Communication attributes modify the anxiety risk associated with social media addiction: a prospective diary method study

Chenziheng Allen Weng, Jahshara Bulgin, Savannah Diaz, Jiafang Zhang, Runzi Tan, Le Li, Mari Armstrong-Hough

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Abstract

Background: Research on social media use in younger individuals shows mixed effects on mental health. While previous studies have linked problematic social media use to mental health outcomes, there is limited knowledge on how specific communication behaviors during social media engagement can modify these associations. The rapid increase in social media usage, especially among youth and adolescents, necessitates a deeper understanding of pragmatic interventions that address the relationship between social media addiction (SMA) and anxiety.

Objective: This study examines how four distinct communication dimensions – Consumption, Broadness, Online Exclusivity, and Parasociality – modify the association between SMA and anxiety in young adults.

Methods: We recruited a cohort of undergraduate students aged 18-26 to participate in daily surveys over two weeks using a diary method to assess daily social media use, SMA, anxiety symptoms, and the four dimensions of communication. Lagged logistic regression models with generalized estimation equations evaluated the influence of daily SMA and communication type on subsequent anxiety levels.

Results: Out of 79 participants, 1009 daily records were analyzed. SMA positively correlated with anxiety (Kendall rank correlation ?=0.30). Interaction analysis indicated that levels of parasociality and consumption moderated the association between SMA components and anxiety outcomes. In young adults with high levels of consumption or parasociality, a 1-standard-deviation rise in SMA's social conflict component led to an 11%-13% increase in next-day anxiety scores. This association was absent for those with low to moderate levels of parasociality and consumption.

Conclusions: Elevated levels of passive consumption and one-sided interactions amplify the anxiety risk associated with social media dependence. Further longitudinal evidence can elucidate the connections between communication types, social media exposure, and anxiety, guiding the development of a model for healthy social media use.

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Keywords: social media addiction; anxiety; communication types; ecological momentary assessment; daily diary method

Introduction

The past two decades have seen a surge in social media use, with the percentage of American adults on these platforms jumping from 5% in 2005 to 72% by early 2021 [1]; young users aged 18-29 reported checking platforms like Instagram or Snapchat multiple times daily [2]. Concurrently, the mental health effects of social media use, such as on loneliness [3], stress management [4], attention span [5], and addictive behaviors [6, 7], have become increasingly scrutinized.

Social media addiction (SMA) is considered a behavioral addiction and evidence from longitudinal studies and meta-analyses have associated SMA with anxiety and depression [8, 9]. A nationally

representative U.S. panel study from 2014 to 2016 observed a 9% increase in the odds of depression symptoms for young adults with problematic social media use [7], while a multi-country survey linked intense SMA in school-aged adolescents with lower well-being across various domains [10]. Thus, developing effective prevention strategies for SMA-related conditions in youth is crucial for public health.

Although SMA itself has been well researched, previous work has been limited by an undifferentiated concept of social media activities that did not attend to differences between individuals in how or why they use social media. For example, a group of people primarily using the sites for making friends and chatting may experience different risk levels compared to another group using most of the time browsing content [11, 12]. There is limited scientific understandings of how specific types of communication on social media may modify the relationship between SMA and mental health outcomes. Few studies have investigated whether the effects of SMA are equal across different types of social media communication [13, 14].

Previous studies have related specific communication types – such as targeted composed communication, active socializing, and “one-click” likes and sharing – to mental health [11, 15, 16]. These communication types appear to be correlated with mental well-being [15]. For example, Burke and Kraut (2016) reported that receiving targeted, composed communication from strong-tie friends was associated with improvements in psychological well-being while viewing broadcasted messages and receiving one-click feedback were not [15]. In a survey of high school students, Frison and Eggermont (2016) found that the incidence of depressed mood was higher among those who used Facebook passively, defined as viewing others’ profiles and posts [17]. This line of work is especially invaluable in putting novel, online communication in the context of established models of human needs for information exchange and social connections, whether it facilitates essential social efforts (e.g., facilitating belongingness, signaling relational investment, maintaining stock of friendships, and bolstering self-affirmation [16, 18, 19]) or amplifies morbid psychosocial mechanisms (e.g., stimulating unhealthy social comparison, sensation seeking, ignoring real-life relationships, and causing decreased productivity [20-23]). This body of work establishes the importance of communication type for contextualizing social media exposures and their health implications, although they did not consider the pre-existing levels of SMA.

In this study, we build on the work of Burke and Kraut (2016)[15] and Shakya et al.(2017)[24] by systemizing four dimensions of communication with which to characterize communication type and standardizing their measure with coherent, unitary factors. Using prospective data collected leveraging a daily diary design, we assessed the interactive effects of four communication dimensions and SMA on subsequent anxiety among young adults. In doing so, we aim to strengthen empirical research on communication types and test the hypothesis that the effects of SMA on anxiety would vary by exposure to different types of social media communication.

Methods

Study Design

The study was designed to collect prospective behavioral data through ecological momentary assessment (EMA; also called the diary method) [25]. Individual participants’ daily social media activities and dimensions of communication, measures of SMA, and anxiety levels were repeatedly captured and analyzed longitudinally across a 14-day period. Data collection procedures were designed to minimize recall bias, consistently record daily measures, and deliver daily surveys on mobile devices in the same context as participants used social media.

The study population included current full-time NYU undergraduate students (9 credits or above per semester) between 18-26 years old and currently residing in the United States. Potential participants were excluded if they were not regular users of major social networking site (SNS) applications. We defined SNS as any social media application that connects users via user-created individual profiles [26]. Examples of SNS applications/platforms given to participants at recruitments and during daily surveys include Facebook, Snapchat, WeChat, Instagram, Twitter, TikTok, Weibo, LinkedIn, Reddit, and Tumblr.

Study size

Through a review of previous EMA-based or diary method studies with a similar study population, we found that the range of study size and time points fall around 75-120 subjects and last from 5 to 21 days [27, 28]. We selected 14 days to balance variance against risk of response fatigue.

We conducted a standard statistical power analysis under Repeated Measures ANOVA for within-group factors. To detect an effect size of 0.06, the number of measurements at 14, and the power set at 0.80, the required sample size is 90. G*Power 3.1 [29] was used for the statistical power analysis and study size determination.

Procedures

Data were collected from March 2021 to May 2021. Recruitment emails were distributed to undergraduates at New York University through the institutional email system. The research team sent out three rounds of recruitment emails to reach the predetermined sample size of 90.

Completion of the study involved three phases: an orientation session through a prerecorded tutorial video and web page, a baseline questionnaire, and 14 consecutive days of diary records. During the study period, participants received an email each day at 8pm directing them to the survey. Participants were asked to finish the diary survey within 3 hours. Three reminders were sent via email. Participants were permitted to make up a missing diary survey until 12:00 pm on the following day. Design, distribution, and data collection were conducted using Qualtrics XM.

At the beginning of the daily survey, participants completed calibration questions to systematically review their social media usage. These questions consisted of (1) a selection of all SNS applications they had used since the last check-in, where the ten most popular SNS platforms were listed and a free text entry was provided for other platforms; (2) a number entry of an estimation of the total number of times and the total time spent in checking the SNSs, broken down into evening, morning, and afternoon. The main daily-level questionnaire was then administrated block by block. The survey did not allow skipped responses.

Participants received USD $25 compensation for completing 14 consecutive diary days and $10 for completing at least 7 consecutive days.

Constructs and Measures

Time-independent measures: baseline characteristics

Demographic variables including gender, age, and race/ethnicity were measured by self-report in the baseline survey. Measures of four control variables were collected at baseline: history of diagnosis with a depression disorder, history of diagnosis with an anxiety disorder, recent experience of a major exam or major life event (e.g., marriage, breakup, losing a job, or the death of a loved one), and COVID-19-related adjustment disorder. *COVID-19-related adjustment disorder* was measured

by an adapted International Adjustment Disorder Questionnaire (IADQ) (See Supplementary Textbox 1).[13]

Time-dependent measures: Daily-level entries

Anxiety is the primary outcome of interest and was measured by the Generalized Anxiety Disorder scale, known as the GAD-7[16]. The scale consists of seven questions with a 0-3 measured Likert scale, which were adapted for daily measures. The total score is the sum of each question. A score >= 10 was considered to indicate anxiety symptoms, with a score of 10-14 indicating moderate symptoms and a score >= 15 indicating severe symptoms.

We measured *SNS communication type* using four dimensions: (a) Consumption: creating content *versus* consuming content; (b) Broadness: information or messages sent or received were targeted and/or private *versus* broadcasted and public; (c) Online exclusivity: connections or interactions took place exclusively on SNS *versus* both on SNS in other settings; (d) Parasociality: connections or interactions on SNS were one-way *versus* mutual. Specifically, we defined *Consumption* as the proportion of time spent viewing content (+), compared to the proportion spent composing content (–). We defined *Broadness* as, among messages sent and received, what proportion were broadcasted to a broad audience (+), compared to the proportion that was targeted at a particular person (–). *Online exclusivity* was defined as, among connections fostered on social media sites, what proportion of relationships existed online-only (+, e.g., net friends, celebrities), compared to the proportion existing offline as well (–, e.g., classmates, family members). Parasociality was defined as, among connections they made on social media sites, what proportion was primarily one-way (+), while what proportion was primarily mutual (–). Participants were asked to assess their communications on SNS since the last study contact on a bipolar scale from 1 to 10 for each dimension. The full scale is shown in Textbox 1.

Social media addiction was assessed by a set of 12 items adapted from the Bergen Facebook Addiction Scale [30], as shown in Supplementary Textbox 2. Each item represented one of four components of addiction: salience, mood modification, social conflict, and withdrawal. Each addiction component has three questions. Participants responded on a Likert scale with anchors from Rarely (0) to All the time (3). While the original items specified “Facebook,” we substituted “Facebook” with “social networking sites”. The resulting composite scale ranged from 0 to 36 and served as a primary independent variable in our model.

Textbox 1. SNS communication type scale. SNS: social networking sites.

Scoring: Scored from 1 to 10 to indicate the proportion of time. Participants rate their daily SNS activities in terms of each communication type as relative deciles that add up to 100% of total activity time.

Item 1 – Consumption

Instructions: Generating content vs. Viewing content

Item 2 – Broadness

Instructions: The content you interact (send and receive) with are: Targeted at the recipient vs. Broadcast to many recipients

Item 3 – Online exclusivity (Shown as “Social connections”)

Instructions: The connections you made on SNS exist offline also (fellow students, dates, parents, etc.) vs. exist only online (celebrities, influencers, idols, etc.)

Item 4 – Parasociality (Shown as “Direction of relationships”)

Instructions: The connections you made on SNS were primarily one-way (e.g., following an influencer) vs. primarily mutual (e.g., interacting in a two-way conversation.)

Statistical analysis

Intraclass correlations (ICC) for dimensions of communication and SMA were computed to describe the correlation of daily-level measures within individual participants over the study period. Generalized equation modeling was used to estimate how SMA dimensions and communication types predict changes in anxiety. All regression models included a lagged dependent variable, by which the analyses controlled for individual participants' anxiety levels on the previous day and the unmeasured factors contributing to the overall anxiety.

In multivariable analysis, the independent variables and the anxiety outcome were standardized. The outcome variable was transformed to a relative scale so that regression coefficients represent the percent change in the anxiety outcome by each unit of 1-standard-deviation increase in independent variables. Further stratified analysis applied the final multivariable model on the tertiles of each communication dimension.

R software (version 4.3.0; R Foundation for Statistical Computing), including the *gee* package (version 4.13-25).

Results

Sample Characteristics

Among 94 participants who finished the baseline survey, 79 (84%) participants finished at least 3 daily (survey) records and were included in the analysis, from whom 1009 daily records were collected (Table 1). On average, participants completed 12 daily records (mean: 13; median: 14).

The median age of the sample was 20 years old (range 18 to 26 years old.) Most participants were women (72, 91%). Over two-thirds (53, 67%) of the participants reported moderate or severe levels of COVID-19 adjustment disorder, among which one-fourth of participants (21, 27%) reported severe COVID-19 adjustment disorder. There were 24% and 30% of participants who reported previously diagnosed depression and anxiety disorder, respectively.

Table 1. Study sample characteristics (*n*=79)

Characteristics		*n*
Demographics		
Median age (IQR, range)		20 (2, 18-26)
Gender, %	Female	72 (91%)
	Male	5 (6%)
	Other	2 (3%)
Race, %	Non-Hispanic white	21 (27%)
	Non-Hispanic black	10 (13%)
	Hispanic/Latino(a)	7 (9%)
	Asian	26 (33%)
	Mixed/other	15 (19%)

Control variables		
COVID-19 adjustment disorder, %	No/minor	26 (33%)
	Moderate	32 (40%)
	Severe	21 (27%)
Previously diagnosed depression disorder, %	No	60 (76%)
	Yes	19 (24%)
Previously diagnosed anxiety disorder, %	No	55 (70%)
	Yes	24 (30%)
Recently had a major exam or major life event[a], %	No	14 (18%)
	Yes	65 (82%)

IQR: Interquartile Range.

[a] Major life event was defined as events that recently occurred and impacted the subjects at baseline; examples given include marriage, breakup, losing a job, and the death of a loved one.

Distribution of daily-level measures

Distributions for the four communication dimensions are shown in Figure 1; the summary statistics of all daily-level measures included in the model and their correlations with anxiety score are shown in Supplementary Table 3. Most daily diaries reported a high level of consumption (median=9, range 1 to 10). However, consumption also showed the largest within-subject variances among the four dimensions of communication (ICC=0.40).

The broadness dimension also showed a concentration on the broadcast end of the spectrum (median=8, range 1 to 10), but values from the same individual participant were relatively similar over time (ICC=0.58). Online exclusivity (median=6, range 1 to 10, ICC=0.54) and parasociality (median=6, range 1 to 10, ICC=0.53) had an averaged distribution and medium ICC values.

The four SMA components - Salience, Mood modification, Social conflict, and Withdrawal - each correlated with anxiety scores. The correlation coefficients were as follows: Salience (0.28), Mood modification (0.08), Social conflict (0.35), and Withdrawal (0.33). All correlations were statistically significant (P<0.001). The correlations indicate that Salience and Withdrawal had moderate positive relationships with anxiety, while Mood modification showed a smaller positive relationship, and Social conflict displayed a notable positive relationship. In contrast, SNS communication types were not associated with anxiety scores in the bivariate analysis.

Figure 1. Distribution of the four dimensions of communication type of the daily survey records (n=1009). Axis labels show the visual analog of the self-reported relative proportion of time on the type of communication exchanged with a range of one to ten. ICC was measured in two-way random effects models. A higher ICC score indicates that the values from individual participants were more consistent over time. IQR: Interquartile range. ICC: Intraclass correlation.

Multivariable regression

Table 2 presents the population-averaged effect from GEE models, in which day-to-day change in daily anxiety score was regressed on previous-day SMA dimensions, previous-day communication characteristics, and their interactions. All models use a lagged dependent variable and were adjusted for age, gender, race, COVID-19 adjustment disorder, major life events or exams, and previously

diagnosed anxiety or depression disorder.

Previous-day anxiety score was negatively associated with next-day anxiety level in all models (Table 2, Model D, β=-0.58, 95% CI 0.28-0.56). Without accounting for attributes of communication, the salience component of SMA was associated with increased anxiety level (Table 2, Model A, β=0.16, *P*=0.01). The effect of withdrawal was also positively associated with anxiety score (β=0.10, *P*=0.07). Mood modification was associated with decreased anxiety level (β=-0.09, *P*=0.05). The effect of social conflict was not statistically significant (*P*>0.1). In Model B, communication characteristics are added to the model. None of the communication dimensions were independently associated with anxiety level. The full model (Model C) includes SMA components, communication characteristics, and the interaction terms of all pairwise combinations (4×4) of these dimensions. The main effects of SMA components and communication characteristics are similar to those in the first two crude models. Four significant interaction effects stand out: parasociality negatively moderated the effect of mood modification; consumption and parasociality positively moderated the effect of social conflict; broadness negatively moderated the effect of withdrawal.

In the parsimonious model (Model D), parasociality negatively moderated the effect of mood modification (β=-0.03, *P*=0.01); consumption and parasociality positively moderated the effect of social conflict (β=0.02, *P*=0.02; and β=0.03, *P*=0.02, respectively). That is, for every 1-standard-deviation increase in consumption, the effect of social conflict on next-day anxiety increased by 2% (95% CI 0.04%-4%). For every 1-standard-deviation increment in parasociality, the effect of social conflict on next-day anxiety increased by 3% (95% CI 1%-5%). The interaction of broadness and withdrawal was not significantly significant.

Model fit improved significantly in the full and parsimonious models accounting for the interactions between SMA components and communication types.

Table 2. Population-averaged effect of social media addiction and communication type on prospective daily anxiety score (*n*=1009)

	Model A: SMA only			Model B: Communication types only			Model C: Full model			Model D: Parsimonious model		
	β	*SE*	*P*	β	*SE*	*P*	β	*SE*	*P*	β	*SE*	*P*
Intercept	0.03	0.55	.96	-0.13	0.46	.79	0.03	0.16	.84	-0.42	0.51	.41
Lagged anxiety score	-0.34	0.05	<.001	-0.45	0.06	<.001	-0.15	0.02	<.001	-0.58	0.07	<.001
SMA components												
Salience	0.16	0.06	.01				0.05	0.02	.01	0.05	0.02	.01
Mood modification	-0.09	0.05	.05				-0.03	0.02	.08	-0.02	0.01	.10
Social conflict	0.07	0.05	.17				0.02	0.02	.31	0.02	0.02	.27
Withdrawal	0.10	0.05	.07				0.04	0.02	.03	0.04	0.02	.02
Communication types												
Consumption				0.03	0.04	.42	0.02	0.01	.18	0.02	0.01	.19
Broadness				-0.03	0.04	.48	-0.02	0.01	.12	-0.02	0.01	.14
Online exclusivity				0.04	0.06	.44	0.01	0.02	.40	0.02	0.02	.28
Parasociality				-0.02	0.05	.61	0.004	0.02	.81	<0.001	0.01	.98
SMA components × Communication types												
Salience ×												
Consumption							-0.01	0.02	.45	–[a]		
Broadness							0.01	0.02	.72	–[a]		
Online exclusivity							0.02	0.02	.32	–[a]		
Parasociality							0.001	0.01	.92	–[a]		
Mood modification ×												
Consumption							0.001	0.01	.92	–[a]		
Broadness							0.01	0.02	.65	–[a]		
Online exclusivity							-0.02	0.02	.29	–[a]		
Parasociality							-0.02	0.01	.07	-0.03	0.01	.01
Social conflict ×												
Consumption							0.03	0.01	.07	0.02	0.01	.03
Broadness							0.01	0.01	.44	–[a]		
Online exclusivity							-0.002	0.02	.90	–[a]		
Parasociality							0.03	0.02	.05	0.03	0.01	.02
Withdrawal ×												
Consumption							-0.001	0.01	.94	–[a]		

Broadness			-0.02	0.01	.07	-0.01	0.00 9 .21
Online exclusivity			0.004	0.02	.87	–[a]	
Parasociality			-0.02	0.02	.30	–[a]	
QICu/CIC	827.3/30.5	870.4/24.6	148.2/55.2			124.9/40.8	
Residual Std. Dev.	0.93	0.96	0.28			0.28	

All models were adjusted for age, gender, race, COVID-19 adjustment disorder, major life events or major exams, and previously diagnosed anxiety or depression disorder. Standardized Regression coefficients (β) reflect the percent change in the anxiety as a function of a 1-standard-deviation change in the predictor variables. SMA: social media addiction.

[a] Interaction terms were insignificant in the full model at *P*=.1 level and were not carried forward to the subsequent model.

Stratified by communication types

The results of a stratified analysis further examined the effects of SMA based on the levels of the moderating dimensions of communication (Figure 2). For the three pairs of significant interactions identified in the multivariable analysis, the models were rerun on the tertiles of their corresponding dimension of communication.

For participants with the lowest level of consumption versus composition of content, the effect size of social conflict on anxiety score was close to zero and was not statistically significant (P>0.05). For the group with the highest level of consumption versus composition of content, a 1-standard-deviation increase in social conflict was associated with a 13% increase in anxiety level the next day (95% CI 5%-20%). For the interaction between parasociality and mood modification, the effects were not statistically significant in stratified groups (P>0.05). For the study sample with the least amount of one-sided social media interaction, the effect of social conflict on anxiety score was not statistically significant (P>0.05). But for the group with the highest level of consumption, a 1-standard-deviation increase in social conflict was associated with an 11% increased anxiety level the next day (95% CI 4%-17%).

Figure 2. Stratified analysis of the effects of SMA components on anxiety based on tertiles of the dimensions of communication type. Coefficients indicate percentage changes in the outcome as a function of a 1-standard-deviation increase in the SMA component. SMA: social media addiction.

Discussion

In this analysis of the moderating role of social media use type in the association between SMA and anxiety among young adults, we found that not all styles of social media use carry the same risks of heightened anxiety. Young adults whose social media interactions were characterized by consumption rather than composition experienced significant increases in SMA-induced anxiety. Similarly, young adults with primarily parasociality experienced significant increases in SMA-induced anxiety, an effect not observed in those with low or moderate interaction levels.

We also observed a pronounced effect of social conflict in the interactions between SMA and communication types. The results indicate that SMA problems make individuals more susceptible to experiencing interpersonal and productivity-related conflicts. This aligns with prior studies pointing out that behaviors characterizing social conflict are the most observable among SMA components [24, 31]. Recognizing this, it's crucial to investigate further how different facets of social media use can either exacerbate or alleviate these conflicts, especially since such conflicts have profound implications for mental health and daily functioning. More comprehensive research on social conflict induced by SMA will be essential to inform interventions aimed at reducing the adverse effects of problematic social media use.

A core finding was the negative impact of excessive consumption as opposed to

composition, or what is often termed "passive use", on anxiety. This is consistent with Frison's study which linked passive use of social media with depressive moods in adolescent girls, ascribed largely to upward social comparison [17]. Conversely, active use, encompassing activities like posting photos and sending personal messages, was found beneficial due to the perception of increased online social support. Our findings reaffirm the potential dangers of passive consumption, particularly given the personalized content and highly self-relevance information prevalent on social media platforms [32, 33]. These patterns of consumption have been linked to sensation seeking [20, 34], attentional deficits [35], and even structural brain changes among young adults [35]. Future research should delve deeper into the mechanisms to explain how consumption exacerbates SMA-related anxiety.

Our research also underscored role of parasociality in exacerbating SMA-related anxiety. Engaging in parasociality, which are devoid of genuine relational feedback [5, 11, 15], can detract from time spent on meaningful, supportive relationships [36]. Interestingly, increased parasociality was observed to have an almost immediate impact on next-day anxiety, suggesting potential mechanisms beyond just impairing other social interactions. While some argue that moderate levels of parasociality can foster feelings of community and identity exploration among young adults [37], our findings emphasize the importance of understanding and balancing such interactions to mitigate potential negative effects on mental well-being.

Our findings contribute to the growing body of literature emphasizing the cognitive implications of social media behaviors and their parallels in real-world social interactions (see a review by [38]). It's imperative to understand that communication types on social media platforms are often intertwined. While beyond the scope of the current study, a more comprehensive understanding of how communication dimensions interact is needed. Further research to examine these interrelations could ultimately inform interventions to promote healthier online communication.

Limitations

This study's conclusions are constrained by its dependence on participants' self-reporting of their social media use, which introduces variability in the interpretation of activity types and hinders direct comparisons across subjects. Furthermore, reported proportions of communication types, such as "consumption," may not accurately reflect actual time spent, complicating the assessment of exposure's impact. We employed calibration questions to standardize activity ratings, required at the beginning of the daily survey to allow participants to break down the time, sessions, and platforms on social media and help them preserve an objective review and estimation. Our sensitivity analysis, which included converting self-reported data into actual usage time, confirmed the consistency of our results.

Secondly, the predominance of female participants in our sample suggests a need for subsequent research to incorporate a more balanced gender representation. Moreover, the timing of the study—conducted during the initial COVID-19 outbreak—might have influenced the generalizability of the findings, given the potential for heightened stress

levels among participants. However, we controlled for gender and COVID-19-related distress in our regression and stratified analyses.

Notwithstanding these limitations, the study's methodological strengths lie in its use of an ecological momentary assessment framework coupled with prospective design in regression estimation. This study design enhances the ecological validity of our findings and decreases retrospective bias, providing a reliable record of subjective experiences, anxiety trends, and the immediate effects of social media interaction.

Conclusions

Using a daily diary design, we found that two dimensions of social media communication significantly worsened the risk of anxiety associated with SMA among young adults. Young adults with high levels of passive social media use as defined by consumption and parasociality experienced significantly higher risk of next-day anxiety. experienced significant increases in SMA-induced anxiety. Future research should systematically examine how the nature of social media communication—rather than just its quantity—shapes anxiety risk. Deepening understanding of the mechanisms linking problematic social media use, communication type, and anxiety can inform interventions to promote healthier use of social media among young adults.

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Ethics approval and consent to participate

Ethical approval for the study was obtained from the New York University Institutional Review Board (IRB-FY2020-4578). Informed consent to participate was obtained from all of the participants in the study.

Authors' contributions

CAW: Conceptualization, Formal Analysis, Methodology, Project administration, Writing original draft. JB: Data curation, Methodology, Investigation. SD: Project administration, Investigation, Resources. JZ: Formal Analysis, Software. RT: Investigation, Software. LL: Investigation. MAH: Validation, Writing review & editing, Resources.

Funding

The study process required minimal funding from NYU internal faculty, and the funding source was not involved in the research process.

Conflicts of Interest

We declare no competing interests.

Abbreviations

EMA: ecological momentary assessment
SMA: social media addiction

SNS: Social networking site

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Supplementary Textbox 1. Measure of COVID-19-Related Adjustment Disorder.

Participants identified their most significant stressor since the onset of the pandemic in March 2020 from a list of ten options, including “Overwhelmed by information,” “Disrupted ability to work or learn,” “Death of a loved one,” “Moving,” “Reduced/suspended social life,” “Financial difficulties,” “Family conflict,” “Serious illness,” “Unemployment,” and “Illness/care of a loved one.” This selected stressor was used in the International Adjustment Disorder Questionnaire (IADQ) main scale, which consists of six items assessing difficulty in adaptation (e.g., “I find it difficult to relax and feel calm after [Overwhelmed by information]”) and functional impairment (e.g., “Has [Overwhelmed by information] affected your relationships or social life?”). Participants rated these items on a Likert scale from 0 (No) to 3 (Extreme). A score of 10 or higher indicated moderate adjustment disorder, while a score of 14 or higher

indicated severe adjustment disorder.

Supplementary Textbox 2. Social media addiction scale. Dimensions of the items: Salience (s), Mood modification (m), Social conflict (c), Withdrawal (w). SNS: social networking sites.

Scoring: Scored 1 (Rarely), 2 (Sometimes) 3 (Over half of the day) 4 (All the time) for items. Higher scores indicate more addictive symptoms. SNS: social networking sites.
Scale items:
While I study/work, my mind remains on the social networking sites. (s)
The sites help to lift my mood. (m)
I find it difficult to switch off while I am on the sites. (s)
I feel like going to the sites whenever I am upset. (m)
I check my SNS accounts before starting any task or activity. (s)
I feel at ease when I am on the sites. (m)
I prefer the excitement of the sites over being with my close friends. (c)
I find myself anticipating when I will go on the sites again. (w)
I've given less priority to hobbies, leisure activities, and exercise because of time spent on the sites. (c)
I've become restless when I do not have time to log in to the sites. (w)
I feel defensive or secretive if someone bothers me while on the sites. (c)
I feel frustrated when I cannot use the sites. (w)

Supplementary Table 1. Distribution, intraclass correlations, and association measures of daily-level social media behavioral variables. Variables are the aggregates from the 14-day follow-up records (*n*=1009).

Variables	Min	Max	Median (IQR)	ICC	Corr. With Anxiety Score
Social media communication dimensions					
Consumption	1	10	9 (3)	0.40	<0.01[a]
Broadness	1	10	8 (4)	0.58	-0.01[a]
Online exclusivity	1	10	6 (5)	0.54	<0.01[a]
Parasociality	1	10	6 (5)	0.53	0.02[a]
Social media addiction (SMA)					
Salience	3	12	6 (3)	0.65	0.28[b]
Mood modification	3	12	6 (2)	0.65	0.08[b]
Social conflict	3	12	4 (2)	0.71	0.35[b]
Withdrawal	3	12	4 (2)	0.74	0.33[b]
Sum score	12	48	20 (8)	0.75	0.30[b]
Anxiety score	7	28	12 (8)	0.65	/

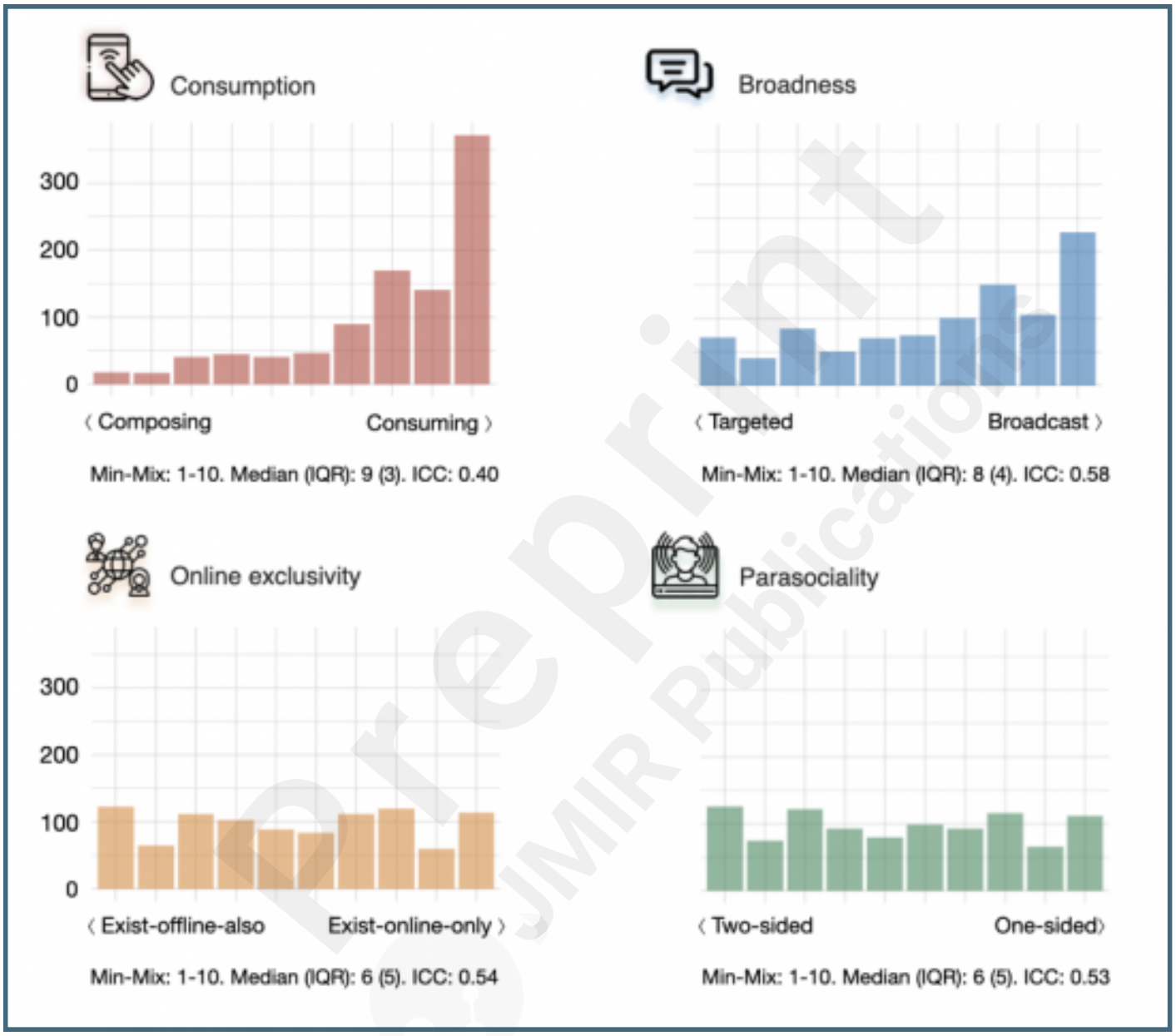
Note: Scores were measured by a GAD-7 anxiety scale adapted for daily measures. ICC was measured in two-way random-effect models. A higher ICC score indicates that the

values from individual participants were more consistent over time. Correlation coefficients were measured by Kendall's rank correlation τ. IQR = Interquartile range. ICC = Intraclass correlation coefficient.
[a]*P*>.1
[b]*P*<.001

Supplementary Files

Figures

Distribution of the four dimensions of communication type of the daily survey records (n=1009). Axis labels show the visual analog of the self-reported relative proportion of time on the type of communication exchanged with a range of one to ten. ICC was measured in two-way random effects models. A higher ICC score indicates that the values from individual participants were more consistent over time. IQR: Interquartile range. ICC: Intraclass correlation.



Stratified analysis of the effects of SMA components on anxiety based on tertiles of the dimensions of communication type. Coefficients indicate percentage changes in the outcome as a function of a 1-standard-deviation increase in the SMA component. SMA: social media addiction.