SPECIAL COLLECTION: BEHAVIORAL ADDICTION TO TECHNOLOGY

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

Cornelia Sindermann[1,2], Christian Montag[1], and Jon D. Elhai[2,3]

[1] Department of Molecular Psychology, Institute of Psychology and Education, Ulm University
[2] Department of Psychology, University of Toledo
[3] Department of Psychiatry, University of Toledo

While relations between certain personality traits and problematic social media use (PSMU) are well-acknowledged, mechanisms underlying these associations are mostly unclear. One putatively mediating variable in these relations is fear of missing out (FoMO). Moreover, certain design elements of social media platforms are suspected to lure users into spending increasing time on the platforms and into PSMU, accordingly. Thus far, however, (independent) empirical research on whether there are individual differences driving tendencies toward design element-driven increased social media use is barely existent. Furthermore, there is a lack of empirical research on whether these tendencies are related to PSMU. The present work was conducted to close these gaps. College students from the United States ($N = 446$) completed scales on the Big Five personality traits, impulsivity, FoMO, and PSMU and indicated how often they spend more time on social media than intended due to design elements of social media platforms in an online survey. Results showed that individuals tend to use social media more frequently and time-intensively due to certain design elements. Such increased use was strongly positively related to PSMU. A cross-sectional path model revealed among others indirect positive associations of neuroticism and impulsivity with PSMU mediated via FoMO and design element-driven increased social media use. These results indicate that design elements of social media platforms could contribute to PSMU. Thus, a healthier design of such platforms must be discussed. Moreover, therapeutic interventions to reduce PSMU might profit from psychoeducation on strategies to prevent design element-driven increased social media use.

Keywords: personality, fear of missing out, problematic social media use, design element-driven increased social media use

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The associations between certain personality traits and problematic social media use (PSMU) are well-established (Brand et al., 2016; Marino et al., 2018). However, empirical research on mechanisms underlying these relations is rare. Nevertheless, research on such mechanisms is of great importance because knowledge on mechanisms contributing to PSMU is crucial not only for an enhanced understanding but also to create effective treatments for PSMU.

In order to better understand the mechanisms linking certain personality traits and PSMU, some researchers draw attention to fear of missing out (FoMO) as a mediating variable (Elhai et al., 2020; Sindermann, Yang, et al., 2021). Moreover, experts criticize social media companies for driving users to spend an increasing amount of time on their platforms and to interact more often with the platforms. Specifically, certain design elements of social media platforms (e.g., personalized news feeds, notifications, likes) are suspected to lure users into spending increasing time on the platforms and putatively into PSMU (Montag et al., 2019; Montag & Hegelich, 2020; Neyman, 2017). Based on these considerations, we argue that it is crucial to consider the design of social media platforms and how certain users react to it as additional mechanism to explain associations between certain personality traits and PSMU.

In summary, thus far, there is little empirical research on associations between personality traits, design element-driven increased social media use, and PSMU. In more detail, no study provides empirical data on whether there are individual differences predicting tendencies toward design element-driven increased social media use; for instance, spending more time on social media than intended because one cannot stop "scrolling down" to see new content. Furthermore, there is a lack of research on whether these tendencies are related to PSMU. The present work was conducted to close these gaps in the literature and provide novel insights into putative mechanisms explaining associations between certain personality traits and PSMU.

Problematic Social Media Use and Personality

In the present work, the concept labeled PSMU describes excessive, pathological use of social media platforms linked to negative functional consequences for the affected person (Andreassen & Pallesen, 2014). As such, what is labeled PSMU in the present work has been called social networks use disorder (Sindermann, Elhai, & Montag, 2020) or social media/online social network site addiction (Andreassen & Pallesen, 2014) in other works; see ongoing discussions on nomenclature of internet-related problematic behaviors like PSMU (Elhai et al., 2021; Montag, Wegmann, et al., 2021).

Given the focus on negative consequences related to PSMU, PSMU is not the same as time-intensive or frequent use of social media. The latter two are not necessarily related to adverse consequences. The difference between PSMU and duration and frequency of social media use is underlined by only moderate positive relations between the constructs (Parry et al., 2021; van den Eijnden et al., 2016). Moreover, PSMU can be defined as a specific internet use disorder describing the problematic use of one specific activity carried out via the internet, in this case, social media use (Montag et al., 2015; Montag, Wegmann, et al., 2021).

The phenomenon of PSMU is not yet included in official diagnostic manuals (American Psychiatric Association, 2013; World Health Organization, 2019). Nevertheless, a significant proportion of individuals around the world seems to be affected by negative consequences arising from social media use (estimates vary; see Cheng et al., 2021). Thus, investigating which predisposing factors and psychological mechanisms might contribute to PSMU is crucial. Knowledge on predisposing factors and mechanisms related to PSMU can support not only the identification of vulnerable groups. Beyond that, it can provide information on which mechanisms to "break", for instance, in therapeutic interventions, in order to prevent or reduce PSMU.

Regarding predisposing factors for PSMU, links between several personality traits and PSMU are well-established both through models and empirical research findings. For instance, in the Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2016, 2019), attention is drawn among others to certain personality traits (as part of the P component) posing vulnerability factors for the emergence and maintenance of behaviors like PSMU. In detail, the I-PACE model constitutes complex moderation and mediation effects between predisposing person characteristics (P component), affective and cognitive reactions (A and C components), and (reduced) executive functions (E component) to impact the use of an application, like a social media platform/application, and contribute to behaviors like PSMU. Thus, based on the I-PACE model, it can be assumed among others that certain personality traits predict the likelihood of developing PSMU. Such relations might be mediated among others via certain cognitive and affective reactions leading to the repeated, time-consuming use of social media and PSMU (Brand et al., 2016). In line with the I-PACE model, however, not only personality traits but also other factors, such as early childhood events, social cognitions, and use motives, and complex interactions between those factors and interactions with A- and C-component variables contribute to PSMU (Brand et al., 2016).

Contact Information: Correspondence concerning this article should be addressed to Cornelia Sindermann, Department of Molecular Psychology, Institute of Psychology and Education, Ulm University, Helmholtzstraße 8/1, 89081 Ulm, Germany. Email: cornelia.sindermann@uni-ulm.de

The specific personality traits that might act as vulnerability factors for PSMU, are mentioned in the I-PACE model publication, and are of interest for the present work are low conscientiousness, high neuroticism, and high impulsivity. Conscientiousness and neuroticism are traits of the Big Five derived from the Five-Factor Model of personality (Digman, 1990; Goldberg, 1990). Low conscientiousness describes individuals not carrying out their duties overtly carefully, not being too orderly or ambitious, and so forth (John et al., 1991; Rammstedt & Danner, 2017). It can be assumed that individuals scoring low in conscientiousness use social media, a putatively fun activity, instead of focusing on work or other duties and experience negative consequences from social media use, hence, PSMU, accordingly. High neuroticism describes individuals worrying a lot and being anxious and/or individuals who might even show depressive tendencies (John et al., 1991; Rammstedt & Danner, 2017). Neuroticism might among others be related to PSMU via FoMO (detailed below). High impulsivity, as investigated in the present work, relates to tendencies to act without thinking, to do things on impulse, to not plan for the future, as well as having trouble concentrating and paying attention (Spinella, 2007). Individuals scoring high in impulsivity might use social media, for instance, when they cannot concentrate; or they might not be able to control their behavior when the social media use gets problematic.

In addition to the I-PACE model indicating the aforementioned three personality traits as vulnerability factors for PSMU, empirical research findings support the notion of all three traits being related to PSMU. Several studies report significant negative relations between conscientiousness and PSMU as assessed both broadly and for specific social media platforms (Andreassen et al., 2012, 2013; Kircaburun, 2016; Kircaburun et al., 2020; Kircaburun & Griffiths, 2018; Montag, Sindermann, et al., 2021; Sindermann, Duke, & Montag, 2020; Wilson et al., 2010). Additionally, a meta-analysis reported significant negative relations of conscientiousness and significant positive relations of neuroticism with problematic Facebook use (Marino et al., 2018). Similarly, more recent studies investigating other social media platforms (e.g., Instagram) and social media use in general (without specifying a platform) support the notion of a positive relation between neuroticism and PSMU (Kircaburun et al., 2020; Moore & Craciun, 2021). Moreover, studies report positive associations between impulsivity and PSMU (Barbar et al., 2021; Sindermann, Elhai, & Montag, 2020). Wegmann et al. (2020) report that specifically attention impulsivity is related to PSMU in correlational analyses.

In summary, lower conscientiousness, higher neuroticism, and higher impulsivity might pose vulnerability factors for PSMU.

FoMO as Mediator

The concept of FoMO is of interest to understand mechanisms underlying the relations between personality traits, such as conscientiousness, neuroticism, and impulsivity, and PSMU. Higher FoMO describes higher tendencies to fear that others have positive and rewarding experiences on which one is missing out. Thus, FoMO is directly related to the urge to stay connected to others and to what they are doing (Przybylski et al., 2013).[1]

FoMO has been linked to the personality traits of conscientiousness (negatively) and neuroticism (positively) in a recent meta-analysis (Fioravanti et al., 2021). The relation with neuroticism has been found in several other studies as well (Moore & Craciun, 2021; Rozgonjuk et al., 2021). Moreover, FoMO has been positively related

to impulsivity previously (Brown et al., 2021). Given the considerable stability of personality traits (Edmonds et al., 2008; Roberts & Mroczek, 2008; Terracciano et al., 2006), it can be assumed that personality traits like low conscientiousness, high neuroticism, and high impulsivity predict FoMO. Especially, the link between neuroticism and FoMO seems plausible because neuroticism describes individuals who among others worry a lot (John et al., 1991; Rammstedt & Danner, 2017). This general tendency to worry might, in turn, predict worrying on missing out on rewarding experiences, hence, FoMO.

Additionally, and in line with the desire to stay connected, FoMO has been positively related to PSMU and use intensity of social media (Alt & Boniel-Nissim, 2018; Blackwell et al., 2017; Fuster et al., 2017; Moore & Craciun, 2021; Oberst et al., 2017; Savci et al., 2022; Stead & Bibby, 2017), among others in a recent meta-analysis (Fioravanti et al., 2021). The link between FoMO and PSMU can be explained by FoMO putatively triggering PSMU based on the desire to stay connected with others: This desire might lead individuals to regularly check social media in an attempt to not miss out on what friends are doing via reading their posts, and so forth (Fioravanti et al., 2021).

Given the associations of FoMO with personality traits on the one hand and of FoMO with PSMU on the other hand, and based on Przybylski et al. (2013) describing FoMO as mediating variable in the relations between individual differences and social media engagement, it can be assumed that FoMO acts as a mediating variable in the relation between personality and PSMU. Similarly, in context of the I-PACE model (Brand et al., 2016), the mediating role of FoMO in relations between personality and PSMU is reasonable: FoMO can be understood as tendencies to specific affective or cognitive responses (Müller et al., 2021; Sindermann, Yang, et al., 2021) like an internet-related cognitive bias (Elhai et al., 2019; Wegmann et al., 2017). Internet-related cognitive biases are described as false beliefs about effects of using applications, such as social media platforms, in the I-PACE model (Brand et al., 2016). FoMO and its urge to stay connected and social media use, accordingly, might reflect such a bias based on the belief that checking social media often/time-intensively prevents missing out on rewarding experiences of others. Conceptualized as an internet-related cognitive bias, according to the I-PACE model, FoMO is likely to mediate the relations between P-component variables, such as personality traits, and PSMU. In line with this assumption, FoMO has been found to act as a mediating variable in previous research. For example, Sindermann Yang et al. (2021) found FoMO to (cross-sectionally) mediate the relation between neuroticism and problematic use of the social media app WeChat.

Taken together, FoMO is likely to act as mediator in the relations of conscientiousness, neuroticism, and impulsivity with PSMU.

Design Element-Driven Increased Social Media Use as Mediator

The aforementioned personality traits and FoMO have all been associated with PSMU in theory and empirical research. Another putatively important variable to understand relations between personality and PSMU has yet to be investigated. This variable is

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[1] By this definition, the present work focuses on the social aspect of FoMO rather than news or commercial aspects of FoMO (Alt, 2015) and examines general tendencies to experience FoMO (more often) rather than the experience of FoMO in one specific moment.

labeled "design element-driven increased social media use" in the present work.

For quite some time, various experts have been concerned about certain design elements of social media platforms luring their users into spending more and more time on the platforms and increasing interaction rates (Montag et al., 2019; Montag & Hegelich, 2020; Montag, Hegelich, et al., 2021; Neyman, 2017; Sindermann, Ebner, et al., 2021). For example, the personalized news feeds on social media platforms, presenting content most likely being of interest to each individual user, is feared to increase usage times and contribute to PSMU, accordingly. Similarly, read and sent receipts might enhance social pressure and time and frequency of use of social media as well as PSMU. Also, reactions to one's own posts, such as likes, might contribute to time-consuming social media use and PSMU, accordingly, via feelings of social rewards (Marengo et al., 2020, 2021, 2022; Montag et al., 2019; Sherman et al., 2016).

For now, however, it is not clear if (all) individuals do actually use social media more frequently, longer, and in a more problematic way because of such design elements. Nevertheless, it is plausible to assume that individuals driven to use social media more because of certain design elements might be vulnerable to develop PSMU. Individuals using social media more frequently and time-intensively because of design elements might do so despite this use being disadvantageous for them, for their productivity at work, and for their life overall. Thus, such individuals might experience PSMU symptoms. Following from this, it can be expected that design element-driven increased social media use predicts PSMU.

In addition, design element-driven increased social media use and FoMO are likely to be highly intertwined. This is because several of the design elements of social media have been found to trigger FoMO (Alutaybi et al., 2019). Based on this assumption, it is proposed that individuals with generally higher FoMO tendencies are more vulnerable to design element-driven increased social media use because the design elements trigger already existing FoMO tendencies.[2] Following from this, it can be expected that design element-driven increased social media use acts as a mediator in the relation between FoMO and PSMU.

Furthermore, design element-driven increased social media use may mediate the relations of the personality traits conscientiousness, neuroticism, and impulsivity with PSMU. For example, individuals scoring lower in conscientiousness might be more likely to follow design elements of social media distracting them from work and other duties compared to individuals scoring higher in conscientiousness. In contrast, individuals scoring high in conscientiousness might not react with increased use to those design elements because they value their time, tasks, and duties more in comparison to social media use. Individuals with higher trait neuroticism might tend to design element-driven increased social media use, among others because they fear social pressure when not responding to messages quickly; especially if read and sent receipts are turned on. Finally, impulsivity might be linked to design element-driven increased social media use. This is because individuals scoring higher in impulsivity might not control the impact on their behavior by design elements but follow the design elements because it seems easy and fun (see conceptualization of impulsivity in the present work; Spinella, 2007).

In summary, it can be expected that design element-driven increased social media use acts as a mediator in both the relation of FoMO with PSMU and the relations of personality traits with PSMU. Similarly, it might act as serial mediator in the relations between personality traits, FoMO, and PSMU. Importantly, a mediation by design element-driven increased social media use is also plausible against the background of the I-PACE model. Similar to FoMO, design element-driven increased social media use might pose a cognitive or affective reaction to certain triggers (i.e., the design elements) associated with increased and problematic use of social media. In the later stages of PSMU, design element-driven increased social media use might be a form of cue reactivity (Brand et al., 2016, 2019).

Summary of Hypotheses and the Research Model of the Present Work

The research model depicted in Figure 1 was investigated in the present work in a cross-sectional manner; hypotheses on bivariate correlations between conscientiousness, neuroticism, impulsivity, FoMO, design element-driven increased social media use, and PSMU as described in the previous paragraphs are listed in the preregistration (https://osf.io/3m8ab).

By investigating the role of tendencies to design element-driven increased social media use in PSMU, the present work goes beyond previous work, since - to the best of our knowledge - this work is the first to directly investigate design elements as reasons for increased social media use and relations to PSMU.

Materials and Method

Procedure

The present work, including hypotheses, study design, recruitment strategy, sample size, measurement tools, and an analysis plan has been preregistered at the Open Science Framework website. The preregistration is available at https://osf.io/3m8ab.

The sample for the present online survey was recruited at the University of Toledo, Toledo, Ohio, United States. More specifically, the survey was advertised at the university's Sona Systems portal. Participants received course research points as compensation for complete participation. Eligibility criteria for participation were an age of at least 18 years and providing consent. All participants gave informed electronic consent prior to participation. The study was approved by the institutional review board at the University of Toledo.

Sample

The initial sample comprised $N = 550$ individuals. After data cleaning (see Supplemental Material), the final sample size was $N = 446$ ($n = 137$ males, $n = 303$ females, $n = 6$ others). This sample size is larger than the minimum sample size of $N = 252$ individuals deemed necessary for this work based on considerations presented in the preregistration: A power analysis for regression analysis (assuming only manifest variables are included in the model) leads

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[2] We acknowledge that one might assume that design element-driven increased social media use precedes FoMO or that design element-driven increased social media use and FoMO impact each other instead of FoMO preceding design element-driven increased social media use as proposed in the present work. However, in the present work, FoMO is understood as general tendencies to fear missing out on rewarding experiences of others. As such, these tendencies are broader, not specifically related to the social media context, and might therefore pose vulnerability factors for design element-driven increased social media use (see also preregistration).

Figure 1
Hypothesized Research Model
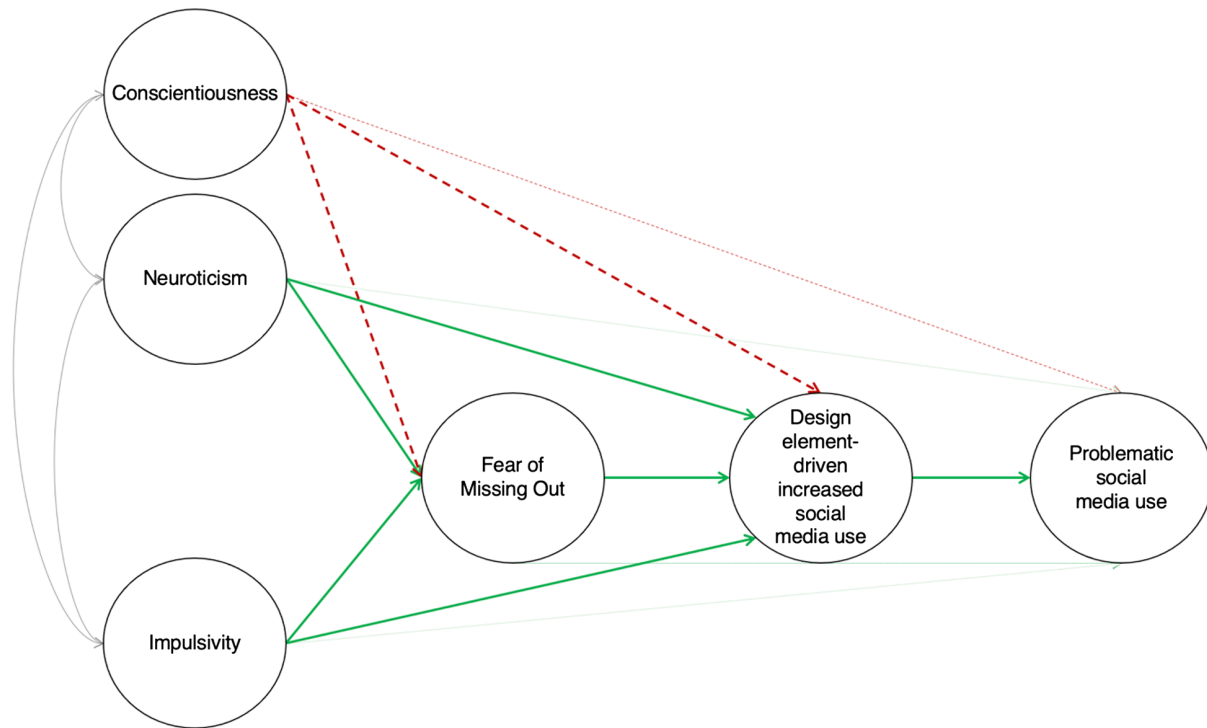
Note. Green (solid) lines and arrows indicate positive and red (dashed) lines and arrows indicate negative relations. Main effects of personality and FoMO on PSMU are depicted with lighter arrows due to the potential mediation effects.

to a necessary sample size of $N = 215$. Moreover, given small effect sizes and a power of 0.80, correlations usually stabilize at $N = 252$ (Schönbrodt & Perugini, 2013). These considerations and results indicated that at least $N = 252$ individuals should be recruited for the present work.

The mean age of the sample was $M = 19.71$ years ($SD = 3.51$). Most participants were in the freshman ($n = 284$), sophomore ($n = 84$), or in a higher college year ($n = 70$); only $n = 8$ stated to not currently being college degree-seeking students.

Self-Report Measures

Next to items on sociodemographic variables, the following self-report measures of interest for the present work were included in the online survey.

The Big Five of Personality: The Big Five Inventory

The English language Big Five Inventory (BFI) with 44 items was used to assess the Big Five personality traits including conscientiousness and neuroticism (John et al., 1991). Each item is responded to on a 5-point Likert scale with response options ranging from $1 = $ *disagree strongly* to $5 = $ *agree strongly*. The internal consistency estimates (Cronbach's αs) ranged from α = .72 (openness) to α = .85 (extraversion) in the present sample. Despite the model described in the introduction only including conscientiousness and neuroticism of the Big Five, descriptive and correlational results related to openness, extraversion, and agreeableness are

presented as well for exploratory reasons and transparency (see preregistration). Subscales/facets of the Big Five domains are not investigated in the present work.

Impulsivity: Barratt Impulsiveness Scale–15

To assess impulsivity, the English language Barratt Impulsiveness Scale–15 (BIS-15) comprising 15 items was applied (Spinella, 2007). Items are responded to on a 4-point rating scale ranging from $1 = $ *rarely/never* to $4 = $ *almost always*. Cronbach's αs were α = .82 for the total scale, α = .77 (nonplanning), α = .82 (motor impulsivity), and α = .74 (attention impulsivity) for the subscales in the present sample. To not overload the present work, results related to the subscales are presented in the Supplemental Material only.

FoMO: Fear of Missing Out Scale

The Fear of Missing Out (FoMO) scale by Przybylski et al. (2013) was used to assess FoMO. This scale consists of 10 items, which are responded to on a 5-point scale ranging from $1 = $ *not at all true of me* to $5 = $ *extremely true of me*. Cronbach's α for this scale was α = .87 in the present sample.

Design Element-Driven Increased Social Media Use: Newly Developed Scale

To assess the tendencies to *D*esign *E*lement-*D*riven *I*ncreased *S*ocial *M*edia *U*se, a new scale was developed (DED-ISMU scale).

Based on expert interviews with six experts from science (e.g., political data science) as well as practical fields (e.g., lawyers from the field of data protection) and based on previous literature (Montag et al., 2019; Neyman, 2017), a scale comprising 22 items was created. More specifically, each of the items asks whether participants "spend more time on social media and/or check social media more often than intended because …" of a certain design element. Response options range from 1 = *never* to 7 = *always*. Because the scale was used for the first time in this sample and for this research project, and as described in the preregistration, analyses to check the underlying factorial structure of this scale were implemented (see Supplemental Material). In short, the final structure of the DED-ISMU scale was found to consist of four subscales and 18 items. More specifically, the following scale scores were built: tendencies to design element-driven increased social media use due to (a) social pressure (4 items, α = 0.89), (b) content-related elements (4 items, α = 0.85), (c) social elements (5 items, α = 0.82), and (d) attention prompts and rewards (5 items, α = 0.79). Cronbach's α for the total scale was α = 0.91. The wording of each item is provided in the Supplemental Material.

PSMU: Bergen Social Media Addiction Scale

To assess PSMU, the six-item Bergen Social Media Addiction Scale (BSMAS) based on the Facebook Addiction scale (Andreassen et al., 2012) was used. The items are answered on a 5-point scale with response options ranging from 1 = *very rarely* to 5 = *very often*. The internal consistency estimate (Cronbach's α) of this scale in the present sample was α = .83.

As mentioned in the preregistration, the six-item BSMAS was also applied in the context of several specific social media platforms (e.g., Facebook, Twitter). Since the scales on specific platforms were only presented to those individuals who indicated using the respective platform, data on these specific scales are only available for smaller subsamples which vary in size. Thus, correlational results on relations of these scales with the DED-ISMU scale are presented in the Supplemental Material only.

Statistical Analysis

For statistical analysis, the software R (R Core Team, 2021) and R Studio (RStudio Team, 2020) were used.

First, descriptive statistics for the BFI, BIS-15, FoMO, DED-ISMU scales, and the BSMAS were computed for the total sample and split by gender identity (results of individuals not identifying as either male or female not presented due to the small subsample size) using functions of the *psych* package (Revelle, 2021). The distributions of all variables except age in the total sample and in individuals identifying as males or females indicated an approximate normal distribution based on a skewness and kurtosis <±1 and according to criteria by Miles and Shevlin (2001). Thus, for age only, no normal distribution was assumed. Analyses were implemented, accordingly.

Associations of age and gender with variables of interest were calculated by means of Spearman correlations (*Hmisc* package; Harrell, 2021) and *t* tests (Welch's *t* tests whenever necessary), respectively. These analyses were of importance since both variables might act as confounding variables when investigating personality (Costa et al., 2001; Schmitt et al., 2008; Weisberg et al., 2011), FoMO

(Elhai et al., 2020; Müller et al., 2021), and PSMU (Marino et al., 2018; Rozgonjuk et al., 2020), and may need to be controlled for in the final model, accordingly.

Next, zero-order Pearson correlations between all variables of interest were calculated for the sample comprising males and females (*N* = 440).[3] Only correlations between total scales are presented in the main article. Correlational results including subscales are presented in the Supplemental Material.

Finally, a path analysis was conducted (excluding individuals not identifying as either male or female) using the *lavaan* package (Rosseel, 2012). The final model was based on the model presented in Figure 1, but additionally taking into account the correlations observed between scales (see Results section) in the present data and the feasibility to model latent variables.

The final model is presented in Figure 2. As can be seen from Figure 2, only the dependent variable (PSMU) was modeled as a latent variable (indicated by the circle). This modeling approach was chosen because of the following reason: At first, a fully latent variable model was estimated using the weighted least squares mean and variance adjusted (WLSMV) estimator and treating all items as ordinal given the ordinal response scales of all items. The model converged but did not fit the data well (e.g., comparative fit index [CFI] = 0.86/0.78 [standard/robust]). The nonsatisfactory model fit was most likely due to the complexity of the fully latent variable model and might have been higher in a larger sample. Based on this finding, it was decided to only model the dependent variable (PSMU) as latent and to use the WLSMV estimator treating BSMAS items as ordinal.

Moreover, contrary to the initially proposed model and based on correlational results, agreeableness was included in the final model given significant relations with the FoMO and DED-ISMU scales, as well as the BSMAS. Moreover, no direct relation between conscientiousness and the DED-ISMU scale was modeled given the nonsignificant correlation between both variables. Age and gender were included as additional exogenous variables given significant associations with several of the variables of interest. Similar to the preregistration, direct and indirect relations were modeled as shown in Figure 2. Indirect relations included both simple mediations only via FoMO or only via the DED-ISMU scale as well as serial mediations via both FoMO and DED-ISMU scales. Correlations between exogenous variables were allowed (by default and are set to sample values).

Next to estimating the model using the WLSMV estimator, indirect relations were estimated using the maximum likelihood (ML) estimator. This was necessary to calculate standard errors (*SE*s), *z* values, and *p* values including a bootstrap approach (1,000 samples) to test for indirect relations.[4] More specifically, indirect relations were investigated by means of *p* values (derived from using both WLSMV

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[3] Individuals not identifying as either male or female (*n* = 6) were excluded from these and further analyses. This was due to the following reasons: Gender identity was deemed an important control variable in the final model (see previous paragraph). However, modeling a categorical variable (i.e., gender identity) with three categories, of which one ("other") only comprises six individuals (vs. more than 100 in each of the other categories) is problematic from a statistical point of view. Since the correlational analyses were conducted in order to check which variables/links to include in the final model, correlational results and the final model were only conducted on the sample of individuals identifying as either male or female.

[4] Using the WLSMV estimator, bootstrapping is not possible using the *lavaan* package.

Figure 2
Final Path Model
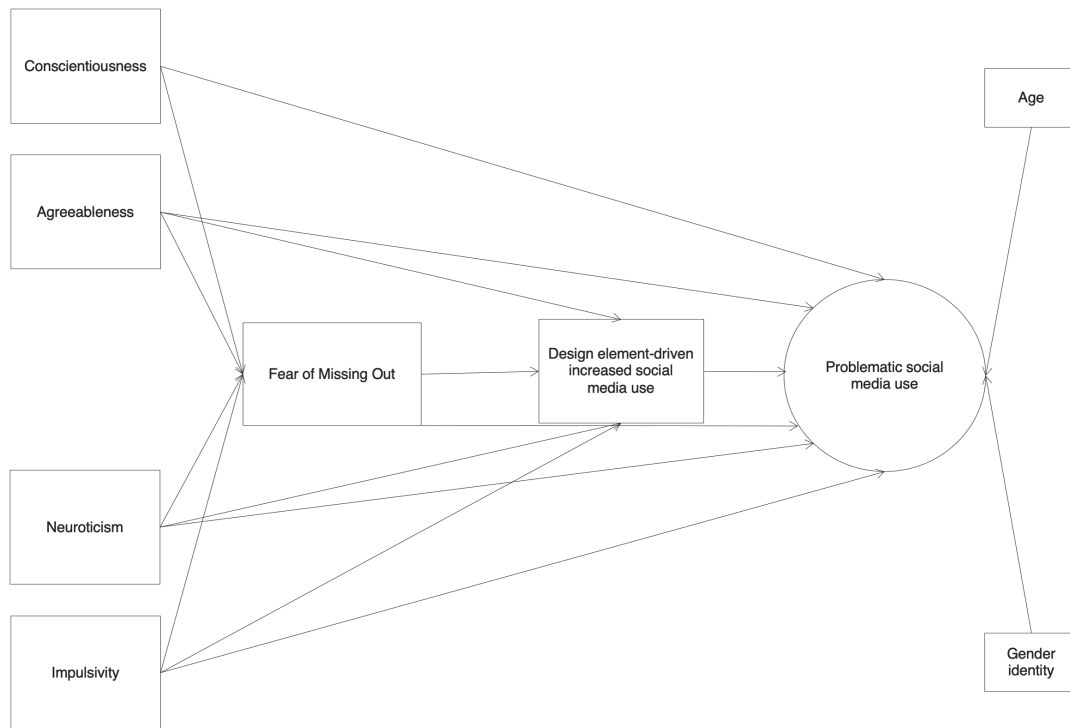
Note. To not overload the figure, both items of the BSMAS (Bergen Social Media Addiction Scale; used to assess problematic social media use) as well as interrelations between exogenous variables are not presented.

and ML estimators) and bootstrapped (adjusted bootstrap percentile) confidence intervals (CIs; based on the ML estimator) using the "parameterEstimates" function in *lavaan* (Rosseel, 2012).

Results

Descriptive Statistics and Associations With Age and Gender

In the total sample, age correlated significantly with openness ($\rho = 0.14$, $p = .002$), extraversion ($\rho = -0.13$, $p = .004$), BIS-15 total ($\rho = -0.09$, $p = .047$), DED-ISMU social pressure ($\rho = -0.11$, $p = .025$), DED-ISMU attention prompts and rewards ($\rho = -0.13$, $p = .005$), DED-ISMU total ($\rho = -0.13$, $p = .007$), and the BSMAS ($\rho = -0.14$, $p = .003$).

Significant differences between the groups of individuals identifying as male versus female were observed in neuroticism, $t(438) = -7.90$, $p < .001$, $g = 0.81$; the FoMO scale, $t(302.85) = -3.57$, $p < .001$, d(unequal variances) $= 0.36$, $g = 0.35$; DED-ISMU social pressure, $t(438) = -4.06$, $p < .001$, $g = 0.42$; DED-ISMU content-related elements, $t(438) = -2.84$, $p = .005$, $g = 0.29$; DED-ISMU social elements, $t(438) = -4.28$, $p < .001$, $g = 0.44$; DED-ISMU attention prompts and rewards, $t(438) = -3.77$, $p < .001$, $g = 0.39$; DED-ISMU total, $t(438) = -4.78$, $p < .001$, $g = 0.49$; and the BSMAS, $t(438) = -5.04$, $p < .001$, $g = 0.52$. Descriptive statistics of the total sample and for individuals identifying as either male or female are presented in Table 1.

Zero-Order Correlations Between Variables of Main Interest

Table 2 depicts bivariate correlations between variables of interest in the sample of individuals identifying as either male or female ($N = 440$) on scale level (no subscales). As expected, conscientiousness (negatively) and neuroticism (positively), as well as the BIS-15 total (positively), FoMO (positively), and DED-ISMU total scales (positively) were significantly correlated with the BSMAS. Additionally, agreeableness was significantly negatively related to the BSMAS. Of those variables significantly correlated to the BSMAS, only agreeableness, neuroticism, the BIS-15 total, and the FoMO scale were significantly positively correlated to the DED-ISMU total scale. Moreover, of those variables significantly correlated to the BSMAS, conscientiousness and agreeableness were negatively related to FoMO, whereas neuroticism and the BIS-15 total score were positively related to FoMO. Aside from the relations of agreeableness with the DED-ISMU and FoMO scales, all of the aforementioned significant correlations remain significant even after manually applying a strict Bonferroni correction. Based on the significant correlations observed (including those of agreeableness), the final model as presented in Figure 2 was estimated.

Structural Equation Model

Figure 2 shows the final path model that was estimated.

Table 1

Descriptive Statistics of Variables of Main Interest in the Total and the Male and Female (Gender Identity) Subsamples

Scale	Total sample ($N = 446$)		Males ($n = 137$)		Females ($n = 303$)	
	M	*SD*	*M*	*SD*	*M*	*SD*
BFI						
Openness	3.41	0.55	3.36	0.56	3.42	0.55
Conscientiousness	3.55	0.56	3.54	0.52	3.57	0.58
Extraversion	3.07	0.79	2.99	0.80	3.11	0.79
Agreeableness	3.81	0.60	3.76	0.64	3.84	0.57
Neuroticism	3.18	0.76	2.78	0.73	3.35	0.70
BIS-15						
Total	2.19	0.46	2.17	0.42	2.20	0.48
FoMO scale						
FoMO	2.37	0.81	2.17	0.71	2.45	0.83
DED-ISMU scale						
Social pressure	3.74	1.51	3.33	1.36	3.95	1.53
Content-related elements	4.45	1.30	4.18	1.25	4.56	1.30
Social elements	4.12	1.32	3.74	1.31	4.31	1.28
Attention prompts and rewards	3.65	1.30	3.31	1.28	3.81	1.29
Total	3.98	1.08	3.63	1.05	4.15	1.05
BSMAS						
BSMAS	2.58	0.87	2.27	0.79	2.71	0.87

Note. BFI = Big Five Inventory; BIS-15 = Barratt Impulsiveness Scale–15; FoMO scale = Fear of Missing Out scale; DED-ISMU scale = Design Element-Driven Increased Social Media Use scale (for this scale, descriptive statistics of subscales are presented because the scale was newly developed for this work); BSMAS = Bergen Social Media Addiction Scale. Results of individuals not identifying as either male or female are not presented separately due to the small subsample size.

The fit of the model presented in Figure 2 (using the WLSMV estimator and treating BSMAS items as ordinal) was CFI = 0.98/0.94, Tucker–Lewis index = 0.99/0.97, root-mean-square error of approximation = 0.05/0.06, standardized root-mean-square residual = 0.05/0.05 (standard/robust). This fit was deemed satisfactory (Hu & Bentler, 1999). More detailed results on paths in this model are presented in Tables 3–5.

As can be seen specifically from Table 5, the only indirect links which were significant and whose CIs did not include zero were the following: (a) + (b) the indirect relations of neuroticism and BIS-15

Table 2

Zero-Order Pearson Correlations and p-Values Between Variables of Main Interest (No Subscales) in the Sample of Individuals Identifying as Either Male or Female (N = 440)

Scale		1	2	3	4	5	6	7	8
1. BFI openness		—							
2. BFI conscientiousness	*r*	0.05	—						
	p	.278							
3. BFI extraversion	*r*	0.14	0.14	—					
	p	.004	.003						
4. BFI agreeableness	*r*	0.08	0.37	0.15	—				
	p	.077	<.001	.001					
5. BFI neuroticism	*r*	0.06	−0.24	−0.18	−0.28	—			
	p	.236	<.001	<.001	<.001				
6. BIS-15 total	*r*	−0.08	−0.56	0.05	−0.31	0.32	—		
	p	.078	<.001	.342	<.001	<.001			
7. FoMO scale	*r*	0.08	−0.16	0.04	−0.15	0.39	0.24	—	
	p	.080	.001	.389	.002	<.001	<.001		
8. DED-ISMU total scale	*r*	0.05	−0.03	0.16	0.10	0.19	0.17	0.41	—
	p	.273	.553	.001	.036	<.001	<.001	<.001	
9. BSMAS	*r*	0.01	−0.32	0.00	−0.17	0.37	0.35	0.49	0.54
	p	.912	<.001	.936	<.001	<.001	<.001	<.001	<.001

Note. BFI = Big Five Inventory; BIS-15 = Barratt Impulsiveness Scale–15; FoMO scale = Fear of Missing Out scale; DED-ISMU total scale = Design Element-Driven Increased Social Media Use total scale; BSMAS = Bergen Social Media Addiction Scale. Manually applying a Bonferroni correction leads to a new significance/α level of 0.0014 (0.05/36). When correlating the FoMO scale excluding item 08 (the only item on online sharing behavior) with the other scales, the sizes of correlations do not change meaningfully; when correlating item 08 with the other scales (using Spearman correlations), some correlations change in size; however, relations with conscientiousness ($\rho = -0.14$, $p = .003$), agreeableness ($\rho = -0.11$, $p = .021$), neuroticism ($\rho = 0.17$, $p < .001$), BIS-15 total ($\rho = 0.21$, $p < .001$), the DED-ISMU total scale score ($\rho = 0.42$, $p < .001$), and the BSMAS ($\rho = 0.43$, $p < .001$) remain significant in the same direction as presented in this table; additionally, the correlation of FoMO item 08 with extraversion is significant ($\rho = 0.17$, $p < .001$).

Table 3

Results of the Structural Equation Model—Part 1: Confirmatory Factor Analysis on the Latent Variable PSMU (N = 440; WLSMV Estimator)

Items	Unstandardized estimate	SE	z	p	Std.all
BSMAS item 01	1.000				0.755
BSMAS item 02	1.179	0.07	18.22	<.001	0.865
BSMAS item 03	0.904	0.06	16.40	<.001	0.692
BSMAS item 04	0.811	0.06	13.35	<.001	0.629
BSMAS item 05	0.996	0.06	16.78	<.001	0.753
BSMAS item 06	0.824	0.06	13.03	<.001	0.638

Note. SE = standard error; WLSMV = weighted least squares mean and variance adjusted; PSMU = latent variable on problematic social media use based on the BSMAS (Bergen Social Media Addiction Scale) items; Std.all = parameter estimate when latent and observed variables are standardized.

with the DED-ISMU scale via FoMO; (c) + (d) the indirect relations of agreeableness and BIS-15 with PSMU via the DED-ISMU scale; (e) the indirect relation of neuroticism with PSMU via FoMO; (f) + (g) the serial mediations from neuroticism and the BIS-15 on PSMU via the FoMO and DED-ISMU scales.

Discussion

The present work is the first to investigate mediators in the relations between personality traits and PSMU by (serial) mediations through FoMO and design element-driven increased social

media use. To the best of our knowledge, the latter variable has not been investigated in this context before.

To begin with, descriptive results confirmed that–at least sometimes–individuals use social media more frequently and/or more time-intensively because of certain design elements of those platforms. This assumption is based on mean scores of the DED-ISMU (sub)scales ranging between 3.65 and 4.45 in the total sample (response scale: 1 = *never*, 7 = *always*).

Moreover, correlational results showed that, among others, tendencies to design element-driven increased social media use were strongly positively ($r = 0.54$) related to PSMU (effect size rating based on Cohen, 1992). This finding supports concerns of experts that certain social media platform design elements might not only increase the time individuals spend on social media but also PSMU (Montag et al., 2019; Sindermann, Ebner, et al., 2021); although causality cannot be shown with the present data. This finding is also in line with a work by Marengo et al. (2022) reporting that in particular, objectively assessed (expressed) likes are linked to higher BSMAS scores. Moreover, the present finding is partly in line with findings of Marengo et al. (2020) investigating status updates and likes as mediators in the relations of neuroticism and extraversion with PSMU. In comparison to the present work, however, those previous works did only assess variables such as the number of received likes. The studies did not directly assess whether those design elements are the reason that individuals tend to use social media more frequently/time-intensively or in a more problematic way.

Moreover, design element-driven increased social media use was positively related to extraversion, agreeableness, neuroticism, impulsivity, and FoMO with small-to-medium effect sizes in the present work. Only the latter three associations were hypothesized. Especially

Table 4

Results of the Structural Equation Model—Part 2: Regressions—Direct Links (N = 440; WLSMV Estimator)

Scale (path)	Unstandardized estimate	SE	z	p	Std.all
PSMU					
BFI conscientiousness (a1)	**−0.278**	**0.07**	**−3.82**	**<.001**	**−0.191**
BFI agreeableness (a2)	**−0.115**	**0.06**	**−2.07**	**.038**	**−0.083**
BFI neuroticism (a3)	0.094	0.05	1.83	.067	0.087
BIS-15 total (a4)	0.105	0.08	1.31	.189	0.059
FoMO scale (a5)	**0.228**	**0.04**	**5.42**	**<.001**	**0.221**
DED-ISMU total scale (a6)	**0.342**	**0.03**	**11.04**	**<.001**	**0.434**
Age (a7)	−0.020	0.01	−1.89	.058	−0.084
Gender identity (a8)	**0.274**	**0.09**	**3.02**	**.003**	**0.155**
DED-ISMU total scale					
BFI agreeableness (b1)	**0.318**	**0.09**	**3.73**	**<.001**	**0.181**
BFI neuroticism (b2)	0.005	0.07	0.07	.945	0.004
BIS-15 total (b3)	**0.356**	**0.13**	**2.80**	**.005**	**0.157**
FoMO scale (b4)	**0.502**	**0.06**	**8.99**	**<.001**	**0.382**
FoMO scale					
BFI conscientiousness (c1)	0.033	0.08	0.44	.660	0.024
BFI agreeableness (c2)	−0.025	0.06	−0.39	.694	−0.018
BFI neuroticism (c3)	**0.355**	**0.05**	**6.92**	**<.001**	**0.339**
BIS-15 total (c4)	**0.220**	**0.09**	**2.47**	**.014**	**0.127**

Note. SE = standard error; WLSMV = weighted least squares mean and variance adjusted; PSMU = latent variable on problematic social media use based on the BSMAS (Bergen Social Media Addiction Scale) items; BFI = Big Five Inventory; BIS-15 = Barratt Impulsiveness Scale–15; FoMO scale = Fear of Missing Out scale; DED-ISMU total scale = Design Element-Driven Increased Social Media Use scale; Std.all = parameter estimate when latent and observed variables are standardized; bold values indicate relations which are significant.

Table 5

Results of the Structural Equation Model—Part 3: Indirect Links (N = 440; WLSMV and ML Estimator)

Independent variable	Mediator(s)	Dependent variable	Unstandardized estimate (WLSMV)	SE (WLSMV)	z (WLSMV)	p (WLSMV)	Std.all (WLSMV)	Unstandardized estimate (ML)	SE (ML)	z (ML)	p (ML)	Std.all (ML)	CI lower (ML)	CI upper (ML)
BFI conscientiousness	→ FoMO scale	→ DED-ISMU scale	0.017	0.04	0.44	.660	0.009	0.005	0.05	0.10	.921	0.002	−0.081	0.100
BFI agreeableness			−0.012	0.03	−0.39	.695	−0.007	−0.008	0.04	−0.21	.831	−0.004	−0.083	0.061
BFI neuroticism			**0.178**	**0.03**	**5.48**	**<.001**	**0.129**	**0.192**	**0.04**	**5.03**	**<.001**	**0.135**	**0.129**	**0.276**
BIS-15 total			**0.110**	**0.05**	**2.38**	**.017**	**0.049**	**0.119**	**0.06**	**2.09**	**.036**	**0.051**	**0.026**	**0.247**
BFI agreeableness	→ DED-ISMU scale	→ PSMU	**0.109**	**0.03**	**3.53**	**<.001**	**0.078**	**0.127**	**0.03**	**4.44**	**<.001**	**0.095**	**0.077**	**0.189**
BFI neuroticism			0.002	0.03	0.07	.945	0.002	0.026	0.03	0.99	.321	0.025	−0.023	0.078
BIS-15 total			**0.122**	**0.05**	**2.72**	**.007**	**0.068**	**0.100**	**0.04**	**2.52**	**.012**	**0.058**	**0.034**	**0.187**
BFI conscientiousness	→ FoMO	→ PSMU	0.008	0.02	0.44	.660	0.005	0.002	0.02	0.10	.920	0.001	−0.037	0.048
BFI agreeableness			−0.006	0.01	−0.39	.695	−0.004	−0.004	0.02	−0.21	.830	−0.003	−0.039	0.029
BFI neuroticism			**0.081**	**0.02**	**4.27**	**<.001**	**0.075**	**0.088**	**0.02**	**4.29**	**<.001**	**0.084**	**0.055**	**0.143**
BIS-15 total			0.050	0.02	2.23	.025	0.028	0.054	0.03	1.92	.055	0.031	0.013	0.123
BFI conscientiousness	→ FoMO → DED-ISMU scale	→ PSMU	0.006	0.01	0.44	.661	0.004	0.002	0.02	0.10	.922	0.001	−0.028	0.034
BFI agreeableness			−0.004	0.01	−0.39	.695	−0.003	−0.003	0.01	−0.21	.832	−0.002	−0.028	0.020
BFI neuroticism			**0.061**	**0.01**	**4.77**	**<.001**	**0.056**	**0.063**	**0.01**	**4.23**	**<.001**	**0.060**	**0.039**	**0.101**
BIS-15 total			**0.038**	**0.02**	**2.35**	**.019**	**0.021**	**0.039**	**0.02**	**2.05**	**.040**	**0.023**	**0.010**	**0.088**

Note. WLSMV = weighted least squares mean and variance adjusted; ML = maximum likelihood; SE = standard error; Std.all = parameter estimate when latent and observed variables are standardized; CI = confidence interval; BFI = Big Five Inventory; BIS-15 = Barratt Impulsiveness Scale-15; FoMO scale = Fear of Missing Out scale; DED-ISMU scale = Design Element-Driven Increased Social Media Use scale; PSMU = latent variable on problematic social media use based on the BSMAS (Bergen Social Media Addiction Scale) items; each line presents one indirect link either on the DED-ISMU scale (First 4 lines) or PSMU (all other lines); bold values indicate relations which are significant (based on both WLSMV and ML estimation) and which CI does not include zero.

the relation to FoMO is in line with the assumption that design elements of social media platforms might trigger FoMO (Alutaybi et al., 2019), especially in individuals generally scoring higher in FoMO. However, it must be mentioned that Alutaybi et al. (2019) in their work on relations between social media design and FoMO investigated FoMO slightly different as compared to the present work. For instance, in the previous work, facets of conversation-, grouping-, presence-, sharing-, and impression-related FoMO were discussed (Alutaybi et al., 2019). Next, contrary to our hypotheses and the hypothesized model, conscientiousness was not significantly correlated to design element-driven increased social media use. One putative explanation is that highly conscientious individuals might only limit their frequency and/or time on social media when it has adverse effects on their lives, hence, when they experience PSMU (Andreassen & Pallesen, 2014). They might not reduce their social media use as long as it is only time-consuming (e.g., because of design element-driven increased use) but unrelated to adverse effects. Also, not hypothesized but revealed in empirical analyses was a significant positive relation of agreeableness with design element-driven increased social media use and negative relations of agreeableness with FoMO and PSMU. It seems like highly agreeable individuals use social media more (frequently/time-intensively) due to certain design elements. However, they seem to experience less FoMO and less PSMU. Thus, despite using social media more due to design elements, this use does not seem to be adverse. Contrary to this assumption, however, the mediation from agreeableness via design element-driven increased social media use on PSMU was positive and significant in the final path model. Hence, the relations of agreeableness with design element-driven increased social media use and PSMU remain puzzling and need to be investigated more in-depth in future studies.

The path model revealed additional insights over correlational findings. In detail, PSMU was significantly and directly predicted by conscientiousness (negatively), agreeableness (negatively), FoMO (positively), and design element-driven increased social media use (positively), as well as gender identity. In line with some previous research, PSMU was higher in individuals identifying as female compared to individuals identifying as male (Marino et al., 2018; Rozgonjuk et al., 2020). Moreover, indirect links from agreeableness (see above) and impulsivity via design element-driven increased social media use on PSMU were observed. Additionally, neuroticism was related to PSMU via FoMO. Finally, links from neuroticism and impulsivity via FoMO and via design element-driven increased social media use on PSMU were observed (serial mediations). In short, conscientiousness seems to be directly related to PSMU or at least not mediated by the variables investigated in the present work. Agreeableness, neuroticism, and impulsivity seem to be indirectly related to PSMU via FoMO and/or design element-driven increased social media use. Because (indirect) relations of neuroticism and impulsivity with PSMU were hypothesized, we want to elaborate on those in-depth.

Neuroticism was neither directly related to design element-driven increased social media use nor directly related to PSMU. Relations of neuroticism with both variables were mediated via FoMO. These findings indicate that (cross-sectionally) neuroticism might predict FoMO, which, in turn, is directly related to PSMU and indirectly related to PSMU via design element-driven increased social media use. Thus, in the relation between neuroticism and PSMU, especially FoMO seems to be a critical construct. Personality traits like neuroticism are rather stable across life, especially in adulthood (Edmonds et al., 2008; Roberts & Mroczek, 2008; Terracciano et al., 2006). Thus, reducing PSMU by trying to change one's personality is not likely to be successful. Instead, treatments for PSMU, especially in individuals scoring high in neuroticism, might profit from reducing general FoMO tendencies or FoMO triggered in a certain moment. To reduce general FoMO tendencies, Martha Beck (as cited in Dossey, 2014) suggests three steps: (a) realizing that lies and exaggerations of frequency and quality of positive experiences by others on social media are the basis of FoMO; (b) reevaluating what FoMO means to oneself; and (c) being present and mindful in the moment.

Different from neuroticism, impulsivity was related to PSMU only via design element-driven increased social media use. It was neither directly nor only via FoMO related to PSMU. Accordingly, individuals with higher impulsivity might be specifically susceptible to design element-driven increased social media use and PSMU, accordingly. Thus, supporting individuals with higher impulsivity to avoid increased use of social media due to those design elements seems helpful to treat PSMU. Because design element-driven increased social media use was in general strongly related to PSMU and of importance in the relations between personality traits (especially neuroticism and impulsivity) and PSMU, we want to explain how putatively negative effects of such design elements might be prevented or at least reduced. For this, on the one hand, some approaches directly related to the design of social media platforms, which need to be implemented by the companies behind social media platforms, are introduced. On the other hand, some strategies which can be implemented by individual users to deal with existing design elements are described.

Social media companies could, for instance, reduce the presentation of always new content which is likely to be of interest to the specific user via the news feed. This suggestion, actually, includes two recommendations: To begin with, the total amount of new information provided to social media users within their news feeds could be reduced. This would leave the users the possibility to search for more content outside news feeds if wanted. It could, however, prevent the urge to "endlessly scroll down" within the news feed (Montag et al., 2019). Similarly, content provided in a news feed could only refresh in certain periods of time, for instance, once per hour. Second, the fit of the content provided to the interests and attitudes of each individual user could be reduced (correlation between the respective item from the DED-ISMU scale and the BSMAS: $\rho = 0.25$; see Supplemental Material). Sometimes content not related to the users' interests or attitudes, or even contradicting them, could be presented. While this might seem odd at first–why would anyone want to see content not of interest for him/her?–such a change is indeed already discussed. More specifically, providing diverse content is especially discussed in relation to political information as a countermeasure against filter bubbles (Pariser, 2011) and echo chambers (Jamieson & Cappella, 2008; Sunstein, 2007), that is, information environments with a high degree of homogeneity and mostly attitude-aligning information. Such environments are feared to contribute to the extremization and polarization of opinions. However, it must be mentioned that research on the existence and effects of information environments characterized by a high degree of homogeneity is inconclusive (Ross-Arguedas et al., 2022; Sindermann, Elhai, Moshagen, & Montag, 2020; Sindermann, Kannen, & Montag, 2021). Other

changes of social media platforms to be implemented by the companies behind them are using/not using colorful designs to highlight new content, the time constrained for the availability of some content, and the provision of rewards (correlations between the respective DED-ISMU scale items and the BSMAS: $\rho = 0.30–0.41$; see Supplemental Material).

Next to changes in the design of social media platforms, each individual user has the power to deal with his/her tendencies for design element-driven increased social media use, at least to a certain degree. Some straightforward and easy to carry out counter-measures are reducing push notifications via settings on the device and switching off read and sent receipts, such as the blue ticks on WhatsApp (correlations of the respective items from the DED-ISMU scale and the BSMAS: $\rho = 0.33–0.44$; see Supplemental Material). In the present work, we assessed individuals' settings regarding how many social media services are allowed to send push notifications and on how many social media platforms individuals have turned on read and sent receipts (see preregistration; higher scores indicate more platforms are allowed to send push notifications, etc.). These settings did significantly correlate with tendencies to design element-driven increased social media use ($r = 0.33$, $p < .001$) and with PSMU ($r = 0.19$, $p < .001$). Thus, shutting these settings off is related to less design element-driven increased social media use and less PSMU. Moreover, and as mentioned above, FoMO and design element-driven increased social media use are highly intertwined. Therefore, the FoMO reduction approach, or at least parts of it, by Alutaybi et al. (2020) might set a valuable starting point to reduce the maladaptive consequences of certain social media design elements, such as fostering PSMU; but note again that Alutaybi et al. (2020) assessed FoMO a bit different as compared to the present work. Moreover, we do not fully agree with all points made by Alutaybi et al. (2018, 2020). For example, Alutaybi et al. (2018, 2020) mention filtering of information according to users' interests as a measure to combat FoMO. While we agree with the necessity to reduce the content provided on social media, specifically on each user's news feed, we also fear that the possibility that filtering of information based on each user's interests might contribute to increased social media use and PSMU, accordingly. Additionally, we draw attention to potential risks of filtering of information in the political context, such as extremization and polarization (see explanations in previous paragraphs).

Some limitations of the present work need to be mentioned. First, the sample mostly comprised young individuals, more specifically undergraduate students, recruited at a university in Ohio, United States. The investigation of younger individuals seems appropriate because individuals between 13 and 29 years of age represent nearly half of social media users (45.3%; Kemp, 2022). The focus on young college students, nevertheless, limits generalizability of findings. This is why we call for future studies replicating the present work in other, more diverse samples in order to test the replicability and generalizability of findings. The DED-ISMU scale items are presented in the Supplemental Material for this purpose. Related to the DED-ISMU scale, it must be mentioned that the scale was built based on previous literature and expert interviews supporting construct validity and content validity of the scale. Additionally, the model fit of the final factorial model was acceptable. However, while those points support validity, validity of the scale ultimately cannot be proved with the present work. This is, for instance, due to a lack of other measurement instruments on design element-driven

increased social media use. Similarly, while positive associations between the DED-ISMU (sub)scales and impulsivity suggest validity of the scale, we propose that future studies should relate objective measures of social media use with the DED-ISMU scale scores of participants in order to test (criterion/concurrent) validity of the scale. Moreover, issues on determining the exact number of factors to retain in the DED-ISMU scale described in detail in the Supplemental Material must be mentioned. Additionally, related to the DED-ISMU scale, it must be mentioned that $n = 57$ individuals provided incomplete responses to this scale ($n = 43$ provided missing data in only one item of the scale) and were, therefore, excluded from analysis to prevent a putative bias. Finally, the formulation on spending more time and/or checking social media more often than intended in the DED-ISMU scale might be understood differently by different individuals. Another limitation of the present work is the cross-sectional data assessment, which disallows for assumptions on causal relations. However, we point to the introduction of the present work outlining why the specific directions of effects were expected and tested. Nevertheless, future longitudinal studies are important, especially to disentangle the causal relations between FoMO tendencies/states and design element-driven increased social media use; see issues already mentioned in the introduction.

Future studies can build upon the present work, for example, by using experimental and objective assessments of the variables investigated in this work. The use of self-report measures prevented the assessment of tendencies for increased social media use because of some specific design elements in the present work; i.e. not all design elements and their potential effect on social media use could be investigated. For instance, the presentation of rewards in variable time intervals in software/apps like social media platforms is a strategy which has been compared to slot machines in Las Vegas and is thought to increase PSMU (see statements by Tristan Harris and other experts, Busby, 2018; Seymour, 2019; Neyman, 2017). Such variable rewards can be based, for example, on receiving likes or seeing new and interesting content. In the present work, we were not able to specifically ask for the role of time invariance of such rewards. To assess reactions to different rewards on social media and to different timing schedules of these rewards, experimental studies are necessary. Thus, future studies either using data from existing platforms (as far as possible) or based on platforms generated for (experimental) research projects are necessary. While the latter approach seems complicated and burdensome, this approach has the advantage of the study's social media platform being fully under the control of the researchers. Nevertheless, scientists should also be allowed to run more experiments on existing social media platforms to get insights into the mechanisms operating on these platforms used in everyday life (Montag, Hegelich, et al., 2021).

Conclusion

In conclusion, the present study provides first evidence of the importance of tendencies for design element-driven increased social media use in PSMU and in the relations between certain personality traits and PSMU. Especially, individuals scoring high in neuroticism and FoMO, and individuals scoring high in impulsivity also showed high design element-driven increased social media use and PSMU. Future studies could investigate more in-depth which personality

traits are related to increased social media use due to which specific design elements. Individuals with different personality characteristics might react to different design elements in a different way. First exploratory results on this matter are presented in the Supplemental Material. Moreover, and in order to reduce PSMU, it might be helpful to reduce design element-driven increased social media use, either via technical measures and changes in the design of social media platforms or via trainings of vulnerable individuals on how to deal with certain design elements.

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