11]), SRMR = 0.03. Therefore, all fit indices showed good fit except for RMSEA. All factor loadings were relatively high, with the lowest loading in the DERS-SF being 0.72 (item 6 loading in the lack of emotional awareness factor), in FoMO being 0.58 (item 8), and in the SAS-SV being 0.49 (item 3).

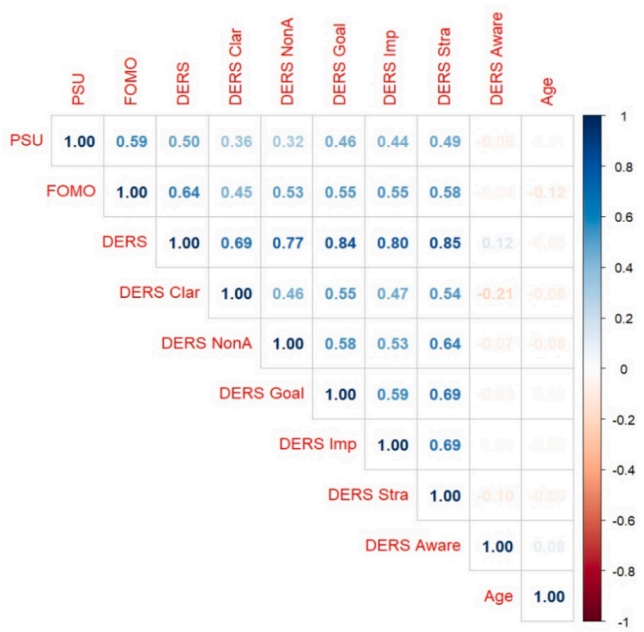

Fig. 2. Correlations Between Study Variables Note. Pearson correlations are presented. PSU = Problematic Smartphone Use; FOMO = Fear of Missing Out; DERS = Difficulties in Emotion Regulation, Full Scale; DERS Clar = Lack of emotional clarity subscale; DERS NonA = Nonacceptance of emotional responses subscale; DERS Goal = Difficulties engaging in goal-directed behavior subscale; DERS Imp = Impulse control difficulties subscale; DERS Stra = Limited access to emotion regulation strategies subscale; DERS Aware = Lack of emotional awareness subscale. This correlation heatmap shows stronger correlations with a darker shade, where positive correlations are blue and negative correlations are red. Almost all correlations were significant at $p < .05$ (two-sided test level). Age only had a significant correlation with FoMO. DERS Aware only had a significant correlation with DERS and DERS Clar.

3.3. Full SEM

We tested the model in Fig. 3, which fit the data well, WLSMV $\chi^2(676, 343) = 1453{,}40$, $p < 0.001$, CFI = 0.96, TLI = 0.95, RMSEA = 0.05 (90 % CI[0.05, 0.06]), SRMR = 0.07. As presented, the only DERS-SF subscale significantly predicting FoMO was "difficulties controlling impulsive behavior." Furthermore, increased FoMO was related to greater PSU, after controlling for sex. Finally, being female linked to higher PSU severity.

3.4. Mediation results

FoMO was a significant mediator in the association between difficulties controlling impulsive behavior and PSU, $\beta = 0.09$, $SE = 0.04$, $p = .04$. However, FoMO did not mediate associations between remaining DERS subscales and PSU: lack of emotional clarity ($\beta = 0.05$, $SE = 0.04$, $p = .23$); non-acceptance of emotional responses ($\beta = 0.05$, $SE = 0.05$, $p = .30$); difficulties engaging in goal-directed behavior ($\beta = 0.08$, $SE = 0.05$, $p = .15$); limited access to emotion regulation strategies ($\beta = 0.14$, $SE = 0.08$, $p = .10$), and lack of emotional awareness ($\beta = 0.00$, $SE = 0.03$, $p = .94$).

4. Discussion

The first aim was to test an SEM model exploring associations between emotion dysregulation, FoMO and PSU severity. We found all fit indices within the expected parameters. We also found generally well-fitting measurement models, except for RMSEA indices. Nonetheless, when using ordinal data and WLSMV estimation (as we did), RMSEA is notorious for not recognizing good fit (Shi et al., 2020).

The second purpose of our study was to analyze FoMO as a possible mediator between the six emotion dysregulation facets and PSU severity. First, we found a positive association between FoMO and PSU, supporting H1 and in accordance with prior research (Elhai et al., 2021). Second, we found some supporting evidence for H2, such that impulse control difficulties (i.e., one of the emotion dysregulation factors) were associated with heightened FoMO. Moreover, partial support was found for H3, because impulse control difficulties were related to greater PSU indirectly through FoMO. This DERS subscale is composed of items that imply having trouble controlling one's behavior when negative emotions are experienced (Gratz & Roemer, 2004). This finding is consistent with prior studies showing that impulse control difficulties are the most predictive of PSU (Fırat et al., 2018; Horwood & Anglim, 2021). Similarly, there are also empirical findings suggesting that impulsivity is associated with PSU severity (de Carvalho et al., 2018; Grant et al., 2019; Peterka-Bonetta et al., 2019). Although related, there is a need to clarify that having difficulties controlling behavioral responses when experiencing negative emotions is not the same as being impulsive, because the latter refers to a relatively stable trait (which would be more in line with the P component in the I-PACE model), and the former implies a (maladaptive) response to negative affect (which is more consistent with an affective process, i.e., A component). This is relevant because a learned response is subject to change, it can be re-learned with training and interventions (Gratz et al., 2020), so it could imply a target for prevention and/or treatment of PSU.

Our main contribution was providing supporting evidence suggesting FoMO as one of the mechanisms explaining associations between having difficulties controlling impulsive behavior when upset and PSU. FOMO was initially conceptualized as being derived from unmet psychological needs (Przybylski et al., 2013; Tandon et al., 2021). It has also been suggested that this proposal is similar to that of responses to ostracism (Elhai et al., 2021). In ostracism there is a negative emotional response following social rejection, which might threaten the satisfaction of psychological needs; depending on which need is threatened the person might resort to prosocial (belonging and self-esteem needs) or antisocial (control over social situations and existence-recognition needs) behavior in order to fortify those needs (Williams & Nida, 2022). These theories are relevant to understanding FoMO as a mediator

Table 2
Means, Standard Deviations and Inferential Statistics (ANOVA) for Primary Variables by Sex.

Variable	Male (N = 121)		Female (N = 222)		ANOVA			η^2
	M	*SD*	*M*	*SD*	*df*	*F*	*p*	
PSU	23.44	8.64	28.51	9.45	1,341	23.95	0.001	0.07
FOMO	20.99	7.55	23.60	8.75	1,341	7.646	0.006	0.02
DERS	41.16	12.07	47.88	13.41	1,341	21.07	0.001	0.06
Clarity	6.48	2.98	7.50	3.06	1,341	8.895	0.003	0.03
NonAcc	6.17	3.02	7.33	3.38	1,341	9.94	0.002	0.03
Goal	7.70	3.37	9.43	3.62	1,341	18.79	0.001	0.05
Impulse	4.78	2.51	5.93	3.44	1,341	10.55	0.002	0.03
Strat	5.74	2.98	6.71	3.22	1,341	7.49	0.007	0.02
Awareness	10.28	2.86	10.96	2.86	1,341	4.398	0.04	0.01

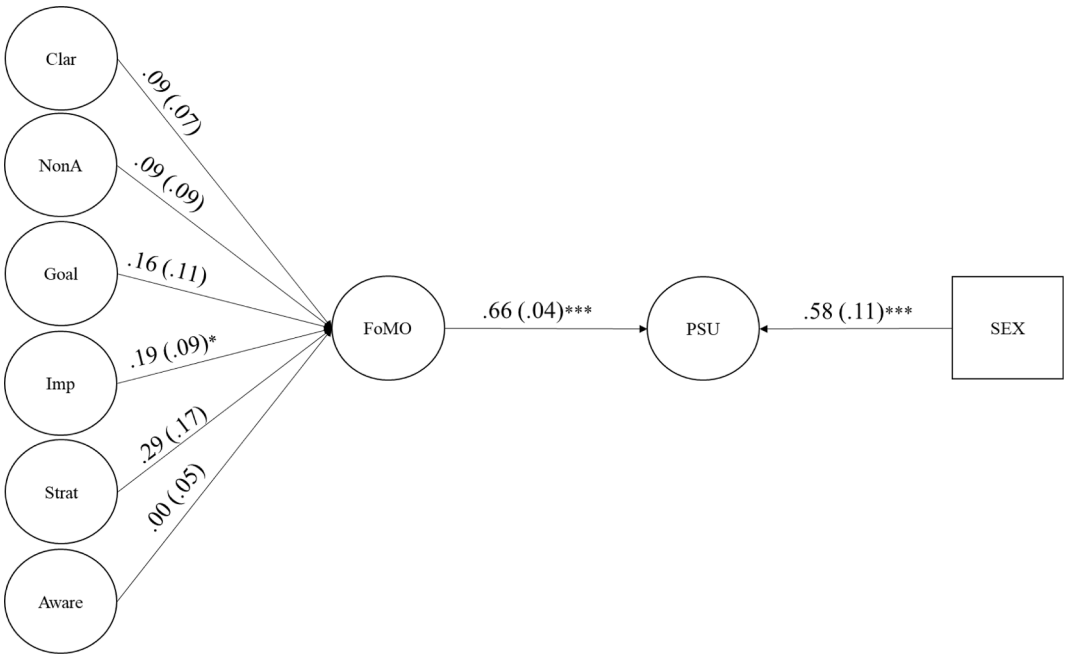

Fig. 3. SEM Model with Standardized Path Coefficients (and Standard Errors in Parentheses) Note. Latent variables are represented in circles, while observed variables are presented in squares. DERS subscales: Clar = Lack of emotional clarity; NonA = Non-acceptance of emotion; Goal = Difficulties in adopting goal-directed behavior; Imp = Impulse control; Stra = Limited access to emotion regulation strategies; Aware = Lack of emotional awareness; FoMO = Fear of Missing Out; PSU = Problematic Smartphone Use. Coding for sex was male = 1, female = 2. For simplicity, factor loadings for the latent variables are not displayed, but are available upon request from the authors. *p < .05, ***p < .001.

because the fear of potential rejection, which underlies the concept of FoMO, is a powerful psychological motor (and this motor is also used by the tech industry by triggering FoMO via platform design, Alutaybi et al., 2019; see also a call for corporate responsibility: Montag et al., 2021; Montag et al., 2022). If an individual with difficulties controlling behavior when upset also experiences FoMO, then continuously turning to the smartphone as a means to check on other people's lives, obtain reassurance and stay continually connected, seems like a reasonable response. To this end, Rozgonjuk et al. (2021) suggested that people with higher belonging need satisfaction and increased activation of the *play* emotional system may engage more with PSU because they are more expectant of smartphone notifications, which serve as social cues. Because notifications follow an unexpected pattern, constant checking behavior may be reinforced by these social cues (Rozgonjuk et al., 2021). This notion is also consistent with that of PSU as a go-to mood-regulation strategy because smartphones are readily available at any time and place, making them the most evident choice for many people to regulate negative affective states (Elhai et al., 2019b).

Similarly, our results provide empirical support for the proposal of negative reinforcement as a path leading to maintenance of PSU (Elhai et al., 2017) because individuals who struggle to control their behavior when feeling negative emotions, and who experience FoMO, might overuse their smartphones in an attempt to ease their distress, leading to PSU. Furthermore, our findings support the pathways model to PSU, specifically the impulsive pathway (Billieux et al., 2015). When considered together with ostracism theory (Williams & Nida, 2022), our findings suggest that FoMO might be one of the mechanisms explaining how impulse control difficulties relate to PSU because control over social situations and existence-recognition needs might feel threatened in people with FoMO, thus leading to an antisocial pattern of smartphone usage. Finally, our study provides empirical evidence for the middle part of the I-PACE model by linking affective and cognitive processes leading to PSU (Brand et al., 2016, 2019).

We did not find support for the mediating role of FoMO in paths from remaining emotion dysregulation facets to PSU. A potential explanation could be that other mechanisms, more closely related to the remaining emotion dysregulation facets than FoMO, would make more intuitive sense as antecedents in models exploring PSU severity. For instance, besides impulse control difficulties, previous studies have found that lack of emotional clarity, limited access to emotion regulation strategies, an excess of emotional awareness and having difficulties in goal-directed behavior are the deficits which are most related to PSU (Fırat et al., 2018; Horwood & Anglim, 2021). As mentioned earlier, there is still scarce evidence relating specific emotion dysregulation difficulties and PSU. Nonetheless, some studies elucidate potential related mechanisms. For instance, relating to the limited access to emotion regulation strategies, Extremera et al. (2019) found that the use of maladaptive cognitive emotion regulation strategies, such as rumination, catastrophizing, and blaming others, distinguished between problematic and non-problematic smartphone users. Moreover, concerning excessive emotional awareness, Hallauer et al. (2022) found that mindfulness, a non-judgemental active engagement with emotional experiences, mediated the association between anxiety and PSU severity. Finally, involving difficulties in goal-directed behavior, Rozgonjuk and Elhai (2021) found that process use of the smartphone, a pleasure-oriented media consumption on smartphones, mediated the association between expressive suppression and PSU. In sum, future studies might aim at addressing mechanisms other than FoMO to explain the relationship between specific emotion dysregulation difficulties and PSU severity.

This study had some limitations. We used cross-sectional data, so causality should not be inferred and associations between the study variables, as well as the proposed model, should be interpreted cautiously. In addition, one-time assessments may not be representative of individuals' general behavior, and no assessment of the incidence of PSU could be made. Altogether, this indicates that the predictive capacity of our results is limited. Future studies could address this shortcoming by using a repeated measures research design. Data were gathered right after the COVID-19 pandemic, so results should be considered in light of the broad societal changes occurring at the time. Finally, there are some considerations regarding potential biases, such as the possibility of social desirability bias in the self-report questionnaires used or self-selection bias, which could affect the generalizability

of the results. Therefore, future studies should consider using other assessment methods and more representative samples to overcome these limitations.

5. Conclusion

Despite these limitations, our study has important theoretical and practical implications. Regarding theoretical implications, our findings provided much-needed evidence for some of the underlying affective and cognitive processes that could lead to PSU in younger populations, thus, supporting current theories, such as dual reinforcement, pathways, and I-PACE models. Concerning practical implications, the meta-analysis by Augner et al. (2022) suggests that non-specific treatments for PSU are more effective than concrete strategies. The authors proposed that, because self-control and self-regulation are at the core of addictive behaviors, interventions aiming at teaching these abilities could reduce PSU severity. Similarly, in our study, by focusing on specific emotion dysregulation factors, we gathered evidence to suggest that aiming at training impulse control abilities in people with FoMO could be a promising path to reduce the probability of PSU.

6. Contributors

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Caleb J. Hallauer and Jon D. Elhai. The first draft of the manuscript was written by Christiane Arrivillaga and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Informed consent

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

Role of the funding source

This work was partially supported by the University of Málaga (PPIT.UMA.A2.2019; PPIT.UMA.D2.2022). The University of Málaga had no role in the study design, collection, analysis or interpretation of the data, writing the manuscript, or the decision to submit the paper for publication.

Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Christiane Arrivillaga and Caleb J. Hallauer declare they have no relevant financial or non-financial interests to disclose. For reasons of transparency Dr. Montag mentions that he has received (to Ulm University and earlier University of Bonn) grants from agencies such as the German Research Foundation (DFG). Dr. Montag has performed grant reviews for several agencies; has edited journal sections and articles; has given academic lectures in clinical or scientific venues or companies; and has generated books or book chapters for publishers of mental health texts. For some of these activities he received royalties, but never from gaming or social media companies. Dr. Montag mentions that he was part of a discussion circle (Digitalität und Verantwortung: https://about.fb.com/de/news/h/gespraechskreis-digitalitaet-und-verantwortung/) debating ethical questions linked to social media, digitalization and society/democracy at Meta. In this context, he received no salary for his activities. Finally, he mentions that he currently functions as independent scientist on the scientific advisory board of the Nymphenburg group (Munich, Germany). This activity is financially compensated. Moreover, he is on the scientific advisory board of Applied Cognition (Redwood City, CA, USA), an activity which is also compensated. Dr. Elhai notes that he receives royalties for several books published on posttraumatic stress disorder (PTSD); is a paid, full-time faculty member at University of Toledo; occasionally serves as a paid, expert witness on PTSD legal cases; and receives grant research funding from the U.S. National Institutes of Health.

Data availability

Data will be made available on request.

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