

Running Head: SOCIAL MEDIA EXPERIENCES AND DEPRESSIVE SYMPTOMS

Emotional responses to social media experiences among adolescents:

Longitudinal associations with depressive symptoms

Jacqueline Nesi^{1,2}, William A. Rothenberg^{3,4}, Alexandra H. Bettis⁵, Maya Massing-Schaffer¹,

Kara A. Fox⁶, Eva H. Telzer⁶, Kristen A. Lindquist⁶, Mitchell J. Prinstein⁶

¹Warren Alpert Medical School of Brown University, Dept. of Psychiatry and Human Behavior

²Bradley/Hasbro Research Center, Rhode Island Hospital

³Duke University, Center for Child and Family Policy

⁴University of Miami Miller School of Medicine, Mailman Center for Child Development

⁵Vanderbilt University Medical Center, Dept. of Psychiatry and Behavioral Sciences

⁶University of North Carolina at Chapel Hill, Department of Psychology and Neuroscience

Correspondence regarding this manuscript may be directed to Jacqueline Nesi, PhD, Coro West, Ste 204, 1 Hoppin St, Providence, RI, 02903. 401-400-0868. jacqueline_nesi@brown.edu. ORCID ID: 0000-0001-5869-6360; Twitter: @JacquelineNesi

Acknowledgements

We wish to thank the project staff and research participants who made this study possible.

Funding

This work was supported in part by the Winston Family Initiative for the Study of Technology and Adolescent Development, co-directed by E.H.T and M.J.P. J.N. was supported by the National Institute of Mental Health (NIMH; K23MH122669) and American Foundation for Suicide Prevention (AFSP; PDF-010517). W.A.R was supported by the Eunice Kennedy Shriver National Institute of Child Health and Development (NICHD; RO1-HD054805). A.H.B. was supported by NIMH (K23MH122737) and the Klingenstein Foundation Access to Care Fellowship. Any opinions, findings, and conclusions or recommendations expressed in this material are solely the responsibility of the authors and do not necessarily represent the views of these funding sources.

Disclosure: The authors have no potential competing interests to report.

Abstract

Objective: The degree to which adolescent social media use is associated with depressive symptoms has been the source of considerable debate. Prior studies have been limited by a reliance on cross-sectional data and measures of overall “screen time.” This study examines prospective associations between adolescents’ emotional responses to social media experiences and depressive symptoms, and examines gender differences in these processes.

Method: A school-based sample of 687 adolescents (48.6% girls; $M_{age} = 14.3$; 38.1% White, 29.4% Hispanic, 23.0% Black) completed measures of positive and negative emotional responses to social media experiences and depressive symptoms at two time points, one year apart.

Results: Higher levels of depressive symptoms were associated with more frequent *negative* emotional responses to social media experiences one year later, whereas greater *positive* emotional responses to social media were associated with later depressive symptoms. Girls reported overall greater emotional responses to social media experiences, but gender did not moderate associations between these emotional responses and depressive symptoms.

Conclusion: Findings highlight the importance of examining adolescents’ positive and negative emotional experiences in the context of social media use, and the ways in which these experiences intersect with depressive symptoms, so as to identify youth who may be most vulnerable to negative effects of social media use.

Keywords: adolescents, social media use, depressive symptoms

Emotional responses to social media experiences among adolescents:

Longitudinal associations with depressive symptoms

Prevalence rates of depressive symptoms among adolescents have increased substantially over the past decade (Twenge et al., 2019), coinciding with the rising popularity of social media sites (Anderson & Jiang, 2018). The degree to which these trends are linked, however, has been a source of considerable debate (Orben & Przybylski, 2019; Twenge et al., 2020; Orben & Przybylski, 2020). Some prior work, including recent meta-analyses, suggests associations between frequent social media use and depressive symptoms (Twenge et al., 2019; Keles et al., 2020; McCrae et al., 2017). Other longitudinal studies find no associations (Heffer et al., 2019; Coyne et al., 2019), and some have suggested that any identified associations are too small to be clinically or practically meaningful (Orben & Przybylski, 2019; Orben, 2020). Given that adolescent depression remains a devastating condition of considerable public health concern, there is an urgent need to address the methodological and conceptual limitations of prior research that may partially explain these mixed findings.

There is a growing consensus in the field that measures of overall “screen time” may be less relevant than understanding underlying mechanisms that heighten depression risk (Ivie et al., 2020, Prinstein, Nesi, & Telzer, 2020). Such mechanisms may include actual online behaviors or experiences (e.g., cybervictimization, passive scrolling, receiving too few “likes”), but critically, may also include adolescents’ *subjective, emotional responses* to those social media experiences. While prior meta-analyses have highlighted associations between depressive symptoms and specific uses of social media (Keles et al., 2020; McCrae et al., 2017), very few studies have emphasized youths’ emotional reactions to this use. This is important because existing theoretical models of adolescent depression risk highlight youths’ emotional sensitivity or

reactivity to experiences – particularly interpersonal experiences – as a key factor in the development and maintenance of depressive symptoms (Beeson et al., 2020; Prinstein & Aikins, 2004; Silk, Davis et al., 2012; Young et al., 2016). Thus, a critical next step is to determine whether certain adolescents are more vulnerable to depressive symptoms in the context of social media use due to more frequent or intense affective responses to the experiences they have online. Further, given a lack of prior longitudinal studies, there is a need to disentangle directionality in the association between depressive symptoms and social media use (Odgers & Jensen 2020). To address these gaps in the literature, the current study examined bidirectional associations between adolescents' emotional responses to social media experiences and depressive symptoms, and explored gender differences in these processes.

Adolescent Depression Risk and the Role of Social Media: The Importance of Emotional Responses to Social Media Experiences

Adolescence represents a developmental period of heightened risk for depressive symptoms (Patton & Viner, 2007). Notably, the adolescent transition is characterized by the establishment of more intimate peer relationships, heightened reliance on peers for self-esteem and identity development, and increased biological sensitivity to peer information and feedback (Masten et al., 2011; Steinberg, 2005). As such, interpersonal factors – and adolescents' emotional responses to those experiences – may be particularly relevant for understanding depression risk in this age group. In recent years, social media has become a primary context in which adolescents' peer experiences take place. The features of social media sites, including possibilities for public self-expression, quantifiable metrics of peer approval, and constant availability, may create new types of peer experiences, both positive (e.g., eliciting immediate social support) and negative (e.g., receiving too few 'likes'; Nesi et al., 2018a,b).

While prior work on adolescent social media use has begun to identify how these specific social media behaviors and events intersect with depressive symptoms (McCrae et al., 2017), very little work has examined adolescents' *emotional responses* to these experiences. The relevance of youths' subjective emotional reactions to their social media use is underscored by social-cognitive and interpersonal models of depression, which highlight youths' affective sensitivity to both positive (e.g., reward) and negative (e.g., rejection) social experiences (e.g., Abramson et al., 1989; Beeson et al., 2020; Rudolph, 2009; Silk, Davis et al., 2012). When it comes to social media, youth may vary considerably, for example, in the degree to which they feel happy in response to positive comments on their posts, feel supported when engaging online with friends, or alternatively, feel upset in response to a negative comment or too few likes. Indeed, the Differential Susceptibility Model of media effects highlights individual differences in youths' use of social media and subsequent emotional "response states" (Valkenburg & Peter, 2013). However, little is known regarding adolescents' subjective positive and negative emotional experiences using social media. Recent U.S. national surveys have found that young people who report greater emotional sensitivity to both positive *and* negative social media experiences also reported higher levels of depression (Rideout & Fox, 2018; Rideout & Robb, 2018). However, these results are based on cross-sectional data, thus the direction of these effects is not clear.

Temporal Associations between Depressive Symptoms and Emotional Responses to Social Media Experiences

On the one hand, it is possible that youth who are *already* experiencing depressive symptoms will show greater emotional sensitivity to social media experiences. Symptoms-driven interpersonal models of depression (Rudolph, 2009; Krygsman & Vaillancourt, 2017) suggest

that adolescents with depressive symptoms are not only more likely to experience peer stressors, but also are more sensitive to social evaluative feedback from peers (Prinstein & Aikins, 2004; Silk, Davis et al., 2012; Young et al., 2016). Indeed, depressive symptoms have been shown to precede and predict both perceived rejection and rejection sensitivity (Beeson et al., 2020).

Cross-sectional U.S. national surveys and qualitative studies indicate that depressed youth may show heightened sensitivity to rejection on social media (e.g., receiving too few “likes”), and also may show greater concern about and emotional investment in indicators of peer approval (e.g., positive online comments) and social support online (Rideout & Fox, 2018; Radovic et al., 2017; Ybarra et al., 2005).

On the other hand, heightened emotional responses to social media experiences may serve as a risk factor that precedes and predicts depressive symptoms. Social-cognitive models of depression (Abramson et al., 1989; Hammen, 2009; Hankin & Abramson, 2001) highlight the ways in which adolescents’ cognitive and emotional vulnerabilities to peer stressors contribute to depressive symptoms. Youth who experience greater negative affect in response to certain social media experiences (e.g., feeling ignored, left out, or excluded) may be at heightened risk for depression over time. At the same time, greater *positive* emotional responses to social media experiences may also signal risk for depression. Youth who experience more positive affect in relation to their social media experiences may be relying more heavily on social media for peer connection and self-expression. In turn, these youth may lack offline opportunities to fulfill these basic socioaffective needs, and may require excessive reassurance or social approval to maintain their self-esteem. In support of this idea, emerging research using EMA suggests that positive peer interactions on social media are associated with lower sustained positive affect compared to in-person interactions (Hamilton et al., 2020), and one longitudinal study of adolescents indicates

that online friendships may be of lower quality than those occurring in-person (Antheunis et al., 2012). However, these ideas remain speculative, as very little work has examined associations between adolescents' positive emotional experiences on social media and depressive symptoms.

Individual differences in adolescents' emotional responses to social media thus are likely to influence associations with depressive symptoms. Certain underlying social and emotional vulnerabilities may also magnify these associations. Distinct from adolescents' specific emotional responses to social media experiences may be youths' general tendency toward emotional sensitivity and reactivity across all life domains. Youth who are more emotionally reactive tend to have stronger emotional responses to interpersonal experiences, which heightens depression risk over time (Owens et al., 2019; Herrens et al., 2016). Thus, youth who are both generally more emotionally reactive *and* experience stronger emotional responses to social media may be at greater risk for subsequent depressive symptoms. Similarly, loneliness reflects adolescents' subjective experience of distress related to social isolation, occurring generally across life domains. Evidence from a recent meta-analysis suggests that adolescents who are lonely may be more emotionally invested in their social media use (Sarmiento et al., 2018). These youth, who may rely more heavily on social media for positive affective experiences related to social connection and support, may be at greater risk for depressive symptoms.

Gender Differences in Social Media Use and Depressive Symptoms

Past work examining gender differences in associations between social media use and depressive symptoms suggests a complex narrative, and the role of gender in adolescents' emotional responses to social media experiences and associated depressive symptoms has rarely been studied. This is further complicated by the fact that most prior work has conflated conceptualizations of gender and sex; thus, although these studies may provide initial evidence

for possible differences by gender, the extent to which these differences are truly reflective of gendered personality or individual differences (versus sex differences) is not clear. Prior studies indicate that rates of depression are higher among adolescent girls than boys (Starr & Davila, 2008). While some studies, including recent cross-sectional work with nationally representative datasets, have shown stronger associations between social media use and depressive symptoms in girls compared to boys (Twenge & Martin, 2020), other cross-sectional studies find several online experiences (e.g., active social media use; preoccupation with self-presentation) are more strongly associated with maladjustment among boys relative to girls (Frison & Eggermont, 2016; Zimmer-Gembeck et al., 2020). However, in regard to emotional responses to these experiences, very little work exists.

Interpersonal theories of depression (Hames et al., 2013) suggest that girls react to interpersonal stressors with more ruminative and negative inferential response styles (Hankin & Abramson, 2001). Girls may also show heightened sensitivity to social stressors (Stroud et al., 2002) and be more emotionally invested in peer feedback and approval (Rose & Rudolph, 2006), which may increase risk for depression. This heightened emotional investment in social experiences may extend to the online context (Nesi & Prinstein, 2015; Nesi & Prinstein, 2018; Zimmer-Gembeck et al., 2020). However, some research suggests that social media may partially “level the playing field” in regard to traditional gender norms and mental health concerns (Manago et al., 2015). While young women have always been socialized to value social relationships, the public and evaluative nature of social media may increase the emotional salience of interpersonal concerns for young men. Taken together, more research is needed to clarify gender differences in emotional responses to social media use, and longitudinal

associations with depressive symptoms. Furthermore, research explicitly examining differences based on self-identified gender, rather than sex, is needed in regard to social media use.

Current Study

The current study addresses limitations of prior work by investigating bidirectional associations between emotional responses to social media experiences and depressive symptoms in a diverse sample of adolescents. The study has two primary aims: 1) To test bidirectional relationships between emotional responses to social media experiences and depressive symptoms, in order to gather preliminary evidence of the direction of effects; 2) To examine gender differences in adolescents' emotional responses to social media experiences and associations with depressive symptoms. In addition, exploratory analyses examined loneliness and emotional sensitivity as moderators of associations between emotional responses to social media experiences and depressive symptoms.

It was hypothesized that depressive symptoms would precede and predict both positive and negative emotional responses to social media use, and that both positive and negative emotional responses to social media use would predict depressive symptoms over time. In regard to gender, it was hypothesized that girls would report greater emotional responses, both positive and negative, to social media experiences compared to boys. However, given mixed findings in prior work, no hypotheses were offered regarding gender differences in the longitudinal associations between these emotional responses and depressive symptoms.

Methods

Participants and Procedure

Participants were 687 students in 8th and 9th grade ($M_{age} = 14.26$, $SD = 0.63$ at Time 1), recruited from public schools in a rural, lower-middle-class community in the southeastern

United States (69.5% of students in the district eligible for free or reduced-price lunch). Participants self-reported their gender identity: 50.8% identified as male, 48.6% as female, and 0.6% as another gender (e.g., transgender, gender fluid). The racial/ethnic composition of the sample was 29.4% Hispanic or Latinx, 23.0% Black or African American, 38.1% White, 11.5% Multi-Racial, 5.2% other races (e.g., Asian, American Indian). Participants were assessed at two time points, 1 year apart, in Fall/Winter 2018 and Fall/Winter 2019, as part of an ongoing longitudinal study of adolescent peer relations and psychosocial adjustment. Measures were administered on computers in classrooms during the school day, and participants were compensated with a \$10 gift card. Measures for the current study were available only during waves 3 (“Time 1”) and 4 (“Time 2”) of the larger study. All procedures were approved by the University Institutional Review Board.

For the larger study, all 6th and 7th grade students from three middle schools ($N=1385$) were recruited, with 76.4% ($n=1059$) families returning consent forms. Of these, 88.3% ($n=935$) gave consent for their child to participate. Of the 935 who originally consented to participate, 768 completed at least one questionnaire at wave 3 (Time 1 of this study). Due to time limitations at some schools, and the placement of social media questionnaires at the end of the battery, 687 participants completed these questionnaires at Time 1 and thus comprised the final sample for this study. Of these, 585 (85.1%) were retained at Time 2; they did not differ on any demographic or study variables from those who were not retained.

Measures

Emotional Responses to Social Media Experiences (Times 1 and 2)

A measure of emotional responses to social media experiences was developed for this study based on a review of prior literature. In particular, items were adapted from previous

national surveys from the Pew Research Center (Anderson & Jiang, 2018), Common Sense Media (Rideout & Robb, 2018), and HopeLab (Rideout & Fox, 2018). The goal of the measure was to briefly assesses the frequency with which adolescents experience positive and negative emotional responses to social media activities. Participants rated, on a 5-point Likert scale from 1=*Never* to 5=*Always*, a series of 10 items (5 positive and 5 negative) following the stem “When you use social media, how often do you...?” (see Table 1). Reliability was good for the positive subscale (T1 $\alpha=.89$; T2 $\alpha=.79$) and negative subscale (T1 $\alpha=.85$; T2 $\alpha=.80$). More information about factor structure of the measure is provided in results below.

Depressive Symptoms (Times 1 and 2)

Depressive symptoms were assessed using the Short Mood and Feelings Questionnaire (SMFQ; Angold et al., 1995). Participants indicated the extent to which they experienced symptoms of depression during the prior two weeks, on a 3-point Likert scale from 0=*not at all true* to 2=*mostly true*. A mean score was calculated; higher numbers indicated higher levels of depressive symptoms (T1 $\alpha=.92$; T2 $\alpha=.93$). The SMFQ has been shown to be reliable and valid (Daviss et al., 2006; Sharp et al., 2006), and has been widely used in adolescent samples (Turner, Joinson, Peters, Wiles, & Lewis, 2014). The original SMFQ is 13 items; a shorter, 9-item version of the scale was used in this study, with items selected based on item-total correlations gathered in pilot data. This 9-item measure has been used in prior studies (e.g., Massing-Schaffer et al., 2020).

Frequency of Social Media Use (Times 1 and 2)

A single item, previously used in U.S. nationally-representative surveys of adolescent social media use (Rideout & Robb, 2018), asked “How often do you check social media like

Instagram, Snapchat, or Facebook?” Responses are provided on a 9-point Likert scale from 0=*Never* to 9=*Almost Constantly*.

Loneliness (Time 1)

Loneliness was assessed using a 5-item adaptation of the Loneliness and Social Dissatisfaction Questionnaire (LSDQ; Cassidy & Asher, 1992; see Vanhalst et al., 2017). Participants indicated the extent to which they had felt lonely in the last year (e.g., “I was lonely,” “I was sad and alone”) on a 5-point Likert scale from 1=*Never* to 5=*Very Often* ($\alpha=.93$).

Emotional Reactivity – Sensitivity Subscale (Time 1)

The Emotional Reactivity Scale (Nock et al., 2007) is a 21-item measure that assesses individuals’ experience of emotional reactivity across three domains: emotion sensitivity, arousal/intensity, and persistence. For this study, the 10-item sensitivity subscale was examined given its potential relevance to the construct of emotional responses to social media experiences. An example item from this subscale is: “I tend to get emotional very easily.” Participants rated items on a five-point Likert scale from 0=*not at all like me* to 4=*completely like me* ($\alpha=.92$).

Data Analytic Plan

Descriptive statistics were conducted within SPSS 25.0. The remainder of analyses were conducted within a structural equation modelling (SEM) framework in MPlus 8.0. First, an exploratory factor analysis (EFA) was conducted using goemin (oblique) rotation, to determine the optimal factor solution for the emotional responses to social media experiences scale. A two-factor solution was found to be optimal, with separate factors representing positive and negative emotional responses to social media experiences (see Results below).

A series of measurement invariance tests was then conducted. Measurement models for the social media and depressive symptoms measures were tested for invariance by gender and

across time points. Configural invariance (i.e., equivalence of model form) was tested by examining overall fit statistics for the multiple group, measurement model with all factor loadings, item intercepts, and item residuals set to vary freely across gender and/or time. Metric invariance was tested by constraining factor loadings to be equal across gender groups and/or time, and comparing fit with the configural invariance models. Scalar invariance was tested by constraining factor loadings and item intercepts to equality across gender groups and/or time and comparing fit with the metric invariance model. Model fits were compared using multiple fit indices: chi-square value, CFI, TLI, SRMR, and RMSEA, considering guidelines of Chen (2007) of no more than -.01 change in CFI, paired with changes in RMSEA of -0.015 and SRMR of -.030 (for metric invariance) and -0.015 (for scalar invariance).

Cross-lagged panel analyses were then conducted, with separate models used to test associations between each of positive and negative emotional responses to social media experiences and depressive symptoms over time. Models with autoregressive paths only, i.e., paths from emotional responses to social media at T1 to T2 and from depressive symptoms at T1 to T2, were compared to cross-lagged models, i.e., paths from all T1 to all T2 variables. Chi-square difference tests were conducted to compare the models, and significance of paths in each model were examined. Sensitivity analyses were also conducted controlling for frequency of social media use at T1 and T2 in fully cross-lagged models, and with positive and negative emotional response variables included in a single model.

Moderation by gender of paths from emotional responses to social media to depressive symptoms and vice versa were tested using multiple group (by gender) models, comparing model fit when paths were set equal versus free to vary across gender groups. Finally, exploratory analyses were conducted examining loneliness and emotional reactivity (sensitivity subscale) as

moderators of paths from emotional responses to social media to depressive symptoms. Latent variable interactions were created between positive and negative responses to social media and each of these variables, and these interactions were included in additional models. Significant interactions were probed and plots constructed within MPlus 8.0.

Results

Descriptive Statistics and Comparisons by Gender

A mean score was calculated for each variable and bivariate correlations were examined. Separate means were calculated for each of the positive and negative emotional responses to social media experiences subscales. Mean differences were also examined by gender. Although positive and negative emotional responses to social media experiences were each significantly associated with emotional reactivity at Time 1, the obtained correlation coefficients were $r = .35$ and $r = .46$. This provides preliminary evidence that these positive and negative emotional responses to social media are likely distinct constructs from overall emotional sensitivity. In addition, the association between positive and negative responses was moderate ($r = .46$ at Time 1, $r = .30$ at Time 2), preliminarily indicating that these factors may be distinct from one another. Notably, compared to boys, girls reported higher levels of both positive and negative emotional responses to social media experiences at each time point (see Table 2).

Factor Analysis

An exploratory factor analysis was conducted using all 10 items of emotional responses to social media experiences measured at Time 1. Models were constructed for a one-factor, two-factor, and three-factor solution. Model fit for the single factor solution was poor, $\chi^2(35)=1121.43, p<.001, CFI=0.69, TLI=0.60, RMSEA=0.21, SRMR=0.14$. Fit was excellent for the two-factor solution, $\chi^2(26)=150.55, p<.001, CFI=0.96, TLI=0.94, RMSEA=0.084,$

SRMR=0.026. Chi-square tests revealed that the two-factor model fit the data significantly better than the one-factor model, $\Delta\chi^2(9)=970.88, p < .001$, and revealed two factors representing separate positive and negative emotional responses. A three-factor solution fit the data better than the two-factor solution, $\Delta\chi^2(8)=113.55, p < .001$; $\chi^2(18)=37.00, p = .005$, CFI=1.00, TLI=0.99, RMSEA=0.039, SRMR=0.011. However, the third factor contained only two items (items 8 and 10) and was not interpretable. In addition, Eigenvalues for the first ($\lambda = 4.76$), and second ($\lambda = 1.89$) factors were above one, whereas the eigenvalue for the third factor ($\lambda = 0.69$) was much lower. Eigenvalues below one suggest that additional factors may not explain a meaningful proportion of variance in the items. Thus, the two-factor solution was retained. All factor loadings were above 0.64, with most above 0.72 (see Table 1).

Measurement Invariance Tests

A series of measurement invariance tests was conducted to ensure that measurement models for the latent social media experiences and depressive symptoms variables were invariant across time points and genders. Tests were conducted for configural (i.e., equivalence of model form), metric (i.e., equivalence of factor loadings), and scalar (i.e., equivalence of item intercepts) invariance. First, the measurement model for the social media measure was examined on its own, with comparisons across time points. Then, the measurement model for both time points of the social media measure was compared across genders. Next, the depressive symptoms scale was added to the measurement model, and invariance was tested across time points (see Table 3a). Positive and negative emotional responses to social media subscales were then separated into separate measurement models for further invariance testing by gender (Table 3b). Results revealed scalar invariance for depression and social media variables across gender groups and time points. Notably, the presence of scalar invariance by gender for the positive and

negative social media subscales indicates that the factor structure, factor loadings, and item intercepts of the scale are equivalent for boys and girls.

Cross-Lagged Models

Separate models were tested for the longitudinal association between each of positive and negative emotional responses to social media experiences and depressive symptoms¹. The decision to run separate models was based on poor model fit when combining both negative and positive emotional responses variables into a single model. This poor model fit was likely due to the lack of association between the positive and negative variables across time points, which resulted in added model complexity (i.e., less parsimony) without the benefit of additional explanatory power (Bauer & Curran, 2019).

Positive emotional responses to social media experiences and depressive symptoms.

First, an autoregressive model, which contained only paths from positive emotional experiences on social media at T1 to T2 and from depressive symptoms at T1 to T2, was constructed. Model fit was adequate, $\chi^2(370)=975.46, p<.001, CFI=0.940, TLI=0.939, RMSEA=0.049, SRMR=0.054$. However, the cross-lagged model, with paths from all T1 to all T2 variables (see Figure 1) showed a significant improvement in model fit over the autoregressive model, $\Delta\chi^2(2)=7.33, p = .026; \chi^2(368)=968.13, p<.001, CFI=0.941, TLI=0.939, RMSEA=0.049, SRMR=0.049$. In addition, the path from T1 positive emotional responses to social media experiences to T2 depressive symptoms was significant, $\beta=0.11, SE=0.04, p=.009$. However, the path from T1 depressive symptoms to T2 positive emotional responses to social media was non-

¹Sensitivity analyses were conducted with positive and negative emotional responses to social media use (as well as frequency of use) included in a single model. Model fit was poor $\chi^2(756)=2541.10, p<.001, CFI=0.868, TLI=0.863, RMSEA=0.059, SRMR = 0.099$. The pattern of significant and non-significant results remained the same. Positive emotional responses at T1 did not predict negative emotional responses at T2 ($\beta=0.02, SE=.05, p=.70$), nor vice versa ($\beta=0.03, SE=.03, p=.42$). Positive and negative emotional responses significantly covaried at T1 (0.27, $p<.001$) and T2 (0.08, $p<.001$).

significant, $\beta = -0.02$, $SE=0.03$, $p=.48$. This provides initial evidence that positive emotional responses to social media experiences may precede and predict depressive symptoms, but not vice versa.

In sensitivity analyses, controlling for frequency of social media use at T1 and T2, the pattern of results remained the same. Specifically, the path from T1 positive emotional responses to social media experiences to T2 depressive symptoms was significant, $\beta=0.11$, $SE=.04$, $p=.01$, and the opposite direction of effects, from T1 depressive symptoms to T2 positive emotional responses to social media was not, $\beta = -0.03$, $SE=.05$, $p = .48$. Notably, T1 social media use frequency was not significantly associated with T2 depressive symptoms, $\beta=0.007$, $SE=0.04$, $p=.86$, nor with T2 positive emotional responses to social media, $\beta = -.01$, $SE=.04$, $p=.82$. T1 depressive symptoms was not associated with T2 social media use frequency, $\beta= -0.01$, $SE =0.04$, $p=.86$; however, T1 positive emotional responses to social media was associated with T2 social media use frequency, $\beta=0.11$, $SE=0.04$, $p=.005$.

Negative emotional responses to social media experiences and depressive symptoms.

Model fit for the autoregressive model was adequate, $\chi^2(370)=1103.79$, $p<.001$, CFI=0.926, TLI=0.925, RMSEA=0.054, SRMR=0.052. Again, the cross-lagged model (see Figure 2) showed a significant improvement in model fit over the autoregressive model, $\Delta\chi^2(2)=12.96$, $p=.002$; $\chi^2(368)=1090.83$, $p<.001$, CFI=0.927, TLI=0.925, RMSEA=0.053, SRMR=0.043.

Unlike for the positive emotional responses model, the path from T1 depressive symptoms to T2 negative emotional responses to social media was significant, $\beta=0.12$, $SE=0.04$, $p=.004$. The path from T1 negative emotional responses to social media to T2 depressive symptoms was non-significant, $\beta=0.08$, $SE=0.05$, $p=.084$. This provide initial evidence that depressive symptoms may precede and predict negative emotional responses to social media, but not vice versa.

The pattern of results again remained the same in sensitivity analyses, controlling for frequency of social media use at T1 and T2. The path from T1 depressive symptoms to T2 negative emotional responses to social media was significant, $\beta=0.15$, $SE=.05$, $p=.002$, but the path from T1 negative emotional responses to social media to T2 depressive symptoms was not, $\beta=0.08$, $SE=.05$, $p=.097$. Again, T1 social media use frequency was not significantly associated with T2 depressive symptoms, $\beta=0.009$, $SE=0.04$, $p=.82$, nor with T2 negative emotional responses to social media, $\beta=.06$, $SE=.04$, $p=.14$. T1 depressive symptoms was not associated with T2 social media use frequency, $\beta = -0.05$, $SE=0.04$, $p=.21$; however, T1 negative emotional responses to social media was associated with T2 social media use frequency, $\beta=0.17$, $SE=0.04$, $p < .001$.

Gender Moderation Analyses

Moderation of cross-lagged paths by gender was examined. Given that scalar invariance had been established by gender, factor loadings and item intercepts were set equal across gender. A model in which the cross-lagged paths (i.e., from T1 positive emotional responses to social media to T2 depressive symptoms, and from T1 depressive symptoms to T2 positive emotional responses to social media) were free to vary across gender groups was compared to a model in which these paths were set equal across gender groups. Freeing the paths to vary across gender groups did not result in a significant improvement in model fit, $\Delta\chi^2(2)=0.046$, $p=.98$. For models examining associations between negative emotional responses to social media and depressive symptoms, there was again no significant improvement in model fit when freeing cross-lagged paths to vary across gender groups, $\Delta\chi^2(2)=4.42$, $p=.11$. Thus, moderation of the association between emotional responses to social media experiences and depressive symptoms by gender was not supported.

Exploratory Moderation Analyses: Loneliness and Emotional Reactivity

Next, exploratory analyses were run to examine whether associations between T1 emotional responses to social media experiences and T2 depressive symptoms were moderated by each of emotional reactivity and loneliness. Latent variable interactions were created and four separate cross-lagged models were run: one with the interaction between negative emotional responses to social media and emotional reactivity, one with negative responses and loneliness, one with positive responses and emotional reactivity, and one with positive responses and loneliness. The association between Time 1 negative emotional responses to social media experiences and Time 2 depressive symptoms was not moderated by loneliness, $\beta = -0.02$, $SE=0.04$, $p=.627$, nor emotional reactivity, $\beta = -0.07$, $SE=0.04$, $p=.070$. However, the association between Time 1 positive emotional responses to social media experiences and Time 2 depressive symptoms was significantly moderated by both loneliness, $\beta=0.18$, $SE=0.04$, $p<.001$, and emotional reactivity, $\beta=0.011$, $SE=0.04$, $p=0.010$.

To further understand the nature of the loneliness moderating effect, the association between Time 1 positive emotional responses to social media and Time 2 depressive symptoms was examined at one standard deviation above, average, and one standard deviation below average levels of Time 1 loneliness. When Time 1 positive responses to social media was 0.7 standard deviations or higher above average, greater positive responses to social media predicted significantly higher levels of depressive symptoms if Time 1 loneliness was one standard deviation above average, compared to one standard deviation below average (See Figure 3). In other words, greater reported positive responses to social media at Time 1 predicted greater depressive symptoms at Time 2 in adolescents with high levels of loneliness at Time 1.

For the emotional reactivity moderating effect, the association between Time 1 positive emotional responses to social media and Time 2 depressive symptoms was initially examined at one standard deviation above average, average, and one standard deviation below average levels of emotional reactivity. However, no significant differences among these simple slopes emerged, nor did such differences emerge even when the full range of data was examined. Therefore, though emotional reactivity significantly moderated the association between positive responses to social media and depressive symptoms, this significant moderating effect emerged at levels of emotional reactivity beyond those measured in the current data.

Discussion

Prior research examining the relationship between social media use and depressive symptoms in adolescents has been limited by a reliance on measures of overall “screen time” and a preponderance of cross-sectional studies (Ivie et al., 2020). While prior studies have begun to examine specific online behaviors or experiences, very little is known about youths’ subjective, emotional responses to those experiences. Thus, the present study extends prior work by examining adolescents’ emotional responses to social media use, and testing bidirectional associations with depressive symptoms. The extent to which adolescents, for example, feel happy or socially connected, or alternatively, feel upset or socially excluded, while using social media differs considerably across individual adolescents. Examining adolescents’ positive and negative emotional experiences in the context of social media use, and the ways in which this intersects with depressive symptoms, is critical for identifying those who may be most vulnerable to negative effects of social media use.

Findings of the current study suggest that more frequent *positive* emotional responses to social media may precede and predict depressive symptoms, whereas depressive symptoms may

precede and predict more frequent *negative* emotional responses to social media. These effects were found even over and above the effects of adolescents' overall frequency of social media use. While girls reported greater positive and negative emotional experiences on social media compared to boys, associations between these experiences and depressive symptoms did not differ by gender. Taken together, this research highlights the importance of moving beyond measures of simple frequencies of social media use, and instead examining adolescents' individual emotional vulnerabilities in the context of social media use as they relate to the onset and maintenance of depressive symptoms.

Positive Emotional Responses to Social Media Experiences and Depressive Symptoms

Bidirectional analyses of the association between depressive symptoms and emotional responses to social media revealed a complex picture of the longitudinal relationship between these constructs. In cross-lagged models, greater reports of positive emotional experiences in the context of social media predicted higher levels of depressive symptoms one year later. However, the reverse relationship was not supported. There are several potential explanations for these findings. First, it is possible that youth reporting higher levels of positive emotional responses to social media use may be relying more on social media, rather than in-person interactions, for affectively rewarding peer experiences. This may be due to a preference for online versus in-person relationships, or may be the result of social skills deficits that inhibit certain youths' abilities to create and maintain in-person friendships. Studies support the importance of social connection to mitigate depression risk (Werner-Seidler et al., 2017). It is possible that the online social world on which these adolescents are relying is not providing the same benefits and social connection as offline, even though adolescents may perceive it as beneficial. Indeed, preliminary work suggests that online friendships may be of poorer quality than in-person relationships

(Antheunis et al., 2012), and that in general, compared to in-person interactions, positive peer interactions via social media are associated with lower sustained positive affect (Hamilton et al., 2020). Over time, this may increase risk for depressive symptoms.

Another possible explanation is that placing a high emotional value on positive social media experiences may offer diminishing returns over time. That is, the emotional reward associated with a “like” or post on social media may decrease over time, increasing adolescents’ vulnerability to feelings of loneliness and depression. Indeed, these findings are in line with prior studies, which support an association between emotional investment in social media and depressive symptoms among adolescents (Keles et al., 2019; Vernon et al., 2017). Youth who are more heavily invested in their social media interactions, experiencing greater positive emotional responses to receiving likes or connecting with friends online, may ultimately be vulnerable to depressive symptoms over time. However, further research is needed to understand how and why positive emotional responses to social media may lead to later affective problems during the adolescent developmental period.

These explanations also align with the finding that loneliness moderated the relationship between positive emotional responses to social media experiences and elevated depression, such that prospective associations between positive emotional responses to social media and depressive symptoms were stronger among youth reporting higher levels of loneliness. Adolescents who lack quality in-person relationships may experience elevated levels of loneliness. Insofar as these youth are turning to social media to provide affectively rewarding social experiences that they are not receiving in-person, this may create a pathway through which depressive symptoms increase over time. Indeed, prior studies have found that loneliness is associated with time spent using social media (Aalbers et al., 2019; Hunt et al., 2018), and that

loneliness predicts subsequent increased passive social media use (Aalbers et al., 2018). Thus, adolescents' reports of positive emotional responses to social media may be a result of utilizing social media in an effort to cope with loneliness or increase social connection, and if those efforts are ineffective, they may incur greater risk for developing symptoms of depression.

Negative Emotional Responses Social Media Experiences and Depressive Symptoms

Findings supported hypotheses in suggesting that depressive symptoms preceded and predicted more frequent *negative* emotional responses to social media experiences. These findings may be interpreted in light of cognitive and interpersonal theories of depression (Abramson et al., 1989; Clark et al., 1999; Hammen, 2009) Krygsman & Vaillancourt, 2017; Rudolph, 2009). According to cognitive models, adolescents already experiencing depressive symptoms may be more likely to attend to negative information and perceive experiences more negatively in their social environments (Beeson et al., 2020; Prinstein & Aikins, 2004). Adolescents with depressive symptoms may experience cognitive distortions, or dysfunctional thought patterns whereby youth may discount positive experiences and show negative biases toward themselves and their lives (Clark et al., 1999). It may be the case that adolescents with depression are exhibiting greater attention to, and thus experiencing greater distress associated with, negative experiences on social media (Orchard, Pass, & Reynolds, 2016).

The interpersonal model of depression notes that depressed adolescents may experience heightened levels of interpersonal and rejection sensitivity, leading them to engage in problematic social behaviors, such as reassurance-seeking or negative feedback-seeking (Beeson et al., 2020; Hames et al., 2013; Prinstein et al., 2005; Young et al., 2016). Following this model, it is possible that teens with depression utilize social media for reassurance when feeling down, and in turn are particularly vulnerable to negative emotional experiences on social media, such as

feeling less than others or feeling excluded. Studies have found that adolescents with elevated depressive symptoms are more likely to report engaging in social media to cope with and regulate emotions (Radovic et al., 2017; Rideout & Fox, 2018). However, seeking out support to manage distress via social media may also expose adolescents to the likelihood of having online experiences to which they experience negative emotional responses. The finding that adolescents with depressive symptoms experience greater negative emotional responses to social media experiences is consistent with prior cross-sectional work (Rideout & Fox, 2018; Rideout & Robb, 2018), and speaks to the importance of identifying those youth who may be especially vulnerable to the risks of social media use. Notably, the reverse direction of effects (i.e., negative emotional responses to social media predicting depressive symptoms) was not significant in the current study ($p = .084$); however, future work should continue to explore possible bidirectional relationships between these variables over longer periods of time.

Gender Differences in Subjective Social Media Experiences

Findings from the current study revealed that girls reported more frequent positive and negative emotional responses to social media compared to boys. This indicates that girls, compared to boys, may be more emotionally sensitive to social media use—experiencing both “higher highs” and “lower lows” when using social media, and emotionally investing more heavily in both positive (e.g., social support) and negative (e.g., social exclusion) events online. These findings are consistent with social role theories (Eagly, 1987), which suggest that girls are socialized to be more attuned and oriented to interpersonal experiences. Findings are also consistent with prior empirical work showing greater emotional sensitivity to both negative social experiences (e.g., stress, rejection; Stroud et al., 2002) and positive social experiences (e.g., social support, positive social evaluation; Rose & Rudolph, 2006) among adolescent girls

compared to boys. Notably, findings suggest differences by gender for those identifying as boys versus girls, rather than by sex. Continued work that clarifies between conceptualizations of gender versus sex, as well as future studies examining adolescents of other gender identifies (e.g., transgender, gender fluid) is needed.

Notably, however, findings did not support gender differences in the association between emotional responses to social media experiences and depressive symptoms. An increasing number of recent studies have found that associations between time spent using social media and depression may be stronger among girls, compared to boys (e.g., Twenge et al., 2020). It may be the case that these prior findings are the result of girls' greater emotional sensitivity or reactivity to social media experiences, rather than the time spent using social media per se, which may explain why gender moderation was not supported in the current study. Notably, findings are consistent with prior studies suggesting that girls place greater importance on social media in their lives generally, and for maintaining friendships specifically (Rideout & Robb, 2018). This may be an extension of traditional gender differences in offline relationships, whereby girls may experience heightened pressure to maintain relationships, with consequences for depression risk (Hankin et al., 2001).

Limitations and Future Directions

The present study has several strengths. First, the sample was large and racially and ethnically diverse. Second, the study was longitudinal, assessing depression and social media experiences at two points in time over the course of one year. Third, this study expands upon prior studies examining the impact of social media on depressive symptoms in adolescents by utilizing a measure of how adolescents emotionally experience social media.

Future research should build on the limitations of this study to advance the field of adolescent social media use and mental health. First, the distinction between actual social media behaviors or experiences (e.g., receiving positive comments) and subjective emotional responses to those experiences (e.g., feeling happy) is difficult to disentangle in a self-report measure. Our measure aims to capture adolescents' emotional responses in the context of social media, with adolescents reporting how frequently they *feel* a certain way when having certain experiences online. However, for some items, this distinction may be blurred: when an adolescent states, in a self-report format, they frequently feel upset about getting too few likes on their posts, this is inherently subjective. Yet it may not be clear whether this is a factual report about their true online experience (getting few likes), or an emotional appraisal of their response to this experience (feeling upset because of the perception of too few likes). Although this measure provides an important first step toward elucidating adolescents' emotional lives online, more research will be needed to clarify these effects. This should include multi-method work, incorporating physiological measures of emotional response to social media stimuli, as well as objective measures of social media engagement.

Furthermore, future research with clinical samples is needed to better understand the implications of social media use for youth with more severe depressive symptoms. More work will also be needed with gender minority adolescents, to further clarify differences in emotional responses to social media by gender. Although participants were able to self-report their gender identity in the current study, limited options were presented (i.e., "male", "female", "other" with option to specify), and no information was collected on gendered role behaviors or gender expression. It is possible that adolescents misinterpreted this question to be asking about sex

assigned at birth, and future studies would benefit from utilizing more comprehensive and inclusive measures of gender identity, roles, and expression.

In addition, nuanced investigations of race and ethnicity, and associated contextual variables (e.g., racial identity, experiences of racism or discrimination), will be needed to examine the role of these factors in associations between social media use and mental health. Finally, in this study social media experiences and depressive symptoms were examined over a period of one year. The measure of depressive symptoms assessed symptoms over the past two weeks, loneliness over the past year, and other variables atemporally. The specific timeframe by which these constructs may influence one another is thus unclear. While depressive symptoms tend to persist over longer periods of time, ranging from a few weeks to years, the degree to which affective responses to social media experiences change over time in adolescents requires further investigation to determine the optimal windows of time to study the relationships between these processes. Understanding how these constructs relate to one another over both shorter (e.g., momentary assessment) and longer (e.g., across adolescent development) periods of time may inform how and when adolescents may be most vulnerable to the impact of social media, and may inform future interventions. It will be critical for future research to build on the current study by examining adolescents' emotional responses to social media over multiple time points, allowing for the disentangling of between and within-person effects and the further exploration of bidirectional effects between these constructs.

Clinical Implications

Nearly 97% of adolescents use some form of social media (Anderson & Jiang, 2018), with many teens reporting use of social media “almost constantly” (Anderson & Jiang, 2018). Given the pervasive presence of social media in adolescents' lives, understanding the ways in

which social media use may heighten depression risk, and which youth are most vulnerable to negative effects, is critical. The current study builds on prior work by highlighting the importance of understanding adolescents' emotional experience of social media use. Findings suggest that it may be of clinical value to assess not only how often adolescents are utilizing social media, but also their perception of both positive and negative emotional experiences on social media. Further, findings indicate that, perhaps counterintuitively, adolescents' reporting heightened emotional responses to positive social media experiences (e.g., feeling happy in response to a positive comment, or feeling supported or encouraged on social media) may be at higher risk for depressive symptoms over time. It may thus be worthwhile for parents, teachers, and clinicians to monitor the extent to which adolescents are emotionally invested and reliant on social media experiences, and to ensure adequate opportunities for in-person socialization. Results also highlight the unique risk that girls and adolescents with depressive symptoms may encounter when using social media; these youth may be especially emotionally sensitive to negative social media experiences, perhaps heightening vulnerability to the maintenance and exacerbation of depressive symptoms over time. Future interventions, particularly those emphasizing the interpersonal nature of depressive symptoms in teens, should aim to support adolescents in monitoring and managing their emotional responses to social media use.

Conclusions

Associations between adolescent social media use and depressive symptoms have been the subject of significant scholarly and public debate. However, prior work has often been limited to cross-sectional studies examining the time adolescents spend online, and has frequently ignored adolescents' emotional experience of social media use. Results of the current study underscore the importance of understanding adolescents' positive and negative emotional

responses to social media use in the context of depressive symptoms, and suggest greater emotional responses to social media experiences among girls compared to boys. It is critical that future research continue to move beyond examinations of overall “screen time,” in order to identify youth who may be most vulnerable to negative effects of social media use.

References

- Aalbers, G., McNally, R. J., Heeren, A., de Wit, S., & Fried, E. I. (2019). Social media and depression symptoms: A network perspective. *Journal of Experimental Psychology: General*, 148(8), 1454–1462. <https://doi.org/10.1037/xge0000528>
- Abramson, L. Y., Metalsky, G. I., & Alloy, L. B. (1989). Hopelessness depression: A theory-based subtype of depression. *Psychological Review*, 96(2), 358–372. <https://doi.org/10.1037/0033-295X.96.2.358>
- Anderson, M., & Jiang, J. (2018). Teens, social media & technology 2018. Pew Research Center, 31, 2018.
- Antheunis, M. L., Valkenburg, P. M., & Peter, J. (2012). The quality of online, offline, and mixed-mode friendships among users of a social networking site. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace*, 6(3), <https://doi.org/10.5817/CP2012-3-6>
- Bauer, D.J. & Curran, P.J. (2019). Structural equation modeling: R demonstration notes (Version 2019.3). Curran-Bauer Analytics, Durham: NC. <https://curranbauer.org/sem-r-notes-2019-3/>
- Beeson, C. M. L., Brittain, H., & Vaillancourt, T. (2020). The Temporal Precedence of Peer Rejection, Rejection Sensitivity, Depression, and Aggression Across Adolescence. *Child Psychiatry & Human Development*. <https://doi.org/10.1007/s10578-020-01008-2>
- Cassidy J, Asher SR. Loneliness and peer relations in young children. *Child Development*. 1992;63:350–365. doi: 10.1111/j.1467-8624.1992.tb01632.x.
- Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural equation modeling: a multidisciplinary journal*, 14(3), 464-504. <https://doi.org/10.1080/10705510701301834>
- Clark, D.A., Beck, A.T., & Alford, B.A. (1999). *Scientific foundations of cognitive theory and therapy of depression* New York: Wiley and Sons.

- Coyne, S. M., Rogers, A. A., Zurcher, J. D., Stockdale, L., & Booth, M. (2020). Does time spent using social media impact mental health?: An eight year longitudinal study. *Computers in Human Behavior, 104*, 106160. <https://doi.org/10.1016/j.chb.2019.106160>
- Dumas, T. M., Maxwell-Smith, M. A., Tremblay, P. F., Litt, D. M., & Ellis, W. (2020). Gaining likes, but at what cost? Longitudinal relations between young adults' deceptive like-seeking on instagram, peer belonging and self-esteem. *Computers in Human Behavior, 112*, 106467. <https://doi.org/10.1016/j.chb.2020.106467>
- Eagly, A. H. (1987). *Sex differences in social behavior: A social-role interpretation*. Lawrence Erlbaum Associates, Inc.
- Ehrenreich, S. E., & Underwood, M. K. (2016). Adolescents' internalizing symptoms as predictors of the content of their Facebook communication and responses received from peers. *Translational Issues in Psychological Science, 2*(3), 227–237. <https://doi.org/10.1037/tps0000077>
- Feinstein, B., Hershenberg, R., Bhatia, V., Latack, J., Meuwly, N., & Davila, J. (2013). Negative Social Comparison on Facebook and Depressive Symptoms: Rumination as a Mechanism. *Psychology of Popular Media Culture, 2*(3), 161–170. <https://doi.org/10.1037/a0033111>
- Frison, E., & Eggermont, S. (2016). Gender and Facebook motives as predictors of specific types of Facebook use: A latent growth curve analysis in adolescence. *Journal of Adolescence, 52*, 182–190. <https://doi.org/10.1016/j.adolescence.2016.08.008>
- Hames, J. L., Hagan, C. R., & Joiner, T. E. (2013). Interpersonal processes in depression. *Annual Review of Clinical Psychology, 9*, 355–377. <https://doi.org/10.1146/annurev-clinpsy-050212-185553>
- Hamilton, J.L., Do, Q.B., Choukas-Bradley, S., Ladouceur, C.D., & Silk, J.S. (2020). Where it hurts the most: Peer interactions on social media and in person are differentially associated with emotional reactivity and sustained affect among adolescent girls. *Research on Child and Adolescent Psychopathology, 1-13*. <https://doi.org/10.1007/s10802-020-00725-5>

- Hammen, C. (2009). Adolescent Depression: Stressful Interpersonal Contexts and Risk for Recurrence. *Current Directions in Psychological Science*, 18(4), 200–204.
<https://doi.org/10.1111/j.1467-8721.2009.01636.x>
- Hankin, B. L., & Abramson, L. Y. (2001). Development of gender differences in depression: An elaborated cognitive vulnerability–transactional stress theory. *Psychological Bulletin*, 127(6), 773–796. <https://doi.org/10.1037/0033-2909.127.6.773>
- Heffer, T., Good, M., Daly, O., MacDonell, E., & Willoughby, T. (2019). The Longitudinal Association Between Social-Media Use and Depressive Symptoms Among Adolescents and Young Adults: An Empirical Reply to Twenge et al. (2018). *Clinical Psychological Science*, 7(3), 462–470. <https://doi.org/10.1177/2167702618812727>
- Herres, J., Ewing, E.S.K. & Kobak, R. Emotional reactivity to negative adult and peer events and the maintenance of adolescent depressive symptoms: A Daily diary design. *Journal of Abnormal Child Psychology*, 44, 471–481 (2016). <https://doi-org./10.1007/s10802-015-0043-6>
- Hunt, M. G., Marx, R., Lipson, C., & Young, J. (2018). No more FOMO: Limiting social media decreases loneliness and depression. *Journal of Social and Clinical Psychology*, 37(10), 751-768.
- Ivie, E. J., Pettitt, A., Moses, L. J., & Allen, N. B. (2020). A meta-analysis of the association between adolescent social media use and depressive symptoms. *Journal of Affective Disorders*, 275, 165–174. <https://doi.org/10.1016/j.jad.2020.06.014>
- Joiner, R., Cuprinskaite, J., Dapkeviciute, L., Johnson, H., Gavin, J., & Brosnan, M. (2016). Gender differences in response to Facebook status updates from same and opposite gender friends. *Computers in Human Behavior*, 58, 407–412.
<https://doi.org/10.1016/j.chb.2016.01.008>
- Joiner, R., Stewart, C., Beaney, C., Moon, A., Maras, P., Guiller, J., Gregory, H., Gavin, J., Cromby, J., & Brosnan, M. (2014). Publically different, privately the same: Gender

- differences and similarities in response to Facebook status updates. *Computers in Human Behavior*, 39, 165–169. <https://doi.org/10.1016/j.chb.2014.07.004>
- Keles, B., McCrae, N., & Grealish, A. (2020). A systematic review: The influence of social media on depression, anxiety and psychological distress in adolescents. *International Journal of Adolescence and Youth*, 25(1), 79–93. <https://doi.org/10.1080/02673843.2019.1590851>
- Krygsman, A., & Vaillancourt, T. (2017). Longitudinal associations between depression symptoms and peer experiences: Evidence of symptoms-driven pathways. *Journal of Applied Developmental Psychology*, 51, 20–34. <https://doi.org/10.1016/j.appdev.2017.05.003>
- Liu, Q.-Q., Zhou, Z.-K., Yang, X.-J., Niu, G.-F., Tian, Y., & Fan, C.-Y. (2017). Upward social comparison on social network sites and depressive symptoms: A moderated mediation model of self-esteem and optimism. *Personality and Individual Differences*, 113, 223–228. <https://doi.org/10.1016/j.paid.2017.03.037>
- Manago, A. M., Ward, L. M., Lemm, K. M., Reed, L., & Seabrook, R. (2015). Facebook involvement, objectified body consciousness, body shame, and sexual assertiveness in college women and men. *Sex Roles: A Journal of Research*, 72(1–2), 1–14. <https://doi.org/10.1007/s11199-014-0441-1>
- Massing-Schaffer, M., Nesi, J., Telzer, E. H., Lindquist, K. A., & Prinstein, M. J. (2020). Adolescent peer experiences and prospective suicidal ideation: the protective role of online-only friendships. *Journal of Clinical Child & Adolescent Psychology*, 1-12. <https://doi.org/10.1080/15374416.2020.1750019>
- Masten, C. L., Eisenberger, N. I., Borofsky, L. A., McNealy, K., Pfeifer, J. H., & Dapretto, M. (2011). Subgenual anterior cingulate responses to peer rejection: A marker of adolescents' risk for depression. *Development and Psychopathology*, 23(1), 283–292. <https://doi.org/10.1017/S0954579410000799>
- McCrae, N., Gettings, S., & Pursell, E. (2017). Social Media and Depressive Symptoms in Childhood and Adolescence: A Systematic Review. *Adolescent Research Review*, 2(4), 315–330. <https://doi.org/10.1007/s40894-017-0053-4>

- Neira, C. J. B., & Barber, B. L. (2014). Social networking site use: Linked to adolescents' social self-concept, self-esteem, and depressed mood. *Australian Journal of Psychology*, *66*(1), 56–64. <https://doi.org/10.1111/ajpy.12034>
- Nesi, J., & Prinstein, M. J. (2015). Using social media for social comparison and feedback-seeking: Gender and popularity moderate associations with depressive symptoms. *Journal of Abnormal Child Psychology*, *43*(8), 1427-1438. <https://doi.org/10.1007/s10802-015-0020-0>
- Nesi, J., Choukas-Bradley, S., & Prinstein, M. J. (2018a). Transformation of Adolescent Peer Relations in the Social Media Context: Part 1—A Theoretical Framework and Application to Dyadic Peer Relationships. *Clinical Child and Family Psychology Review*, *21*(3), 267–294. <https://doi.org/10.1007/s10567-018-0261-x>
- Nesi, J., Choukas-Bradley, S., & Prinstein, M. J. (2018b). Transformation of adolescent peer relations in the social media context: Part 2—application to peer group processes and future directions for research. *Clinical Child and Family Psychology Review*, *21*(3), 295-319. <https://doi.org/10.1007/s10567-018-0262-9>
- Nesi, J., Miller, A. B., & Prinstein, M. J. (2017). Adolescents' Depressive Symptoms and Subsequent Technology-Based Interpersonal Behaviors: A Multi-Wave Study. *Journal of Applied Developmental Psychology*, *51*, 12–19. <https://doi.org/10.1016/j.appdev.2017.02.002>
- Odgers, C. L., & Jensen, M. R. (2020). Annual Research Review: Adolescent mental health in the digital age: facts, fears, and future directions. *Journal of Child Psychology and Psychiatry*, *61*(3), 336–348. <https://doi.org/10.1111/jcpp.13190>
- Orben, A. (2020). Teenagers, screens and social media: A narrative review of reviews and key studies. *Social Psychiatry and Psychiatric Epidemiology*, *55*(4), 407–414. <https://doi.org/10.1007/s00127-019-01825-4>
- Orben, A., & Przybylski, A. K. (2019). The association between adolescent well-being and digital technology use. *Nature Human Behaviour*, *3*(2), 173–182. <https://doi.org/10.1038/s41562-018-0506-1>

- Orben, A., & Przybylski, A. K. (2020). Reply to: Underestimating digital media harm. *Nature Human Behaviour*, 4(4), 349–351. <https://doi.org/10.1038/s41562-020-0840-y>
- Orchard, F., Pass, L., & Reynolds, S. (2016). ‘It Was All My Fault’; Negative Interpretation Bias in Depressed Adolescents. *Journal of Abnormal Child Psychology*, 44(5), 991–998. <https://doi.org/10.1007/s10802-015-0092-x>
- Owens, S.A., Helms, S.W., Rudolph, K.D. et al. Interpersonal stress severity longitudinally predicts adolescent girls’ depressive symptoms: The Moderating role of subjective and HPA axis stress responses. *Journal of Abnormal Child Psychology*, 47, 895–905 (2019). <https://doi.org/10.1007/s10802-018-0483-x>
- Patton, G. C., & Viner, R. (2007). Pubertal transitions in health. *The Lancet*, 369(9567), 1130–1139. [https://doi.org/10.1016/S0140-6736\(07\)60366-3](https://doi.org/10.1016/S0140-6736(07)60366-3)
- Prinstein, M. J., & Aikins, J. W. (2004). Cognitive Moderators of the Longitudinal Association Between Peer Rejection and Adolescent Depressive Symptoms. *Journal of Abnormal Child Psychology*, 32(2), 147–158. <https://doi.org/10.1023/B:JACP.0000019767.55592.63>
- Prinstein, M. J., Borelli, J. L., Cheah, C. S. L., Simon, V. A., & Aikins, J. W. (2005). Adolescent Girls’ Interpersonal Vulnerability to Depressive Symptoms: A Longitudinal Examination of Reassurance-Seeking and Peer Relationships. *Journal of Abnormal Psychology*, 114(4), 676–688. <https://doi.org/10.1037/0021-843X.114.4.676>
- Prinstein, M. J., Nesi, J., & Telzer, E. H. (2020). Commentary: An updated agenda for the study of digital media use and adolescent development – future directions following Odgers & Jensen (2020). *Journal of Child Psychology and Psychiatry*, 61(3), 349–352. <https://doi.org/10.1111/jcpp.13219>
- Radovic, A., Gmelin, T., Stein, B. D., & Miller, E. (2017). Depressed adolescents’ positive and negative use of social media. *Journal of Adolescence*, 55, 5–15. <https://doi.org/10.1016/j.adolescence.2016.12.002>
- Rideout, V., & Fox, S. (2018). Digital Health Practices, Social Media Use, and Mental Well-Being Among Teens and Young Adults in the U.S. San Francisco, CA: Hopelab.

- Rideout, V., & Robb, M. B. (2018). *Social media, social life: Teens reveal their experiences*. San Francisco, CA: Common Sense Media.
- Rose, A. J., Carlson, W., & Waller, E. M. (2007). Prospective associations of co-rumination with friendship and emotional adjustment: considering the socioemotional trade-offs of co-rumination. *Developmental Psychology*, 43(4), 1019–1031. <https://doi.org/10.1037/0012-1649.43.4.1019>
- Rudolph, K. D. (2009). The interpersonal context of adolescent depression. In *Handbook of depression in adolescents* (pp. 377–418). Routledge/Taylor & Francis Group.
- Robinson, A., Bonnette, A., Howard, K., Ceballos, N., Dailey, S., Lu, Y., & Grimes, T. (2019). Social comparisons, social media addiction, and social interaction: An examination of specific social media behaviors related to major depressive disorder in a millennial population. *Journal of Applied Biobehavioral Research*, 24(1), e12158. <https://doi.org/10.1111/jabr.12158>
- Rose, A. J., & Rudolph, K. D. (2006). A review of sex differences in peer relationship processes: potential trade-offs for the emotional and behavioral development of girls and boys. *Psychological Bulletin*, 132(1), 98. <https://doi.org/10.1037/0033-2909.132.1.98>
- Sarmiento, I. G., Olson, C., Yeo, G., Chen, Y. A., Toma, C. L., Brown, B. B., ... & Mares, M. L. (2018). How does social media use relate to adolescents' internalizing symptoms? Conclusions from a systematic narrative review. *Adolescent Research Review*, 1-24. <https://doi.org/10.1007/s40894-018-0095-2>
- Silk, J. S., Davis, S., McMakin, D. L., Dahl, R. E., & Forbes, E. E. (2012). Why Do Anxious Children Become Depressed Teenagers?: The Role of Social Evaluative Threat and Reward Processing. *Psychological Medicine*, 42(10), 2095–2107. <https://doi.org/10.1017/S0033291712000207>
- Starr, L. R., & Davila, J. (2008). Differentiating interpersonal correlates of depressive symptoms and social anxiety in adolescence: Implications for models of comorbidity. *Journal of*

Clinical Child & Adolescent Psychology, 37(2), 337-349.

<https://doi.org/10.1080/15374410801955854>

Steinberg, L. (2005). Cognitive and affective development in adolescence. *Trends in Cognitive Sciences*, 9(2), 69–74. <https://doi.org/10.1016/j.tics.2004.12.005>

Stroud, L. R., Salovey, P., & Epel, E. S. (2002). Sex differences in stress responses: Social rejection versus achievement stress. *Biological Psychiatry*, 52(4), 318–327.

[https://doi.org/10.1016/S0006-3223\(02\)01333-1](https://doi.org/10.1016/S0006-3223(02)01333-1)

Turner, N., Joinson, C., Peters, T. J., Wiles, N., & Lewis, G. (2014). Validity of the Short Mood and Feelings Questionnaire in late adolescence. *Psychological Assessment*, 26(3), 752–762.

<https://doi-org.proxy.lib.duke.edu/10.1037/a0036572.supp>

Twenge, J. M., Joiner, T. E., Rogers, M. L., & Martin, G. N. (2018). Increases in depressive symptoms, suicide-related outcomes, and suicide rates among US adolescents after 2010 and links to increased new media screen time. *Clinical Psychological Science*, 6(1), 3-17.

<https://doi.org/10.1177/2167702617723376>

Twenge, J. M., Cooper, A. B., Joiner, T. E., Duffy, M. E., & Binau, S. G. (2019). Age, period, and cohort trends in mood disorder indicators and suicide-related outcomes in a nationally representative dataset, 2005–2017. *Journal of Abnormal Psychology*, 128(3), 185–199.

<https://doi.org/10.1037/abn0000410>

Twenge, J. M., Haidt, J., Joiner, T. E., & Campbell, W. K. (2020). Underestimating digital media harm. *Nature Human Behaviour*, 4(4), 346–348. <https://doi.org/10.1038/s41562-020-0839-4>

Twenge, J. M., & Martin, G. N. (2020). Gender differences in associations between digital media use and psychological well-being: Evidence from three large datasets. *Journal of Adolescence*, 79, 91–102.

<https://doi.org/10.1016/j.adolescence.2019.12.018>

Valkenburg, P. M., & Peter, J. (2013). The Differential Susceptibility to Media Effects Model: Differential Susceptibility to Media Effects Model. *Journal of Communication*, 63(2), 221–

243. <https://doi.org/10.1111/jcom.12024>

- Vanhalst, J., Gibb, B. E., & Prinstein, M. J. (2017). Lonely adolescents exhibit heightened sensitivity for facial cues of emotion. *Cognition & Emotion*, 31(2), 377–383. <https://doi.org/10.1080/02699931.2015.1092420>
- Vernon, L., Modecki, K. L., & Barber, B. L. (2017). Tracking effects of problematic social networking on adolescent psychopathology: The mediating role of sleep disruptions. *Journal of Clinical Child and Adolescent Psychology*, 46(2), 269–283. <https://doi-org.proxy.lib.duke.edu/10.1080/15374416.2016.1188702>
- Werner-Seidler, A., Afzali, M. H., Chapman, C., Sunderland, M., & Slade, T. (2017). The relationship between social support networks and depression in the 2007 National Survey of Mental Health and Well-being. *Social Psychiatry and Psychiatric Epidemiology*, 52(12), 1463–1473. <https://doi.org/10.1007/s00127-017-1440-7>
- Ybarra, M. L., Alexander, C., & Mitchell, K. J. (2005). Depressive symptomatology, youth Internet use, and online interactions: A national survey. *Journal of Adolescent Health*, 36(1), 9–18. <https://doi.org/10.1016/j.jadohealth.2003.10.012>
- Young, J. F., Mufson, L., & Schueler, C. M. (2016). *Preventing adolescent depression: Interpersonal psychotherapy-adolescent skills training*. Oxford University Press.
- Zimmer-Gembeck, M. J., Hawes, T., & Pariz, J. (2020). A closer look at appearance and social media: Measuring activity, self-presentation, and social comparison and their associations with emotional adjustment. *Psychology of Popular Media*. <https://doi.org/10.1037/ppm0000277>

Table 1

Emotional responses to social media experiences items and factor loadings

	Positive Emotional Responses to SM	Negative Emotional Responses to SM
1. ...feel you can express yourself creatively	0.72	
2. ...feel hurt by a negative comment from someone		0.78
3. ...feel more connected with your friends	0.86	
4. ...feel less alone	0.66	
5. ...feel left out or excluded		0.71
6. ...feel supported and encouraged by your friends	0.88	
7. ...feel bad about getting too few likes or comments on your posts/photos		0.74
8. ...feel pressure to show the best version of yourself		0.64
9. ...feel happy because of a positive comment from someone	0.69	
10. ...feel like other people are doing better than you		0.73

Note: SM = Social Media. Items were rated in response to the question “When you use social media, how often do you...?” and rated on a 5-point Likert scale (*1 = Never, 5 = Always*). Factor loadings refer to results of the Exploratory Factor Analysis conducted for the scale at Time 1.

Table 2

Descriptive statistics and gender comparisons for study variables

	Full Sample <i>M (SD)</i>	Girls <i>M (SD)</i>	Boys <i>M (SD)</i>	<i>t(df)</i>	1	2	3	4	5	6	7	8	9
1. T1 Positive Emotional Responses to SM	2.90 (1.14)	3.12 (1.09)	2.69 (1.15)	5.07(681.0) ^{***}	--								
2. T1 Negative Emotional Responses to SM	1.88 (0.89)	1.97 (0.87)	1.80 (0.90)	2.47(681) [*]	.44 ^{**}	--							
3. T2 Positive Emotional Responses to SM	3.39 (0.89)	3.54 (0.80)	3.25 (0.95)	4.04(572.0) ^{***}	.44 ^{**}	.23 ^{**}	--						
4. T2 Negative Emotional Responses to SM	1.93 (0.79)	2.09 (0.82)	1.78 (0.74)	4.80(581) ^{***}	.24 ^{**}	.46 ^{**}	.30 ^{**}	--					
5. T1 Depressive Symptoms	0.38 (0.48)	0.46 (0.51)	0.30 (0.44)	4.38(659.2) ^{***}	.14 ^{**}	.31 ^{**}	.07	.28 ^{**}	--				
6. T2 Depressive Symptoms	0.36 (0.47)	0.44 (0.51)	0.28 (0.42)	4.06(552.3) ^{***}	.17 ^{**}	.21 ^{**}	.13 ^{**}	.39 ^{**}	.42 ^{**}	--			
7. T1 Emotional Reactivity	1.17 (0.99)	1.42 (1.03)	0.92 (0.90)	6.73(661.3) ^{***}	.35 ^{**}	.46 ^{**}	.23 ^{**}	.36 ^{**}	.48 ^{**}	.32 ^{**}	--		
8. T1 Loneliness	2.09 (1.07)	2.31 (1.11)	1.87 (0.99)	5.37(663.6) ^{***}	.21 ^{**}	.34 ^{**}	.11 ^{**}	.33 ^{**}	.75 ^{**}	.41 ^{**}	.52 ^{**}	--	
9. T1 SM Use Frequency	6.01 (2.44)	6.31 (2.24)	5.77 (2.56)	2.91(675.5) ^{**}	.14 ^{**}	.15 ^{**}	.06	.13 ^{**}	.01	.02	.03	.00	--
10. T2 SM Use Frequency	6.47 (1.83)	6.75 (1.70)	6.21 (1.91)	3.61(578.6) ^{***}	.17 ^{**}	.22 ^{**}	.29 ^{**}	.21 ^{**}	.03	.05	.10 [*]	.04	.47 ^{**}

For T1: total $N = 687$, girls $n = 334$, boys $n = 349$; For T2: total $N = 585$; girls $n = 285$, boys $n = 298$; N varies slightly across comparisons due to missing data on some variables; SM = Social media;

Table 3a. Invariance testing by gender groups and time points for the full social media scale

<i>Social Media Scale - Invariance Across Time Points</i>							<i>Model Fit Comparisons</i>							
Model	χ^2	df	CFI	TLI	RMSEA	SRMR	Comparisons	$\Delta\chi^2$	Δdf	p	ΔCFI	ΔTLI	$\Delta RMSEA$	$\Delta SRMR$
M1: Configural	635.9	164	0.918	0.905	0.065	0.057								
M2: Metric	644.39	172	0.918	0.909	0.063	0.058	M2 vs. M1	8.49	8	.387	0.000	0.004	-0.002	0.001
M3: Scalar	701.76	180	0.909	0.904	0.065	0.06	M3 vs. M2	57.37	8	.000	-0.009	-0.005	0.002	0.002
<i>Social Media Scale (Time 1 and Time 2) - Invariance by Gender</i>							<i>Model Fit Comparisons</i>							
Model	χ^2	df	CFI	TLI	RMSEA	SRMR	Comparisons	$\Delta\chi^2$	Δdf	p	ΔCFI	ΔTLI	$\Delta RMSEA$	$\Delta SRMR$
M1: Configural	824.06	328	0.912	0.898	0.067	0.063								
M2: Metric	847.23	344	0.911	0.901	0.065	0.067	M2 vs. M1	23.17	16	.109	-0.001	0.003	-0.002	0.004
M3: Scalar	899.617	360	0.904	0.899	0.066	0.068	M3 vs. M2	52.39	16	.000	-0.007	-0.002	0.001	0.001
<i>Depression and Social Media Scales - Invariance Across Time Points</i>							<i>Model Fit Comparisons</i>							
Model	χ^2	df	CFI	TLI	RMSEA	SRMR	Comparisons	$\Delta\chi^2$	Δdf	p	ΔCFI	ΔTLI	$\Delta RMSEA$	$\Delta SRMR$
M1: Configural	1673.37	650	0.923	0.916	0.048	0.051								
M2: Metric	1700.29	666	0.922	0.917	0.048	0.051	M2 vs. M1	26.92	16	.042	-0.001	0.001	0.000	0.000
M3: Scalar	1783.57	682	0.917	0.914	0.048	0.052	M3 vs. M2	83.28	16	.000	-0.005	-0.003	0.000	0.001

Table 3b. Invariance testing by gender groups for positive and negative social media subscales

<i>Positive SM and Depression Scales (Time 1 and 2) - Invariance by Gender</i>							<i>Model Fit Comparisons</i>							
Model	χ^2	df	CFI	TLI	RMSEA	SRMR	Comparisons	$\Delta\chi^2$	Δdf	p	ΔCFI	ΔTLI	$\Delta RMSEA$	$\Delta SRMR$
M1: Configural	1498.49	738	0.924	0.922	0.055	0.06								
M2: Metric	1542.73	750	0.921	0.92	0.056	0.062	M2 vs. M1	44.24	12	.000	-0.003	-0.002	0.001	0.002
M3: Scalar	1610.23	762	0.915	0.916	0.057	0.064	M3 vs. M2	67.50	12	.000	-0.006	-0.004	0.001	0.002
<i>Negative SM and Depression Scales (Time 1 and 2) - Invariance by Gender</i>							<i>Model Fit Comparisons</i>							
Model	χ^2	df	CFI	TLI	RMSEA	SRMR	Comparisons	$\Delta\chi^2$	Δdf	p	ΔCFI	ΔTLI	$\Delta RMSEA$	$\Delta SRMR$
M1: Configural	1632.47	738	0.91	0.908	0.06	0.053								
M2: Metric	1681.14	750	0.906	0.906	0.06	0.056	M2 vs. M1	48.67	12	.000	-0.004	-0.002	0.000	0.003
M3: Scalar	1727.25	762	0.903	0.904	0.061	0.056	M3 vs. M2	46.11	12	.000	-0.003	-0.002	0.001	0.000

Note: SM = social media; χ^2 = chi-square; df = degrees of freedom; CFI = Comparative Fit Index; TLI = Tucker Lewis Index; RMSEA = Root Mean Square Error of Approximation; SRMR = Standardized Root Mean Square Residual; Δ = change in parameter. Model 1 (M1) = baseline model (without invariance); Model 2 (M2) = invariant factor loadings; Model 3 (M3) = invariant factor loadings and item intercepts

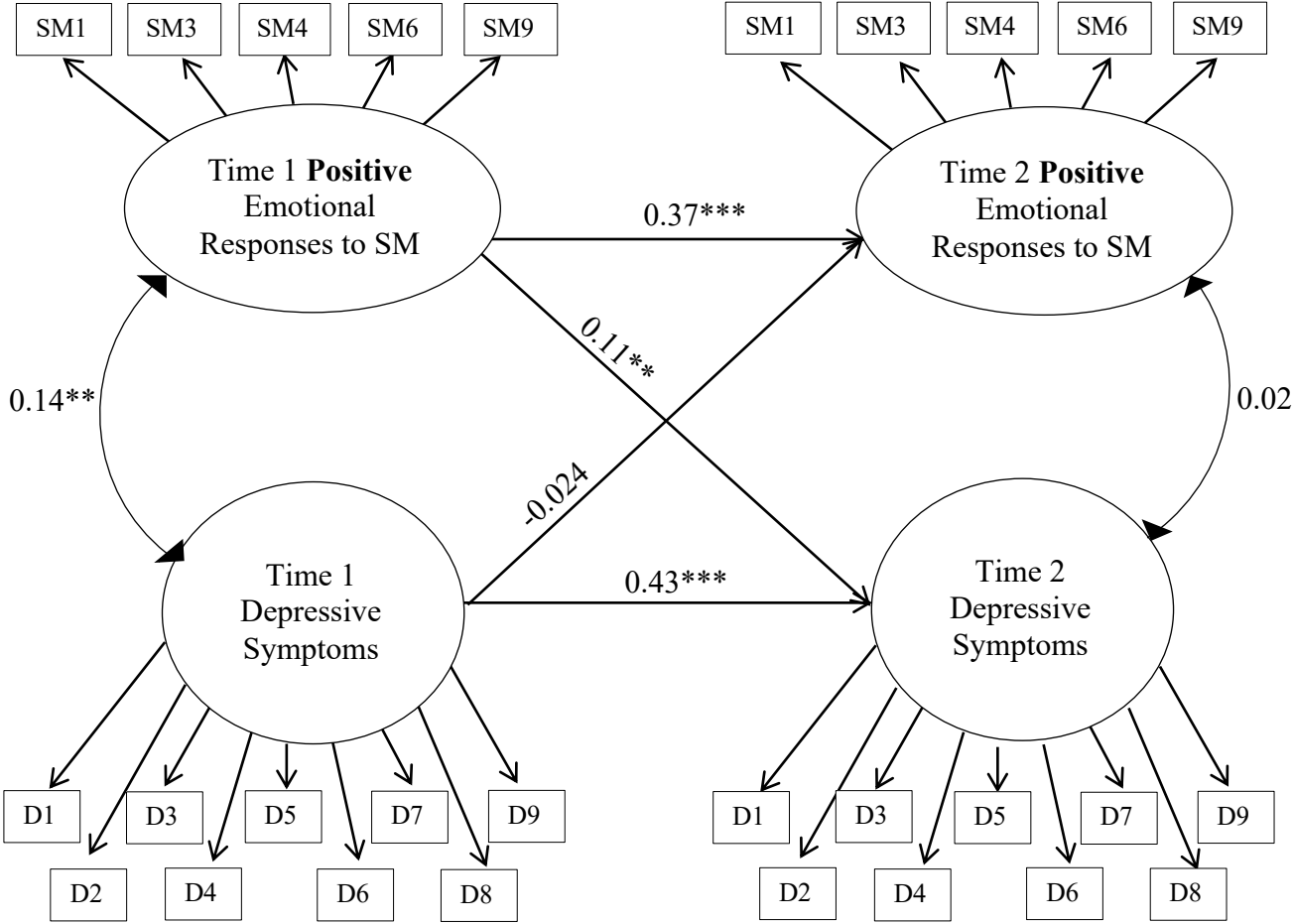


Figure 1. Cross-lagged panel model for longitudinal associations between positive emotional responses to social media experiences and depressive symptoms. Factor loadings and item intercepts set equal across time points for model parsimony; SM = Social Media.

* $p < .05$, ** $p < .01$, *** $p < .001$

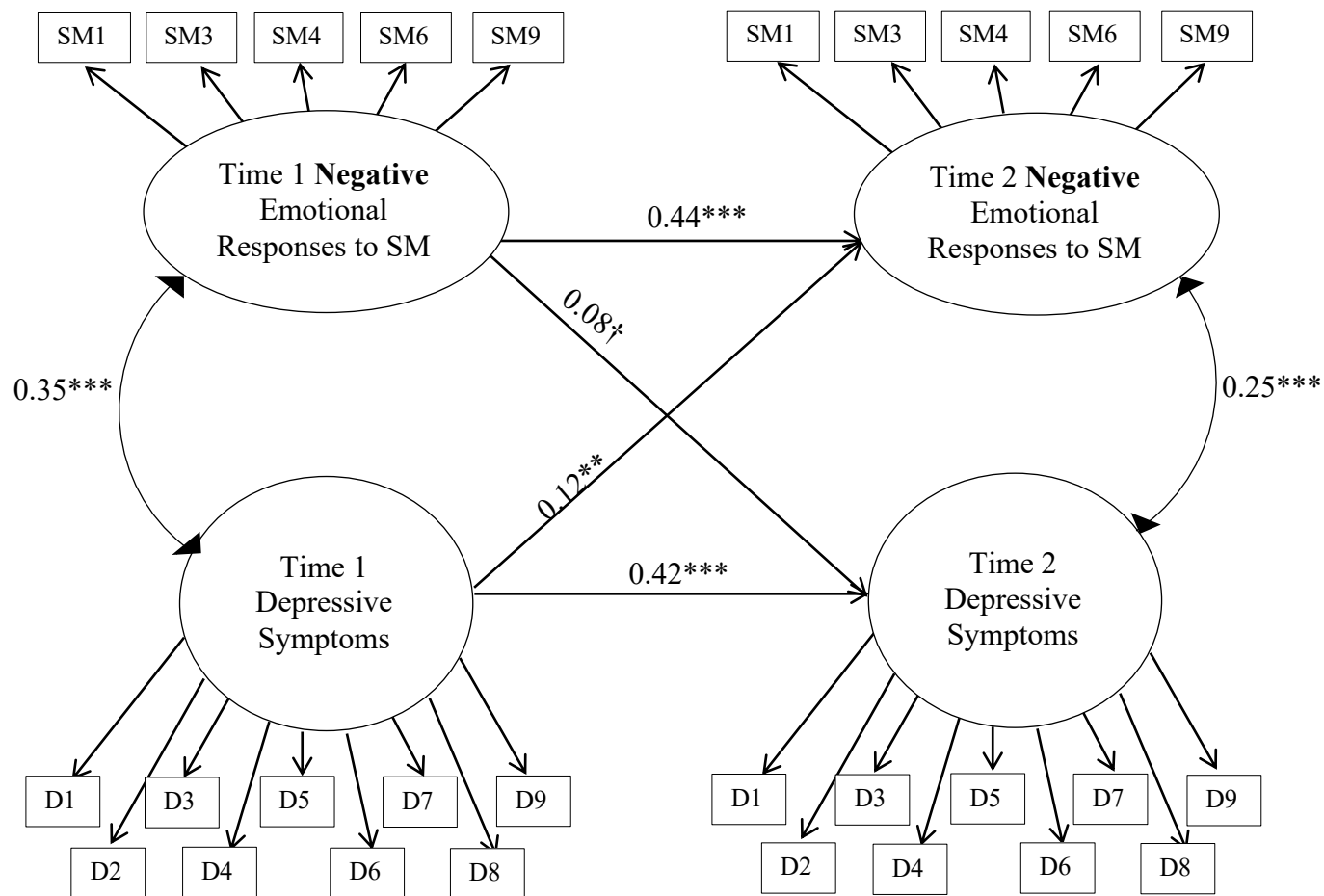


Figure 2. Cross-lagged panel model for the association between negative emotional responses to social media experiences and depressive symptoms. Factor loadings and item intercepts set equal across time points for model parsimony.

† $p = .084$; * $p < .05$, ** $p < .01$, *** $p < .05$

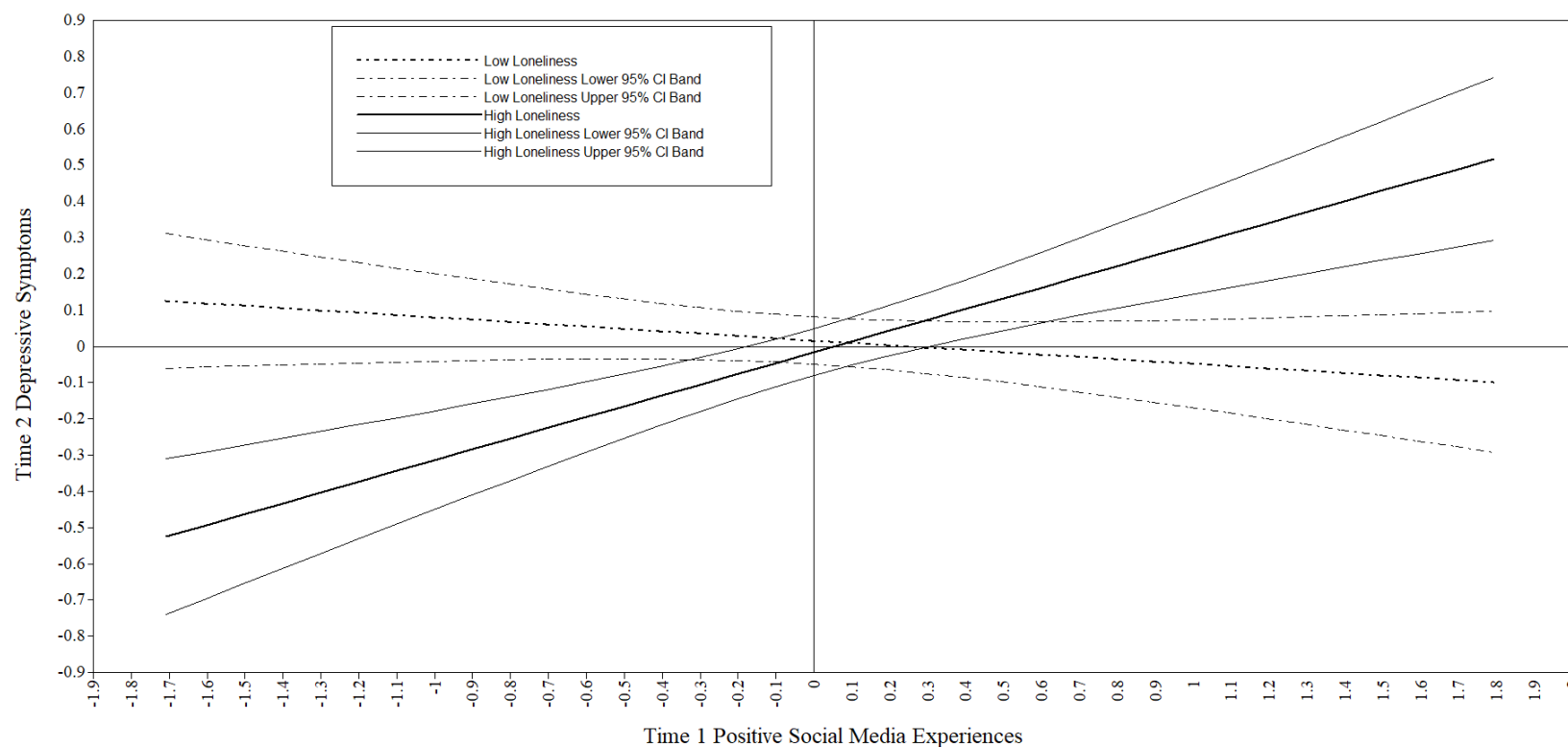


Figure 3. Plot of the moderating effect of T1 loneliness on the association between T1 positive emotional responses to social media experiences and T2 depressive symptoms. Association between T1 positive emotional responses to social media and T2 depressive symptoms is plotted at 1 standard deviation below average loneliness (“Low Loneliness”) and 1 standard deviation above (“High Loneliness”). “Lower 95% CI Band” and “Upper 95% CI Band” represent upper and lower bounds of estimated 95% Confidence Intervals. Plot of associations at average levels of loneliness are not depicted here to ensure readability.