

**Momentary Links Between Adolescents' Social Media Use  
and Social Experiences and Motivations: Individual Differences by Peer Susceptibility**

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## Abstract

This longitudinal ecological momentary assessment study examined whether adolescents' use of social media to interact with peers relates to their experiences of social connectedness, social craving, and sensation seeking on an hourly level. The sample was 212 adolescents in the southeastern United States ( $M_{\text{age}} = 15$  years; range 14 to 17; 56.2% Female; 40% White, 28% Latinx, 26% African American, 15% Mixed/Other Race). Further, we investigated whether these associations differ for adolescents who were nominated by their peers as more or less susceptible to social influences, because highly susceptible youth may be more strongly impacted by social media due to heightened focus on peer behaviors and social feedback. Controlling for both daily and between-subject effects, we found a consistent pattern of hourly-level results that were robust to sensitivity analyses. When highly susceptible adolescents used social media to interact with peers in the last hour, they felt less socially connected to others and more strongly craved social connections and novel sensations. Youth who are particularly sensitive to social input from peers may feel less connected to others and crave more connections and exciting stimuli within one hour after using social media to interact with peers.

*Public significance statement:* When highly susceptible adolescents used social media to interact with peers in the last hour, they felt less socially connected to others and more strongly craved social connections and novel sensations. Youth who are particularly sensitive to social input from peers may feel less connected to others and crave more connections and exciting stimuli within one hour after using social media to interact with peers. Findings inform efforts to promote youths' wellbeing in the context of increasing online exposures.

*Keywords:* Social media, social connection, social craving, sensation seeking, peer susceptibility, ecological momentary assessments

## **Momentary Links Between Adolescents' Social Media Use and Social Experiences and Motivations: Individual Differences by Peer Susceptibility**

Adolescents' use of social media (e.g., Tik-Tok, Twitter, Instagram) has dramatically increased in the past 20 years (Auxier & Anderson, 2021). Today in the United States, 95% of 13- to 17-year-olds own a smartphone, and 45% are online almost constantly (Rideout & Robb, 2018). Given that social media is used frequently for connecting with peers and seeking novel stimuli (Rideout & Robb, 2018), social media likely impacts adolescents' social experiences and motivations. In this longitudinal, multi-method study, we investigated how adolescents feel proximally in the moments after using social media. Specifically, we conducted ecological momentary assessments across 2 weeks. We tested whether adolescents' use of social media to interact with peers in daily, real-world settings relates to their feelings of social connectedness, social craving, and sensation seeking in the same hour. Moreover, we examined whether these hourly associations differed for adolescents who were nominated by their peers as more or less susceptible to social influences. The findings help to elucidate how adolescents feel in the moment after using social media to interact with peers, and whether some adolescents are particularly sensitive to social media use with peers compared to others.

### **Social Media and Adolescents' Social Adjustment**

Social media is an increasingly pervasive feature of adolescents' daily lives. Social media use refers to interactions and communications which occur online digitally via TikTok, Twitter, Instagram, Snapchat, Facebook, and other platforms. Many adolescents use social media throughout the day to interact with their peers (Rideout & Robb, 2018). Adolescents use social media to exchange information and ideas with their peers, ranging from short, light-hearted chats to ongoing efforts for social justice (Rideout & Robb, 2018; Armstrong-Carter & Telzer, 2021).

Adolescents also use social media to maintain social relationships, learn information about peers, friends, and partners, expand their peer networks, and seek and view novel social information (Lenhart et al., 2015).

The prevalence and ongoing nature of adolescents' social media use have raised important questions about how social media impacts adolescents' social relationships and experiences. In particular, there is growing public concern that social media use may be driven by, and negatively affecting youth's social and emotional wellbeing. Adolescents often use social media to engage in social comparison with peers (Nesi & Prinstein, 2015), which can be taxing emotionally. Many adolescents feel stress about their online interactions and social networks (Hall et al., 2021; Nick et al., 2021), fear missing out, feel relational pressures, and are concerned that others will judge their online behavior (Hall et al., 2021; Steele et al., 2020; Weinstein et al., 2016). Adolescents who feel more stress about social media interactions report greater fears of social rejection (Nick et al., 2021). Because social media is frequently used for connecting with peers and viewing new, interesting stimuli (Rideout & Robb, 2018), social media use with peers may be related to adolescents' feelings of social connectedness, craving, and sensation seeking (e.g., Pouwels et al., 2021).

### **Social Connectedness, Social Craving, and Sensation Seeking**

Social connectedness is the extent to which individuals feel that they are emotionally distant or close with others in their lives (e.g., friends, partners, family), and feel a sense of belonging, intimacy, and mutual support (Lee & Robbins, 1995). Social connectedness is an integral feature of positive youth development (Barber & Schluterman, 2008; Stoddard et al., 2011; Uchino et al., 1996), and is particularly important during adolescence – a period of identity formation, increased social learning, and valuing of peers and peer relationships (Dahl et al.,

2018). Youth who feel a greater sense of connection to others experience higher levels of life satisfaction, and better mental and physical health (Beam et al., 2002; DuBois & Silverthorn, 2005; Hawkins et al., 1999; Zimmerman et al., 2002). In Canada, middle school and high school students who used social media for more than two hours per day reported lower feelings of social connectedness toward their school community and peers (Sampasa-Kanyinga et al., 2019). At the same time, however, high school students who used social media for only two hours or less per day reported greater feelings of school connectedness. That study suggested that moderate levels of social media use may promote positive feelings of social connectedness (Sampasa-Kanyinga et al., 2019). Young adults in China who owned more social media accounts and used social media for longer also reported higher levels of social connectedness (Lukindo, 2016). In another study of Chinese middle schoolers, smartphone addiction was not correlated with perceived social connections (Wang et al., 2018). These mixed cross-sectional, between-subject findings highlight a need to further investigate the association between adolescents' social media use and feelings of social connectedness in a robust within-subjects design. Within-subjects designs offer more robust evidence because they hold constant a myriad of potentially confounding characteristics that differ between youth (e.g., personality, family environment). Only one known study has used ecological momentary assessments and a within-person design (Pouwels et al., 2021) - when adolescents spent more time on WhatsApp and Instagram in the past hour, they felt less close to their friends.

Social craving is closely related to social connectedness, but represents more specifically the yearning or desire for more social connections than the adolescent is already experiencing (Tomova et al., 2020). As such, social craving is also linked closely with feelings of loneliness or social isolation (Tomova et al., 2020). Like social connectedness, social craving is particularly

salient during adolescence, when youth are motivated strongly toward social learning and peer interactions (Dahl et al., 2018). However, no known studies have examined specifically how adolescents' use of social media relates to their feelings of social craving. A few related studies have shown that social media use is correlated positively with feelings of loneliness and fear of missing out on social interactions (e.g., Barry et al., 2017; Pittman & Reich, 2016). In the US, adolescents who owned more social media accounts felt lonelier and feared more strongly that they would miss out on activities with their peers (Barry et al., 2017). Similarly, older adolescents who spent more time on social media (assessed via objective screenshots of cell phones) felt lonelier and feared missing peer activities (Fumagalli et al., 2021). In another study, adolescents who more frequently used image-based social media (e.g., Instagram or Snapchat) but not text-based social media (e.g., Twitter) also felt lonelier compared to their peers (Pittman & Reich, 2016). Together, these studies suggest that social media use may be linked to craving social interactions. However, prior studies have only measured related outcomes such as loneliness and fear of missing out, and have focused on between-subject designs that could be confounded by intra-individual differences. More within-subjects research can offer greater temporal specificity and clarify how using social media relates to adolescents' feelings of social craving in the moment.

Sensation seeking is another feature of adolescents' experiences that may be impacted by using social media with peers. Sensation seeking is the motivation and drive to pursue experiences that are rewarding, new, novel, intense or exciting (Jensen et al., 2011). Sensation seeking is particularly salient during adolescence when social, neural, and hormonal changes increase youths' motivation towards exploring novel stimuli and taking risks (Dahl et al., 2018). Using social media may increase sensation seeking by offering adolescents opportunities to

engage in exciting communications with friends and peers. Further, social media offers adolescents opportunities to view novel and interesting stimuli such as videos, tweets, and images – which could leave them wanting more stimulation. Indeed, several cross-sectional studies suggest that adolescents’ social media use is positively correlated with sensation-seeking tendencies and closely related behaviors such as risk-taking (although see also Murphy, 2004; Weisskirch & Yoon et al., 2021). In a recent meta-analysis, social media use was positively associated with engagement in risky substance use and sexual behaviors (Vannucci et al., 2020). In empirical studies of college students and emerging adults, social media and internet dependency were related to greater sensation seeking (Rahmani & Lavasani, 2011; Shi et al., 2011; Weisskirch & Murphy, 2004), disinhibition, and tendencies towards boredom (Velezmoro et al., 2010). Similarly, high school and middle school students who spent more time on smartphones or felt dependent on the internet reported higher levels of sensation seeking and disinhibition compared to those who engaged less frequently with these technologies (Lin & Tsai, 2002; Wang et al., 2018). Longitudinal within-subject research designs can build on these prior between-subject analyses and clarify the extent to which social media use is correlated with sensation seeking within individuals and within short time periods. Importantly, adolescents’ use of social media is likely related to their social experiences and motivations via bidirectional processes. Via one pathway, youth who feel more connected or crave more social interactions or novel sensations may use social media more frequently to satisfy these motivations. Via the opposite directionality, using social media could also either increase or decrease youths’ feelings of social connectedness, social craving and sensation seeking, based on their experiences online.

### **Individual Differences by Susceptibility to Peer Influences**

Social media does not impact all adolescents uniformly; it may be relatively more or less beneficial for some adolescents compared to others (Beyens et al., 2020; Valkenburg & Peter, 2013). One possibility is that adolescents who are more susceptible to peer influences are particularly impacted by their interactions with peers on social media, compared to those who are less susceptible. Adolescents who are highly susceptible strongly value and focus on peers' social feedback, actions and behaviors, and are more concerned and sensitive to potential social rejections and rewards (Nesi et al., 2018). This perceived importance of peers could cause highly susceptible adolescents to crave social interactions more, feel less connected, and report greater sensation seeking after they have interacted with peers on social media. Some prior research supports this hypothesis that social media use with peers is more strongly correlated with adjustment difficulties among youth who are highly susceptible to peer influences. However, prior research has focused primarily on risk-taking behavior. For instance, one study exposed adolescent boys to deviant and risky peer behaviors via an online chatroom (e.g., fighting, stealing) and found that only those who were highly susceptible to peer influences displayed higher levels of deviant behavior 18 months later (Prinstein et al., 2011). In another study, adolescents were exposed to alcohol-related content via an online chatroom (Teunissen et al., 2016). Only those who identified as highly susceptible to peer influences showed an increase in alcohol consumption tendencies (Teunissen et al., 2016). To extend this work that focused on the emergence of risk-taking behavior, it is important to examine whether youth who are highly susceptible to peer experiences also differ in their social experiences and motivations after using social media to interact with peers. Such research may help to reveal important individual differences in how social media impacts youth. For instance, if highly susceptible youth feel a strong sense of social craving and sensation seeking after using social media to interact with



peers, this could explain why they displayed higher levels of risk-taking behavior in prior research.

### **Current study**

This longitudinal study addressed the research questions: (1) Is adolescents' use of social media to interact with peers in the last hour related to their feelings of social connectedness, social craving, and sensation seeking? (2) Does the hourly link between social media use with peers and feelings of social connectedness, social craving, and sensation seeking differ for adolescents who are nominated by their peers as more or less susceptible to peer influences? For the first research question, we had two conflicting hypotheses. On the one hand, social media provides opportunities for youth to connect with their peers, receive social support (Anderson & Jiang, 2018; Ybarra et al., 2015), and satisfy motivations for interesting and stimulating interactions (Rideout & Robb, 2018). So, after using social media to interact with peers, adolescents may feel more connected and crave fewer social connections and novel stimuli. On the other hand, if social interactions online are stressful or superficial, interacting with peers over social media may make youth feel less connected to their peers, and crave more social connections and novel sensations. For the second research question, we expected that social media use to interact with peers would relate to social connectedness, social craving, and sensation seeking particularly strongly among adolescents who were highly susceptible to peer influences, due to their sensitivity to social feedback and rewards from peers.

To test these hypotheses, we drew on a diverse sample of adolescents from a rural low-income community. Adolescents completed ecological momentary assessments three times per day for fourteen days. Ecological momentary assessments offer a unique advantage because they can elucidate how adolescents feel immediately after using social media in real-time. Via

ecological momentary assessments, adolescents can report several times within a single day whether they have been using social media in the last hour, and how they feel in the current moment. This approach even minimizes some of the limitations of daily diary studies in which adolescents report their experiences at the end of the day (e.g., retrospective bias, lack of temporal specificity within days). It also mitigates the potential confounders from between-subject analyses.

We focused on how adolescents use social media to interact with peers (e.g., friends and partners), given the importance of social and peer influences during adolescence (Dahl et al., 2018). Adolescents reported whether they used any type of social media to interact with peers (i.e., friends and partners) during the past hour. In addition, we employed a rigorous peer-nomination approach to measure peer susceptibility, via sociometric nominations of participants administered to all consented classmates in their school grade. Peer susceptibility is notoriously difficult to measure, and this peer-nomination approach minimized potential bias compared to adolescents' self-reports because adolescents tend to underestimate their susceptibility (Prinstein & Giletta, 2020). It also minimized bias compared to adult reporters, because parents and teachers tend not to have a complete insight into adolescents' experiences and perceptions of their peers (Prinstein & Giletta, 2020). We conducted three-level mixed effect modeling in a within-subject design, to isolate the unique hourly associations between social media use and adolescents' feelings, controlling for both daily and between-subject effects. Via this robust, multi-method design, our study sheds light on how adolescents' social media use predicts their social experiences and motivations in the moments shortly afterward, and whether some adolescents are particularly sensitive to the effects of social media compared to others (i.e., using cross-level interactions).

## Methods

### Participants

Participants were 212 adolescents in the 10<sup>th</sup> and 11<sup>th</sup> grades in the U.S. rural southeast ( $M_{\text{age}} = 15$  years;  $SD = 0.66$ , range 14 to 17; 56.2% female). The sample was racially and ethnically diverse (40% White, 28% Latinx, 26% African American, 15% Mixed/Other Race). On average, participants came from families with low socio-economic status; median household income was low ( $M = \$45,239$ ,  $SD = \$15,353$ ,  $Min = \$15,714$ ;  $Max = \$77,313$ ).

### Procedures

Participants were recruited from a larger longitudinal study that was administered in four waves across four school years ( $N = 922$  consented,  $N = 873$  provided data first wave,  $N = 687$  provided data at the fourth wave). The current study uses data that were collected over the course of two years in waves three and four. During the third and fourth years of the longitudinal study, participants in the full study reported their peers' levels of susceptibility to peer influences via sociometric nominations. During the fourth year of the longitudinal study, the ecological momentary assessments (EMAs) were collected virtually over the course of two weeks. This was from May to September 2020, during the COVID-19 pandemic. Specifically, during the fourth wave of the study, 338 participants were contacted (based on providing contact information and permission to be contacted for future studies) and 213 participants volunteered to participate in the follow-up ecological momentary assessment study. Caregivers of participants were contacted virtually via email, text, and/or phone and invited to have their child participate. One participant was excluded from the analysis because they did not complete any surveys but had registered for the study. This yielded a final analytical sample of 212 participants. Caregivers and adolescents

consented online. Participants were compensated \$50 for completing at least 70% of the surveys, \$35 for completing 50-70% of the surveys, and \$25 for completing <50% of the surveys.

The EMA data were collected over the course of the two-week period using ExpiWell (app.expiwell.com). Adolescents downloaded the ExpiWell application to their personal phones with the virtual assistance of study personnel. For the EMAs, participants received a notification on their smartphones. Specifically, the EMAs were randomly sent during three time-blocks: 9am-1pm, 1pm-5pm, and 5pm-10pm. Participants were able to complete each EMA within two hours of the notification. After two hours, the notification disappeared. The EMAs each took approximately 1 minute to complete. Data were collected on both weekdays and weekends. Participants started on different days of the week. The time and date of completion were recorded via the application's website. On average, participants completed 71.12% of their EMAs across the 14 days used for analysis, with 51% completing over 80% of their surveys ( $SD = 26.8\%$ , Range = 5.63% - 100%). All procedures were approved by the university human subjects committee.

## Measures

**Daily EMAs.** All EMA measures were collected at wave 4.

***Social media use with peers.*** We used a dichotomous measure of social media use that captured a specific social media behavior – interacting with peers. At each hourly time point, EMAs prompted adolescents to respond to three items about social media use. Specifically, adolescents were first asked, “Did you interact with your *best friend* in the last hour?” If adolescents selected yes, they were then asked to select via checklist how they had interacted with the best friend and could select “social media” among other options (e.g., “in person”). Next, participants were asked, “Did you interact with *any other friend* in the last hour?” Again, if adolescents selected yes, they immediately checked one or more of several interaction modes,

including the option of “social media”. Similarly, participants were asked “Did you interact with *a partner* in the last hour?” Again, if participants selected yes, they could select “social media” as the mode of the interaction. These three items were all combined as a single dichotomous measure indicating whether adolescents had interacted on social media in the past hour with a friend, best friend, and/or partner. Accordingly, the final measure of social media use with peers was coded as whether or not the adolescent used social media to interact with any one or more of these individuals (i.e., best friend, another friend, or partner) in the last hour (1 = Yes, 0 = No). These measurements were correlated within the same individual each day (ICC = .56) and within each individual’s day at each time point (daily ICCs = .33 - .54).

***Social media use with family.*** A variable about social media use with family was included only in the sensitivity analyses. The method for this variable was identical to *social media use with peers*, except the items inquired about social media use with parents and siblings, instead of best friends, other friends, and partners. Specifically, adolescents were first asked, “Did you interact with a *parent* in the last hour?” If adolescents selected yes, they were then asked to select via checklist how they had interacted with the parent and could select “social media” among other options (e.g., “in person”). Next, participants were asked, “Did you interact with a *sibling* in the last hour?” Again, if adolescents selected yes, they immediately checked one or more of several interaction modes, including the option of “social media”. These two items were combined as a single dichotomous measure indicating whether adolescents had interacted on social media in the past hour with a parent or sibling. Accordingly, our final measure of social media use with family was coded as whether or not the adolescent used social media to interact with any one or more of these individuals (i.e., parents or siblings) in the last

hour (1 = Yes, 0 = No). These measurements were correlated within the same individual each day (ICC = .92) and within each individual's day at each time point (daily ICCs = .35 - .82).

***Social connectedness.*** Participants indicated via EMA the extent to which they felt socially connected to others at that moment. Participants were asked: "How distant or connected do you feel with your close others right now?" Participants responded via a sliding scale which ranged from 0-100, with higher values indicating higher levels of social connectedness.

Measurements were correlated within the same individual each day (ICC = .64) and within each individual's day at each time point (daily ICCs = .36 -.86).

***Social craving.*** Participants indicated via EMA the extent to which they felt social craving at that moment. In particular, participants were asked: "How strongly are you craving social interactions right now?" Participants responded via a sliding scale which ranged from 0-100, with higher values indicating higher levels of social craving. Measurements were correlated within the same individual each day (ICC = .80) and within each individual's day at each time point (daily ICCs = .60 - .93).

***Sensation seeking.*** Participants indicated via EMA the extent to which they felt sensation seeking at that moment. Participants were asked: "How strongly are you craving excitement or new experiences right now?" Participants responded via a sliding scale which ranged from 0-100, with higher values indicating higher levels of sensation seeking. Measurements were correlated within the same individual each day (ICC = .83) and within each individual's day at each time point (daily ICCs = .70 -.79).

### **Peer Nominations.**

***Susceptibility to peer influence.*** To index susceptibility to peer influence, we used a new peer-nomination measure that we developed for this study. A large body of research has used

peer nominations to successfully measure other psychological constructs that are related to peer susceptibility (e.g., Prinstein et al., 2007). Participants were provided with a peer-nomination form that was an alphabetized list of their same-grade peers' names during wave 3 and wave 4 of the study (the year before and during the EMAs). The peer nominations were administered to all consented students in the schools ( $N = 922$ ). The order of names on the peer nomination forms was counterbalanced to control for possible order effects. Participants nominated an unlimited number of peers who were "most likely to do things they don't want to do, or shouldn't do, simply because their peers or friends are doing it? In other words, who is most easily influenced by their peers?" We then summed the number of nominations each adolescent received and standardized it within each school grade. Lower scores indicated relatively lower susceptibility to peer influence and higher scores indicated relatively higher susceptibility to peer influence. We then averaged the sociometric nominations of peer susceptibility from waves 3 and 4 to create a single time-averaged, between-subjects measure that was used in analyses. We used this measure for two reasons. First, averaging across both years provided a relatively more stable estimate of peer susceptibility over time. Second, averaging across both years enabled us to maximize our analytical sample size by using all available data, and therefore increased the accuracy of our estimates. Specifically, our time-averaged measure had the lowest amount of missing data at 5.50%, compared to 5.81% at wave 3 and 12.26% at wave 4 alone. The measurements of *susceptibility to peer influence* from wave 3 and wave 4 were positively correlated ( $r = .58, p = .01$ ).

### **Statistical Analysis**

We used three-level linear mixed effects regression models which nested EMA time point (Level 1) within days (Level 2) within participants (Level 3). We person-centered all

Level 1 predictors, and we included on the intercept daily-mean and person-mean values of social media use (Curran & Bauer, 2011). This approach helps to isolate within-subject effects from within-days and between-subject effects. Accordingly, in the tables, “hourly” variables reflect Level 1 person-centered variables at each time point (i.e., a within-subject effect), whereas “daily” variables reflect Level 2 variables averaged across all EMA time points within days (i.e., within-subject daily effect), and “average” variables reflect Level 3 variables averaged across all days (i.e., between-subject effect). The “hourly” variables can be interpreted as the hour-by-hour associations between social media use to interact with peers (which adolescents reported for the past hour) and outcomes (which adolescents reported for their current state), controlling for both daily and between-subject effects.

Model 1 tested how social media use to interact with peers in the past hour was directly linked to current feelings (connectedness, sensation seeking, social craving), controlling for daily-average and person-average levels of social media use. Model 2 additionally tested whether the hourly and average-level links between social media use and outcomes differed for adolescents who received more or fewer peer nominations for being susceptible. Specifically, Model 2 additionally included two interaction terms. First, there was one cross-level interaction term between hourly social media use to interact with peers (i.e., within person) and person-average-level (i.e., between-person) susceptibility to peer influences. Second, there was another level 3 interaction term between person-average social media use to interact with peers and person-average susceptibility to peer influences. We probed significant interactions using the simple slopes technique at 1 *SD* above and below the mean value of the moderator, peer susceptibility (Aiken, West, & Reno, 1991). Missing data was low for peer susceptibility (5.50%) and higher for connectedness (31.72%), social craving (26.48%) and sensation



seeking (28.19%). Relatively higher levels of missing EMA data are expected due to the intermittent, time-sensitive, and intensive nature of this method. We handled missing data with maximum likelihood. Analyses were conducted in Stata Version 17. This study was not preregistered. Data and syntax are available upon request.

## Results

### Descriptive Statistics

Table 1 displays descriptive statistics for the full sample and by different gender and racial/ethnic groups. Adolescents had used social media to interact with peers in the last hour at 19.87% of the EMA time points. We used one-way ANOVAs to compare adolescents' experiences and feelings at three EMA time points (i.e., morning, afternoon and evening). A significant difference in social media use to interact with peers by EMA time point emerged,  $F(2) = 47.24, p < .001$ . A Tukey post-hoc test revealed that adolescents were significantly more likely to use social media to interact with peers in the afternoon ( $M = 0.10$ ) and evening ( $M = 0.12$ ), compared to the morning ( $M = 0.08; p = .001$ ). Adolescents were equally likely to use social media to interact with peers in the afternoon compared to the evening ( $p = .248$ ). In contrast to social media use with peers, adolescents' levels of social connectedness, social craving and sensation seeking did not vary by the time of day ( $ps > .06$ ). We then used paired-samples t-tests to determine whether adolescents' experiences differed on weekdays compared to weekends. We found there were no significant differences ( $ps > .31$ ). Finally, across the 14-day study period (averaging across the 3 EMAs each day), there was a significant linear decrease in social media use to interact with peers ( $\beta = -.008, SE = .001, p < .001$ ) but no change in other study variables ( $ps > .05$ ).

Adolescents reported moderate levels of connectedness ( $M = 51.25$ ,  $SD = 22.84$ ,  $Range = 0 - 100$ ), social craving ( $M = 52.56$ ,  $SD = 27.93$ ,  $Range = 0 - 100$ ) and sensation seeking ( $M = 61.16$ ,  $SD = 26.63$ ,  $Range = 0 - 100$ ). Girls used social media to interact with peers more frequently compared to boys ( $t(187) = -3.60$ ,  $p < .001$ ), and boys received more nominations for being susceptible to peer influences compared to girls ( $t(174) = 2.92$ ,  $p = .004$ ). There were no other mean level between-subject differences in study variables by gender, race or ethnicity.

### **Bivariate Correlations**

Table 2 displays bivariate Pearson correlations between study constructs averaged across all EMA time points and days within individuals. On average, adolescents who interacted with peers on social media more frequently felt higher levels of social craving and came from households with lower annual incomes. Adolescents who felt higher levels of social craving felt higher levels of sensation seeking. Adolescents who received more nominations for being susceptible to peer influences felt higher sensation seeking, came from households with higher annual incomes, and were from lower grades (i.e., were younger). There were no other significant bivariate correlations.

### **Variability within and between subjects**

Before the primary regression models, we first tested unconditional means models to determine if there was significant variability in our outcomes within- and between-subjects. Table 3 displays these random effects at the individual level and at the daily level. All the random effects were significant ( $p < .05$ ). This finding suggests that levels of social connectedness, social craving, and sensation seeking all showed variability both within- and between-individuals. So, testing both within-subject and cross-level interactions was appropriate.

### **Multilevel Regression Results**

Table 4 displays direct and interactive associations between social media use to interact with peers and outcomes on the hourly and average levels. Model 1 displays direct associations, whereas Model 2 displays interactive associations. As shown in Model 1, on the average, between-subjects level, adolescents who used social media more frequently reported higher levels of social connectedness. On the hourly, within-subjects level, adolescents felt less social connectedness and more social craving when they had interacted with peers on social media in the past hour. However, these direct hourly associations were qualified by significant interactions with susceptibility in Model 2.

As shown in Model 2, the cross-level interaction between hourly social media use and between-subject susceptibility significantly predicted hourly feelings of connectedness, social craving and sensation seeking. As shown in Figures 1, 2 and 3, a consistent pattern of interactions emerged. Specifically, adolescents who were more susceptible to peer influences reported significantly lower feelings of social connectedness, higher feelings of social craving, and higher feelings of sensation seeking when they had interacted with peers on social media in the past hour. In contrast, adolescents who were less susceptible to peer influences reported slightly above average feelings of connectedness and below average feelings of social craving and sensation seeking regardless of whether they had used social media in the last hour or not. There were no other significant direct or interactive associations.

**Sensitivity and Exploratory Analyses.** We conducted additional sensitivity and exploratory analyses.

*Social media use with friends compared to romantic partners.* First, we tested whether we would find similar direct and interactive associations when adolescents used social media to interact with friends specifically (i.e., best friends and other friends) compared to romantic

partners. We ran the same primary regression models as those above, but replaced the predictor as social media use with friends, and then social media use with romantic partners. We tested these two dichotomous predictors in separate regression models. All previous findings remained significant when testing social media use with friends alone. Specifically, the cross-level interaction between hourly social media use to interact with friends and susceptibility significantly predicted feelings of connectedness ( $\beta = -0.10$ ,  $SE = .03$ ,  $p = .003$ ), social craving ( $\beta = 0.09$ ,  $SE = .03$ ,  $p = .001$ ), and sensation seeking ( $\beta = 0.10$ ,  $SE = .03$ ,  $p = .001$ ). In addition, the cross-level interaction between hourly social media use to interact with *partners* and susceptibility significantly predicted feelings of connectedness ( $\beta = -0.27$ ,  $SE = .10$ ,  $p = .009$ ); however, it did not significantly predict adolescents' levels of social craving ( $p = .767$ ) or sensation seeking ( $p = .151$ ). These findings suggest that adolescents who were more susceptible to peer influences felt lower feelings of social connectedness when they had interacted with either friends or romantic partners on social media in the past hour. However, they only felt greater feelings of social craving or sensation seeking specifically when they had interacted with friends in the last hour (not romantic partners).

*Social media use with family.* We also tested whether we would find similar direct and interactive associations when adolescents used social media to interact with family (i.e., parents or siblings) instead of peers (i.e., best friends, other friends or partners). We ran the same primary regression models as those above but replaced the predictor as social media use with family. When adolescents used social media to interact with family the last hour they reported significantly lower feelings of social connectedness ( $\beta = -0.17$ ,  $SE = .09$ ,  $p = .037$ ), but there were no other direct or interactive associations ( $ps > .05$ ).

*In person interactions.* We also tested whether we would find similar direct and interactive associations when adolescents interacted in-person with others (i.e., parents or siblings, best friends, other friends or partners). We ran the same primary regression models as those above but replaced the predictor as in person interactions. There were no direct or interactive associations on the hourly level ( $ps > .05$ ).

*Gender differences.* We tested whether our findings were consistent for both boys and girls, via three-way interaction terms between mean-centered hourly social media use, peer susceptibility, and gender predicting social connectedness, social craving, and sensation seeking. There were no significant gender differences ( $ps > .31$ ).

*Change across the study period.* Finally, we tested whether the association between social media use to interact with peers and social connectedness, social craving, and sensation seeking changed across the two-week study period. Specifically, we tested this via linear growth curve models that predicted each outcome as a function of an interaction term between hourly social media use and day of study (1 through 14). Only one significant finding emerged: social media use significantly interacted with the day of the study period to predict social craving ( $\beta = -.02$ ,  $SE = .01$ ,  $p = .014$ ). Probing this interaction revealed social media use was related positively to social craving during the first week of the study ( $\beta = .17$ ,  $SE = .04$ ,  $p = .001$ ) but not during the second week of the study ( $\beta = .05$ ,  $SE = .04$ ,  $p = .270$ ).

## **Discussion**

This study investigated how adolescents' social experiences and motivations fluctuated when they used social media to interact with peers in the past hour. Further, we examined whether these hourly associations were particularly strong for adolescents who were nominated by their peers as highly susceptible to peer influences. Our methodological approach capitalized

on a diverse research sample, peer nominations, longitudinal ecological momentary assessments, and robust within- and between-subject analyses. We found a consistent pattern of results across all measured outcomes that was robust to alternative specifications considered in sensitivity analyses. Adolescents who were highly susceptible to peer influences felt less social connectedness and more social craving and sensation seeking during hours they used social media with peers more than usual. In contrast, among adolescents who were less susceptible, social media use with peers was unrelated to feelings of social connectedness, social craving and sensation seeking. These findings suggest that youth who are particularly sensitive to social input from peers may feel less connected to others and crave more connections and exciting stimuli during hours that they use social media with their peers.

### **Bidirectional processes linking social media use to social experiences and motivations**

Among highly susceptible youth, social media use with peers was related to lower feelings of connectedness, and higher feelings of social craving and sensation seeking within the past hour. This within-subjects, hourly level finding is consistent with prior between-subject evidence that adolescents who use social media more frequently report greater loneliness and fear of missing out on social interactions (e.g., Barry et al., 2017; Pittman & Reich, 2016). This finding is also consistent with one prior within-subject ecological momentary assessment study that found that adolescents felt less close emotionally to their friends when they spent more time on WhatsApp and Instagram in the past hour (Pouwels et al., 2021).

Bidirectional processes likely underlie these hourly-level associations. On the one hand, adolescents may be more likely to use social media with peers during hours of the day when they feel less connected and crave more social interactions and novel stimuli. In prior qualitative research, adolescents reported most frequently using social media to alleviate boredom when

they wanted more stimulation (Allaby & Shannon, 2020). On the other hand, social media use with peers may also in turn contribute to adolescents' feelings of being connected and craving more social connections. Although our study does not address the precise mechanisms, it is feasible that social media use can at times cause adolescents to feel anxiety, different from their peers, or more isolated, for example if they engage in social comparison with their peers. In turn, these challenging emotions could contribute to adolescents feelings of being more distant and craving more connections and novel sensations. These bidirectional mechanisms may help to explain why adolescents felt lower feelings of connection and higher feelings of social craving and sensation seeking during hours that they used social media.

### **Highly susceptible youth**

Bidirectional processes also likely explain why specifically adolescents who are particularly susceptible to peer influences feel social disconnection and craving most strongly during hours they interact with peers on social media. Highly susceptible adolescents are very attuned to and value their peers' behaviors and experiences, and are more sensitive to social input and rewards (Prinstein & Giletta, 2020). These youth may be motivated to use social media with peers during hours they feel disconnected or are craving social interactions. In contrast, less susceptible adolescents may be more able to tolerate feelings of social disconnection or craving and not as driven towards social media use with peers within the hour. Conversely, it is also possible that highly susceptible adolescents are more impacted by their online interactions with peers. For example, highly susceptible adolescents may be more likely to engage in social comparison during interactions with peers via social media, and then feel that they should be having experiences similar to their peers. In one study, adolescents who compared themselves to others more on Instagram were more motivated to mirror and replicate the social or novel

experiences they viewed online in their own lives (Noon & Meier, 2019). In another study, adolescents who were more motivated to achieve high social status on social media engaged in higher levels of risk-taking behavior one year later (Nesi & Prinstein, 2019). In contrast, adolescents who are less susceptible may not crave social or novel experiences as strongly when they use social media because peer social feedback is not as salient for them (Prinstein & Giletta, 2020).

### **Exploratory hourly-level analyses**

Exploratory analyses indicated that adolescents' in-person interactions were not related significantly to their feelings of social connectedness, social craving and sensation seeking. These findings underscore the interpretation that interacting with peers specifically via social media – not in person – is uniquely related to social connectedness, social craving and sensation seeking. In addition, exploratory analyses revealed that on average, adolescents reported lower feelings of social connectedness during hours they interacted with family via social media. Further, adolescents who were more susceptible to peer influences reported lower feelings of social connectedness during hours they interacted with friends *and* romantic partners via social media. However, they only felt greater feelings of social craving or sensation seeking specifically during hours they interacted with friends, but not romantic partners or family. Social media use with friends may be uniquely related to feelings of social craving and sensation seeking because adolescents are highly attuned to their friends' and peers' behavior (van den Bos, 2013). Highly susceptible youth may feel driven specifically to seek out social media interactions with friends (rather than partners or family) during times they are craving social interactions and novel sensations. Social media interactions specifically with friends could also increase feelings of social craving and sensation seeking because highly susceptible youth are



highly attuned to their friends' behavior and experiences, more than partners' or family's. In contrast to social craving and sensation seeking, social connectedness may be linked less specifically to friendship-based social and novel experiences because connectedness can be derived from many different types of relationships.

### **Between-subject associations**

Although social media use was associated negatively with social connectedness on the hourly, within-subjects level for highly susceptible youth, it was associated positively with social connectedness on the average, between-subjects level. Adolescents who used social media with peers more frequently across time felt less connected socially, while at the same time, adolescents who were highly susceptible felt lower social connectedness in the moments after using social media with peers. These findings raise the possibility that adolescents' social media use relates to their social experiences differently in the short-term versus long-term. It is feasible that general tendency to use social media may help adolescents to stay connected, while also having emotional costs in the short-term. For instance, youth who feel more socially connected across time may use social media more frequently to form and maintain close friendships and relationships. Social media use may even have potential benefits across time, in that it contributes to or facilitates stronger feelings of connection. As such, this finding underscores the importance of investigating how social media is related to adolescents social wellbeing on both the between-subjects and within-subjects levels.

### **Study Implications**

This study contributes to the literature in four primary ways. First, this study demonstrates that there is significant within-subject variability in social media use to interact with peers, and in social connectedness, social craving and sensation seeking. Consistent with

recent recommendations (Beyens et al., 2020), this finding illustrates the utility of within-subject research designs for answering questions about how social media use is related to adolescent wellbeing and development. Specifically, within-subject analyses such as those in the current study offer robust evidence on how social media use is related to adolescents' experiences in the moment, because they hold constant myriad potentially confounding characteristics that differ between youth. They also offer greater temporal specificity by showing how social media is related to adolescents' experiences and feelings within days, hours or moments.

Second, this study illustrates hourly links between social media use to interact with peers and adolescents' experiences, which builds on only a few prior ecological momentary assessment studies (Beyens et al., 2020; Pouwels et al., 2021). The study replicates evidence that social media use with peers is related on an hourly level to lower feelings of social connection (Pouwels et al., 2021) and extends prior work by illustrating that social media use to interact with peers is also related on an hourly level to higher social craving and sensation seeking. Accordingly, our results shed light on how social media relates hourly to motivations towards social interactions and novel sensations, beyond current feelings of connection and affective wellbeing (Beyens et al., 2020). Social craving and sensation seeking are important motivations to study because they reflect the degree to which adolescents are yearning for more social connections and experiences, compared to satisfied with their current experiences. Further, social craving and sensation seeking may underlie downstream reward seeking behaviors such as health-compromising risk taking.

Third, our study is among the first to reveal that social media use is correlated with social experiences and motivations specifically among youth who are highly susceptible to peer influences. This finding supports the growing evidence that social media use impacts different

adolescents divergently based on their personalities and responses to their social environments (Nesi & Prinstein, 2019). Accordingly, we combined our within-subject research design with a between-subject moderator (i.e., via cross-level analyses). By examining on individual differences between youth by susceptibility to peer influence, we extend prior research that focused on individual differences by gender (Haferkamp & Krämer, 2011), openness and extroversion (Kim et al., 2014), and emotional responses (Nesi et al., 2021).

Fourth, our findings offer insight for policy makers, educators, parents and teenagers who aim to promote positive youth development in the context of widespread social media. This study shows that adolescents are more likely to use social media with peers during hours that they feel less socially connected and crave more social and novel experiences. Accordingly, it may be beneficial to structure opportunities for adolescents to engage in meaningful, rewarding interactions on social media with peers during these times of the day. In turn, structured positive online environments may reciprocally increase adolescents' feelings of social connection and emotional wellbeing. For example, online opportunities to help others or exchange mutual support via social media may increase adolescents' feelings of social connection and fulfillment (e.g., Erreygers, et al., 2019).

### **Limitations and future directions**

We acknowledge limitations and highlight future directions for study. First, our data were collected during a global pandemic that limited adolescents' in-person interactions. This timing may influence the generalizability of study findings. Second, although we used robust within-subject analyses that accounted for both daily effects and between-subject characteristics, our study is correlational, not causal. As we have emphasized, it is highly likely that the associations between social media use and social wellbeing are bidirectional. Although we asked adolescents

about their previous social media use in the last hour and their current feelings of social connections and motivations, it cannot be determined from these data whether feelings of connectedness, social craving, and sensation seeking preceded the use of social media or were affected by the social media use. To clarify causal pathways, future experiments could randomly assign adolescents to use social media (or not) and examine the causal impact on their feelings of connectedness, social craving, and sensation seeking.

In the future, researchers may measure greater variability in social connectedness, social craving and sensation seeking by asking adolescents to respond to multiple survey items. We used single items to assess social connectedness, social craving, and sensation seeking to minimize the length of the EMAs and the burden on participants. Further, social craving and sensation seeking were correlated strongly and positively across days in our study. Future research could investigate whether these items capture a single underlying construct or feature of adolescents' social experiences.

We also used dichotomous yes/no items for social media use with peers. Dichotomous measures are common for EMA studies that capitalize on fast response times and short surveys (Hall, Scherner, Kreidel, & Rubel, 2021), and the dichotomous measure showed sufficient variability for our analyses. However, dichotomous measures of social media use do not offer information about the frequency or amount of time that adolescents use social media. In the future, researchers could use continuous measures of social media use. For example, EMAs could ask adolescents *how often* they contacted peers using social media in the last hour. Alternatively, intermittent screenshots of adolescents' phones could provide more objective information about which specific digital behaviors and content adolescents engaged with, and for how long. For instance, objective screenshots of adolescents' phones could clarify whether our

findings are consistent or differ for passive social media use (e.g., viewing images, watching videos) vs active social media use (e.g., texting). It is still an open question whether our observed associations would differ depending on whether the peer interaction was superficial (e.g., sending snaps) or more meaningful (e.g., talking on facetime, engaging in extensive conversation through text).

To measure adolescents' levels of susceptibility to peer influences, we used a peer-nomination approach that offers a new and potentially useful method for assessing susceptibility to peer influence in future research. Peer susceptibility is quite difficult to measure due to self-report biases, and parents' and teachers' lack of insight into adolescents' behaviors and motivations. Our peer-nominated approach revealed sufficient variability for our analyses, and emerged as a consistent between-subject moderator of the within-subject relations between adolescents' social media use and their experiences. However, the peer nomination approach for measuring peer susceptibility is not yet well-validated and may have biases. For example, our peer nomination measure focuses on adolescents' behaviors that were displayed or perceived by their peers (i.e., peers' perceptions of adolescents' tendency to mirror their peers behavior). The measure did not address emotional or cognitive aspects of peer influences that are less readily observable (e.g., adolescents' tendencies to feel and think the way their peers do).

Future research should also examine whether the association between social media use and social experiences and motivations changes over the course of early to late adolescence. It is possible that social media use with peers is related to social experiences and motivations particularly strongly among very young adolescents, because social media use is less familiar for them and they have not developed effective emotion-regulation skills (Valkenburg et al., 2005). Prior developmental neuroscience research also suggests that very young adolescents are more

susceptible to peer influences (Van Hoorn, Van Dijk, Güroğlu, & Crone, 2016). In addition, there are also age differences in social media behavior (e.g., posting/viewing, self-expression). In one study, pre-teens and younger teens (age 9–13) were more likely than older teens (age 14–18) to post carefully curated photos on social media, which may make them feel more connected or fulfilled compared to older adolescents.

## **Conclusion**

Adolescents often use social media for connecting with peers and seeking novel stimuli (Rideout & Robb, 2018). We investigated the possibility that using social media to interact with peers is related to adolescents' social experiences and motivations within the hour. By measuring hour-to-hour variability in adolescents' feelings of social connection, social craving and sensation seeking (beyond focusing on affect and emotions) we revealed previously undetected hourly associations with adolescents' social experiences, particularly among those who were more susceptible to peer influences. Our robust multi-level models controlled for both daily and between-subjects effects. A consistent pattern of results illustrated that during hours when highly susceptible youth used social media to interact with peers, they reported lower levels of social connection, higher levels of social craving, and higher levels of sensation seeking. Using social media to interact with peers may be related to social discontent among youth who are most likely to follow their peers' lead and place high levels of importance on their peers' experiences and behaviors. As such, our study suggests that social media use may be linked to social challenges among highly sensitive youth. Although future research should clarify the extent to which this depends on the quality and content of social media-based interactions, this finding may inform efforts to scaffold adolescents' feelings of social connection and satisfaction in online environments.

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Table 1

Descriptive statistics for full sample and by subgroups

	Full Sample		Male		Female		White non-Latinx		Black		Latinx		Other Race	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Social Media Use	0.20	0.25	0.13 <sup>1</sup>	0.18	0.26 <sup>2</sup>	0.29	0.16	0.24	0.21	0.26	0.29	0.28	0.17	0.23
Connectedness	51.25	22.84	51.24	23.51	51.73	22.01	51.19	22.55	50.54	25.38	49.24	21.35	55.66	23.45
Social Craving	52.56	27.93	48.02	30.61	55.36	26.16	48.79	27.31	59.42	29.37	53.03	28.64	48.59	30.60
Sensation Seeking	61.16	26.63	60.51	30.19	61.35	24.60	55.28	27.83	67.28	24.99	63.99	26.69	60.54	29.79
Peer Susceptibility	0.12	0.91	0.25 <sup>1</sup>	0.93	-0.10 <sup>2</sup>	0.69	0.15	0.89	0.17	0.94	-0.06	0.59	0.23	0.78

*Note.* Values are person-means averaged within individuals across all time points. All mean values without superscripts are not statistically significantly different from the others. In particular, all mean values were statistically similar across racial/ethnic groups. For gender, mean values with different numerical superscripts indicate significant differences. Peer susceptibility was a standardized measure of peer nominations, so values less than zero indicate less susceptibility than average.

Table 2

Bivariate correlations between study constructs

	1	2	3	4	5	6
1 Social Media Use	1					
2 Connectedness	0.02	1				
3 Social Craving	0.18*	-0.10	1			
4 Sensation Seeking	0.12	-0.13	0.73***	1		
5 Peer Susceptibility	-0.09	-0.02	0.06	0.17*	1	
6 Household Income	-0.20**	0.10	-0.05	-0.02	0.03	1
7 Grade	0.07	-0.02	-0.02	-0.22**	0.00	-0.11

Note: \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

*Table 3*

Unconditional means models display the random effects for social outcomes. All random effects were significant, as indicated via confidence intervals that did not include zero, revealing significant within-subject and between-subject variability in these outcomes.

Random Effects	Estimates		
	Social Connectedness	Social Craving	Sensation Seeking
Individual level	.54	.65	.69
Daily level	.13	.09	.10
Residual	.30	.25	.21

Table 4

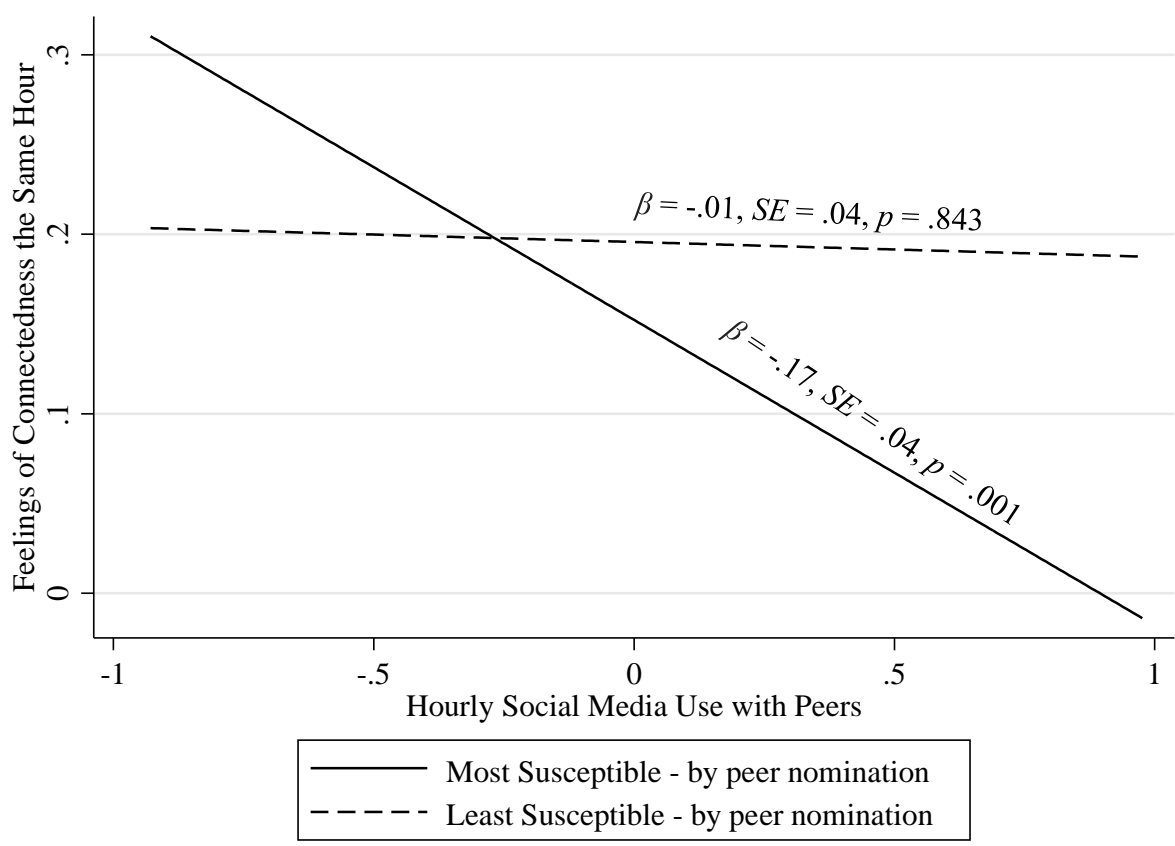
Direct and interactive associations linking social media to interact with peers and susceptibly to feelings of connectedness, social craving, and sensation seeking.

	<i>Model 1</i>			<i>Model 2</i>		
	<i>Direct Associations</i>			<i>Interactive Associations</i>		
	Social Connectedness	Social Craving	Sensation Seeking	Social Connectedness	Social Craving	Sensation Seeking
	$\beta$ (SE)	$\beta$ (SE)	$\beta$ (SE)	$\beta$ (SE)	$\beta$ (SE)	$\beta$ (SE)
Using Social Media in Past Hour	-0.16** (0.04)	0.11** (0.03)	0.05 (0.03)	-0.13** (0.04)	0.10** (0.03)	0.04 (0.03)
Daily Average Social Media Use	-0.44 (0.28)	0.65 (0.30)	0.26 (0.31)	-0.49 (0.29)	0.56 (0.30)	0.25 (0.31)
Person Average Social Media Use	0.27** (0.07)	-0.06 (0.06)	0.01 (0.06)	0.22** (0.08)	-0.02 (0.06)	0.04 (0.06)
Peer Susceptibility				-0.03 (0.08)	0.07 (0.08)	0.09 (0.09)
Hourly Social Media Use X Susceptibility				-0.12** (0.03)	0.09** (0.03)	0.09** (0.03)
Daily Social Media Use X Susceptibility				0.17* (0.07)	-0.04 (0.06)	-0.06 (0.06)
Person Average Social Media Use X Susceptibility				-0.35 (0.27)	-0.02 (0.28)	-0.00 (0.29)
Constant	0.13 (0.07)	-0.11 (0.07)	-0.06 (0.07)	0.17* (0.07)	-0.08 (0.07)	-0.07 (0.08)
<i>Number of Adolescents</i>	206	208	208	193	195	195
<i>Daily Observations</i>	4,188	4,521	4,412	3,919	4,244	4,157

Note: Standard errors in parentheses. \*\*\*  $p < 0.001$ , \*\*  $p < 0.01$ , \*  $p < 0.05$ .

Figure 1

Adolescents who received more peer nominations as highly susceptible to peer influences felt less social connectedness during hours they used social media with peers more than usual. In contrast, adolescents who received fewer peer nominations as highly susceptible did not show a link between social media use and feelings of social connectedness. Hourly social media use was a dichotomous measure that was person-mean centered. Social connectedness was standardized.



*Figure 2*

Adolescents who received more peer nominations as highly susceptible to peer influences felt more social craving during hours they used social media with peers more than usual. In contrast, adolescents who received fewer peer nominations as highly susceptible did not show a link between social media use and social craving. Hourly social media use was a dichotomous measure that was person-mean centered. Social craving was standardized.

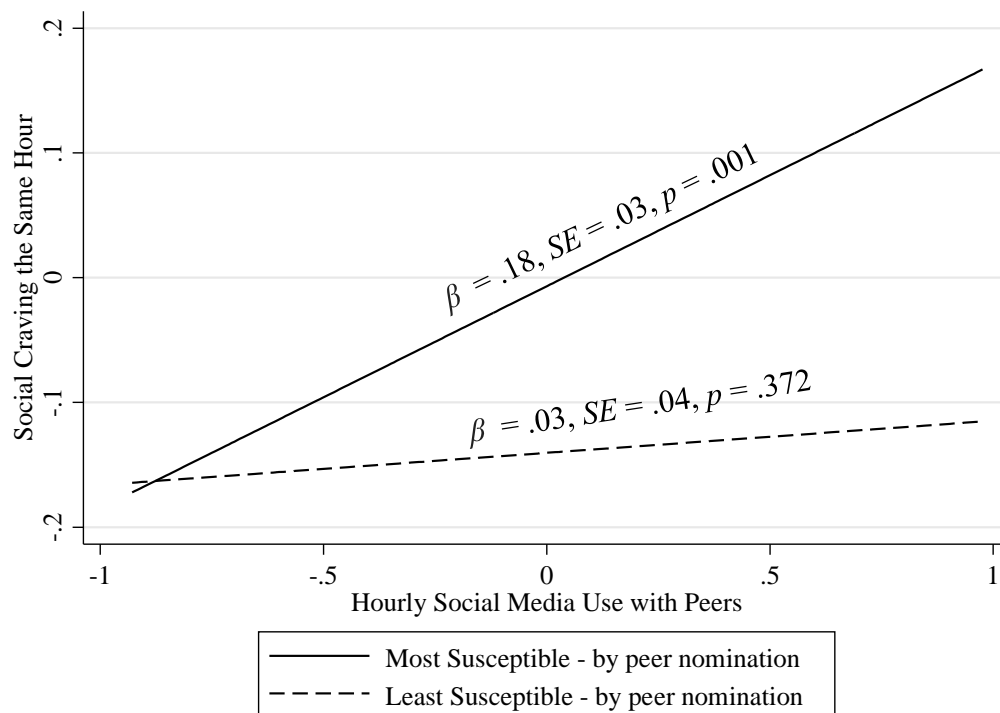


Figure 3

Adolescents who received more peer nominations as highly susceptible to peer influences felt more sensation seeking during hours they used social media with peers more than usual. In contrast, adolescents who received fewer peer nominations as highly susceptible did not show a link between social media use and sensation seeking. Hourly social media use was a dichotomous measure that was person-mean centered. Sensation seeking was standardized.

