Depression and social anxiety in relation to problematic smartphone use
The prominent role of rumination

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Abstract

Purpose – Previous research has found support for depression and anxiety severity in association with both increased and problematic smartphone use. However, little research has explored transdiagnostic psychopathology constructs as mediators that may account for these relationships. The purpose of this paper is to test rumination as a possible transdiagnostic (cross-sectional) mediator in these relationships.

Design/methodology/approach – The authors recruited 296 college students to complete relevant web survey measures, including the patient health questionnaire-9 (for depression severity), social interaction anxiety scale (for social anxiety severity), ruminative thought styles questionnaire, smartphone addiction scale-short version (to measure levels of problematic smartphone use), and a measure of smartphone use frequency.

Findings – The authors found support for a structural model whereby the severity of depression and social anxiety accounted for variance in rumination, which, in turn, correlated with problematic smartphone use levels. Rumination accounted for relations between both depression and social anxiety severity with levels of problematic use.

Originality/value – The authors discuss the role of rumination as a possible mechanism between anxiety- and depression-related psychopathology levels with problematic smartphone use severity. This study is unique in exploring rumination in the context of problematic smartphone use.

Keywords Social sciences, Modelling, Depression, Psychology, Mobile communications, Smartphone use, Social anxiety, Internet addiction, Rumination, Communication theory, Problematic technology use, Smartphone addiction

Paper type Research paper

Introduction

In recent years, published studies have examined the construct of problematic smartphone use. Problematic smartphone use is often defined as excessive use of a smartphone, with social or occupational functional impairment, and including dependence and symptoms seen in addictive disorders, such as withdrawal and tolerance (Billieux, Maugue, Lopez-Fernandez, Kuss and Griffiths, 2015). Research has examined relations between psychopathology and problematic smartphone use and/or the continuum of smartphone use frequency. Depression and anxiety severity in particular are well supported in association with problematic smartphone use and smartphone use frequency (reviewed in Elhai, Dvorak, Levine and Hall, 2017). However, little research has explored the role of more contemporary transdiagnostic constructs of psychopathology in studying these relationships.
The most commonly studied psychopathology constructs in relation to problematic smartphone use and usage frequency include variables measuring levels of depression, anxiety, stress, and low self-esteem (reviewed in Elhai, Dvorak, Levine and Hall, 2017). Depression and anxiety severity have demonstrated moderate and small links (respectively) to levels of problematic smartphone use and usage frequency, with effect sizes of 0.30-0.50 for depression severity (recently in Demirci et al., 2015; Lu et al., 2011; Smetaniuk, 2014), and approximately 0.20 for anxiety severity (recently, Demirci et al., 2015; Elhai et al., 2016; Kim, Lee and Choi, 2015; Lee et al., 2014). These findings generally parallel those from the literature on internet addiction (but not specifically smartphone use) (Ho et al., 2014; Prizant-Passal et al., 2016). However, effect sizes are nonetheless small on average for anxiety, and in some studies for depression severity (Augner and Hacker, 2012; Elhai et al., 2016; Elhai, Levine, Dvorak and Hall, 2017; Kim, Seo and David, 2015). Some evidence suggests a bidirectional relationship, whereby problematic smartphone use can lead to depression and anxiety severity, and vice-versa (van Deursen et al., 2015; Yen et al., 2012).

Theory and empirical evidence demonstrate a dual system process that underlies addictive disorders, involving a balance between impulsive reward seeking and reflection/inhibition (Bechara, 2005; Volkow and Fowler, 2000). This theory has been supported in research on problematic use of technology, and suggests that deficits in brain circuitry may be responsible for such problematic use (Turel and Qahri-Saremi, 2016; Turel et al., 2016). Relevant to the present paper, depression and anxiety severity, and rumination may be caused by the same types of brain circuitry deficits found in the addictive disorders.

Furthermore, research on problematic smartphone use thus far has not examined more contemporary “transdiagnostic” psychopathology constructs – that is, constructs which cut across numerous mental disorders. Such constructs are increasingly important in understanding mechanisms involved in the etiology and maintenance of psychopathology (Mansell et al., 2008). Mediating and moderating variables between psychopathology and problematic internet use (albeit not specific to smartphone) have been tested and supported recently (Brand et al., 2016; Jiang, 2014).

In addition to depression and anxiety severity, in the present paper, we focus on the transdiagnostic construct of rumination. Rumination is a maladaptive method for coping with negative emotion that focuses individuals on their negative self-referencing thoughts rather than the more adaptive processing of their emotion (Mennin and Fresco, 2013). Rumination is a construct that has large relationships with numerous types of psychopathology (Aldao et al., 2010). Rumination is associated with depressed and anxious mood (Joormann and Gotlib, 2010), inhibits recovery from depressed mood and has been found to increase the length of depressive episodes (Nolen-Hoeksema et al., 2008). Rumination is also implicated in social anxiety symptoms (Brotzovich and Heimberg, 2008). Rumination is found to have reciprocal relations with psychopathology, whereby depression and anxiety severity predict rumination over time, and vice-versa (McLaughlin and Nolen-Hoeksema, 2011; Nolen-Hoeksema et al., 2007).

Billieux, Philippot, Schmid, Maurage, De Mol and Van der Linden (2015) discussed how rumination in social relationships can lead to excessive reassurance-seeking behavior by habitually checking one’s phone for social-related notifications. In fact, excessive reassurance seeking is considered a pathway to problematic smartphone use (Billieux, Maurage, Lopez-Fernandez, Kuss and Griffiths, 2015). Such reassurance seeking is a maintenance factor of depression (Evraire and Dozois, 2011) and anxiety (Cougle et al., 2012; Rector et al., 2011). Furthermore, because rumination is a maladaptive coping method (Mennin and Fresco, 2013), as is problematic smartphone use (Kardelvelt-Winther, 2014), these two constructs should be related. In fact, maladaptive coping is related to other forms of problematic technology use (Brand et al., 2014).
Aims
Our purpose is to test the relationships between levels of smartphone use and levels of problematic smartphone use with both: depressive symptoms and anxiety symptoms. We are particularly interested in the extent to which rumination (cross-sectionally) mediates relations between depressive/anxious psychopathology levels and increased/problematic smartphone use. This topic is important in understanding mechanisms that explain why some depressed or anxious individuals engage in problematic use of a smartphone, while others do not.

Theory
We used theory to conceptualize a model of psychopathology, smartphone use frequency, and increased problematic use. Uses and gratifications theory (UGT) (Blumler and Katz, 1974) explains motivations for the consumption of mass media and technology. When UGT was first developed, it was unique (in contrast to other mass communication theories) in being audience/user-centered, assuming that the user is an active (rather than passive) participant of choosing media to consume. UGT assumes that particular media consumption choices are driven by specific gratifications that the user needs to be met (e.g., socializing, relaxation, etc.) (Blumler and Katz, 1974). Such gratifications in UGT can be driven by individual differences or psychological constructs. UGT has been used to explain the use of particular smartphone features (Grellhesl and Punyanunt-Carter, 2012; Wei and Lu, 2014). UGT has been implemented to explain the use of various types of technology use (Chiang and Hsiao, 2015; Hamari and Sjöblom, 2017; Huang and Hsieh, 2011; Pei-Shan and Hsi-Peng, 2014). UGT has used background characteristics or individual differences to explain increased smartphone use, such as gender, reward seeking, academic performance, behavioral activation, depression, anxiety, and locus of control (Dhir et al., 2015; Elhai, Levine, Dvorak and Hall, 2017; Grellhesl and Punyanunt-Carter, 2012; Park et al., 2013). The notion that rumination in interpersonal relationships can drive excessive reassurance seeking (Billieux, Philippot, Schmid, Maurage, De Mol and Van der Linden, 2015), evidenced by increased smartphone use, is in line with UGT’s focus on individual differences causing specific media-based gratifications to be met. While UGT can explain increased smartphone use, it does not necessarily explain why some people would engage in problematic smartphone use.

Of more precise relevance to this study is Kardefelt-Winther’s (2014) recently developed compensatory internet use theory (CIUT). This theory could be viewed as an extension of UGT in understanding variables that drive increased smartphone use and problematic use. CIUT attempts to understand the negative life events and stressors that motivate some people to use (or overuse) technology, as a means to alleviate negative emotion about such stressors. CIUT emphasizes negative life circumstances as the cause, and problematic internet use as the consequent, compensatory behavior aimed at regulating stressor-related negative emotion. Several studies thus far have found empirical support for this theory as related to the study of problematic smartphone use (Long et al., 2016; Wang et al., 2015; Zhitomirsky-Geffet and Blau, 2016).

CIUT fits well with UGT in providing context for the research questions of the present study. Specifically, psychopathology, such as anxiety, depression, and rumination severity can be conceptualized as background characteristics in UGT that explain increased smartphone use. And within CIUT, problematic smartphone use is conceptualized as a compensatory behavior to regulate depressed and anxious mood.

Research model
We first tested a model whereby psychopathology levels were specified to predict the frequency of smartphone use, which, in turn, predicts levels of problematic smartphone use. Similar models have been tested, such as that of Kim, Seo and David (2015) testing depression
severity as a correlate of the extent and types of smartphone use, in turn predicting problematic use. van Deursen et al. (2015) tested social stress in association with habitual smartphone use, then predicting increases in problematic smartphone use. And Elhai, Levine, Dvorak and Hall (2017) examined depression and anxiety severity as correlates of types of smartphone use frequency, in turn relating to problematic smartphone use severity. However, these models did not include transdiagnostic constructs that may account for relations between depressive/anxious symptoms and smartphone use (e.g. rumination).

Our model is depicted in Figure 1. All variables were estimated as latent factors, with the exception of smartphone frequency for reasons discussed below. We examined depression and anxiety severity factors as correlates of smartphone use based on the aforementioned research, among a sample of college students. We included a specific type of anxiety – social anxiety – as a predictor. People with social anxiety have been found to compensate for their in-person anxiety by socializing excessively online, including with their smartphones (Lee, 2015; Lee et al., 2014). We also included rumination in our model, as a variable potentially accounting for relations between depression/social anxiety severity and smartphone use (Billieux, Philippot, Schmid, Maurage, De Mol and Van der Linden, 2015). Because problematic smartphone use and frequency are related to younger age (Lu et al., 2011; van Deursen et al., 2015) and female gender (Jeong et al., 2016; Wang et al., 2015), we statistically adjusted for age and gender. We subsequently tested variations on this model, described below.

Hypotheses
Based on this backdrop of theory and empirical work, we posed the following hypotheses. Each of these hypotheses represents a portion of Figure 1.

Rumination involves focusing on one’s negative thoughts (e.g. see Mennin and Fresco, 2013). In social relationships, people who ruminate often do so about aspects of the
relationship (Kashdan and Roberts, 2007). While rumination can represent the cognitive aspect of anxiety in social relationships, habitually checking one’s smartphone for social notifications can represent the behavioral aspect of such anxiety (Billieux, Philippot, Schmid, Maurage, De Mol and Van der Linden, 2015). Such habitual use is shown to lead to problematic smartphone use (Oulasvirta et al., 2012).

In the context of UGT (Blumler and Katz, 1974) and CIUT (Kardefelt-Winther, 2014), rumination would serve as an individual difference variable that would be gratified by using more social-related technology (e.g. a smartphone’s social features) in an attempt to alleviate one’s social-related anxiety. Rumination is a maladaptive coping method (Mennin and Fresco, 2013), associated with depression and anxiety (Nolen-Hoeksema et al., 2007, 2008). Problematic smartphone use is also an avoidant coping method. Rumination and problematic smartphone use, both as maladaptive coping methods, logically should be correlated:

**H1.** Rumination should be positively related to smartphone use frequency overall.

**H2.** Rumination should be positively related to levels of problematic smartphone use.

Depression and anxiety, including social anxiety, have been found to relate to increases in smartphone use and problematic use (Elhai, Dvorak, Levine and Hall, 2017). Depression and anxiety also are found to prospectively predict rumination (McLaughlin and Nolen-Hoeksema, 2011; Nolen-Hoeksema et al., 2007). Rumination has been theorized to lead to habitual smartphone use through excessive reassurance seeking by checking one’s phone notifications (Billieux, Philippot, Schmid, Maurage, De Mol and Van der Linden, 2015). And habitual behaviors can become automatic, resulting in many repetitions of the behavior, without antecedent cognition required (Orbell and Verplanken, 2000). Thus, rumination could serve as a mediator between depression and anxiety severity on the one hand, and increased smartphone use and problematic use on the other.

Within the context of UGT, rumination would serve as an individual difference variable accounting for the relationship between both depression and anxiety severity (also individual difference variables) and increased smartphone use. And within CIUT, increased problematic smartphone use would be the regulatory process aimed at decreasing depressed and anxious mood:

**H3.** Rumination would account for relationships between depression severity and smartphone use frequency, as a significant mediating variable.

**H4.** Rumination would account for relations between depression severity and increased problematic smartphone use, as a significant mediating variable.

**H5.** Rumination would explain the relationship between social anxiety severity and smartphone use frequency, as a significant mediating variable.

**H6.** Rumination would explain the relationship between social anxiety severity and increased levels of problematic smartphone use, as a significant mediating variable.

### Method

**Participants and procedure**

We recruited 299 college students in spring 2016 from a large Midwestern psychology department research pool using its Sona Systems website. Those signing up to participate were routed to an online consent statement and web survey (for those consenting), hosted on psychdata.com. The 20-30-minute survey offered research credit in courses in exchange for participation. Three subjects did not complete more than 50 percent of items on each of the primary measures and were excluded (resulting in an effective sample of 296 participants).
Among the 296 participants, age averaged 20.00 years (SD = 3.02). A slight majority of participants were women (n = 169, 57.1 percent). Most participants were of Caucasian racial background (n = 220, 74.3 percent), with some representation from African Americans (n = 38, 12.8 percent), Asian Americans (n = 18, 6.1 percent), and Hispanic/Latino (n = 18, 6.1 percent). A majority were freshmen (n = 143, 48.3 percent) or sophomores (n = 91, 30.7 percent). A slight majority of participants reported working part-time (n = 157, 53.0 percent) or full-time (n = 35, 11.8 percent), or were not employed (n = 104, 35.1 percent).

Instruments

Demographics. We inquired about demographics, such as age, gender, race, school, and employment.

We also used the following questionnaires, with items listed in Table I. We summed item responses within each scale in order to form total scores, for the purpose of presenting descriptive scale data, below.

Smartphone usage. We used the scale developed by Elhai et al. (2016) to ask about the frequency of using 11 different smartphone features. We used six-point Likert-type response options ranging from “1 = Never” to “6 = Very often.” Elhai et al. (2016) created this measure as an adaptation from several sources (Cheever et al., 2014; Hoffner and Lee, 2015; Smith and Page, 2015). Elhai et al. found adequate internal consistency; in the present effective sample, coefficient α was 0.79. Elhai et al. discovered a moderate correlation with Kwon, Lee, Won, Park, Min, Hahn, Gu, Choi and Kim’s (2013) smartphone addiction scale (SAS).

Smartphone addiction scale-short version (SAS-SV). We administered the SAS-SV (Kwon, Kim, Cho and Yang, 2013). We used this scale to measure the range of levels of problematic smartphone use. The SAS-SV includes ten items using a Likert scale ranging from “1 = Strongly disagree” to “6 = Strongly agree,” measuring smartphone use-related health and social impairment, withdrawal and tolerance. Coefficient α is reported to be adequate (Kwon, Kim, Cho and Yang, 2013); our sample’s coefficient α was 0.88. The SAS-SV has demonstrated convergent validity with other scales measuring problematic internet and smartphone use (Kwon, Kim, Cho and Yang, 2013).

Patient health questionnaire-9 (PHQ-9). The PHQ-9 is a nine-item self-report measure of DSM-5 major depression symptoms over the past two weeks (Kroenke et al., 2001). Response options ranging from 0 = “Not at all” to 3 = “Nearly every day.” Internal consistency is good (reviewed in Manea et al., 2015); our sample’s coefficient α was 0.86. High test-retest reliability within 48 hours has been found. Diagnostic validity has been demonstrated (reviewed in Manea et al., 2015).

Social interaction anxiety scale (SIAS). We assessed social anxiety using the SIAS (Mattick and Clarke, 1998), a 20-item measure with response options ranging from 0 = “Not at all characteristic or true of me” to 4 = “Extremely characteristic or true of me.” Good internal consistency has been reported (Rodebaugh et al., 2007); our sample’s coefficient α was 0.93. Factorial validity and convergence with other similar measures has been revealed (Rodebaugh et al., 2007). In calculating a total scale score for descriptive purposes, we summed the 17 straightforwardly-worded items, based on suggestions and findings from Rodebaugh et al. (2007).

Ruminative thought style questionnaire (RTSQ). The RTSQ (Brinker and Dozois, 2009) is a self-report measure of ruminative thinking. It includes 20 items rated on a seven-point Likert scale ranging from 1 = “does not describe me at all” to 7 = “describes me very well.” We included only the 15 items retained after confirmatory factor analysis (CFA) in Brinker and Dozois (2009). This measure has demonstrated adequate psychometrics, including internal consistency (Brinker and Dozois, 2009); coefficient α in our sample was 0.95. Convergent validity with similar scales has been revealed (Brinker and Dozois, 2009).
**Smartphone usage**

"How often do you use your smartphone for the following purposes?"

<table>
<thead>
<tr>
<th>Purpose</th>
<th>M</th>
<th>SD</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Voice/video calls (making and receiving)</td>
<td>3.98</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>2. Texting/instant messaging (sending and receiving)</td>
<td>5.36</td>
<td>1.11</td>
<td></td>
</tr>
<tr>
<td>3. E-mail (sending and receiving)</td>
<td>4.24</td>
<td>1.46</td>
<td></td>
</tr>
<tr>
<td>4. Social networking sites</td>
<td>4.99</td>
<td>1.39</td>
<td></td>
</tr>
<tr>
<td>5. Internet/websites</td>
<td>5.17</td>
<td>1.07</td>
<td></td>
</tr>
<tr>
<td>6. Music/podcasts/radio</td>
<td>4.96</td>
<td>1.32</td>
<td></td>
</tr>
<tr>
<td>7. Games</td>
<td>3.37</td>
<td>1.62</td>
<td></td>
</tr>
<tr>
<td>8. Taking pictures or videos</td>
<td>4.76</td>
<td>1.23</td>
<td></td>
</tr>
<tr>
<td>9. Watching video/TV/movies</td>
<td>3.97</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>10. Reading books/magazines</td>
<td>2.61</td>
<td>1.38</td>
<td></td>
</tr>
<tr>
<td>11. Maps/navigation</td>
<td>3.89</td>
<td>1.32</td>
<td></td>
</tr>
</tbody>
</table>

**Smartphone addiction scale-short version (SAS-SV)**

"How much do you agree with these statements about your use of your smartphone?"

<table>
<thead>
<tr>
<th>Statement</th>
<th>M</th>
<th>SD</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I miss planned work due to smartphone use</td>
<td>2.10</td>
<td>1.38</td>
<td>0.48</td>
</tr>
<tr>
<td>2. I have a hard time concentrating in class, while doing assignments, or while working due to smartphone use</td>
<td>3.02</td>
<td>1.57</td>
<td>0.62</td>
</tr>
<tr>
<td>3. I feel pain in the wrists or at the back of the neck while using a smartphone</td>
<td>2.07</td>
<td>1.30</td>
<td>0.61</td>
</tr>
<tr>
<td>4. I will not be able to stand not having a smartphone</td>
<td>3.36</td>
<td>1.62</td>
<td>0.58</td>
</tr>
<tr>
<td>5. I feel impatient and fretful when I am not holding my smartphone</td>
<td>2.55</td>
<td>1.47</td>
<td>0.83</td>
</tr>
<tr>
<td>6. I have my smartphone in my mind even when I am not using it</td>
<td>2.38</td>
<td>1.34</td>
<td>0.84</td>
</tr>
<tr>
<td>7. I will never give up using my smartphone even when my daily life is already greatly affected by it</td>
<td>2.47</td>
<td>1.36</td>
<td>0.64</td>
</tr>
<tr>
<td>8. I constantly check my smartphone so as not to miss conversations between other people on Twitter or Facebook</td>
<td>2.98</td>
<td>1.63</td>
<td>0.66</td>
</tr>
<tr>
<td>9. I use my smartphone longer than I had intended</td>
<td>3.73</td>
<td>1.51</td>
<td>0.63</td>
</tr>
<tr>
<td>10. The people around me tell me that I use my smartphone too much</td>
<td>2.46</td>
<td>1.47</td>
<td>0.62</td>
</tr>
</tbody>
</table>

**Patient health questionnaire-9 (PHQ-9)**

"Over the last 2 weeks, how often have you been bothered by any of the following problems?"

<table>
<thead>
<tr>
<th>Problem</th>
<th>M</th>
<th>SD</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Little interest or pleasure in doing things</td>
<td>0.74</td>
<td>0.86</td>
<td>0.64</td>
</tr>
<tr>
<td>2. Feeling down, depressed, or hopeless</td>
<td>0.76</td>
<td>0.85</td>
<td>0.84</td>
</tr>
<tr>
<td>3. Trouble falling or staying asleep, or sleeping too much</td>
<td>1.09</td>
<td>1.04</td>
<td>0.65</td>
</tr>
<tr>
<td>4. Feeling tired or having little energy</td>
<td>1.24</td>
<td>0.95</td>
<td>0.72</td>
</tr>
<tr>
<td>5. Poor appetite or overeating</td>
<td>0.89</td>
<td>0.99</td>
<td>0.63</td>
</tr>
<tr>
<td>6. Feeling bad about yourself – or that you are a failure or have let yourself or your family down</td>
<td>0.77</td>
<td>0.96</td>
<td>0.86</td>
</tr>
<tr>
<td>7. Trouble concentrating on things, such as reading the newspaper or watching television</td>
<td>0.64</td>
<td>0.90</td>
<td>0.78</td>
</tr>
<tr>
<td>8. Moving or speaking so slowly that other people could have noticed? Or the opposite – being so fidgety or restless that you have been moving around a lot more than usual</td>
<td>0.39</td>
<td>0.74</td>
<td>0.82</td>
</tr>
<tr>
<td>9. Thoughts that you would be better off dead or of hurting yourself in some way</td>
<td>0.27</td>
<td>0.64</td>
<td>0.71</td>
</tr>
</tbody>
</table>

**Social interaction anxiety scale (SIAS)**

"For each item, please check the number to indicate the degree to which you feel the statement is characteristic or true for you"

<table>
<thead>
<tr>
<th>Item</th>
<th>M</th>
<th>SD</th>
<th>Loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I get nervous if I have to speak with someone in authority (teacher, boss, etc.)</td>
<td>1.39</td>
<td>1.12</td>
<td>0.59</td>
</tr>
<tr>
<td>2. I have difficulty making eye contact with others</td>
<td>0.98</td>
<td>1.09</td>
<td>0.55</td>
</tr>
<tr>
<td>3. I become tense if I have to talk about myself or my feelings</td>
<td>1.66</td>
<td>1.24</td>
<td>0.62</td>
</tr>
<tr>
<td>4. I find it difficult to mix comfortably with the people I work with</td>
<td>0.84</td>
<td>0.99</td>
<td>0.66</td>
</tr>
<tr>
<td>5. I tense up if I meet an acquaintance in the street</td>
<td>1.09</td>
<td>1.06</td>
<td>0.69</td>
</tr>
<tr>
<td>7. When mixing socially, I am uncomfortable</td>
<td>1.18</td>
<td>1.12</td>
<td>0.68</td>
</tr>
<tr>
<td>8. I feel tense if I am alone with just one other person</td>
<td>0.90</td>
<td>1.06</td>
<td>0.59</td>
</tr>
<tr>
<td>10. I have difficulty talking with other people</td>
<td>1.00</td>
<td>1.07</td>
<td>0.72</td>
</tr>
</tbody>
</table>

(continued)
Analysis

About 1 percent of participants missed more than 50 percent of items on any given scale, and we excluded those participants from analyses (described above). About 10 percent of participants were missing between one and three items on a given scale. Therefore, we used maximum likelihood (ML) procedures to estimate and impute small amounts of missing item-level data, and then summed responses to form scale scores (Graham, 2009) for descriptive analyses. No skewness value was above 2.0 in absolute size, and the largest kurtosis value was 2.6 (SEs ranged from 0.29 to 0.57), thus demonstrating normal distributions. Multicollinearity was not an issue, with largest obtained correlations of $r = 0.50$.

We first conducted separate CFAs of our psychological constructs indicated above, using Mplus 7.4 software. One-factor models were used for assessing the continuum of severity on our psychological constructs: the PHQ-9 for depression (Manea et al., 2015),
SIAS for social anxiety (Rodebaugh et al., 2007), smartphone use frequency (Elhai et al., 2016), and SAS-SV for problematic smartphone use (Kwon, Kim, Cho and Yang, 2013) scales; a higher-order factor with five lower-order constructs was used with the RTSQ for rumination (Brinker and Dozois, 2009). We used ML estimation with robust standard errors (MLR; Yuan and Bentler, 2000), treating the variables as continuously scaled, thus using a Pearson covariance matrix and linear regression coefficients for estimating factor loadings. However, for the depression items, which have only four response options, we used weighted least squares estimation with a mean- and variance-adjusted χ² (WLSMV), using a polychoric covariance matrix and probit regression coefficients (Wirth and Edwards, 2007). Residual error covariances were fixed to 0. All unstandardized factor loadings were freely estimated, and the factor variance was fixed to a value of 1 for scaling purposes. Fit indices we reported are the comparative fit index (CFI), Tucker-Lewis Index (TLI), root mean square error of approximation (RMSEA), and (for MLR-estimated CFAs only) standardized root mean square residual (SRMR). Typically, an adequately fitting model is indicated by values ⩽ 0.90 for CFI and TLI ⩽ 0.08 for RMSEA, and ⩽ 0.10 for SRMR (Hu and Bentler, 1999).

Next, we estimated a structural equation model (SEM Model A; see Figure 1), using the same estimation approach we used in CFA. Because of the inclusion of the depression items, for reasons mentioned above, the overall model estimator was WLSMV. We statistically adjusted for paths pointing to smartphone use frequency and levels of problematic smartphone use with covariates, including age (Lu et al., 2011; van Deursen et al., 2015) and gender (Jeong et al., 2016; Wang et al., 2015). Social anxiety and depression were specified to predict rumination. In turn, rumination was specified to predict smartphone use frequency (testing H1) and problematic smartphone use (testing H2). Effect specifications and corresponding hypotheses are listed in Table III.

Next, we tested rumination in explaining relations between depression severity and smartphone use frequency (H3), and between depression severity and levels of problematic use (H4). We also tested rumination in accounting for relations between social anxiety severity and smartphone use frequency (H5), and between social anxiety and problematic use levels (H6). To test these indirect effects, we calculated the cross-product of direct path coefficients, calculating the indirect effect’s standard error using the Delta method, with 1,000 bootstrapped samples (MacKinnon, 2008).

We also tested a variation of SEM Model A, adding four paths: from social anxiety and depression severity to both smartphone use frequency and problematic use severity variables (SEM Model B). Finally, we tested another variation of SEM Model A, removing smartphone use frequency from the model (SEM Model C).

Results
We present a correlation matrix of the primary measures, with scale means and standard deviations, and coefficient α’s in Table II. Item means and standard deviations are displayed

<table>
<thead>
<tr>
<th>Variable</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PHQ-9</td>
<td>6.78</td>
<td>5.44</td>
<td>0.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. SIAS</td>
<td>21.21</td>
<td>13.59</td>
<td>0.44***</td>
<td>0.93</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. RTSQ</td>
<td>85.42</td>
<td>24.14</td>
<td>0.50***</td>
<td>0.50***</td>
<td>0.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. SAS-SV</td>
<td>27.08</td>
<td>10.15</td>
<td>0.25***</td>
<td>0.22***</td>
<td>0.34***</td>
<td>0.88</td>
<td></td>
</tr>
<tr>
<td>5. SUF</td>
<td>43.32</td>
<td>7.82</td>
<td>−0.03</td>
<td>0.04</td>
<td>0.15*</td>
<td>0.16***</td>
<td>0.79</td>
</tr>
</tbody>
</table>

Table II. Descriptive statistics, zero-order intercorrelations, and coefficient α’s for the primary measures using scale scores

Notes: PHQ-9, patient health questionnaire-9; SIAS, social interaction anxiety scale; RTSQ, ruminative thought styles questionnaire; SAS-SV, smartphone addiction scale-short version; SUF, smartphone use frequency. The α coefficients appear in parentheses on the diagonal. *p < 0.05; **p < 0.01; ***p < 0.001
The only non-significant relationships were for smartphone use frequency with both depression and social anxiety scores. Depression and social anxiety were significantly associated with rumination. Rumination was statistically associated with both increased smartphone use frequency and problematic use (*H1 and *H2*, respectively).

Next, we present results from measurement models based on CFA for our variables presented in Figure 1. Standardized factor loadings are presented in Table I.

The one-factor problematic smartphone use model demonstrated some evidence for adequate fit, $\chi^2(35, n=296) = 131.06, p < 0.001, \text{CFI} = 0.90, \text{TLI} = 0.87, \text{RMSEA} = 0.10$ (90 percent CI: 0.08-0.11), SRMR = 0.06. Next, in modeling smartphone frequency using CFA, a one-factor model demonstrated poor fit, $\chi^2(44, n=296) = 153.02, p < 0.001, \text{CFI} = 0.83, \text{TLI} = 0.78, \text{RMSEA} = 0.09$ (90 percent CI: 0.08-0.11), SRMR = 0.07.

A one-factor depression model yielded some evidence for adequate fit, $\chi^2(27, n=296) = 149.16, p < 0.001, \text{CFI} = 0.96, \text{TLI} = 0.93, \text{RMSEA} = 0.12$ (90 percent CI: 0.11-0.14). A one-factor social anxiety model fit well, $\chi^2(119, n=296) = 329.62, p < 0.001, \text{CFI} = 0.90, \text{TLI} = 0.89, \text{RMSEA} = 0.08$ (90 percent CI: 0.07-0.09), SRMR = 0.05. Finally, a higher-order rumination model with five first-order factors fit well, $\chi^2(86, n=296) = 134.57, p < 0.001, \text{CFI} = 0.98, \text{TLI} = 0.97, \text{RMSEA} = 0.04$ (90 percent CI: 0.03-0.06), SRMR = 0.05.

We next tested the structural model from Figure 1 (SEM Model A) for direct effects. Smartphone frequency was the only primary study variable modeled as an observed, summed score variable, because of poor measurement model fit discussed above. Results are shown in Figure 2. This model fit well, $\chi^2(1365, n=296) = 2844.11, p < 0.001, \text{CFI} = 0.94, \text{TLI} = 0.94, \text{RMSEA} = 0.06$ (90 percent CI: 0.06-0.06). Figure 2 displays standardized parameter estimates for the direct effects between constructs; factor loadings are displayed in Table I. Adjusting for age and gender, rumination was not significantly associated with increased smartphone use frequency (*H1*), but was

**Figure 2.**
Model A: structural equation model of depression and anxiety predicting rumination, and rumination predicting smartphone use frequency and predicting problematic smartphone use (adjusting for age and gender), with standardized path coefficients for direct effects.

**Notes:** SIAS, social interaction anxiety scale; PHQ-9, patient health questionnaire-9; SAS, smartphone addiction scale-short version; SUF, smartphone use frequency. Circles represent latent variables; squares represent observed variables. For visual clarity, the latent variables’ observed items are not pictured. See Table I for item-to-factor mappings, and factor loadings. *p < 0.05; **p < 0.01; ***p < 0.001
associated with levels of problematic smartphone use (H2). Both social anxiety and depression severity were significantly related to rumination. Test statistics for these hypotheses are presented in Table III.

We also tested indirect effects in the structural model from Figure 2 (see Table III for details). Rumination accounted for relations between depression severity and problematic smartphone use severity (H4). Rumination also explained relations between social anxiety severity and levels of problematic smartphone use (H6). However, rumination did not significantly account for relations between depression severity and smartphone use frequency (H3). And rumination did not explain relations between social anxiety severity and smartphone use frequency (H5).

We additionally tested a variation of SEM Model A (labeled SEM Model B), adding four paths: from both social anxiety and depression severity to both smartphone use frequency and problematic use severity variables (Figure 3). However, this revised model did not enhance fit, $WLSMV \chi^2(4, n = 296) = 3.27, p = 0.51$. The only added path that was statistically significant was from depression severity to smartphone use frequency, though, this path represented an inverse effect.

Finally, we tested an additional variation of SEM Model A, whereby we removed smartphone use frequency from the model. This model (SEM Model C) did not fit well, $WLSMV \chi^2(1316, n = 296) = 1374.79, p < 0.001$, $CFI = 0.87$, $TLI = 0.87$, $RMSEA = 0.03$ (90 percent CI: 0.03-0.04).[2]

**Discussion**

In the present paper, we examined the role of rumination in understanding relations between both depression and social anxiety with increased/problematic smartphone use. Several of our hypotheses were supported, demonstrating the impact of rumination in these relationships.

At the bivariate and multivariate levels of analysis, rumination was related to problematic smartphone use (H2) but not to smartphone use frequency in multivariate analyses (failing to support H1). We found support for rumination in explaining relations between depression severity and problematic smartphone use levels (H4), and between

<table>
<thead>
<tr>
<th>H1 Effect specified</th>
<th>Indirect test statistic $(a \times b)$</th>
<th>Result</th>
<th>Direct effect (a)</th>
<th>Direct effect (b)</th>
<th>Total effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 RTSQ $\rightarrow$ SUF</td>
<td>n/a</td>
<td>U</td>
<td>0.07</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>2 RTSQ $\rightarrow$ SAS-SV</td>
<td>n/a</td>
<td>S</td>
<td>0.40</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>3 PHQ9 $\rightarrow$ RTSQ $\rightarrow$ SUF $\beta = 0.03$ (95% CI: -0.01-0.07), SE = 0.03, $p = 0.23$</td>
<td>U</td>
<td>0.44</td>
<td>0.07</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>4 PHQ9 $\rightarrow$ RTSQ $\rightarrow$ SAS-SV $\beta = 0.18$ (95% CI: 0.12-0.24), SE = 0.04, $p &lt; 0.001$</td>
<td>S</td>
<td>0.44</td>
<td>0.40</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>5 SIAS $\rightarrow$ RTSQ $\rightarrow$ SUF $\beta = 0.02$ (95% CI: -0.01-0.06), SE = 0.02, $p = 0.28$</td>
<td>U</td>
<td>0.34</td>
<td>0.07</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>6 SIAS $\rightarrow$ RTSQ $\rightarrow$ SAS-SV $\beta = 0.14$ (95% CI: 0.08-0.20), SE = 0.04, $p &lt; 0.001$</td>
<td>S</td>
<td>0.34</td>
<td>0.40</td>
<td>0.28</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** S, supported; U, unsupported; PHQ-9, patient health questionnaire-9; SIAS, social interaction anxiety scale; RTSQ, ruminative thought styles questionnaire; SAS-SV, smartphone addiction scale-short version; SUF, smartphone use frequency. Total effect = Direct effect (a) + Direct effect (b) + Indirect effect

**Table III.** Hypotheses and associated results in the structural model
social anxiety severity in relation to increased problematic smartphone use (H6). However, rumination did not explain relations between depression severity or social anxiety severity with smartphone use frequency (H3 and H6 respectively). Most previous research has examined relations between smartphone use frequency or increased problematic use with depression (recently in Demirci et al., 2015; Lu et al., 2011; Smetaniuk, 2014) and anxiety (recently, Demirci et al., 2015; Kim, Lee and Choi, 2015; Lee, et al., 2014), evidencing direct effects. We found that social anxiety and depression severity may not solely account for increased problematic use of a smartphone. Rumination may be an important mechanism linking anxious and depressive psychopathology with problematic smartphone use.

Rumination is conceptualized as a maladaptive, avoidant coping mechanism, whereby rumination facilitates the avoidance of focusing on negative emotion (Mennin and Fresco, 2013; Nolen-Hoeksema et al., 2008). Focusing on and processing negative emotions is a healthy, adaptive response to negative affect (Gross, 1998), rather than suppressing emotion through cognitive techniques, such as rumination. In fact, processing emotion is a key focus of psychological treatment (Mennin and Farach, 2007; Olatunji et al., 2010).

Rumination’s role in problematic smartphone use has been theorized previously (Billieux, Philippot, Schmid, Maurage, De Mol and Van der Linden, 2015), and is supported by our results. Specifically, Billieux, Philippot, Schmid, Maurage, De Mol and Van der Linden (2015) discussed rumination as a mechanism in interpersonal relationships that can cause excessive reassurance-seeking behavior by triggering habitual and constant checking of one’s smartphone for social-related notifications. Other forms of maladaptive coping have demonstrated relations with problematic internet use (Brand et al., 2014), relevant to and supporting the present findings. And habitual smartphone checking behavior serves as intermittent positive reinforcement that strengthens problematic smartphone use (Oulasvirta et al., 2012). Thus, individuals using rumination as a response to depressed or
anxious affect may be more susceptible to increased and problematic smartphone use. Alternatively, it could be that people who are not excessive ruminators, and thus have good emotion regulation skills, can deal with depression and anxiety using healthy emotion regulation strategies. Such individuals could consequently use a smartphone productively, rather than excessively or without purpose.

Despite finding support for rumination’s role in the relationship between psychopathology (depression and social anxiety) and problematic smartphone use severity (H4 and H6 respectively), rumination did not play such a role in the increased frequency of smartphone use (H3 and H5). Thus, rumination may be an important mechanism in explaining problem smartphone behaviors, rather than natural variations in smartphone use frequency.

Our results support UGT and CIUT. The individual characteristic of rumination in this case would be a background characteristic in UGT. Integrating these models and applying them here, people who have maladaptive emotion regulation skills, such as using rumination to avoid negative emotion – especially individuals who are already depressed or anxious – may be more likely to inappropriately or excessively use a smartphone in an effort to regulate their negative emotion. Indeed, Hoffner and Lee (2015) found that people who reported that they would especially miss particular smartphone features were more likely to use maladaptive emotion regulation skills.

We should clarify that the concept of “problematic smartphone use” is not without controversy (De-Sola Gutierrez et al., 2016). Only limited empirical evidence supports this construct as an addictive disorder (Billieux, Maurage, Lopez-Fernandez, Kuss and Griffiths, 2015). Additionally, the frequent use of a smartphone is not necessarily a maladaptive behavior, unless it is accompanied by hallmark symptoms of addictive disorders, including functional impairment (Billieux, Maurage, Lopez-Fernandez, Kuss and Griffiths, 2015).

In the present study, we had several limitations. First, we used a convenience sample of college students. Second, we relied on self-report measures of psychopathology and smartphone use. Third, our measures of problematic smartphone use and smartphone use frequency were correlated; in fact, problematic smartphone use, by definition, includes the frequency of smartphone use. Such conceptual and construct-related issues with defining use and problematic use should be considered in light of our study’s focus on both, possibly overlapping constructs. Fourth, we did not have longitudinal data to draw causal inferences. Fifth, because brain circuit deficits have been found responsible for problematic technology use (Turel and Qahri-Saremi, 2016; Turel et al., 2016), perhaps these deficits rather than our study variables were responsible for problematic smartphone use in the present study. Keeping these limitations in mind, our findings on rumination as an important construct in explaining smartphone use are novel and contribute to the literature on relations between psychopathology and problematic smartphone use.

This study has implications for theory and practice with regard to problematic smartphone use and relations with psychopathology. Existing models examining smartphone use frequency as a mediator between increased psychopathology and problematic smartphone use (Elhai, Levine, Dvorak and Hall, 2017; Kim, Seo and David, 2015; van Deursen et al., 2015) could be extended by incorporating transdiagnostic psychological constructs (Mansell et al., 2008), such as rumination. Such transdiagnostic constructs may help explain why some people with psychopathology develop problematic use of technology, while others do not. From a clinical practice perspective, depressed and anxious patients should be offered interventions aimed at not only managing mood and anxiety, but that also provide adaptive coping techniques, including better ways to regulate emotion (Mennin and Farach, 2007). Such interventions could offset the possibility that a depressed or anxious patient would engage in problematic technology use.

Future research should directly examine the role of excessive reassurance seeking, as another chain on the link between depressive/anxious psychopathology and excessive
smartphone use. Relevantly, social interaction and support should be further examined for its role in problematic smartphone use — especially problematic smartphone-based social network use (Yang et al., 2016). Transdiagnostic constructs, such as avoidance, suppression, and anxiety sensitivity (Aldao et al., 2010), could also be explored as potential mechanisms explaining the relations between psychopathology and problematic smartphone use. The nature of the association between smartphone use frequency and problematic use should be further explored. Finally, future research should examine brain circuitry deficits in addition to mental health variables as underlying problematic smartphone use.

Notes

1. We also attempted modeling smartphone frequency using WLSMV estimation, treating items as ordinal variables. This model also did not show an indication of good fit, $\chi^2(44, n = 296) = 211.29$, $p < 0.001$, CFI = 0.89, TLI = 0.85, RMSEA = 0.11 (90% CI: 0.10-0.13). Finally, we used exploratory factor analysis (EFA) to assess for a better fitting smartphone frequency model. We used ML estimation and a promax rotation method. Based on the eigenvalue > 1 rule, we found two factors, $\chi^2(26, n = 296) = 96.97$. However, the second factor’s eigenvalue (1.03) barely exceeded the eigenvalue rule, with very low factor loadings.

2. This model could not be statistically compared to SEM Models A or B. Removing the smartphone use frequency variable made this model non-nested within those other models. Therefore, traditional $\chi^2$ difference testing is contraindicated.

References


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