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Research paper

Do people with elevated social anxiety respond differently to digital and face-to-face communications? Two daily diary studies with null effects

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ABSTRACT

Background: Retrospective studies have found that people with elevated social anxiety (SA) show a preference for digital/online communication, which may be due to perceptions of enhanced emotional safety. Whether these individuals prefer digital compared to face-to-face communication and experience emotional benefits naturalistically remains unclear.

Methods: We recruited college students (N = 125) and community adults (N = 303) with varying levels of SA and sampled their emotions during digital and face-to-face communication using ecological momentary assessment (EMA) (Study 1) and a day reconstruction method (DRM) (Study 2). We preregistered our hypotheses (https://osf.io/e4y7x/).

Results: Results from both studies showed that SA did not predict the likelihood of engaging in digital compared to face-to-face communication, and SA was associated with less positive and more negative emotions regardless of the communication medium. Study 2 showed that whether digital communication was synchronous (e.g., in real time via phone/video chat) or asynchronous (e.g., texting/instant messaging) did not impact the association between SA and emotions.

Limitations: EMA and DRM methods, despite their many advantages, may be suboptimal for assessing the occurrence of digital communication behaviors relative to more objective methods (e.g., passively collecting smartphone communication data). Using event-contingent responding may have also yielded more reports of digital communication, thus strengthening our power to detect small, cross-level interaction effects.

Conclusions: These results challenge beliefs that digital/online communication provides a source of emotional

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Data Availability: The data featured in this report are available via the Open Science Framework (https://osf.io/e4y7x/).

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safety for people with elevated SA and suggests a greater need to address SA-related emotional impairments across digital communication platforms.

1. Introduction

Elevated social anxiety (SA) is characterized by excessive fear and avoidance of social and evaluative situations (Heimberg et al., 2010; Hofmann, 2007; Rapee and Heimberg, 1997). When communicating face-to-face, people with elevated SA tend to think and behave in ways that exacerbate negative emotions and dampen positive emotions. They often overestimate social threats and underestimate their social abilities (Clark and Wells, 1995). They are prone to allocating excess attention to negative social information, interpreting neutral information as negative, and discounting positive information (Mellings and Alden, 2000; Pineles and Mineka, 2005). People with elevated SA tend to avoid social situations or engage in safety behaviors (e.g., averting eye contact, limiting self-disclosure) to reduce their risk of embarrassment or rejection; however, these behaviors only serve to prevent disconfirmation of feared outcomes (Kim, 2005; Wells et al., 1995).

For people with elevated SA, difficulties with face-to-face communication can impair relationship and life satisfaction (Barrera and Norton, 2009; Wittchen et al., 1999). Yet, many of these individuals still communicate on a regular basis, and we know little about the nature of their communication behaviors. Researchers have speculated that young adults with elevated SA rely more on digital/online communication platforms as an alternative to in-person interactions. One retrospective study of high school students (Pierce, 2009) found a positive association between SA and communicating with others online and via text message; however, low SA was also associated with making friends online, which could ostensibly lead to increased in-person communication. Other retrospective research suggests that young adults with elevated SA spend more time on Facebook but do so passively rather than actively communicating with others (Erwin et al., 2004; Shaw et al., 2015). Taken together, retrospective reports suggest that some association exists between SA and digital/online communication. These studies should be interpreted with caution, however, as retrospective measures of digital communication behaviors have shown only moderate correlations with daily diary data and momentary assessments (Naab et al., 2018; Scharkow, 2016). Researchers require more advanced methods to gain a clearer understanding of whether SA is associated with digital communication naturalistically.

Regardless of their objective communication behaviors, people with elevated SA may believe digital communication offers a safer context for interpersonal connection, self-disclosure, and emotional expression compared to in-person interactions (Erwin et al., 2004; Schouten et al., 2007; Shepherd and Edelmann, 2005). Research suggests people with elevated SA perceive greater control and reduced risk of negative evaluation when communicating digitally compared to face-to-face (Lee and Stapinski, 2012). This may be particularly true for texting, instant messaging, or other forms of asynchronous digital communication (e.g., digital communication that does not unfold in real time), which allow people to conceal their appearance, hide mistakes in speech, and take more time to craft desirable responses. If people with elevated SA do find digital communication advantageous, they may experience associated emotional benefits (e.g., when using asynchronous methods specifically).

When communicating online compared to face-to-face, research demonstrates people with elevated SA report greater feelings of comfort and self-disclosure (Weidman et al., 2012). Additionally, those who spend more time on the internet perceive strong social support and encouragement from their online communities (Erwin et al., 2004). While these studies did not capture real-time communication or emotions, data suggest people with elevated SA experience more positive and less negative emotions when communicating digitally compared to face-to-face.

A large body of research on the phenomenology of SA also suggests that people with elevated SA tend to think, behave, and regulate their emotions in maladaptive ways across a range of social contexts (e.g., Clark and Wells, 1995; Kashdan et al., 2013; 2014; Kim, 2005; Mellings and Alden, 2000; Pineles and Mineka, 2005; Wells et al., 1995). Why, then, would digital social contexts be any different? This literature suggests a competing hypothesis that people with elevated SA experience similar emotional impairments regardless of communication medium (digital or face-to-face), as they are still interacting with others, are susceptible to negative evaluation, and exhibit similar maladaptive cognitive/attentional biases that impair functioning during face-to-face interactions.

To better understand the influence of SA on communication behaviors and how people with elevated SA feel when they are communicating digitally versus face-to-face, we conducted two studies involving college students (N = 125) and community adults (N = 303), respectively, with varying levels of SA. In Study 1, we intensively sampled momentary communication habits 10 times per day across seven consecutive days using ecological momentary assessment (EMA). At each assessment, participants reported on their momentary positive and negative emotions and whether they were communicating with others digitally/online (e.g., texting, video chatting, Facebook messaging) or face-to-face. Because EMA data are captured naturalistically, they provide insight into how emotions spontaneously change in response to real-world events (in this case, momentary communication medium) while circumventing issues related to retrospective recall bias (e.g., Stone et al., 2007).

We tested the same research question in Study 2 among community adults using the day reconstruction method (DRM) in which participants came into the laboratory and systematically reconstructed their five most meaningful experiences (i.e., episodes) from the previous day using strategies to reduce recall bias (Kahneman et al., 2004). For each episode, participants reported on their positive and negative emotions and whether they were communicating with others digitally or face-to-face. Unlike Study 1, participants in Study 2 also reported on whether their digital communication was synchronous (phone/video chatting) or asynchronous (text/instant messaging). Unlike traditional experience-sampling methods, the DRM reduces participant burden, does not interrupt daily activities, and allows for the contiguous assessment of episodes spanning an entire day rather than specific moments. DRM data have been shown to correspond with data from traditional experience-sampling reports (Kahneman et al., 2004).

To enhance transparency and contribute reproducible research (e.g., Fox et al., 2017), we pre-registered our data analytic strategy and the following hypotheses (https://osf.io/e4y7x/):

1 People with elevated levels of SA will have more instances of digital compared to face-to-face communication throughout the course of a week.
2 Existing research suggests two possible ways that communication medium may influence the association between SA and experienced emotions.
   a Some retrospective research suggests that people with elevated SA find digital communication to be less threatening than in-person interactions (Erwin et al., 2004). As such, those with elevated SA may experience higher positive and lower negative emotions during digital compared to face-to-face communication.
   b Other work indicates people with elevated SA exhibit emotional

impairments and negative cognitive biases across a wide range of social and evaluative situations (e.g., Clark and Wells, 1995; Kashdan et al., 2013; 2014; Kim, 2005; Mellings and Alden, 2000; Pineles and Mineka, 2005; Wells et al., 1995). This suggests that those with elevated SA may experience similar levels of positive and negative emotions regardless of whether they are communicating digitally or face-to-face.

3 As an exploratory analysis (i.e., not pre-registered), we tested whether the style of digital communication (synchronous versus of asynchronous) moderated the association between SA and positive and negative emotions during daily episodes in Study 2.

2. Study 1

2.1. Method

2.1.1. Participants

As part of an ongoing research program focused on the etiology of mood and anxiety disorders, undergraduate students (n = 2501) completed screening measures of negative emotionality (i.e., the propensity to experience and express more frequent, intense, and enduring anxiety, worry, and other negative emotions; Shackman et al., 2016, Shackman et al., 2018) in exchange for course extra credit. Data from the screening measures were stratified by tertile (high, medium, low) and sex (male, female). For the present study, 133 undergraduates with consistent smartphone access were independently and randomly recruited via email from each of the resulting six strata, allowing us to sample participants with a broad spectrum of emotional functioning (including SA) without gaps or discontinuities.

Eight participants were excluded from data analysis: six were excluded for insufficient compliance with the EMA protocol (<50% completed assessments) and two were excluded due to missing SA data. The final sample consisted of 125 participants (50.4% women; 53.2% White, 16.1% Asian, 12.9% Black, 11.3% Multiracial/Other, and 6.5% Hispanic). The mean age was 19.3 years old (SD = 1.6). The final sample did not differ significantly from the initial screening sample on demographics. At enrollment, participants provided written informed consent, were trained on the EMA protocol, and completed a measure of trait SA. The University of Maryland's Institutional Review Board approved all procedures.

2.1.2. EMA procedures

We used SurveySignal (Hofmann and Patel, 2015) to deliver 10 text messages per day over seven consecutive days to each participant's smartphone, which contained links to brief online surveys. For each survey, participants answered questions about whether they were communicating when pinged, the medium of communication (i.e., digital or face-to-face), and emotional experience when communicating (i.e., participant ratings of emotional experience during the interaction). Because the focus of this study was on digital versus face-to-face communication, all instances in which participants were either communicating both digitally and face-to-face at the same time (e.g., text messaging when interacting with a group in person; n = 517) or not communicating at all (n = 3161) were removed prior to analysis, leaving a total of 3172 observations in which people were communicating either digitally or face-to-face.

Text messages were delivered between 8:30 AM and 11:00 PM and successive messages were delivered between 1 and 2 h apart (M = 86.5 min, SD = 14.7 min). Participants took an average of 3.25 min to complete each survey (SD = 5.65 min). During weekday hours, we only delivered surveys between regularly scheduled university courses to maximize compliance. Participants were instructed to complete each survey within 30 min of being texted. Participants were also cautioned to avoid responding at unsafe or inconvenient moments (median response latency = 8.78 min, SD = 15.85 min). At enrollment, we used several well-established procedures to maximize compliance and data quality (Palmier-Claus et al., 2011): (1) delivering a test message to the participant's phone in the laboratory and confirming that they were able to successfully complete the online survey, (2) providing participants with a 24/7 technical support number, (3) 24-h and 72-h check-in calls or emails, (4) real-time monitoring of compliance and re-contacting participants showing low levels of compliance, and (5) monetary bonuses for strong compliance. Participants were debriefed and compensated after the seventh and final day of data collection. In the final sample, EMA compliance was acceptable (M = 79%, SD = 11%) and unrelated to SA (r = 0.04, p = .66).

2.1.3. Measures

2.1.3.1. Trait

2.1.3.2.0. Social anxiety. Trait-level SA symptoms were assessed using the 20-item Social Interaction Anxiety Scale (SIAS; Mattick and Clarke, 1998). Items assess fear and anxiety when interacting with others using a 5-point Likert scale (0 = not at all characteristic or true of me; 4 = extremely characteristic or true of me). Sample items include, “I worry about expressing myself in case I appear awkward,” and, “I find myself worrying that I won't know what to say in social situations.” The SIAS reliably discriminates individuals with SA disorder from those with other anxiety disorders (Brown et al., 1997; Cox et al., 1998) and shows excellent psychometric properties (Rodebaugh et al., 2006) (α = 0.96).

2.1.3.3. Momentary

2.1.3.4.0. Emotions. Participants rated their levels of the following six emotions at the moment they were pinged: cheerful, happy, joyful, anxious, nervous, and uneasy (e.g., “How cheerful were you feeling at ping?”) using a 5-point Likert scale (1 = Not at all; 5 = Very). Given strong correlations between cheerful, happy, and joyful (rs = 0.84–0.89) and nervous, anxious, and uneasy (rs = 0.71–0.78), we created composite scales for positive and negative emotions. We then used well-established procedures outlined by Nezlek (2012; 2017) to compute the reliability of multi-item scales in the context of a multilevel design. Reliability was acceptable for both the positive (α = 0.88) and negative emotion scales (α = 0.88).

2.1.3.5.0. Communication. Participants reported the communication medium used when pinged by answering “Yes” or “No” to the following items: “Were you engaged in face-to-face conversation at ping?” “Were you engaged in real-time digital (phone, text, Facebook, video) conversation at ping?” Participants were instructed to only endorse “Yes” if they were communicating at the moment they were pinged. For example, participants having an ongoing text exchange with a friend would not endorse “Yes” unless they were actively texting when pinged. Passive social media use (e.g., scrolling) or commenting on posts did not count as communication.

2.1.3.6. Data analytic strategy. To evaluate the interdependence of the data, intraclass coefficients (ICCs) were calculated for both outcomes: momentary positive and negative emotions. Given the 3-level structure of the data (moments within days within people), we first examined the proportion of variance in outcomes attributable to days, then within people. Results showed that neither momentary positive emotions nor negative emotions varied significantly across days (ICCs = 0.01). However, both positive and negative emotions varied significantly across people. As such, we constructed 2-level models with momentary observations nested within people to test primary competing hypotheses.

Analyses were conducted using R 3.6.1 (R Core Team, 2013). To test whether SA was associated with a higher likelihood of engaging in momentary digital versus face-to-face communication (see hypothesis 1), we conducted a logistic regression with SA centered at the grand mean predicting binary communication medium (0 = face-to-face;

1 = digital). Because SA is a person-level predictor, it was not necessary to account for nesting, and we used ordinary least-squares regression.

To test our primary question – whether the associations between SA and momentary emotions differed depending on communication medium (Hypotheses 2a and 2b) – we constructed 2-level models using maximum likelihood estimation to examine associations between SA (level 2), communication medium (digital or face-to-face; level 1), and their interaction predicting momentary positive and negative emotions (both at level 1). SA was grand-mean centered and communication medium, a dichotomous variable, was not.

2.2. Results

2.2.1. Descriptive statistics

Descriptive statistics and between- and within-person correlations are presented in Tables 1 and 2. The mean score on the SIAS was 25.98 (SD = 17.98; range = 64), which is consistent with other college samples recruited on the basis of trait-level negative emotions (Adkins et al., 2008).

2.2.2. Hypothesis testing

Contrary to our pre-registered hypothesis, SA was not associated with a greater likelihood of engaging in momentary digital compared to face-to-face communication ($b = -0.0001$; SE = $z = -0.052$; $p = .959$) (see Tables 3a and 3b). For hypotheses 2a and 2b, there were significant main effect of SA on momentary positive and negative emotions while controlling for communication medium and the interaction between SA and communication medium. Higher levels of trait SA were associated with lower levels of momentary positive emotions ($b = -0.02$; SE = 0.004; $t = -3.39$; $p < .001$) and higher levels of momentary negative emotions ($b = 0.01$; SE = 0.003; $t = 4.79$; $p < .001$) on average. The interaction between SA and communication medium was not a significant predictor of momentary positive or negative emotions (see Tables 4a and 4b).

3. Study 2

3.1. Method

3.1.1. Participants

We recruited 303 community adults living in the D.C./Maryland/Virginia region

(66% women; 47.1% White, 20% Asian, 14.2% Black, 8.4% Hispanic, 3.5% Middle Eastern, 6.8% Other). The mean age was 31.1 (SD = 13.49). In the laboratory, participants provided written informed consent, completed a measure of trait SA, and responded to items assessing their emotions and communication behaviors during daily episodes using the DRM. George Mason University's Institutional Review Board approved all procedures.

3.1.2. DRM procedures

3.1.2.7. Day reconstruction survey. Using the Day Reconstruction Method (DRM; Kahneman et al., 2004), participants were instructed to "think about yesterday as a story with five different chapters, or episodes" and select five episodes of any length that stood out as being particularly meaningful/memorable. Starting with their first episode from the previous day then proceeding chronologically, participants answered questions about their emotions and whether they communicated with anyone during each episode in-person or digitally.

3.1.3. Measures

3.1.3.8. Trait

3.1.3.9.0. Social anxiety. As with Study 1, we used the 20-item SIAS to measure trait-level SA symptoms in Study 2 (SIAS; Mattick and Clarke, 1998) ($\alpha = 0.94$).

3.1.3.10. Day reconstruction

3.1.3.11.0. Emotions. Using an affect grid adapted from Russell et al., 1989, participants rated four positive emotions (enthusiastic, cheerful, content, relaxed) and six negative emotions (nervous, angry, sad, tired, ashamed, bored) that characterized each episode, averaged to create composite positive ($\alpha = 0.58$) and negative emotion ($\alpha = 0.47$) variables, respectively.

3.1.3.12.0. Communication. Participants reported the communication medium used during each episode by answering the question, "Were you interacting with anyone (including on the phone, online, etc.)?" Participants then endorsed one or more of the following options: "Yes: In-person," "Yes: Phone/Skype" (synchronous), "Yes: Texting/Instant Messaging" (asynchronous), "No: Not interacting with anyone."

3.1.3.13. Data analytic strategy. Analyses were conducted using R 3.6.1 (R Core Team, 2013). To evaluate the interdependence of the data, intraclass coefficients (ICCs) were calculated for both outcomes: momentary positive and negative emotions, and results showed that positive (ICC = 0.27) and negative emotions (ICC = 0.32) varied significantly across days. As such, we constructed 2-level models with daily episodes nested within people to test hypotheses.

To test whether SA was associated with a higher likelihood of engaging in momentary digital versus face-to-face communication (see hypothesis 1), we conducted a logistic regression with grand mean-centered SA predicting binary communication medium (0 = face-to-face; 1 = digital). Because SA is a person-level predictor, it was not necessary to account for nesting, and we used ordinary least-squares regression.

To test our primary question – whether the associations between SA and momentary emotions differed depending on communication medium (Hypotheses 2a and 2b) – we constructed 2-level models using maximum likelihood estimation to examine associations between SA (level 2), communication medium (digital or face-to-face; level 1), and their interaction predicting momentary positive and negative emotions (both at level 1). SA was grand-mean centered, and communication

Table 1
Study 1 between- and within-person correlations.

	Communication Medium	Momentary Positive Emotions	Momentary Negative Emotions	Social Anxiety
Communication Medium	–	−0.04*	.04*	N/A
Momentary Positive Emotions	.10	–	−0.32*	N/A
Momentary Negative Emotions	.14	−0.22*	–	N/A
Social Anxiety	−0.08	−0.28*	.42*	–
M	.36	3.09	1.76	25.98
SD	.48	1.17	.91	17.98

Notes. *$p < .05$. Between-person correlations are below the diagonal and within-person correlations are above. Communication Medium is a binary variable (0 = face-to-face; 1 = digital). Social Anxiety was measured at the trait level. N/A = no within correlations for Social Anxiety, which is a person-level variable. Positive and negative emotions were scored on 1–5 scales.

Table 2
Study 2 between- and within-person correlations.

	Communication Medium	Async/Sync	Episode-level Positive Emotions	Episode-level Negative Emotions	Social Anxiety
Communication Medium	–	.00	.02	−0.01	N/A
Async/Sync	.17*	–	−0.13	.16*	N/A
Episode-level Positive Emotions	.01	−0.01	–	−0.59*	N/A
Episode-level Negative Emotions	.13*	.10	−0.31*	–	N/A
Social Anxiety	.01	.04	−0.35*	.29*	–
M	.24	.52	2.04	.58	1.32
SD	.43	.50	1.21	.61	.80

Notes. *$p < .05$. Between-person correlations are below the diagonal and within-person correlations are above. Async/Sync = Asynchronous versus synchronous digital communication. Communication Medium (0 = face-to-face; 1 = digital) and Async/Sync (0 = Text/instant messaging; 1 = Phone/Skype) are binary variables. Social Anxiety was measured at the trait level. N/A = no within correlations for Social Anxiety, which is a person-level variable. Positive and Negative emotions were scored on 0–4 scales.

Table 3a
Study 1 logistic regression: Social anxiety predicting the odds of momentary face-to-face versus digital communication.

	b	SE	*p*
(Intercept)	−0.56	0.04	<0.001
Social Anxiety	0.00	0.00	0.96

Notes. Face-to-face communication = 0; Digital communication = 1.

Table 3b
Study 2 logistic regression: Social anxiety predicting the odds of face-to-face versus digital communication during yesterday's meaningful episodes.

	b	SE	*p*
(Intercept)	0.25	0.02	<0.001
Social Anxiety	−0.01	0.02	0.55

Notes. Face-to-face communication = 0; Digital communication = 1.

medium, a dichotomous variable, was not.

To test our exploratory question – whether the synchronous or asynchronous nature of communication impacted the association between social anxiety and emotions in daily life – we used similar 2-level models but entered a different binary variable as the moderator, in which 0 = asynchronous and 1 = synchronous. Observations in which participants engaged in both asynchronous and synchronous digital communication, in-person communication, in-person and digital communication (synchronous, asynchronous, or both) or engaged in no communication at all were excluded when calculating this variable. The result was a total of 102 episodes involving synchronous digital communication and 96 episodes involving asynchronous digital communication.

3.2. Results

3.2.1. Descriptive statistics

Descriptive statistics and between- and within-person correlations are presented in Tables 1 and 2. The mean score on the SIAS was 26.47 (SD = 16.09, range = 75), which is similar to the SIAS mean from Study 1 25.98 (SD = 17.98, range = 64) and slightly higher than in other studies of community adults (Mattick and Clarke, 1998; Rodebaugh et al., 2011).

3.2.2. Hypothesis testing

Results mirrored Study 1. Contrary to our pre-registered hypothesis, SA was not associated with a greater likelihood of engaging in digital compared to face-to-face communication ($b = -0.01$; SE = 0.02; $z = -0.60$; $p = .548$; see Tables 3a and 3b) during meaningful daily episodes. There were significant main effects of SA on momentary positive and negative emotions when controlling for communication medium and the interaction between SA and communication medium. Higher levels of trait SA were associated, on average, with lower levels of positive emotions ($b = -0.28$; SE = 0.07; $t = -4.06$; $p < .001$) and higher levels of negative emotions ($b = 0.13$; SE = 0.03; $t = 3.65$; $p < .001$) during meaningful daily episodes. The interaction between SA and communication medium was not a significant predictor of positive or negative emotions (see Tables 4a and 4b).

Counter to our exploratory hypothesis, the style of digital communication (i.e., synchronous versus asynchronous) did not moderate the association between SA and positive ($b = -0.41$; SE = 0.21; $t = -1.96$; $p = .052$) or negative emotions ($b = 0.14$; SE = 0.10; $t = 1.38$; $p = .169$) during daily episodes (Table 5).

3.3. General discussion

Previous research suggests that people with elevated SA prefer digital communication and perceive it as “safer” (e.g., Erwin et al., 2004; Schouten et al., 2007; Shepherd and Edelmann, 2005). In the current research program, we failed to find evidence that SA is associated with the use of and preference for digital versus face-to-face communication. This discrepancy has several possible explanations. First, the present research assessed communication naturalistically (with EMA) and when recalling yesterday's meaningful events in a structured manner (with the Day Reconstruction Method). Previous studies gathered retrospective data, which is considered a less accurate measure of digital/online communication behaviors (Naab et al., 2018; Scharkow, 2016).

Table 4a
Study 1 linear mixed effects moderation models with trait social anxiety, communication medium, and their interaction predicting momentary positive and negative emotions.

	Momentary Positive Emotions				Momentary Negative Emotions			
Predictor	*b*	SE	*t*	*p*	*b*	SE	*t*	*p*
(Intercept)	3.09	0.08	38.92	< 0.01	1.71	0.05	31.73	< 0.01
Social Anxiety	−0.02	0.00	−3.39	< 0.01	0.01	0.00	4.79	< 0.01
Communication Medium	−0.08	0.05	−1.61	0.11	0.09	0.05	1.67	0.10
SA x CM Interaction	0.00	0.00	0.19	0.85	0.00	0.00	0.89	0.38

Notes. Communication Medium (CM) = Digital versus face-to-face communication. SA = Social anxiety. SA × CM = Social anxiety and communication medium interaction.

Table 4b
Study 2 linear mixed effects moderation models with trait social anxiety, communication medium, and their interaction predicting positive and negative emotions during yesterday's meaningful episodes.

Episode-level Positive Emotions					Episode Negative Emotions			
Predictor	*b*	SE	*t*	*p*	*b*	SE	*t*	*p*
(Intercept)	2.06	0.05	38.24	< 0.01	0.54	0.03	21.17	< 0.01
Social Anxiety	−0.28	0.07	−3.98	< 0.01	0.13	0.03	3.84	< 0.01
Communication Medium	0.02	0.09	0.24	0.81	0.03	0.04	0.71	0.48
SA x CM Interaction	−0.09	0.12	−0.73	0.47	−0.01	0.06	−0.17	0.87

Notes. Communication Medium (CM) = Digital versus face-to-face communication. SA = Social anxiety. SA × CM = Social anxiety and communication medium interaction.

Second, people with elevated SA may find digital communication emotionally protective but typically cannot engage in more digital compared to face-to-face communication for logistical reasons (e.g., while at school or work). Lastly, people with elevated SA may also avoid communication indiscriminately (regardless of its form) since both digital and online communication hold the potential for scrutiny and negative evaluation.

Consistent with long-standing findings, results showed that levels of SA predicted greater positive and less negative momentary emotions (Kashdan, 2007). Communication medium did not influence this association in Study 1 or 2, suggesting that a person's level of SA is just as influential on emotions regardless of whether they are communicating digitally or face-to-face. Although it makes intuitive sense for digital communication to bring emotional relief to people with elevated SA, emerging research suggests that attentional and interpretation biases in SA extend to digital interactions as well (e.g., self-focused attention in video conferencing, Vriends et al., 2017; negative interpretation of ambiguous emojis, Derks et al., 2008), which could result in similarly impaired social and emotional functioning relative to face-to-face communication.

Exploratory analyses revealed that the effects of social anxiety on momentary positive and negative emotions did not depend on whether digital communication was synchronous or asynchronous. Although style of digital communication was not a significant moderator of the association between SA and both positive and negative emotions, we believe future studies with larger sample sizes should further explore these associations. When ignoring statistical significance and looking at the magnitude of moderation effects (particularly when predicting positive emotions), it may be that people with elevated social anxiety truly experience higher positive and lower negative emotions when communicating asynchronously compared to synchronously. However, we were not able to detect this effect given a smaller number of episodes during which digital communication was reported (n = 198) relative to the total number of episodes.

Findings from both studies require interpretative caveats. We assessed momentary emotions and communication behaviors 10 times per day in Study 1. To reduce participant burden, our assessment period was only one week. This may have limited our power to detect smaller cross-level interaction effects (e.g., the interaction between SA at the person level and communication medium at the momentary level). However, given the observed magnitude of the interaction effects (bs = 0.00), we do not anticipate that a larger sample size would change our conclusions.

Our findings should also be interpreted while noting measurement differences between Studies 1 and 2. DRM and EMA may not produce comparable odds ratios of behavior and the instruction to only record "meaningful" episodes from the previous day in Study 2 (which represents a slight deviation from established procedures; Kahneman et al., 2004) may have influenced the type and extent of communication participants reported (i.e., capturing communication that took place during meaningful as opposed to mundane, daily episodes). Though data suggest moderate to high correspondence between DRM and EMA (e.g., Dockray et al., 2010; Kahneman et al., 2004), more objective procedures, such as using mobile sensing technologies to passively collect digital (e.g., Harari et al., 2017) and in-person communication are more objective than both DRM and EMA. Ample resources are required to collect, process, and code mobile sensing data. Objective measures of real-time emotions during various communication behaviors (e.g., via skin conductance) may also be useful, but are challenging to obtain outside the laboratory.

Another limitation is the potential lack of temporal correspondence between DRM-reported emotions and communication behaviors. Since DRM episodes could be of any length (e.g., a few minutes to a couple of hours) and participants reported on their emotions during each episode broadly, perhaps reported emotions in a longer episode were only slightly influenced by a digital or face-to-face conversation that accounted for a small portion of that episode. Further, participants were instructed to only report "meaningful" episodes from their previous day, and previous research suggests that daily meaning is associated with daily positive and negative daily affect (King et al., 2006). Therefore, it may be that reported emotions were at least partially influenced by how meaningful the episode was in addition to how participants were communicating. Future studies should incorporate these and other episode-level details into theoretical and analytical models.

In addition to addressing these limitations, future studies can explore other contextual factors that influence the role of communication medium on the association between SA and momentary emotions. Interacting with a trusted loved one is likely to result in different emotional responses relative to interacting with a stranger. The same could be said about whether the conversation went well or poorly and

Table 5
Study 2 linear mixed effects moderation models with trait social anxiety, asynchronous/synchronous digital communication, and their interaction predicting momentary positive and negative emotions.

Episode-level Positive Emotions					Episode-level Negative Emotions			
Predictor	*b*	SE	*t*	*p*	*b*	SE	*t*	*p*
(Intercept)	2.08	0.13	16.68	< 0.01	0.54	0.07	8.22	< 0.01
Social Anxiety	−0.21	0.15	−1.37	0.17	0.07	0.08	0.82	0.42
Async/Sync	0.00	0.17	0.02	0.99	0.08	0.09	0.93	0.36
SA x Async/Sync Interaction	−0.38	0.20	−1.90	0.06	0.14	0.10	1.38	0.17

Notes. SA = Social Anxiety. Async/Sync = Asynchronous versus synchronous digital communication.
SA × Async/Sync = Social anxiety and asynchronous versus synchronous digital communication interaction.

whether focus was directed inwardly or toward the conversation partner. High-powered studies should also test whether asynchronous digital communication has momentary benefits for people with elevated SA (e.g., downregulating anxiety), why these benefits occur (e.g., allowing for concealment of one's voice or appearance, greater response time, lower perceived risk of negative evaluation), and how reliance on asynchronous digital communication affects anxiety during face-to-face communication among people with elevated social anxiety. To understand the generalizability of our inferences, future research should extend our approach to larger samples and people with greater symptom severity (e.g., with a diagnosis of social anxiety disorder).

The results of the present, pre-registered study show that people with elevated SA do not communicate more digitally as opposed to face-to-face, and when they do communicate digitally, it does not confer the emotional safety they might expect. Further, the style of digital communication (synchronous versus asynchronous) does not influence the association between SA and momentary emotions, but this may be a promising area of future study. These findings, if replicable, suggest people with elevated SA may display similar emotional impairments during face-to-face and digital communication. Clinical scientists should consider adapting existing SA interventions, such as exposures, to digital formats (e.g. video chatting) in order to reduce anxiety and improve functioning in these contexts.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2020.07.069.

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