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Research paper

Fear of missing out predicts repeated measurements of greater negative affect using experience sampling methodology

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ABSTRACT

Background: Fear of missing out (FOMO) has been increasingly researched recently, especially in relation to negative affectivity constructs. Our aim was to examine relations between FOMO and repeated measurements of negative affect over one week.

Method: We investigated associations between FOMO and prospectively-measured negative affect over one week in an experience sampling study of 93 undergraduate students. Participants completed an initial web survey assessing depression, anxiety and FOMO. Over the week, participants responded to daily text messages, assessing negative affect from earlier in the day.

Results: On a bivariate basis, FOMO, depression and anxiety severity were related to daily negative affect assessments. Using multivariate growth modeling, higher initial negative affect was related to decreasing negative affect over the week. Female sex and higher anxiety related to higher initial negative affect ratings. Higher FOMO levels related to increasing negative affect over the week.

Limitations: Findings were based on self-report methodology, using university students and only one week of measurement.

Conclusions: Results suggest that women and more anxious individuals had higher initial negative affect, while FOMO predicted increasing negative affect over the week. Results advance understanding of FOMO in relation to psychopathology, and are discussed in the context of Self-Determination Theory.

1. Introduction

The fear of missing out (FOMO) has been increasingly studied in social science research recently. FOMO involves apprehension of missing rewarding and pleasurable experiences, and the corresponding need to constantly stay connected with one's social network (Przybylski et al., 2013). FOMO correlates with frequent and excessive use of social networking sites (SNS; e.g., Blackwell et al., 2017; Dempsey et al., 2019). FOMO is also associated with psychopathology variables - specifically, negative affect, depression and anxiety severity (e.g., Dhir et al., 2018; Elhai et al., 2018). However, FOMO has been largely studied cross-sectionally; we do not know FOMO's relations with psychopathology-related variables (such as depression, and anxiety severity) across repeated measurements.

Since FOMO first received empirical scrutiny (Przybylski et al., 2013), numerous studies examined its construct validity by examining correlations with relevant variables. Because of unmet social relatedness needs involved with FOMO (Przybylski et al., 2013), it has been studied in relation to online social engagement. Specifically, FOMO evidences moderate to large positive correlations with SNS use (Alt, 2015; Beyens et al., 2016; Blackwell et al., 2017; Dempsey et al., 2019; Franchina et al., 2018; Fuster et al., 2017; James et al., 2017; Oberst et al., 2017; Przybylski et al., 2013; Reer et al., 2019), and small but significant correlations with social smartphone use (Wolniewicz et al., 2018). FOMO also demonstrates moderate to large positive associations with problematic SNS use (Błachnio and Przepiórka, 2018; Blackwell et al., 2017; Dempsey et al., 2019; Dhir et al., 2018; Franchina et al., 2018; James et al., 2017). Furthermore, FOMO reveals moderate to large relationships with problematic smartphone use (Chotpitayasunondh and Douglas, 2016; Elhai et al.,

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2018, 2016, 2019; Fuster et al., 2017; Oberst et al., 2017; Wolniewicz et al., 2018). Relatedly, FOMO is associated with distracted pedestrian walking from overusing one's smartphone (Appel et al., 2019), and disruptions in daily activities from receiving smartphone notifications (Rozgonjuk et al., 2019).

FOMO's unmet social relatedness needs are conceptualized to drive negative emotion (Przybylski et al., 2013). Specifically, FOMO shows small to moderate positive relationships with depression severity (Baker et al., 2016; Dempsey et al., 2019; Dhir et al., 2018; Elhai et al., 2018, 2016, 2019; Oberst et al., 2017; Reer et al., 2019), and moderate to large associations with anxiety severity (Blackwell et al., 2017; Dhir et al., 2018; Elhai et al., 2018, 2016, 2019; Oberst et al., 2017; Reer et al., 2019; Scalzo and Martinez, 2017), including social anxiety (Dempsey et al., 2019; Wolniewicz et al., 2018). Furthermore, FOMO reveals small to moderate positive correlations with worse negative affect and mood (Milyavskaya et al., 2018; Przybylski et al., 2013; Wolniewicz et al., 2018).

Relatedly, FOMO is inversely correlated with constructs involving positive mood and quality of life. FOMO is mildly to moderately, inversely correlated with life satisfaction and psychological need satisfaction (Błachnio and Przepiórka, 2018; Przybylski et al., 2013). Finally, FOMO is moderately inversely associated with psychological well-being (Stead and Bibby, 2017) and mindful awareness (Baker et al., 2016).

Our specific interest is in FOMO's relationship with negative affectivity. Despite numerous studies examining the FOMO-negative affectivity relationship, the vast majority used cross-sectional designs. As one exception, using a repeated-measures design Milyavskaya et al. (2018) found FOMO related to repeated assessments of negative affect; however, this study used only single-item measures of FOMO and negative affect. Despite the conceptualization that FOMO drives negative affect (Przybylski et al., 2013), cause and effect cannot be concluded with confidence. Our interest was in empirically investigating whether FOMO related to repeated assessments of negative affect.

1.1. Aim

Our aim was to assess FOMO using a baseline survey assessment, and prospectively study relationships with negative affect collected over one week using experience sampling methodology (ESM). Negative affect is important to investigate, as it is an underlying dimension of many mood and anxiety disorders (Watson, 2005, 2009). Additionally, negative affect can vary from day to day (Eid and Diener, 1999), making it worthwhile to study using ESM. Furthermore, we controlled for baseline depression and anxiety severity. This study is important in ultimately clarifying the underlying mechanisms of FOMO with regard to psychopathology and negative affectivity – in particular, using a repeated measures design.

1.2. Theory

Self-Determination Theory (SDT; Deci and Ryan, 1985; Ryan and Deci, 2000) attempts to understand psychological needs that drive motivation and personality formation. SDT discriminates between intrinsic and extrinsic motivation. Intrinsic motivation is essential to mental health, involving the seeking of new experiences, learning, and exploring, without external reward. Intrinsic motivation is maximized when one's innate need for socialization and human connection (``relatedness'') is fulfilled (Deci and Ryan, 1985; Ryan and Deci, 2000). In SDT, effective emotion regulation and psychological well-being are driven in part by socialization and relatedness. And therefore, unmet social relatedness needs are conceptualized to drive negative emotion in SDT.

Using SDT, FOMO is thought to involve unmet social relatedness needs (Przybylski et al., 2013). And higher levels of FOMO (indicating poor socialization) are conceptualized to generate poor emotional well-being, including negative affectivity (Beyens et al., 2016; Przybylski et al., 2013). We should note that the opposite sequence is possible: negative affectivity can result in FOMO. However, related research finds that social deficiencies drive negative affectivity, rather than the other way around (reviewed in Kawachi and Berkman, 2001; Santini et al., 2015). Whereas, increased social capital plays a substantial role in offsetting negative affectivity, improving mood and affect (Kawachi and Berkman, 2001). Thus, we conceptualized FOMO as the predictor variable, and negative affect measurements as the outcome variables based on this prior research.

1.3. Hypothesis

Baseline levels of FOMO should predict initial and repeated measurements of negative affect. As indicate above, FOMO correlates with negative mood and affect, and other negative affectivity variables such as depression and anxiety severity. According to SDT, poor social relatedness drives emotional dysregulation and impaired psychological well-being (Deci and Ryan, 1985; Ryan and Deci, 2000). FOMO involves unfulfilled social relatedness needs, and thus should contribute to negative affect, found in prior work (Beyens et al., 2016; Przybylski et al., 2013). Furthermore, Milyavskaya et al. (2018) discovered that FOMO predicted repeated measurements of negative affect. Therefore, we hypothesize that using multivariate growth models, FOMO should not only correlate with an initial measure of negative affect, but additionally should predict multiple, repeated assessments of negative affect. In fact, repeated measurements (rather than a single assessment) of negative affect are important to investigate, as negative affect can vary from day to day (Eid and Diener, 1999).

1.4. Research model

Fig. 1 displays seven daily repeated measurements of negative affect over one week. As discussed below, the latent intercept represents a model-implied initial estimate of negative affect, while the latent slope estimates changes in negative affect over seven days of measurement. We modeled FOMO as a baseline covariate of the intercept and slope. We also included depression and anxiety as baseline covariates, because of prior mentioned relationships with FOMO and negative affect. Finally, we included sex as a covariate, because negative affect is often higher in women than men (e.g., McLean and Anderson, 2009; Thomsen et al., 2005).

2. Method

2.1. Participants

We recruited undergraduate participants (age 18–25) from a large, Midwestern U.S. public university's psychology department research pool in fall 2018. The university's IRB approved the study. Students located our study on the department's Sona Systems web portal listing available studies for course research points. 112 students enrolled, but 19 of them did not respond to the ESM phase of the study, resulting in an effective sample of 93 participants.

Age averaged 19.01 years (SD = 1.46). A majority of participants were women (n = 66, 71.0%). Most were Caucasian (n = 74, 79.6%), with minority representation from people identifying as African American (n = 17, 18.3%), Hispanic (n = 4, 4.3%), and Asian (n = 4, 3.4%). Participants were primarily college freshman (n = 54, 58.0%) or sophomores (n = 26, 28.0%). A slight majority were working part-time (n = 54, 58.1%).

2.2. Procedure

Participants enrolled via the web portal, routed to an online consent

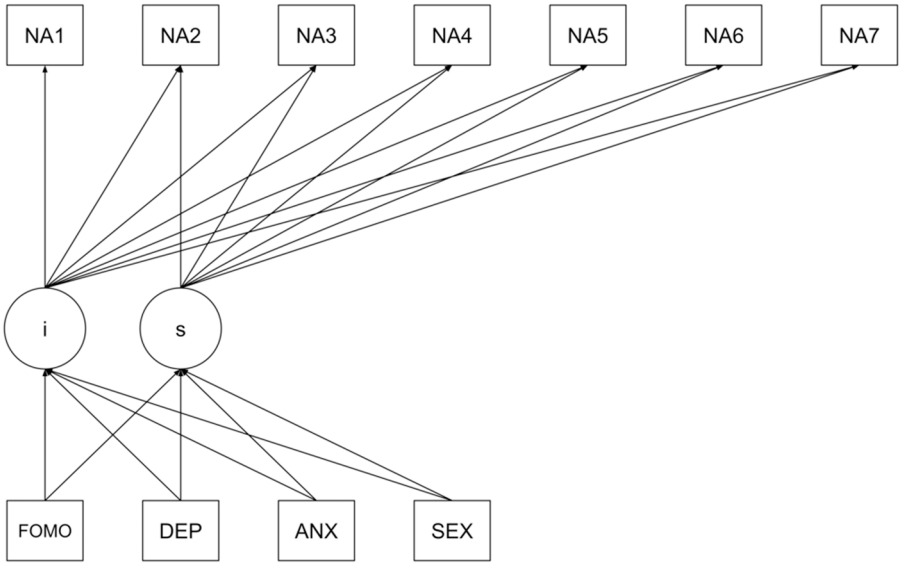

Fig. 1. Growth curve model predicting seven repeated negative affect measurements.
Note: *i* = Intercept; *s* = Slope; FOMO = Fear of missing out; DEP = Depression; ANX = Anxiety; NA = Negative affect (with the number indicating the day of measurement).

statement hosted on psychdata.com; those consenting were routed to a baseline web survey. Upon survey completion, participants were asked for contact information (including cell phone number) to initiate the ESM phase.

Each day, we checked for newly enrolled participants, registering cell phone numbers to receive SMS text messages from us (starting that evening), using the Clicksend.com service. Text messages were sent from a shortcode number (e.g., 400–10) often used by businesses for text alerts, to prevent spam flagging by cell phone carriers. We automated messages for daily delivery at about 8:00pm (Eastern Time). After seven evenings of messages, we manually removed a given participant from our outgoing message system.

Each message indicated the name of our study, providing a web link to our ESM survey. We instructed participants to answer survey items in reference to a specific one-hour time-block from earlier that day (i.e., querying their affect from that hour). We referenced one-hour time-blocks starting from 10:00am to 6:00pm, randomly varying each day (Kushlev et al., 2016). We used this methodology rather than randomly delivering text messages assessing affect throughout the day in order to minimize disruptions in normal activities and decrease participant burden (Kahneman et al., 2004). Such participant burden can result in careless responding and low-quality data (Curran, 2016), which we attempted to avoid. We instructed participants to complete the survey preferably upon receiving the message, but at least before bedtime (Campbell et al., 2017). The average number of days from baseline survey completion until a participant's first completed ESM survey was 1.32 days (SD = 1.09).

2.3. Baseline web survey instruments

In the baseline survey, we first asked participants for the last four digits of their cell phone number, and their month of birth. These two pieces of data were combined to form a numerical identification number to match a participant's baseline and subsequent ESM data. We also queried demographic characteristics (above), and the following measures.

2.3.1. FOMO scale

The FOMO Scale (Przybylski et al., 2013) is a 10-item survey of the FOMO construct, with response selections ranging from ``1 = Not at all true of me" to ``5 = Extremely true of me." Item content includes, for example, ``I fear others have more rewarding experiences than me" and ``I get worried when I find out my friends are having fun without me." Reliability is adequate, and scores converge with measures of SNS use and poor life satisfaction (Przybylski et al., 2013), depression, anxiety and negative affect (Elhai et al., 2018, 2016; Wolniewicz et al., 2018). Coefficient alpha in our sample was 0.90.

2.3.2. Depression anxiety stress scale-21 (DASS-21)

The DASS-21 (Lovibond and Lovibond, 1995) is a shortened version of the original DASS, measuring depression, anxiety and stress symptoms. Items are evaluated over the past week, and response selections range from ``0 = Did not apply to me" to ``3 = Applied to me very much or most of the time." We used the depression and anxiety subscales (seven items each), evidencing reliability, and convergent validity against related scales (Antony et al., 1998; Brown et al., 1997). Our coefficient alphas were 0.92 for depression, and 0.84 for anxiety.

2.4. ESM survey instruments

For each daily ESM assessment, we asked for participants' last four cell phone number digits and birth month, for baseline-ESM data matching.

Next, we asked participants to think about what they were doing during the one-hour time-block identified in the text message. We presented a list of 20 daily activities developed by Kahneman et al. (2004), adapted by Kushlev et al. (2016), instructing participants to select activity(ies) they were doing during that hour (e.g., ``Exercising," ``Shopping," ``Napping/sleeping"). We used this method for more accurate recall of affect from earlier that day (Kahneman et al., 2004), rather than analyzing these activities as model covariates.

We next administered the Positive and Negative Affect Schedule (PANAS)-Short Form, instructing participants to evaluate items based how they felt during the one-hour time-block. The PANAS (Watson et al., 1988) is a well-established self-report measure, using a response scale from ``1 = Very slightly or not at all" to ``5 = Extremely." We used a short, 10-item version (Mackinnon et al., 1999), with reliability, factorial validity, and convergence with related measures (Mackinnon et al., 1999). We analyzed the 5-item negative affect subscale. We calculated coefficient alpha for each of the seven ESM assessments, with alpha values ranging from 0.69 to 0.90 (see Table 1).

Table 1
Means, standard deviations, and bivariate correlations for the baseline primary psychological variables, and the seven repeated negative affect measurements.

Variable	*Alpha*	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. FOMO	.90	22.83	8.87									
2. DEP	.92	4.76	5.37	.47**								
3. ANX	.84	4.04	4.21	.36**	.69**							
4. NA1	.82	7.51	3.49	.07	.32**	.48**						
5. NA2	.69	6.61	2.40	.09	.30**	.37**	.59**					
6. NA3	.83	6.86	3.09	.22*	.23*	.28**	.42**	.54**				
7. NA4	.86	6.91	3.48	.09	.25*	.26*	.42**	.44**	.58**			
8. NA5	.90	7.04	3.76	.04	.19	.21*	.44**	.31**	.45**	.41**		
9. NA6	.83	7.01	3.18	.21*	.10	.12	.29**	.22*	.44**	.25*	.54**	
10. NA7	.81	6.17	2.44	.27**	.20	.27**	.29**	.20	.47**	.23*	.26*	.38**

Note: FOMO = Fear of missing out; DEP = Depression; ANX = Anxiety; NA = Negative affect (with the number indicating the day of measurement).
* indicates $p < .05$.
** indicates $p < .01$.

2.5. Data analysis

Because completed ESM surveys were timestamped, we checked for daily surveys completed later than 10:00am on mornings after text message delivery (Campbell et al., 2017; Machell et al., 2015). We removed one completed ESM survey for each of 20 participants because of late survey response times. We quickly communicated with participants, requesting prompt survey completion on subsequent evenings.

The average number of assessments (out of 7) filled out by respondents was 6.51 (SD = 0.82; ranging from 4 to 7). Using R software version 3.5.2 (R Core Team, 2019), we used the *careless* package to check for insufficiently effortful responding by participants (Curran, 2016). Specifically, we looked for instances of many consecutive identical survey responses across a) the baseline FOMO and DASS-21 scales (31 items), and b) 10 PANAS items within a particular day's ESM survey administration (to examine cross-sectional careless responding); and c) daily administrations of the same PANAS item (to examine careless responding across 7 days). We did not find overwhelming evidence of careless responding. Participants averaged 2.54 (SD = 2.57) consecutive responses across the baseline scales, 2.81 (SD = 2.80) consecutive responses within a PANAS administration and averaged across days, and 2.63 (SD = 1.90) consecutive responses across days for the same PANAS item. Most consecutive responding on the PANAS involved low ratings of ``1″ to items expected to have low ratings in this sample (e.g., ``Scared," ``Afraid," ``Nervous").

We next implemented R's *mice* package to impute small amounts of missing item-level data within a scale, using maximum likelihood (ML) procedures. After imputation, we computed scale scores by summing items, with higher scale scores indicating greater severity on the measure. We subsequently estimated missing scale score values using ML based on all available data. We used R packages *fmsb* (for internal consistency), *pastecs* (descriptives), *apatables* (correlations), and *sjstats* (ANOVA's partial eta-squared). No scale scores evidenced non-normality (skewness > 2.0, or kurtosis > 7), except for the last two days of negative affect scores (addressed below). We conducted bivariate correlations among FOMO, depression, anxiety, and seven days of negative affect measurements.

Next, using Mplus version 8 software (Muthén and Muthén, 1998–2019) we conducted latent growth curve modeling to assess our Hypothesis, a type of multilevel modeling for repeated measures data (Raudenbush and Bryk, 2002; Snijders and Bosker, 2002). This approach allowed us to simultaneously model random effects on the seven negative affect measurements, rather than using a single averaged variable. We used equidistant time scores (one-day intervals) across repeated measurements, because ESM assessment was conducted at the same time of each evening. We implemented ML estimation with robust standard errors to correct for non-normality using Yuan-Bentler's (Y-B) chi-square (Zhong and Yuan, 2011), with residual covariances fixed to zero, and dependent variables treated continuously. We estimated a latent intercept and growth slope over seven measurement days. We also tested a non-linear, quadratic slope compared to a linear slope, using a correction factor (Muthén and Muthén, 2006). Our first models were unconditional (i.e., without covariates). Subsequently we added conditional models (e.g., with covariates; Fig. 1).

3. Results

We first report the most commonly endorsed daily activities in which participants were engaged during the one-hour time-block referenced for ESM assessment. Averaged across seven repeated measurements, the most commonly endorsed activities were ``Relaxing" ($M$ = 23.71 participants endorsing, SD = 3.25), ``Eating" (M = 21.14, SD = 3.02), ``Using social networking sites" ($M$ = 17.29, SD = 5.09), and ``Doing schoolwork/studying outside of class time" (M = 17.29, SD = 4.16).

We report descriptive statistics and bivariate correlations for the primary psychological variables in Table 1. On a bivariate basis, higher FOMO scores were significantly positively related to three of the seven repeated negative affect measurements. Depression and anxiety were also related to numerous daily negative affect measurements. Using ANOVA, sex was not significantly related to any of the seven negative affect measurements (all ps > 0.05, average $\eta_p^2 = 0.01$; full results available upon request).

We tested an unconditional linear growth model, assessing change across repeated negative affect measurements without covariates, Y-B $\chi^2(23, N = 93) = 54.62$, $p = .002$. The slope's mean was non-significant, $\beta = -0.31$, SE = 0.18, $z = -1.74$, $p = .08$, indicating that negative affect did not significantly increase or decrease over the week. The slope and intercept were significantly inversely correlated, $\beta = -0.67$, SE = 0.29, $z = -2.31$, $p = .02$, demonstrating that higher initial negative affect scores correlated with decreasing negative affect over the week. We added a quadratic effect to modeling changes in negative affect, Y-B $\chi^2(19, N = 93) = 50.96$, $p = .0001$, but this modification did not enhance model fit over the linear model, corrected Y-B $\chi^2_{diff}(4, N = 93) = 4.67$, $p = 0.32$. The lack of a quadratic effect suggests linear rather than non-linear change in negative affect over the week; thus, subsequent analyses modeled a linear rather than non-linear slope.

Next, we tested a conditional linear growth model, adding the four covariates from Fig. 1, Y-B $\chi^2(43, N = 93) = 76.77$, $p = .001$. Table 2 presents standardized regression coefficients for covariates predicting the intercept and slope. Female sex and higher anxiety were positively associated with negative affect's intercept. This finding suggests that women and more anxious individuals had greater initial negative affect at baseline. Higher FOMO scores were positively related to negative affect's slope (Table 2); thus, those individuals with greater baseline FOMO had increasingly greater negative affect throughout the week.

Table 2
Standardized covariate regression coefficients for the intercept and slope (for negative affect repeated measurements) in the linear growth model.

	Intercept		Slope	
Covariate	B (SE)	z	B (SE)	z
FOMO	−0.13 (0.11)	−1.19	.43 (0.18)	2.35*
DEP	.17 (0.16)	1.04	−0.21 (0.18)	−1.15
ANX	.44 (0.14)	3.19**	−0.36 (0.21)	−1.72
SEX	.42 (0.18)	2.37*	−0.24 (0.28)	−0.85

Note: FOMO = Fear of missing out; DEP = Depression; ANX = Anxiety. Sex is coded 1 = men, 2 = women.
* indicates $p < .05$.
** indicates $p < .01$.

4. Discussion

Our primary aim was to examine FOMO's relationship with prospective, repeated measurements of negative affect over one week. This research question is important because past research has primarily tested FOMO in relation to negative affect cross-sectionally. We next discuss our specific findings.

We found that female sex related to negative affect's latent intercept, indicating initial negative affect values. This finding corroborates prior research revealing particular types of psychopathology-related constructs more prevalent in women than men, including sad, anxious and ruminative negative affect, and anxiety/depressive disorders (McLean and Anderson, 2009; Thomsen et al., 2005). However, we should note that sex was not associated with negative affect in bivariate correlations, perhaps because the PANAS has more evidence for measuring normal rather than clinically-oriented variations in negative affect (Crawford and Henry, 2004) found to differ between men and women (Thomsen et al., 2005).

We also discovered that higher anxiety severity was related to negative affect at the latent multivariate level (intercept), as well as based on bivariate relationships. These findings support research revealing negative affect as an underlying dimension of anxiety disorders (Watson, 2005, 2009), and correlated with anxiety severity (e.g., Nima et al., 2013; Watson et al., 1988). Contrary to our hypothesis, FOMO was not related to negative affect on a multivariate latent level (i.e., intercept), but was related on a bivariate basis, which we discuss next.

Consistent with expectations, on a bivariate basis FOMO correlated with several negative affect measurements over the week. Based on SDT (Deci and Ryan, 1985; Ryan and Deci, 2000), this finding supports theoretical conceptualizations (Beyens et al., 2016; Przybylski et al., 2013) in which FOMO should result in negative affectivity. The social relatedness impairments involved with FOMO would be expected to drive negative affect, poor emotion regulation, and lower psychological well-being according to SDT (Przybylski et al., 2013). And, we found (bivariately) that depression and anxiety severity were *also* related to several repeated negative affect measurements. This point is important because we found that FOMO correlated with depression and anxiety severity, supported in prior work (Baker et al., 2016; Blackwell et al., 2017; Dempsey et al., 2019; Dhir et al., 2018; Elhai et al., 2018, 2016, 2019; Oberst et al., 2017; Reer et al., 2019; Scalzo and Martinez, 2017; Wolniewicz et al., 2018).

Yet baseline FOMO was the only significant predictor of negative affect's slope over the week's course, when controlling for covariates (including depression and anxiety). Therefore, individuals with greater FOMO had increasingly greater negative affect over the week. This significant FOMO-negative affect relationship is supported by numerous cross-sectional studies discussed above. And in particular, this finding is supported in a repeated measures study finding FOMO prospectively related to negative affect (Milyavskaya et al., 2018). Furthermore, impaired social relatedness involved in FOMO would be conceptualized to consistently drive negative affect, according to SDT (Deci and Ryan, 1985; Ryan and Deci, 2000). Thus despite significant bivariate relationships with negative affect for FOMO and anxiety, with covariate adjustment in growth models FOMO accounted for the most variance. However, we should emphasize that before adding FOMO as a covariate, in the unconditional growth model negative affect did not significantly vary over the week. Adding FOMO and other covariates in the conditional growth model modified the results, whereby covariates (FOMO) significantly predicted negative affect's (previously non-significant, unvarying) slope. However, because of the unconditional model's non-significant slope, we should be cautious about inferring FOMO's relationship with the slope in the conditional growth model. Nonetheless, perhaps ESM text messages throughout the week were disappointing to those participants scoring high in FOMO, instead expecting and hoping for social-related messages. For these individuals, perhaps their disappointment unfavorably influenced their assessment of negative affect. Of course participants were instructed to rate affect from earlier that day (rather than current affect), but current negative affect can impact our recall of prior affect (Joormann et al., 2007).

We found that negative affect ratings were stable over the course of one week. Despite prior work finding minor variations in negative affect from day-to-day (Eid and Diener, 1999), our sample's variation across days (Table 1) was not statistically significant (unconditional model's slope). This finding of stability was observed even though we used randomly varying daily time-blocks for participants to rate negative affect, allowing for a wider range of activities in which participants were engaged across the assessments. And activity level and engagement are related to mood and affect (Dimidjian et al., 2011).

We discovered that negative affect's intercept inversely correlated with its slope. Thus, higher initial negative affect was associated with decreasing negative affect over the week. One explanation could involve regression to the mean, whereby participants were not accustomed to completing daily ESM assessments by text message and consequently responded at first with higher negative affect until habituating.

Limitations include that we did not use structured diagnostic interviews to assess depression or anxiety symptoms. Thus we were confined to using self-report variables rather than standardized clinical diagnoses. Second, we used a convenience sample of college students who may not generalize to the overall population; a more generalizable sample may have produced slightly different results. Additionally, we only used one week of repeated measurements, so our results may not generalize to longer time periods of weeks or months. Furthermore, participants' negative affect ratings were somewhat low in severity. Finally, we should note that only three significant correlations were revealed between baseline FOMO and the repeated negative affect assessments, and these correlations were not large in size. Again, some caution should be used in interpreting FOMO's relationship with repeated negative affect measurement in this study. Nonetheless, results may advance understanding on FOMO by offering insight into prospective relations with repeated measurement of negative affectivity, suggesting that FOMO may be consistently related with such repeated measurements. Future research could assess negative affect and FOMO prospectively over longer periods of time using ESM, to examine possible bidirectional effects.

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CRediT authorship contribution statement

Jon D. Elhai: Conceptualization, Supervision, Writing - original draft. **Dmitri Rozgonjuk:** Conceptualization, Supervision, Writing - original draft. **Tour Liu:** Conceptualization, Supervision, Writing - original draft. **Haibo Yang:** Conceptualization, Supervision, Writing -

original draft.

Declaration of Competing Interest

All authors report no competing financial conflicts of interest with this paper.

Outside the scope of the present paper, the first author notes that he receives royalties for several books published on posttraumatic stress disorder (PTSD); is a paid, full-time faculty member at University of Toledo; is a paid, visiting scientist at Tianjin Normal University; occasionally serves as a paid, expert witness on PTSD legal cases; and receives grant research funding from the U.S. National Institutes of Health and Department of Defense.

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Supplementary materials

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References

Alt, D., 2015. College students' academic motivation, media engagement and fear of missing out. Comput. Human Behav. 49, 111–119.

Antony, M.M., Bieling, P.J., Cox, B.J., Enns, M.W., Swinson, R.P., 1998. Psychometric properties of the 42-item and 21-item versions of the depression anxiety stress scales in clinical groups and a community sample. Psychol. Assess. 10, 176–181.

Appel, M., Krisch, N., Stein, J.-P., Weber, S., 2019. Smartphone zombies! Pedestrians' distracted walking as a function of their fear of missing out. J. Environ. Psychol. 63, 130–133.

Baker, Z.G., Krieger, H., LeRoy, A.S., 2016. Fear of missing out: relationships with depression, mindfulness, and physical symptoms. Transl. Issues Psychol. Sci. 2, 275–282.

Beyens, I., Frison, E., Eggermont, S., 2016. ``I don't want to miss a thing'': adolescents' fear of missing out and its relationship to adolescents' social needs, facebook use, and facebook related stress. Comput. Human Behav. 64, 1–8.

Błachnio, A., Przepiórka, A., 2018. Facebook intrusion, fear of missing out, narcissism, and life satisfaction: a cross-sectional study. Psychiatry Res. 259, 514–519.

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. Pers. Individ. Dif. 116, 69–72.

Brown, T.A., Chorpita, B.F., Korotitsch, W., Barlow, D.H., 1997. Psychometric properties of the depression anxiety stress scales (DASS) in clinical samples. Behav. Res. Ther. 35, 79–89.

Campbell, S.B., Renshaw, K., Kashdan, T.B., Curby, T.W., Carter, S.P., 2017. A daily diary study of posttraumatic stress symptoms and romantic partner accomodation. Behav. Ther. 48, 222–234.

Chotpitayasunondh, V., Douglas, K.M., 2016. How ``phubbing'' becomes the norm: the antecedents and consequences of snubbing via smartphone. Comput. Human Behav. 63, 9–18.

Crawford, J.R., Henry, J.D., 2004. The positive and negative affect schedule (PANAS): construct validity, measurement properties and normative data in a large non-clinical sample. Br. J. Clin. Psychol. 43, 245–265.

Curran, P.G., 2016. Methods for the detection of carelessly invalid responses in survey data. J. Exp. Soc. Psychol. 66, 4–19.

Deci, E., Ryan, R.M., 1985. Intrinsic Motivation and Self-Determination in Human Behavior. Plenum Press, New York, New York.

Dempsey, A., E., O'Brien, K.D., Tiamiyu, M.F., Elhai, J.D., 2019. Fear of missing out (FoMO) and rumination mediate relations between social anxiety and problematic facebook use. Addict. Behav. Rep. 9, 100150.

Dhir, A., Yossatorn, Y., Kaur, P., Chen, S., 2018. Online social media fatigue and psychological wellbeing: a study of compulsive use, fear of missing out, fatigue, anxiety and depression. Int. J. Inf. Manage. 40, 141–152.

Dimidjian, S., Barrera Jr., M., Martell, C., Munoz, R.F., Lewinsohn, P.M., 2011. The origins and current status of behavioral activation treatments for depression. Annu. Rev. Clin. Psychol. 7, 1–38.

Eid, M., Diener, E., 1999. Intraindividual variability in affect: reliability, validity, and personality correlates. J. Pers. Soc. Psychol. 76, 662–676.

Elhai, J.D., Levine, J.C., Alghraibeh, A.M., Alafnan, A., Aldraiweesh, A., Hall, B.J., 2018. Fear of missing out: testing relationships with negative affectivity, online social engagement, and problematic smartphone use. Comput. Human Behav. 89, 289–298.

Elhai, J.D., Levine, J.C., Dvorak, R.D., Hall, B.J., 2016. Fear of missing out, need for touch, anxiety and depression are related to problematic smartphone use. Comput. Human Behav. 63, 509–516.

Elhai, J.D., Yang, H., Fang, J., Bai, Y., Hall, B.J., 2019. Depression and anxiety symptoms are related to problematic smartphone use severity in Chinese young adults: fear of missing out as a mediator. Addict. Behav In press.

Franchina, V., Vanden Abeele, M., van Rooij, A.J., Lo Coco, G., De Marez, L., 2018. Fear of missing out as a predictor of problematic social media use and phubbing behavior among flemish adolescents. Int. J. Environ. Res. Public Health 15.

Fuster, H., Chamarro, A., Oberst, U., 2017. Fear of missing out, online social networking and mobile phone addiction: a latent profile approach. Revista de Psicologia, Ciències de l'Educació i de l'Esport 35, 23–30.

James, T.L., Lowry, P.B., Wallace, L., Warkentin, M., 2017. The effect of belongingness on obsessive-compulsive disorder in the use of online social networks. J. Manage. Inf. Syst. 34, 560–596.

Joormann, J., Siemer, M., Gotlib, I.H., 2007. Mood regulation in depression: differential effects of distraction and recall of happy memories on sad mood. J. Abnorm. Psychol. 116, 484–490.

Kahneman, D., Krueger, A.B., Schkade, D.A., Schwarz, N., Stone, A.A., 2004. A survey method for characterizing daily life experience: the day reconstruction method. Science 306, 1776–1780.

Kawachi, I., Berkman, L.F., 2001. Social ties and mental health. J. Urban Health 78, 458–467.

Kushlev, K., Proulx, J., Dunn, E.W., 2016. ``Silence your phones'': smartphone notifications increase inattention and hyperactivity symptoms. In: Proceedings of ACM CHI 2016, pp. 1011–1020.

Lovibond, P.F., Lovibond, S.H., 1995. The structure of negative emotional states: comparison of the depression anxiety stress scales (DASS) with the beck depression and anxiety inventories. Behav. Res. Ther. 33, 335–343.

Machell, K.A., Goodman, F.R., Kashdan, T.B., 2015. Experiential avoidance and well-being: a daily diary analysis. Cognit. Emot. 29, 351–359.

Mackinnon, A., Jorm, A.F., Christensen, H., Korten, A.E., Jacomb, P.A., Rodgers, B., 1999. A short form of the positive and negative affect schedule: evaluation of factorial validity and invariance across demographic variables in a community sample. Pers. Individ. Dif. 27, 405–416.

McLean, C.P., Anderson, E.R., 2009. Brave men and timid women? A review of the gender differences in fear and anxiety. Clin. Psychol. Rev. 29, 496–505.

Milyavskaya, M., Saffran, M., Hope, N., Koestner, R., 2018. Fear of missing out: prevalence, dynamics, and consequences of experiencing FOMO. Motiv. Emot. 42, 725–737.

Muthén, B.O., Muthén, L., 2006. Chi-square Difference Testing Using the Satorra-Bentler scaled Chi-Square. Muthén & Muthén. http://statmodel.com/chidiff.shtml.

Muthén, L.K., Muthén, B.O., 1998. Mplus User's Guide, 8th ed. Muthén & Muthén, Los Angeles, California.

Nima, A.A., Rosenberg, P., Archer, T., Garcia, D., 2013. Anxiety, affect, self-esteem, and stress: mediation and moderation effects on depression. PLoS ONE 8, e73265.

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

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

R Core Team, 2019. R: a language and environment for statistical computing. https://www.R-project.org/.

Raudenbush, S.W., Bryk, A.S., 2002. Hierarchical Linear models: Applications and Data Analysis Methods, 2nd ed. Sage Publications, Thousand Oaks, CA.

Reer, F., Tang, W.Y., Quandt, T., 2019. Psychosocial well-being and social media engagement: the mediating roles of social comparison orientation and fear of missing out. New Media Soc. 21, 1486–1505.

Rozgonjuk, D., Elhai, J.D., Ryan, T., Scott, G., 2019. Fear of missing out is associated with disrupted activities from receiving smartphone notifications and surface learning in college students. Comput. Educ. 140, 103590.

Ryan, R., Deci, E.L., 2000. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. Am. Psychol. 55, 68–78.

Santini, Z.I., Koyanagi, A., Tyrovolas, S., Mason, C., Haro, J.M., 2015. The association between social relationships and depression: a systematic review. J. Affect. Disord. 175, 53–65.

Scalzo, A., Martinez, J.A., 2017. Not all anxiety is the same: how different ``types'' of anxiety uniquely associate with college students' drinking intentions. J. Coll. Stud. Dev. 58, 943–947.

Snijders, T.A.B., Bosker, R.J., 2002. Multilevel analysis: An introduction to Basic and Advanced Multilevel Modeling. Sage, Thousand Oaks, California.

Stead, H., Bibby, P.A., 2017. Personality, fear of missing out and problematic internet use and their relationship to subjective well-being. Comput. Human Behav. 76, 534–540.

Thomsen, D.K., Mehlsen, M.Y., Viidik, A., Sommerlund, B., Zachariae, R., 2005. Age and gender differences in negative affect: is there a role for emotion regulation?Pers. Individ. Dif.38, 1935–1946.

Watson, D., 2005. Rethinking the mood and anxiety disorders: a quantitative hierarchical model for DSM-V. J. Abnorm. Psychol. 114, 522–536.

Watson, D., 2009. Differentiating the mood and anxiety disorders: a quadripartite model. Annu. Rev. Clin. Psychol. 5, 221–247.

Watson, D., Clark, L.A., Tellegen, A., 1988. Development and validation of brief measures of positive and negative affect: the panas scales. J. Pers. Soc. Psychol. 54, 1063–1070.

Wolniewicz, C.A., Tiamiyu, M.F., Weeks, J.W., Elhai, J.D., 2018. Problematic smartphone use and relations with negative affect, fear of missing out, and fear of negative and positive evaluation. Psychiatry Res. 262, 618–623.

Zhong, X., Yuan, K.-H., 2011. Bias and efficiency in structural equation modeling: maximum likelihood versus robust methods. Multivariate Behav. Res. 46, 229–265.