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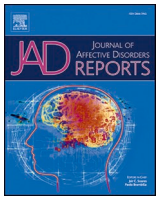

Research Paper

Extraversion moderates the relationship between social media use and depression

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ABSTRACT

Background: There is evidence that extraversion and associated frequent personal and digital social contacts are associated with mental health, reflected in reduced risk for anxiety or depression. However, excessive social media use (SMU) has been related to a decrease of mental health. We test how extraversion moderates the effect of SMU on anxiety and depression in times of social distancing.
Methods: Data were collected with an app-based survey combined with passive sensing of social media usage time. We analyzed SMU (objective average duration of communication app usage) and cross-sectional questionnaire data from 486 adults (mean age = 42.42). Using multiple regression models, we tested how SMU, extraversion and their interaction relate to individual depression and anxiety scores.
Results: Depression scores were associated with a higher SMU and lower extraversion. There was a significant positive relationship between SMU and extraversion that predicted higher depression scores.
Limitations: In the present sample, there is a recruitment bias since only data from smartphones running iOS were included. Future research should also take a closer look at the purpose behind SMU.
Conclusions: We conclude that extraversion might be a protective factor for depression which can turn into a harmful one if it is related to higher SMU. Thus, the interplay between SMU and extraversion needs to be considered when predicting individual differences in mental health.

Introduction

Positive social interactions are known to be beneficial for well-being (Baumeister and Leary, 2018; Cohen, 2004; Sandstrom and Dunn, 2014). This is particularly true for interactions taking place face-to-face (e.g., Sacco and Ismail, 2014) as they can provide social support and a sense of belonging, thus contributing considerably to achieving and maintaining mental and physical well-being (Cohen, 2004; Cornwell and Waite, 2009; Hagerty and Williams, 1999; Thoits, 2011). As such, positively perceived interactions with others can reduce stress and support mental health (Segrin and Rynes, 2009), which we refer to as appreciation of social interactions (APSI). APSI, as a proxy for positive effects by valuing social support, can be used as a psychological resource for coping with stress (Cohen, 2004). Social support is thought to reduce the adverse effects of sources of stress on an individual's mental health as indicated by the Stress-Buffering Model (Cohen and Wills, 1985). Upholding close social ties with family and friends reduces symptoms of depression (Cruwys et al., 2013), stimulates engagement in physical activities (Kaczynski and Glover, 2012), and improves life satisfaction (Stavrova and Luhmann, 2016). However, in the wake of the coronavirus disease 2019 (COVID-19) pandemic, nations worldwide have introduced strict contact restrictions to control the spread of the novel Sars-Cov-2 coronavirus (Khanna et al., 2020; Roser et al., 2020). As a result, many individuals have spent more time at home than before the pandemic. This led to an increase in social media use (SMU), especially in, but not limited to, females (Lemenager et al., 2021).

During physical distancing, communicating via smartphone can help maintain social support and the feeling of being part of a community

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(Banerjee and Rai, 2020; Naslund et al., 2016). Social media can also help adults make new friends, especially in the context of a pandemic (O'Keeffe et al., 2011). Furthermore, research showed that the possibility to connect anonymously with others could be a major benefit of social media for anxious and shy individuals (Valkenburg and Peter, 2011), persons suffering from shame and isolation (Whitlock et al., 2006), and even for those with stigmatized health conditions such as mental illness (Berger et al., 2005; Highton-Williamson et al., 2015).

However, recent studies showed that during the pandemic, prolonged SMU might have led to mental health problems (Ahmad and Murad, 2020; Allington et al., 2020) such as depression (Zhong et al., 2021) and anxiety (Boursier et al., 2020). This, in turn, was associated with a greater SMU to compensate for the increased sense of loneliness by trying to uphold a sense of belonging – a vicious circle (Boursier et al., 2020). Therefore, the reduction of direct contacts could have detrimental effects on mental health (Cornwell and Waite, 2009; Marroquín et al., 2020). Outside the pandemic context, SMU has been associated with lower emotional support from face-to-face interactions and, in consequence, greater social isolation, anxiety, and depression (e.g., Lin et al., 2016; for a review on problematic SMU, see Marino et al., 2018; Primack et al., 2018; Shensa et al., 2018; Yoon et al., 2019). For instance, a longitudinal study showed that Facebook use was negatively related to well-being and mental health (Shakya and Christakis, 2017). The authors demonstrated that the negative implications of Facebook use on various health indices (i.e., body mass index and self-reported physical health, mental health, and life satisfaction) were comparable or even greater in magnitude than the positive effects of face-to-face interactions on these indices. In contrast, there is also evidence that SMU is only a nuanced or weak predictor of well-being (Orben et al., 2019).

Taken together, there is inconsistent evidence regarding the relationship between SMU and mental health. Providing a possible explanation for this inconsistency, the Differential Susceptibility to Media Effects Model (Valkenburg and Peter, 2013) proposes that the effect of SMU on mental health is moderated by individual differences in personality traits, along with developmental and social factors.

Specifying the personality traits that may play a role, more recent research has proposed that extraversion, a trait characterized by sociability, high energy levels, and appreciation of social interactions, may moderate the relationship between the type of social contact and mental health (e.g., Soto and John, 2017). Extraversion is associated with positive mental health (e.g., Lamers et al., 2012) and with decreases in symptoms of depression, anxiety, and mental illness (e.g., Jylhä and Isometsä, 2006), but also with high social media consumption (e.g., Caci et al., 2014; Moore and McElroy, 2012). Especially in times of limited face-to-face interactions, social media applications (apps) provide an important platform for socializing: extraverted individuals experience positivity through SMU which reflects their offline behavior (Bowden-Green et al., 2020). At the same time, extensive SMU is associated with mental health problems (Lin et al., 2016; Vannucci et al., 2017).

Given that extraversion is related to SMU and mental health, it is plausible to assume that extraversion, characterized by the appreciation of social interactions, may be one variable that affects the strength or the direction of the relationship between SMU and mental health.

However, so far it remains unclear whether extraversion moderates the relationship between SMU and mental health.

Moreover, in previous studies, SMU was often assessed based on subjective ratings of social app consumption (e.g., Bányai et al., 2017; Berryman et al., 2018; Kircaburun et al., 2020; Vannucci et al., 2017) which may be biased by social desirability.

The current study investigated the moderation effect of extraversion based on the recorded average duration of social media app use on participants' smartphones, i.e., an objective indicator of SMU. We tested the link between this objective SMU measure to self-reported symptoms of anxiety and depression (assessed by well-established questionnaires) and investigated whether and how this link is moderated by extraversion. Given that a preference for personal social interactions can affect SMU (e.g., Grieve et al., 2013) and mental health (in case of a lack of personal social interactions, e.g., Cacioppo et al., 2010; Teo et al., 2015), we also assessed individuals' appreciation of personal social interactions and tested its effect on SMU and both mental health dimensions.

Inspired by studies showing a positive effect of social contact (e.g., Sacco and Ismail, 2014) and extraversion on mental health (e.g., Lamers et al., 2012), we hypothesized that extraverted individuals and those who tend to appreciate social contacts (e.g., Best et al., 2014) report lower anxiety and depression scores. Although we expected that SMU itself would predict a decline in mental health (e.g., Allington et al., 2020; Boursier et al., 2020), beneficial aspects of social contact support the assumption that the stronger the positive interaction between extraversion and SMU, the lower the depression and anxiety scores. Alternatively, based on results showing a negative effect of SMU on mental health (e.g., Yoon et al., 2019), it is also possible that the higher SMU in extraverted individuals is associated with a decline of mental health, i.e., an increase in depression and anxiety scores. In this case, a strong positive interaction between extraversion and SMU should predict higher depression and anxiety scores. The tested model is visualized in Figure 1.

Method

Sample and Procedure

Data were collected using the Corona Health App which was initiated by the Mental Health Research Unit of the Robert Koch Institute (RKI), i.e., the German federal agency for public health responsible for disease control and prevention, and the Universities of Würzburg, Ulm and Regensburg (for details, see Beierle et al., 2021). The goal of Corona Health is to monitor mental and physical well-being during the COVID-19 pandemic. The app allows for interdisciplinary collaboration with experts from different fields to work together and use different questionnaires, sensor data, and smartphone usage statistics. Users can download the Corona Health App for free from the Apple Store and from the Google Play store. A detailed description for the Corona Health App is provided by Beierle et al. (2021). There were no specific criteria for recruitment. However, for legal reasons the transmission of app data usage was only possible for Android users, so Apple users were excluded. The total sample (incl. Apple users) was N=1760, of which N=18 were removed due to failure in the plausibility check. 60.4% (N=1,052) of the participants used Android, of which 46.6% (N=490) agreed to transfer their usage data. The participants who agreed and disagreed to data transfer were comparable in variables important for our research question such as trait depression (PHQ-score, $p = .580$) and trait anxiety (GAD-score, $p = .713$), as well as with regard to age ($p = .064$). Overall, slightly more males (54%) than females (41%) agreed to data transfer ($\chi^2 = 15.18$, $p < .001$). As an ongoing study, it combines a cross-sectional and a longitudinal design, with weekly follow-ups starting from July 2020. The present analyses were based on the cross-sectional questionnaire and communication app data collected between July 2020 and February 2021. This time period represents different stages of contact restrictions in which physical distancing was encouraged at all times. From July to October 2020, public gatherings of up to ten persons were still allowed (Wieler et al., 2021). In response to exponentially rising cases (Robert Koch Institut, 2020), social restrictions were then gradually tightened, resulting in a strict lockdown (December 13 2020 onwards) with the discouragement of group gatherings and contacts beyond households and the closing of high-risk public places (e.g., restaurants; Wieler et al., 2021). The lockdown endured throughout January and February 2021 (Landeszentrale für politische Bildung Baden-Württemberg, 2021).

Within the total sample of 1052 Android users, 490 agreed to the transfer of smartphone communication app data. We excluded one

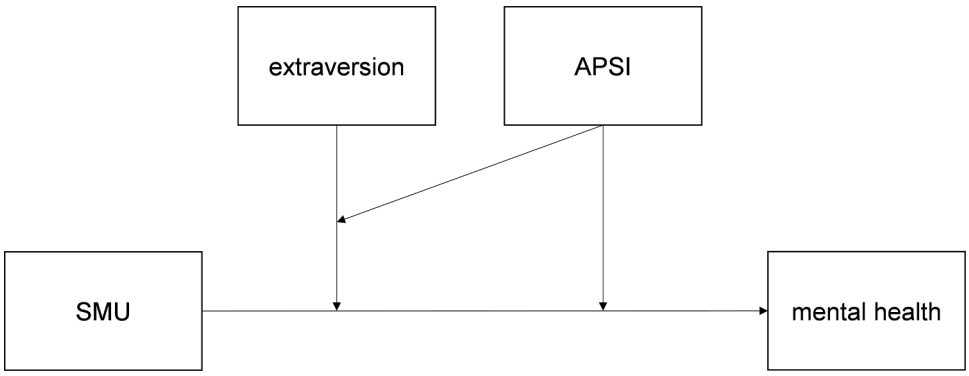

Figure 1. Visualization of the tested model. Extraversion and appreciation of social interactions (APSI) are expected to moderate the relation between social media usage (SMU) and mental health outcomes (i.e., depression and anxiety).

person who stated having completed the survey for someone else and three other persons due to incomplete data. Finally, we analyzed 486 data sets (257 females (52.9 %); age average = 42.42 years (*SD* = 13.28)). Participation was voluntary, and no financial compensation was provided. Data collection was approved by the data protection officer and the ethics committee of the University of Würzburg (No. 130/20-me). Each participant provided informed consent.

Measures

Passive sensing of social media use (SMU)

We collected smartphone communication app usage times for each day in the last seven days before answering the questionnaire. The usage time covered a selection of ten smartphone communication apps. It refers to the amount of time an app was actively used by a person, rather than passively open in the background. We derived the apps relevant for answering our research by the average of the daily aggregated usage times of social media apps, i.e., Facebook, Instagram, and Snapchat, and social instant messenger apps, i.e., WhatsApp, Telegram, Facebook Messenger, and Skype Messenger (see also, Wetzel et al., 2021).

Self-report measures

Participants' depression was assessed using a smartphone-based Patient Health Questionnaire (PHQ-9; Cronbach's α = .89; Kroenke et al., 2001), with sum scores of 0-4 indicating minimal depression, 5-9 mild depression, 10-14 moderate depression, 15-19 moderately severe depression, and 20-17 severe depression. An exemplary item is "feeling down, depressed, or hopeless". Anxiety was assessed with the Generalized Anxiety Disorder Scale (GAD-7; Cronbach's α = .86; Löwe et al., 2008), with sum scores of 0-4 indicating minimal anxiety, 5-9 mild anxiety, 10-14 moderate anxiety, and ≥ 15 severe anxiety. An exemplary item is "feeling nervous, anxious or on edge." For extraversion, we used the two extraversion items of the 10-item Big Five Inventory (BFI-10; Cronbach's $\alpha_{extraversion}$ = .75; Rammstedt et al., 2014): "I see myself as someone who is outgoing, sociable." and "I see myself as someone who is reserved." (inverted). APSI was assessed using the following question on a Likert scale from 1 (very often) to 5 (never): "How often do you have the feeling that positive interactions with people who are present relax you?". To facilitate interpretation, the APSI item was inverted (higher values = more appreciation of personal social interactions). For the analysis, we used continuous variables of all measures. While extraversion covers sociability as a trait, APSI refers more specifically to the subjective effect of personal social interactions. The item was added to assess the subjective value of personal social interactions and its potential effect on SMU and the mental health variables.

Statistical Analyses

Data analyses were performed using correlation analyses and multiple linear regression in R-Studio (R Core Team, 2021). First, we tested the bivariate correlations between the predictors. Then, we conducted two regression models, one with individual PHQ scores and one with individual GAD scores as dependent variables and SMU, extraversion, APSI, interactions of SMU x extraversion, SMU x APSI, extraversion x APSI, and SMU x extraversion x APSI as predictors. Given that gender and age are known to correlate with social media use (Blackwell et al., 2017; Choi et al., 2017; Kircaburun et al., 2020) and mental health (e.g., Faravelli et al., 2013; Leach et al., 2008), both variables were included as covariates. To account for significant correlations between age and APSI as well as gender and extraversion (see below), APSI x age and extraversion x gender were added as additional predictors (see Table 1 for descriptive statistics). Due to its skewness (2.44), we transformed SMU by using its square root (as it can be applied to zero values). Continuous variables were standardized in both analyses to have a mean of 0 and a standard deviation of 1 to obtain standardized β weights. The variance inflation factors (VIFs) were < 2.5 (see Table 2), indicating low collinearity between the predictors (Johnston et al., 2018; Sheather, 2009). We have also tested the full models for depression and anxiety with main effects and interaction terms between all five predictors, i.e., SMU, extraversion, APSI, age, and gender. In these models, many predictors showed a VIF ≥ 2.5, which according to recent research indicates considerable collinearity (e.g., Johnston et al., 2018). Therefore, we refrained to include these predictors, as the reliability of results decreases with increasing VIFs. Including age and female as main effects only, i.e., as covariates in a traditional way, did not affect the reported results. In the present sample, 181 individuals scored above the clinically relevant cutoff score of 10 or greater in the PHQ-9 (Kroenke et al., 2001) and 162 scored above the clinically relevant cutoff score of 10 or greater in the GAD-7 (Spitzer et al., 2006). Therefore, we additionally computed the models reported above as logistic regressions (1 = above the cutoff, 0 = below the cutoff) to make clinically relevant predictions for depression and anxiety. Finally, we conducted a sensitivity analysis

Table 1
Descriptive statistics.

	M	SD	min	max
APSI	3.63	0.99	1	5
extraversion	2.85	1.06	1	5
SMU	23.94	27.79	0	196
PHQ	8.67	6.21	0	27
GAD	7.68	4.95	0	21
age	42.42	13.28	18	78

APSI = appreciation of personal social interactions; SMU = use time of social media applications (in minutes per day); PHQ = depression score, GAD = anxiety score.

Table 2
Results of linear regression analyses testing associations of age, gender, appreciation of personal social interactions (APSI), social media use (SMU), and extraversion (E) as well as their interactions with depression (PHQ) and anxiety (GAD) scores.

	PHQ			GAD			
	β (se)	t	p	β (se)	t	p	VIF
Age	-.19 (.05)	-4.32	< .001	-.10 (.05)	-2.16	.031	1.12
Gender	.17 (.09)	1.98	.048	.25 (.09)	2.83	.005	1.05
APSI	-.07 (.05)	-1.58	.116	-.03 (.05)	-0.54	.586	1.15
SMU	.14 (.05)	2.94	.003	.14 (.05)	3.05	.002	1.17
E	-.26 (.06)	-4.07	< .001	-.23 (.07)	-3.41	< .001	2.31
SMU x E	.12 (.05)	2.47	.014	.07 (.05)	1.48	.139	1.15
SMU x APSI	-.05 (.05)	-1.08	.281	.01 (.05)	0.16	.873	1.20
APSI x E	-.02 (.04)	-0.52	.601	-.04 (.04)	-1.05	.293	1.10
APSI x age	.02 (.04)	0.40	.688	.05 (.04)	1.12	.263	1.11
E x gender	-.12 (.09)	1.36	.173	.18 (.09)	1.91	.057	2.22
SMU x E x APSI	.02 (.04)	0.47	.641	-.01 (.04)	-0.33	.742	1.14
Adjusted R^2		.12			.07		

Note. VIF = variation inflation factor; gender is a dummy variable, female = 1, male/diverse = 0

to evaluate the degree to which the effects were similar when social media apps and social instant messenger apps are considered separately. Accordingly, we recalculated the previous models separately for each of the two subtypes of social media apps.

Results

In the present study, the participants reported mild symptoms of depression ($M = 8.67$, $SD = 6.21$) and anxiety ($M = 7.68$, $SD = 4.95$) on average. A priori sample size calculation using G*Power Version 3.1.9. (Faul et al., 2007) suggested that a minimum sample size of $N = 325$ is sufficient for detecting a small to medium effect of $f^2 = .08$ in a multiple linear regression fixed effects model with eleven predictors at a power level of .95 and with an error probability of .05.

Correlation analyses showed that SMU was positively associated with extraversion ($r = .12$) and APSI ($r = .11$), and that there was a positive relationship between extraversion and APSI ($r = .24$). Gender was positively related to extraversion (1 = female; $r = .14$), indicating stronger extraversion scores in females. Age was negatively related to APSI, indicating decreasing appreciation with increasing age ($r = -.16$). Exploratorily, we tested for gender differences regarding depression, anxiety, extraversion, SMU, and APSI. While there was no difference between males and females regarding depression, $t(468.03) = 1.85$, $p = .065$, $d = .169$, females reported significantly higher anxiety, $t(475.9) = 2.87$, $p = .004$, $d = .261$. Females reported higher levels of extraversion compared to males, $t(471.75) = 3.17$, $p = .002$, $d = .289$, and had a higher SMU, $t(483.9) = 2.97$, $p = .003$, $d = .268$. For APSI, no difference between females and males was found, $t(466.59) = 1.43$, $p = .154$, $d = .131$.

First, we tested how age, gender, SMU, extraversion, and APSI predicted symptoms of depression. The results showed a significant positive main effect of SMU, indicating that strong SMU is related to higher depression scores (β = .14, *s.e.* = .05, $p = .003$), Fig. 2a. There also was a significant negative main effect of extraversion, indicating lower depression scores in highly extraverted individuals (β = -.26, *s.e.* = .06, $p < .001$), Fig. 2b. With increasing SMU, highly extraverted individuals showed a steeper increase in depression scores as compared to individuals with low extraversion (see Fig. 2c). A simple slopes analysis showed no effect for the slope of SMU when extraversion was low (-1 SD; β = .02, *s.e.* = .07, $p = .800$). However, for the mean of extraversion (β = .14, *s.e.* = .05, $p < .001$) and for high extraversion (+ 1 *SD*; β = .25, *s.e.* = .07, $p < .001$), the slope of SMU was significant. Thus, both average and highly extraverted individuals report increasing depression scores with increasing SMU. In addition, the results showed main effects of age and gender, indicating that depression scores were lower the older individuals were (β = -.19, *s.e.* = .05, $p < .001$) and were higher in females compared to males (β = .17, *s.e.* = .09, $p = .048$). No other effects were significant (see Table 2, left column).

In addition, we computed a logistic model for depression. The results showed a significant main effect of extraversion, indicating that an

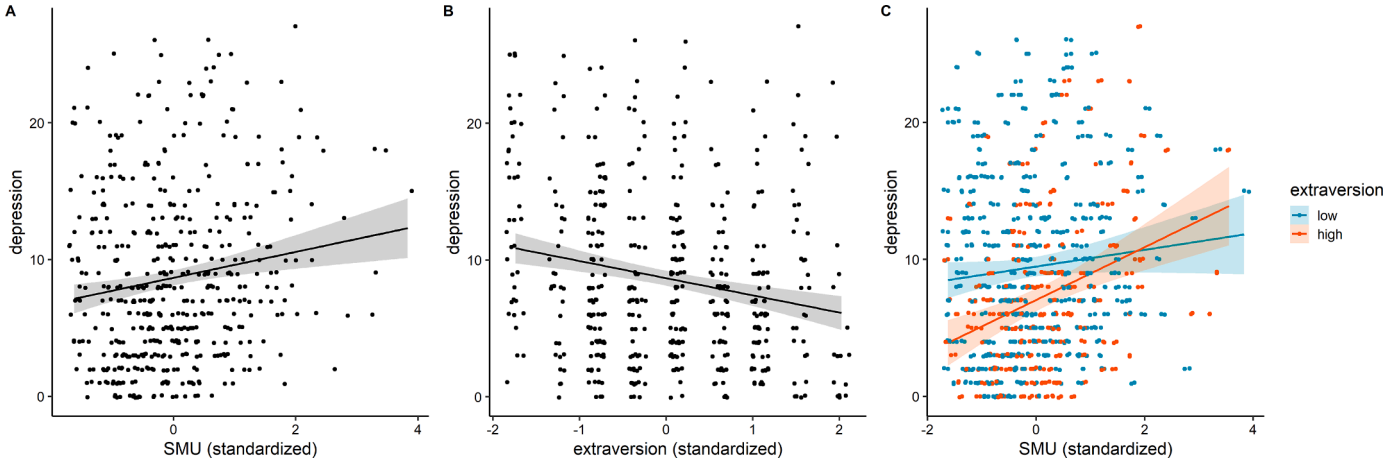

Figure 2. Multiple regression results for depression. (A) Social media usage (SMU) is linked to higher depression scores. (B) Higher trait extraversion is associated with lower depression scores. (C) Based on a median split (median = 3), the influence of SMU on depression is visualized for individuals low and high on extraversion. Persons with high extraversion show a steeper increase in depression scores with increasing SMU as compared to low extraverted individuals. Shaded areas indicate the 95% confidence intervals.

increase in extraversion decreases the odds of being above the clinically relevant cutoff (z = -2.62, p = .008, Odds Ratio (OR) = .66). In contrast, the interaction between SMU and extraversion increases the odds of being above the cutoff (z = 2.70, p = .007, OR = 1.36). In addition, increasing age also decreases the odds of being above the cutoff score (z = -4.12, p < .001, OR = .63). No other effect was statistically significant.

Second, we conducted the same analyses to test the effects of age, gender, SMU, extraversion, and APSI on anxiety, captured by individual differences in GAD scores. The results showed a significant positive main effect of SMU, indicating that strong SMU is related to higher anxiety scores (β = .14, *s.e.* = .05, p = .002), and a significant negative main effect of extraversion, indicating lower anxiety scores in highly extraverted individuals (β = -.23, *s.e.* = .07, p < .001). Similar to depression, older age was linked to lower anxiety scores (β = -.10, *s.e.* = .05, p = .031), and females showed higher anxiety scores than males (β = .25, *s.e.* = .09, p = .005). There were no other significant effects (see Table 2, right column). However, the interaction between extraversion and gender was marginally significant (β = .18, *s.e.* = .09, p = .057).

Again, we used a logistic model to predict clinically relevant symptoms of anxiety. The results also showed that an increase in extraversion decreases the odds of being above the clinically relevant cutoff for anxiety (z = -3.07, p = .002, OR = .60). The main effect of SMU indicated that an increase in SMU increases the odds of being above the cutoff score (z = 2.13, p = .033, OR = 1.26). No other effect yielded significance.

Sensitivity Analyses

For depression, all significant results from the confirmatory model were also significant in the model with social instant messenger apps only as proxy for SMU. Thus, SMU, the interaction between SMU and extraversion, as well as female gender were associated with higher levels of depression, whereas extraversion and age were related to lower levels of depression. However, in the model including social media apps only for SMU, the interaction between SMU and extraversion did not reach significance (p = .253). All other significant effects from the hypothesized model remained significant and in the same direction.

Regarding anxiety, the results from the confirmatory model were also significant in the model with social media apps only as proxy for SMU and the effects pointed in the same direction as for depression. In contrast, the model with social instant messenger apps only as proxy for SMU revealed an additional significant interaction between SMU and extraversion (β = .16, *s.e.* = .05, p = .001).

Exploratory Analyses

To test for the specificity of our effects, especially the interaction between personality (i.e., extraversion) and SMU as predictor for depression, we recalculated the models for depression and anxiety separately for the other four Big Five personality traits, i.e., agreeableness, conscientiousness, neuroticism, and openness (i.e., eight models in total). The results are summarized in Tables S1-S4 in the supplemental material. These models did not show any interaction including SMU, neither for depression nor for anxiety. Importantly, across all models, there was only one interaction term that reached significance. For depression, the interaction between neuroticism and APSI (β = -.08, *s.e.* = .04, p = .044) indicated decreasing depression scores for individuals high on neuroticism who appreciate social interactions.

Discussion

In the present study, we investigated whether the association between social media use (SMU) and depression and anxiety is moderated by individual differences in extraversion and the appreciation of social interactions (APSI). To quantify social media use objectively, we used recorded smartphone data from the Corona Health App.

The regression models showed that both depression and anxiety were related to increasing SMU (i.e., a harmful effect), which is consistent with previous literature (Boursier et al., 2020; Lin et al., 2016; Vannucci et al., 2017; Zhong et al., 2021). This might be a hint that the beneficial effects of face-to-face interactions do not transfer to virtual interactions (Cornwell and Waite, 2009; Sacco and Ismail, 2014), which would contradict previous findings showing that SMU may compensate for a lack of personal interactions during physical distancing (Banerjee and Rai, 2020; Naslund et al., 2016; O'Keeffe et al., 2011). Instead, more engagement in SMU was generally associated with lower mental health (Yoon et al., 2019). At the diagnostic level of clinically relevant severity, this effect was significant only for anxiety, as revealed by logistic regression analysis. However, such potential mechanisms need to be tested empirically by further research, as our data lack information about the quality and motivation of the interaction.

Previous findings imply a moderating role of extraversion on the relation between SMU and mental health (Soto and John, 2017). As expected, extraversion correlated positively with SMU and therefore might be the reason for the mental health-depriving behavior (Lin et al., 2016; Vannucci et al., 2017). In line with previous findings (Al-Omiri et al., 2021), extraversion was also shown to be a protective factor for mental health, even in times of contact restrictions during a pandemic. However, this is only true if one exclusively considers the main effect of extraversion. For the relation between SMU and depression, a particularly relevant interaction effect emerged. While SMU was related to an impaired mental health and extraversion had a beneficial effect per se, the interaction between extraversion and SMU showed that the harmful effect of SMU becomes more dominant with increasing levels of extraversion. In individuals with average or high extraversion scores, SMU was related to an increase in depression. This interaction was also predictive for clinically relevant levels of self-rated depression in the present sample, as indicated by the results of logistic regression analysis. This is an important extension of previous findings that failed to show a moderating effect of extraversion on the relationship between SMU and mental health (e.g., Simoncic et al., 2014). Moreover, the exploratory analyses on the other four Big Five personality traits confirmed that this moderation effect is specific to extraversion as no other trait showed a significant interaction with SMU. However, our sensitivity analysis showed that social instant messenger apps might play a more important role than social media apps. One reason for this could be that instant messenger apps are largely used actively (chatting), whereas social media apps are also used passively (viewing pictures and videos). Further research is needed to distinguish between different levels of activity in SMU and their impact on mental health.

Interestingly, extraversion was also related to lower anxiety scores, but we were not able to show an interaction effect of extraversion and SMU, similar to depression, for anxiety (although the trend of the data points in the same direction). Only when distinguishing between social media and social instant messenger apps, we were able to show the interaction with the messenger apps in the model. This particular feature may point to a narrower definition of the constructs "social media use" that could be useful for further studies. Possibly, a measure more closely related to social situations is required here. As has been shown in previous research, the GAD-7 is a useful measure for rather heterogeneous samples, but may not be particularly well-suited for individuals with social anxiety disorders (e.g., Beard and Björgvinsson, 2014). Thus, future studies addressing the interaction between extraversion and SMU in relation to (social) anxiety should include a measure specifically targeting social anxiety.

Our findings show additional factors influencing SMU and mental health. Next to extraversion, APSI was also linked to SMU. We did not find a significant interaction between APSI, extraversion, and SMU for both depression and anxiety, nor a main effect of APSI. However, the correlation analysis showed that individuals who relax through direct social interactions are also more likely to be extraverted. This fits with

extraverts' higher tendency to seek social contacts (Swickert et al., 2002). On the other hand, this correlation between APSI and extraversion is rather weak, which is why APSI seems to measure something fundamentally different from extraversion. However, since APSI had no effect in our models, this does not seem to be highly relevant for the present research.

As in previous studies, older age was associated with lower SMU (Hardy and Castonguay, 2018) and with lower depression and anxiety scores. This supports evidence that with older age, individuals have more positive social interactions (e.g., Luong et al., 2011), which might also include interactions via SMU. Also, as found previously, women showed higher SMU (Choi et al., 2017) and increased levels of symptoms of depression and anxiety (e.g., McLean et al., 2011) compared to men.

Limitations and Outlook

There are some limitations which need to be addressed when interpreting the present findings. First, there are factors which reduce the generalizability of the results. For example, the sample is expected to include accessibility and recruitment bias, and data protection regulations prevented the collection of app usage data on smartphones running iOS. In addition, participants had different starting times during the survey period, depending on when they installed and used the Corona Health App. In Germany, the COVID-19 pandemic resulted in a large number of different measures for virus control which varied widely from state to state. Therefore, it remains unanswered which specific COVID-19-related contact restrictions directly impact SMU and mental health. Second, the results are based on the premise that participants filled in their data honestly. This may be impaired due to the fact that consents are often read inaccurately (see Beierle et al., 2020). Third, the average SMU of approximately 24 min/day (192 min/week) was lower compared to other studies with considerably younger participants (e.g., 61 min/day, age range 19-32; Lin et al., 2016). Nevertheless, our results showed that even in a sample with low SMU, potentially positive aspects of SMU like connectedness and reduced loneliness (Banerjee and Rai, 2020) should be treated with caution as other factors like avoidance behavior or personality traits which have negative associations with SMU and mental health need to be considered. However, these effects need to be studied in more detail, ideally in longitudinal studies that allow for conclusions about the causality of the individual mechanisms and their improvement or deterioration over time. Finally, our analyses focused on objectively assessed app usage durations. However, there are a number of other factors contributing to the effect of SMU on mental health, including the type of social media sites used (Ilakkuvan et al., 2019) and the purpose behind the SMU. Future research should include both quantitative and qualitative aspects of SMU.

To elucidate the underlying causal relationships between SMU, extraversion, and mental health, further research needs to build more complex SMU quantity models. For example, studies indicating less "productive" app use through a higher app switching rate could be an indicator of a different usage pattern between depressed and non-depressed individuals. Furthermore, the results presented here should be retested in a clinical sample and confirmed or revised.

Conclusion

In summary, we were able to show that social media use has the expected negative association with mental health. Despite the general positive influence of extraversion, extraverted individuals also show a deterioration in depression scores when engaging in increased social media use. Our findings may be relevant for clinical practice, in which individuals respond differently to therapy. In the treatment of depressive symptoms, but also potentially in the treatment of smartphone addiction, a differential perspective which integrates basic personality traits could allow for a more nuanced and individualized approach to clinical manifestations and therapy.

Author Contributions

HB, CC, JD, RP, GH designed the research; CC and RP programmed the app and collected the data; MW and MG analyzed the data supervised by GH; MW and GH wrote the paper with input from all other authors.

Institutional Review Board Statement

The Corona Health App study was conducted in accordance with the German medical products law. The data protection officer and the ethics committee of the University of Würzburg, Germany approved the study (No. 130/20-me). The procedures used in this study adhered to the tenets of the Declaration of Helsinki.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

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Data Availability Statement

The data presented in this study are available on request from the corresponding author. The data are not publicly available because participants' informed consent did not cover public deposition of data.

Conflict of Interest Statement

J.D. is an investigator in the EU-Horizon-funded Predict Study of P1Vital and Co-Applicant with BioVariance in the InDepth Study funded by the Bavarian State Government.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jadr.2022.100343.

References

Ahmad, A.R., Murad, H.R., 2020. The impact of social media on panic during the COVID-19 pandemic in Iraqi Kurdistan: online questionnaire study. J. Med. Internet Res. 22 (5), e19556. https://doi.org/10.2196/19556.

AL-Omiri, M.K., Alzoubi, I.A., Al Nazeh, A.A., Alomiri, A.K., Maswady, M.N., Lynch, E, 2021. COVID-19 and personality: a cross-sectional multicenter study of the relationship between personality factors and COVID-19-related impacts, concerns, and behaviors. Front. Psychiatry 12, 608730. https://doi.org/10.3389/fpsyt.2021.608730.

Allington, D., Duffy, B., Wessely, S., Dhavan, N., Rubin, J., 2020. Health-protective behaviour, social media usage, and conspiracy belief during the COVID-19 public health emergency. Psychol. Med. 1–7. https://doi.org/10.1017/S003329172000224X.

Banerjee, D., Rai, M., 2020. Social isolation in Covid-19: the impact of loneliness. In: International Journal of Social Psychiatry, 66. SAGE Publications Ltd., pp. 525–527. https://doi.org/10.1177/0020764020922269

Bányai, F., Zsila, Á., Király, O., Maraz, A., Elekes, Z., Griffiths, M.D., Andreassen, C.S., Demetrovics, Z., 2017. Problematic social media use: results from a large-scale

nationally representative adolescent sample. PLoS One 12 (1), e0169839. https://doi.org/10.1371/journal.pone.0169839.
Baumeister, R.F., Leary, M.R., 2018. The Need to Belong: Desire for Interpersonal Attachments as a Fundamental Human Motivation. Interpersonal Development. Routledge, pp. 57–89. https://doi.org/10.4324/9781351153683-3.
Beard, C., Björgvinsson, T., 2014. Beyond generalized anxiety disorder: Psychometric properties of the GAD-7 in a heterogeneous psychiatric sample. J. Anxiety Disord. 28 (6), 547–552. https://doi.org/10.1016/j.janxdis.2014.06.002.
Beierle, F., Schobel, J., Vogel, C., Allgaier, J., Mulansky, L., Haug, F., Haug, J., Schlee, W., Holfelder, M., Stach, M., Schickler, M., Baumeister, H., Cohrdes, C., Deckert, J., Deserno, L., Edler, J.-S., Eichner, F.A., Greger, H., Hein, G., Pryss, R., 2021. Corona health—a study- and sensor-based mobile app platform exploring aspects of the COVID-19 Pandemic. Int. J. Environ. Res. Public Health 18 (14), 7395. https://doi.org/10.3390/ijerph18147395.
Beierle, F., Tran, V.T., Allemand, M., Neff, P., Schlee, W., Probst, T., Zimmermann, J., Pryss, R., 2020. What data are smartphone users willing to share with researchers?: Designing and evaluating a privacy model for mobile data collection apps. J. Ambient Intell. Humanized Comput. 11 (6), 2277–2289. https://doi.org/10.1007/s12652-019-01355-6.
Berger, M., Wagner, T.H., Baker, L.C., 2005. Internet use and stigmatized illness. Soc. Sci. Med. 61 (8), 1821–1827. https://doi.org/10.1016/j.socscimed.2005.03.025.
Berryman, C., Ferguson, C.J., Negy, C., 2018. Social Media Use and Mental Health among Young Adults. Psychiatr. Q. 89 (2), 307–314. https://doi.org/10.1007/s11126-017-9535-6.
Best, P., Manktelow, R., Taylor, B., 2014. Online communication, social media and adolescent wellbeing: a systematic narrative review. Child. Youth. Serv. Rev. 41, 27–36. https://doi.org/10.1016/j.childyouth.2014.03.001.
Blackwell, D., Leaman, C., Tramposch, R., Osborne, C., Liss, M., 2017. Extraversion, neuroticism, attachment style and fear of missing out as predictors of social media use and addiction. Personal. Individ. Differences 116, 69–72. https://doi.org/10.1016/j.paid.2017.04.039.
Boursier, V., Gioia, F., Musetti, A., Schimmenti, A., 2020. Facing loneliness and anxiety during the COVID-19 isolation: the role of excessive social media use in a sample of Italian Adults. Fron. Psychiatry 11, 586222. https://doi.org/10.3389/fpsyt.2020.586222.
Bowden-Green, T., Hinds, J., Joinson, A., 2020. How is extraversion related to social media use? A literature review. Personal. Individ. Diff. 164, 110040 https://doi.org/10.1016/j.paid.2020.110040.
Caci, B., Cardaci, M., Tabacchi, M.E., Scrima, F., 2014. Personality variables as predictors of facebook usage. Psychol. Rep. 114 (2), 528–539. https://doi.org/10.2466/21.09.PR0.114k23w6.
Cacioppo, J.T., Hawkley, L.C., Thisted, R.A., 2010. Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the chicago health, aging, and social relations study. Psychol. Aging 25 (2), 453–463. https://doi.org/10.1037/a0017216.
Choi, T.R., Sung, Y., Lee, J.A., Choi, S.M., 2017. Get behind my selfies: The Big Five traits and social networking behaviors through selfies. Personality and Individual Differences 109, 98–101. https://doi.org/10.1016/j.paid.2016.12.057.
Cohen, S., 2004. Social Relationships and Health. In: American Psychologist, 59. American Psychological Association, pp. 676–684. https://doi.org/10.1037/0003-066X.59.8.676.
Cohen, S., Wills, T.A., 1985. Stress, social support, and the buffering hypothesis. Psychol. Bull. 98 (2), 310–357. https://doi.org/10.1037/0033-2909.98.2.310.
Cornwell, E.Y., Waite, L.J., 2009. Measuring SOCIAL ISOLATION AMONG OLDER ADULTS USING MULTIPLE INDICATORS FROM The NSHAP Study. J. Gerontol. Ser. B 64B (suppl_1), i38–i46. https://doi.org/10.1093/geronb/gbp037.
Cruwys, T., Dingle, G.A., Haslam, C., Haslam, S.A., Jetten, J., Morton, T.A., 2013. Social group memberships protect against future depression, alleviate depression symptoms and prevent depression relapse. Soc. Sci. Med. 98, 179–186. https://doi.org/10.1016/j.socscimed.2013.09.013.
Faravelli, C., Alessandra Scarpato, M., Castellini, G., Lo Sauro, C., 2013. Gender differences in depression and anxiety: the role of age. Psychiatry Res. 210 (3), 1301–1303. https://doi.org/10.1016/j.psychres.2013.09.027.
Faul, F., Erdfelder, E., Lang, A.G., Buchner, A., 2007. G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav. Res. Methods 39 (2), 175–191. https://doi.org/10.3758/BF03193146.
Grieve, R., Indian, M., Witteveen, K., Anne Tolan, G., Marrington, J., 2013. Face-to-face or Facebook: can social connectedness be derived online? Comput. Hum. Behav. 29 (3), 604–609. https://doi.org/10.1016/j.chb.2012.11.017.
Hagerty, B.M., Williams, A., 1999. The effects of sense of belonging, social support, conflict, and loneliness on depression. Nurs. Res. 48 (4).
Hardy, B.W., Castonguay, J., 2018. The moderating role of age in the relationship between social media use and mental well-being: an analysis of the 2016 General Social Survey. Comput. Hum. Behav. 85, 282–290. https://doi.org/10.1016/j.chb.2018.04.005.
Highton-Williamson, E., Priebe, S., Giacco, D., 2015. Online social networking in people with psychosis: a systematic review. In: International Journal of Social Psychiatry, 61. SAGE Publications Ltd., pp. 92–101. https://doi.org/10.1177/0020764014556392
Ilakkuvan, V., Johnson, A., Villanti, A.C., Evans, W.D., Turner, M., 2019. Patterns of social media use and their relationship to health risks among young adults. J. Adolesc. Health 64 (2), 158–164. https://doi.org/10.1016/j.jadohealth.2018.06.025.
Johnston, R., Jones, K., Manley, D., 2018. Confounding and collinearity in regression analysis: a cautionary tale and an alternative procedure, illustrated by studies of British voting behaviour. Qual. Quan 52 (4), 1957–1976. https://doi.org/10.1007/s11135-017-0584-6.
Jylhä, P., Isometsä, E., 2006. The relationship of neuroticism and extraversion to symptoms of anxiety and depression in the general population. Depress. Anxiety 23 (5), 281–289. https://doi.org/10.1002/da.20167.
Kaczynski, A.T., Glover, T.D., 2012. Talking the talk, walking the walk: examining the effect of neighbourhood walkability and social connectedness on physical activity. J. Public Health 34 (3), 382–389. https://doi.org/10.1093/pubmed/fds011.
Khanna, R.C., Cicinelli, M.V., Gilbert, S.S., Honavar, S.G., Murthy, G.S.V., 2020. COVID-19 pandemic: lessons learned and future directions. Indian J. Ophthalmol. 68 (5), 703–710. https://doi.org/10.4103/ijo.IJO_843_20.
Kircaburun, K., Alhabash, S., Tosuntaş, Ş.B., Griffiths, M.D., 2020. Uses and gratifications of problematic social media use among university students: a simultaneous examination of the big five of personality traits, social media platforms, and social media use motives. Int. J. Mental Health Addict. 18 (3), 525–547. https://doi.org/10.1007/s11469-018-9940-6.
Kroenke, K., Spitzer, R.L., Williams, J.B.W., 2001. The PHQ-9: Validity of a brief depression severity measure. J. Gen. Intern. Med. 16 (9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x.
Lamers, S.M.A., Westerhof, G.J., Kovács, V., Bohlmeijer, E.T., 2012. Differential relationships in the association of the Big Five personality traits with positive mental health and psychopathology. J. Res. Personal. 46 (5), 517–524. https://doi.org/10.1016/j.jrp.2012.05.012.
Landeszentrale für politische Bildung Baden-Württemberg, 2021. Coronavirus - COVID 19. https://www.lpb-bw.de/coronavirus-covid-19 (Accessed: 20 July 2021).
Leach, L.S., Christensen, H., Mackinnon, A.J., Windsor, T.D., Butterworth, P., 2008. Gender differences in depression and anxiety across the adult lifespan: The role of psychosocial mediators. Soc. Psychiatry Psychiatr. Epidemiol. 43 (12), 983–998. https://doi.org/10.1007/s00127-008-0388-z.
Lemenager, T., Neissner, M., Koopmann, A., Reinhard, I., Georgiadou, E., Müller, A., Kiefer, F., Hillemacher, T., 2021. Covid-19 lockdown restrictions and online media consumption in germany. Int. J. Environ. Res. Public Health 18 (1), 1–13. https://doi.org/10.3390/ijerph18010014.
Lin, L.Y., Sidani, J.E., Shensa, A., Radovic, A., Miller, E., Colditz, J.B., Hoffman, B.L., Giles, L.M., Primack, B.A., 2016. Association between social media use and depression among U.S. young adults. Depress. Anxiety 33 (4), 323–331. https://doi.org/10.1002/da.22466.
Löwe, B., Decker, O., Müller, S., Brähler, E., Schellberg, D., Herzog, W., & Yorck Herzberg, P. (2008). *Validation and Standardization of the Generalized Anxiety Disorder Screener (GAD-7) in the General Population* (Vol. 46, Issue 3).
Luong, G., Charles, S.T., Fingerman, K.L., 2011. Better with age: Social relationships across adulthood. J. Soc. Pers. Relations. 28 (1), 9–23. https://doi.org/10.1177/0265407510391362.
Marino, C., Gini, G., Vieno, A., Spada, M.M., 2018. The associations between problematic Facebook use, psychological distress and well-being among adolescents and young adults: a systematic review and meta-analysis. J. Affect. Disord. 226, 274–281. https://doi.org/10.1016/j.jad.2017.10.007.
Marroquín, B., Vine, V., Morgan, R., 2020. Mental health during the COVID-19 pandemic: Effects of stay-at-home policies, social distancing behavior, and social resources. Psychiatry Res. 293, 113419 https://doi.org/10.1016/j.psychres.2020.113419.
McLean, C.P., Asnaani, A., Litz, B.T., Hofmann, S.G., 2011. Gender differences in anxiety disorders: prevalence, course of illness, comorbidity and burden of illness. J. Psychiatr. Res. 45 (8), 1027–1035. https://doi.org/10.1016/j.jpsychires.2011.03.006.
Moore, K., McElroy, J.C., 2012. The influence of personality on Facebook usage, wall postings, and regret. Comput. Hum. Behav. 28 (1), 267–274. https://doi.org/10.1016/j.chb.2011.09.009.
Naslund, J.A., Aschbrenner, K.A., Marsch, L.A., Bartels, S.J., 2016. The future of mental health care: peer-To-peer support and social media. Epidemiol. Psychiatric Sci. 25 (2), 113–122. https://doi.org/10.1017/S2045796015001067.
O'Keeffe, G.S., Clarke-Pearson, K., Mulligan, D.A., Altmann, T.R., Brown, A., Christakis, D.A., Falik, H.L., Hill, D.L., Hogan, M.J., Levine, A.E., Nelson, K.G., 2011. Clinical report - The impact of social media on children, adolescents, and families. In: Pediatrics, 127. Pediatrics, pp. 800–804. https://doi.org/10.1542/peds.2011-0054.
Orben, A., Dienlin, T., Przybylski, A.K., 2019. Social media's enduring effect on adolescent life satisfaction. Proc. Nat. Acad. Sci. U.S.A. 116 (21), 10226–10228. https://doi.org/10.1073/pnas.1902058116.
Primack, B.A., Bisbey, M.A., Shensa, A., Bowman, N.D., Karim, S.A., Knight, J.M., Sidani, J.E., 2018. The association between valence of social media experiences and depressive symptoms. Depress. Anxiety 35 (8), 784–794. https://doi.org/10.1002/da.22779.
R Core Team, 2021. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.
Rammstedt, B., Kemper, C.J., Klein, M.C., Beierlein, C., Kovaleva, A., 2014. Big Five Inventory (BFI-10). Zusammenstellung Sozialwissenschaftlicher Items Und Skalen (ZIS). https://doi.org/10.6102/zis76.
Robert Koch Institut, 2020. Täglicher Lagebericht des RKI zur Coronavirus-Krankheit-2019 (COVID-19). https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Situationsberichte/Gesamt.html (Accessed: 20 July 2021).
Roser, M., Ritchie, H., Ortiz-Ospina, E., Hasell, J., 2020. Coronavirus pandemic (COVID-19). Our World Data.
Sacco, D.F., Ismail, M.M., 2014. Social belongingness satisfaction as a function of interaction medium: Face-to-face interactions facilitate greater social belonging and interaction enjoyment compared to instant messaging. Comput. Hum. Behav. 36, 359–364. https://doi.org/10.1016/j.chb.2014.04.004.

Sandstrom, G.M., Dunn, E.W., 2014. Social interactions and well-being: the surprising power of weak ties. Personal. Soc. Psychol. Bull. 40 (7), 910–922. https://doi.org/10.1177/0146167214529799.

Segrin, C., Rynes, K.N., 2009. The mediating role of positive relations with others in associations between depressive symptoms, social skills, and perceived stress. J. Res. Personal. 43 (6), 962–971. https://doi.org/10.1016/j.jrp.2009.05.012.

Shakya, H.B., Christakis, N.A., 2017. Association of facebook use with compromised well-being: a longitudinal study. Am. J. Epidemiol. 185 (3), 203–211. https://doi.org/10.1093/aje/kww189.

Sheather, S., 2009. A Modern Approach to Regression with R. Springer Science & Business Media.

Shensa, A., Sidani, J.E., Escobar-Viera, C.G., Chu, K.H., Bowman, N.D., Knight, J.M., Primack, B.A., 2018. Real-life closeness of social media contacts and depressive symptoms among university students. J. Am. Coll. Health 66 (8), 747–753. https://doi.org/10.1080/07448481.2018.1440575.

Simoncic, T.E., Kuhlman, K.R., Vargas, I., Houchins, S., Lopez-Duran, N.L., 2014. Facebook use and depressive symptomatology: Investigating the role of neuroticism and extraversion in youth. Comput. Hum. Behav. 40, 1–5. https://doi.org/10.1016/j.chb.2014.07.039.

Soto, C.J., John, O.P., 2017. The next Big Five Inventory (BFI-2): Developing and assessing a hierarchical model with 15 facets to enhance bandwidth, fidelity, and predictive power. J. Pers. Soc. Psychol. 113 (1), 117–143. https://doi.org/10.1037/pspp0000096.

Spitzer, R.L., Kroenke, K., Williams, J.B.W., Löwe, B., 2006. A brief measure for assessing generalized anxiety disorder: the GAD-7. Arch. Intern. Med. 166 (10), 1092–1097. https://doi.org/10.1001/archinte.166.10.1092.

Stavrova, O., Luhmann, M., 2016. Social connectedness as a source and consequence of meaning in life. J. Posit. Psychol. 11 (5), 470–479. https://doi.org/10.1080/17439760.2015.1117127.

Swickert, R.J., Rosentreter, C.J., Hittner, J.B., Mushrush, J.E., 2002. Extraversion, social support processes, and stress. Personal. Indiv. Differences 32 (5), 877–891. https://doi.org/10.1016/S0191-8869(01)00093-9.

Teo, A.R., Choi, H., Andrea, S.B., Valenstein, M., Newsom, J.T., Dobscha, S.K., Zivin, K., 2015. Does Mode of Contact with Different Types of Social Relationships Predict Depression in Older Adults? Evidence from a Nationally Representative Survey. J. Am. Geriatr. Soc. 63 (10), 2014–2022. https://doi.org/10.1111/jgs.13667.

Thoits, P.A., 2011. Mechanisms linking social ties and support to physical and mental health. J. Health Soc. Behav. 52 (2), 145–161. https://doi.org/10.1177/0022146510395592.

Valkenburg, P.M., Peter, J., 2011. Online communication among adolescents: an integrated model of its attraction, opportunities, and risks. J. Adolesc. Health 48 (2), 121–127. https://doi.org/10.1016/j.jadohealth.2010.08.020.

Valkenburg, P.M., Peter, J., 2013. The differential susceptibility to media effects model. J. Commun. 63 (2), 221–243. https://doi.org/10.1111/jcom.12024.

Vannucci, A., Flannery, K.M., Ohannessian, C.M.C., 2017. Social media use and anxiety in emerging adults. J. Affect. Disord. 207, 163–166. https://doi.org/10.1016/j.jad.2016.08.040.

Wetzel, B., Pryss, R., Baumeister, H., Edler, J.-S., Gonçalves, A.S.O., Cohrdes, C., 2021. How Come You Don't Call Me?" Smartphone communication app usage as an indicator of loneliness and social well-being across the adult lifespan during the COVID-19 pandemic. Int. J. Environ. Res. Public Health 18 (12), 6212. https://doi.org/10.3390/ijerph18126212.

Whitlock, J.L., Powers, J.L., Eckenrode, J., 2006. The virtual cutting edge: The Internet and adolescent self-injury. Dev. Psychol. 42 (3), 407–417. https://doi.org/10.1037/0012-1649.42.3.407.

Wieler, L.H., Rexroth, U., Gottschalk, R., 2021. Emerging COVID-19 success story: Germany's push to maintain progress. Our World in Data, 10.25646/8786.

Yoon, S., Kleinman, M., Mertz, J., Brannick, M., 2019. Is social network site usage related to depression? A meta-analysis of Facebook–depression relations. J. Affect. Disord. 248, 65–72. https://doi.org/10.1016/j.jad.2019.01.026.

Zhong, B., Huang, Y., Liu, Q., 2021. Mental health toll from the coronavirus: Social media usage reveals Wuhan residents' depression and secondary trauma in the COVID-19 outbreak. Comput. Hum. Behav. 114, 106524 https://doi.org/10.1016/j.chb.2020.106524.