# Social context and the real-world consequences of social anxiety

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### Abstract

**Background.** Social anxiety lies on a continuum, and young adults with elevated symptoms are at risk for developing a range of psychiatric disorders. Yet relatively little is known about the factors that govern the hour-by-hour experience and expression of social anxiety in the real world.
**Methods.** Here we used smartphone-based ecological momentary assessment (EMA) to intensively sample emotional experience across different social contexts in the daily lives of 228 young adults selectively recruited to represent a broad spectrum of social anxiety symptoms.
**Results.** Leveraging data from over 11 000 real-world assessments, our results highlight the central role of close friends, family members, and romantic partners. The presence of such close companions was associated with enhanced mood, yet socially anxious individuals had fewer confidants and spent less time with the close companions that they do have. Although higher levels of social anxiety were associated with a general worsening of mood, socially anxious individuals appear to derive larger benefits – lower levels of negative affect, anxiety, and depression – from their close companions. In contrast, variation in social anxiety was unrelated to the amount of time spent with strangers, co-workers, and acquaintances; and we uncovered no evidence of emotional hypersensitivity to these less-familiar individuals.
**Conclusions.** These findings provide a framework for understanding the deleterious consequences of social anxiety in emerging adulthood and set the stage for developing improved intervention strategies.

## Introduction

Socially anxious individuals are prone to heightened fear, anxiety, and avoidance of social interactions and situations associated with potential scrutiny (Alden and Taylor, 2004; Heimberg *et al.*, 2014). In addition to heightened negative affect (NA), socially anxious individuals tend to report lower levels of positive affect (PA) (Anderson and Hope, 2008; Kashdan and Collins, 2010; Kashdan *et al.*, 2011; Geyer *et al.*, 2018). Social anxiety symptoms lie on a continuum and, when extreme, can become debilitating (Lipsitz and Schneier, 2000; Katzelnick *et al.*, 2001; Kessler, 2003; Rapee and Spence, 2004; Craske *et al.*, 2017; Stein *et al.*, 2017; Krueger *et al.*, 2018; Conway *et al.*, 2019; Ruscio, 2019). Social anxiety disorder is among the most prevalent mental illnesses; contributes to the development of other psychiatric disorders, such as depression; and is challenging to treat (Schneier *et al.*, 1992; Rodebaugh *et al.*, 2004; Acarturk *et al.*, 2009; Mathew *et al.*, 2011; Neubauer *et al.*, 2013; Craske *et al.*, 2017; Stein *et al.*, 2017). Relapse and recurrence are common, and pharmaceutical treatments are associated with significant adverse effects (Bruce *et al.*, 2005; Rhebergen *et al.*, 2011; Scholten *et al.*, 2013, 2016; Gordon and Redish, 2016; Spinhoven *et al.*, 2016; Batelaan *et al.*, 2017). Yet the situational factors that govern the momentary experience and expression of social anxiety in the real world remain incompletely understood. To date, most of what it known is based on either retrospective report or acute laboratory challenges (Alden and Wallace, 1995; Beck *et al.*, 2006; Buote *et al.*, 2007; Afram and Kashdan, 2015; Crişan *et al.*, 2016).

As part of an on-going prospective-longitudinal study focused on individuals at risk for the development of mood and anxiety disorders, we used smartphone-based ecological momentary assessment (EMA) to intensively sample momentary levels of NA and PA in the daily lives of 228 young adults. Subjects were selectively recruited from a pool of 6594 individuals screened for individual differences in dispositional negativity (i.e. negative emotionality), the tendency to experience more intense, frequent, or persistent levels of depression, worry,

fear and anxiety – including social anxiety (Shackman *et al.*, 2016; Hur *et al.*, 2019). This 'enrichment' strategy enabled us to examine a broader spectrum of social anxiety symptoms than alternate approaches, such as convenience sampling. Because EMA data are captured in real time (e.g. *Who are you with?*), they circumvent the biases that can distort retrospective reports and provide insights into how emotional experience dynamically responds to moment-by-moment changes in social context (Barrett, 1997; Shiffman *et al.*, 2008; Csikszentmihalyi *et al.*, 2013; Lay *et al.*, 2017). We focused on young adulthood because it is a time of profound, often stressful developmental transitions (e.g. moving away from home, forging new social relationships; Hays and Oxley, 1986; Alloy and Abramson, 1999; Arnett, 2000; Pancer *et al.*, 2000). In fact, more than half of undergraduate students report overwhelming anxiety, with many experiencing the first onset or a recurrence of anxiety and mood disorders during this period (Auerbach *et al.*, 2016, in press; American College Health Association, 2016; Global Burden of Disease Collaborators, 2016; Stein *et al.*, 2017; Lipson et al., 2018). Those with elevated levels of social anxiety tend to experience substantial distress and impairment and are more likely to develop psychopathology (Merikangas *et al.*, 2002).

We were particularly interested in understanding how the momentary emotional experience of socially anxious individuals varies as a function of social context. Emotion is profoundly social (Fox and Shackman, 2018). Emotional experiences are routinely shared and dissected with friends, family, and romantic partners (Rime, 2009). Humans and other primates routinely seek the company of close companions in response to stressors, and increased social engagement promotes positive affect (Cottrell and Epley, 1977; Shackman *et al.*, 2018). Indeed, there is abundant evidence that close companions play a critical role in coping with stress and regulating negative affect (Bolger and Eckenrode, 1991; Myers, 1999; Wade and Kendler, 2000; Buote *et al.*, 2007; Marroquin, 2011; Zaki and Williams, 2013; Kendler and Gardner, 2014; Coan and Sbarra, 2015; Ramsey and Gentzler, 2015; Reeck *et al.*, 2016). Many of these beneficial effects appear to be disrupted in socially anxious individuals (Alden and Taylor, 2004).

We began by testing whether social anxiety is associated with the amount of time allocated to different social contexts (e.g. with close companions) and whether this reflects the number of self-reported confidants. Social avoidance is diagnostic of social anxiety disorder, is a key component of dimensional measures of social anxiety, and contributes to functional impairment and reduced quality of life (Turner *et al.*, 1986; Liebowitz, 1987; Beidel *et al.*, 1999; Strahan and Conger, 1999; APA, 2013). Among community samples, adults with elevated levels of social anxiety are less likely to have a close friend and more likely to be unmarried by mid-life (Davidson *et al.*, 1994). They are also more likely to be lonely (Lim *et al.*, 2016). Recent work using unobtrusive, smartphone-based global positioning system (GPS) data provides additional evidence suggestive of social inhibition and avoidance (Boukhechba *et al.*, 2018), demonstrating that socially anxious university students spend significantly less time at 'leisure' (e.g. gymnasiums, pubs, cinemas, and coffee shops) and 'food' (e.g. restaurants, food courts, and dining halls) locations during peak hours in the evening. Socially anxious students also spent more time at home or off-campus (e.g. parents' home), particularly on weekends, and visited fewer locations overall, suggesting a more restricted range of activities (see also Chow *et al.*, 2017). Whether this pattern reflects generalized avoidance,

specific avoidance of socially 'distant' individuals (e.g. strangers, acquaintances), or a lack of confidants remains unknown.

Next, we used a series of multilevel models (MLMs) to understand the interactive effects of social anxiety and the social environment on momentary affect. This enabled us to test whether socially anxious individuals experience heightened NA and attenuated PA in the presence of distant others, as one would expect based on laboratory studies of interactions with unfamiliar peers and researchers (Meleshko and Alden, 1993; Creed and Funder, 1998; Coles *et al.*, 2002; Kashdan and Roberts, 2004, 2006, 2007; Heerey and Kring, 2007; Kashdan *et al.*, 2013*b*; Crişan *et al.*, 2016). This expectation is reinforced by evidence from EMA studies that children with social anxiety disorder experience diminished PA in the presence of distant others (Morgan *et al.*, 2017). Whether this pattern is also evident in adults remains unknown.

Using a MLM approach, we also tested two competing predictions about the consequences of close companions. One possibility is that socially anxious individuals derive increased emotional benefits (e.g. lower levels of NA) from close companions. Consistent with this view, the presence of a friend has been shown to normalize behavioral signs of anxiety and reduce negative self-thoughts in socially anxious adults exposed to an experimental speech challenge (Pontari, 2009). Likewise, diary studies suggest that spousal support plays a key role in dampening negative affect among patients with social anxiety disorder (Zaider *et al.*, 2010) and EMA studies show that the presence of close companions is associated with disproportionately enhanced PA in children with social anxiety disorder (Morgan *et al.*, 2017) and adults with elevated levels of dispositional negativity (Shackman *et al.*, 2018). In fact, a variety of work suggests that individuals with low levels of psychological well-being and patients with depression reap larger emotional benefits from positive daily events (Rottenberg, 2017; Lamers *et al.*, 2018). Although socially anxious adults often show symptoms of depression and anhedonia, it is unclear whether similar benefits extend to this population.

A competing possibility is that socially anxious individuals fail to capitalize on available socio-emotional support. Indeed, socially anxious individuals tend to be less emotionally expressive, disclosing, and intimate with companions (Vernberg *et al.*, 1992; Meleshko and Alden, 1993; Sparrevohn and Rapee, 2009; Cuming and Rapee, 2010; Williams *et al.*, 2018). They perceive themselves as receiving less social support (La Greca and Lopez, 1998; Torgrud *et al.*, 2004; Cuming and Rapee, 2010); perceive their friendships to be of a lower quality (Rodebaugh, 2009; Rodebaugh *et al.*, 2015); are less satisfied with friends, family, and romantic partners (Stein and Kean, 2000; Starr and Davila, 2008; Wong *et al.*, 2012); and are prone to emotional neediness and over-reliance (Davila and Beck, 2002; Darcy *et al.*, 2005). Perhaps as a consequence, socially anxious individuals report elevated levels of interpersonal conflict (Cuming and Rapee, 2010) and many patients show profound impairment of interpersonal relationships (Wittchen *et al.*, 2000; Rapaport *et al.*, 2005; Olatunji *et al.*, 2007; Stein *et al.*, 2017). Taken together, these observations motivate the prediction that socially anxious individuals derive smaller emotional benefits or even costs (e.g. higher levels of NA) from close companions.

Discovering the situational factors associated with the real-world experience of social anxiety is important. The identification of potentially modifiable targets, such as social context, has the potential to guide the development of improved intervention strategies.

## Method

### Overview

As part of an on-going prospective-longitudinal study focused on individuals at risk for the development of internalizing disorders, we used well-established measures of dispositional negativity (often termed neuroticism or negative emotionality; Shackman et al., 2016; Shackman et al., 2018) to screen 6594 young adults (57.1% female; 59.0% White, 19.0% Asian, 9.9% African American, 6.3% Hispanic, 5.8% Multiracial/Other; $M = 19.2$ years, S.D. = 1.1 years). Screening data were stratified into quartiles (top quartile, middle quartiles, bottom quartile) separately for males and females. Individuals who met preliminary inclusion criteria were independently recruited from each of the resulting six strata. Approximately half the subjects were recruited from the top quartile, with the remainder split between the middle and bottom quartiles (i.e. 50% high, 25% medium, and 25% low). Given the typically robust relations between measures of dispositional negativity and social anxiety – $R^2 = 0.25$ in the present sample – this 'enrichment' strategy allowed us to examine a relatively wide range of social anxiety symptoms without gaps or discontinuities. All subjects were first-year university students in good physical health with consistent access to a smartphone. All reported the absence of a lifetime psychotic, bipolar, neurological, or developmental disorder. Given the focus of the larger prospective-longitudinal study on risk for the development of mental illness, all subjects reported the absence of current alcohol/substance abuse, suicidal ideation, internalizing disorder (past 2 months), and psychiatric treatment. To maximize the range of psychiatric risk, subjects with a lifetime history of anxiety and mood disorders were not excluded, as in prior studies of high-risk populations (Alloy et al., 2000). At the baseline laboratory session, subjects provided informed written consent, were familiarized with the EMA protocol (see below), and completed the social anxiety and social network assessments. Beginning the next day, subjects completed up to 8 EMA surveys/day for 7 days. All procedures were approved by the University of Maryland Institutional Review Board. The sample does not overlap with that detailed in prior work by our group (Shackman et al., 2018).

### Subjects

Two-hundred and forty-two subjects completed both the baseline assessment and EMA protocol. Fourteen subjects were excluded from analyses: 2 withdrew and 12 (~5%) failed to complete >39 survey prompts (70% compliance). The final sample included 228 subjects (51.3% female; 62.7% White, 17.5% Asian, 8.3% African American, 4.9% Hispanic, 6.6% Multiracial/Other; $M = 18.76$ years, S.D. = 0.35 years).

### Power analysis

Sample size was determined a priori as part of the application for the award that supported this research (R01-MH107444). The target sample size ($N \approx 240$) was chosen to afford acceptable power and precision given available resources (Schönbrodt and Perugini, 2013). At the time of study design, G-power 3.1.9.2 (http://www.gpower.hhu.de) indicated >99% power to detect a benchmark medium-sized effect ($r = 0.30$) with up to 20% planned attrition ($N = 192$ usable datasets) using $\alpha = 0.05$ (two-tailed).
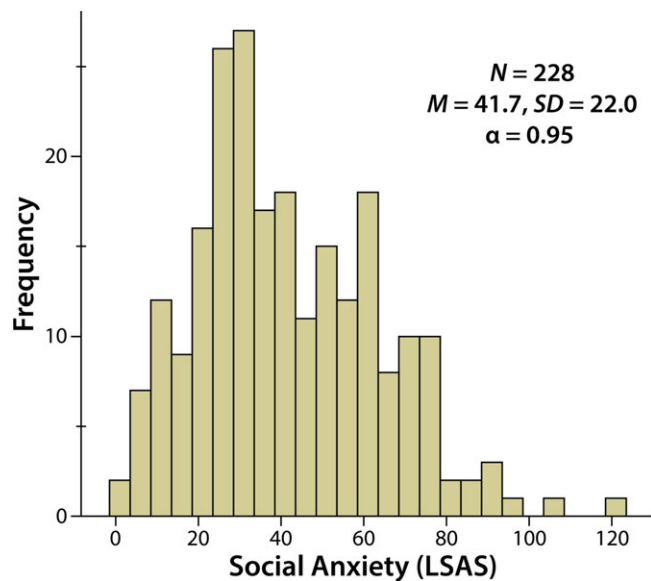


**Fig. 1.** Social anxiety. Social anxiety was assessed at baseline using the self-report version of the Liebowitz Social Anxiety Scale (LSAS). The two highest cases were not excluded because they are sensible – given the nature of the scale and the sample – and because they did not exert undue statistical leverage (Hoaglin et al., 1986; Hoaglin and Iglewicz, 1987). Exploratory analyses indicated that the exclusion of these cases did not meaningfully alter the results (not reported).

### Social anxiety

At baseline, the self-report version of the Liebowitz Social Anxiety Scale (LSAS) was used to quantify social anxiety (Liebowitz, 1987). Subjects used a 0 (none) to 3 (severe) scale to rate the amount of fear and anxiety they typically experience in response to 24 everyday situations (e.g. going to a party, meeting strangers, returning goods to a store, speaking up at meeting). They used a 0 (never) to 3 (usually) rating scale to rate the frequency of avoiding the 24 situations. Social anxiety was quantified by summing the 48 responses. As shown in Fig. 1, LSAS scores were approximately normally distributed ($M = 41.7$, S.D. = 22.0, Range = 1–121, $\alpha = 0.95$) and somewhat higher than that previously reported in large university convenience samples ($N = 856$, $M = 34.7$, S.D. = 20.4; Russell and Shaw, 2009)[1,2†].

### Social network size

At baseline, the self-reported number of close companions was measured using an item (How many people do you know where you have a close, confiding relationship and can share your most private feelings?) from the modified Kendler Social Support Inventory (MKSSI; Spoozak et al., 2009). Single-item measures of social network size are routinely used in epidemiology research (e.g. Kendler et al., 2005; Van Lente et al., 2012; Kocalevent et al., 2018). The resulting descriptive statistics ($M = 5.6$, S.D. = 4.1, Range = 0–30) are broadly consistent with the results of past work focused on confidant networks in university students (Sarason et al., 1983; Freberg et al., 2010) and friendship networks in community-dwelling adults (Wang and Wellman, 2010).

### EMA procedures

SurveySignal (Hofmann and Patel, 2015) was used to automatically deliver 8 text messages/day to each subject's smartphone. On

†The notes appear after the main text.

weekdays, messages were delivered every 1.5 to 3 h ($M = 115$ min, S.D. $= 25$) between 8:30 AM and 10:30 PM. As in prior work by our group (Shackman et al., 2018), weekday messages were delivered during the 'passing periods' between regularly scheduled university courses to maximize compliance. On weekends, messages were delivered every 1.5 to 2.5 h ($M = 99$ min, S.D. $= 17$) between 11:00 AM and 11:00 PM. Messages were delivered according to a fixed schedule that varied across days (e.g. the third message was delivered at 12:52 PM on Mondays and 12:16 PM on Tuesdays). Messages contained a link to a secure on-line survey. Subjects were instructed to respond within 30 min (Latency: Median $= 2$ min, S.D. $= 7$ min, Interquartile Range $= 9$ min) and to refrain from responding at unsafe or inconvenient moments (e.g. while driving). A reminder was sent when subjects failed to respond within 15 min. During the baseline laboratory session, several well-established procedures were used to maximize compliance (Palmier-Claus et al., 2011), including: (1) delivering a test message in the laboratory and confirming that the subject was able to successfully complete the on-line EMA survey, (2) 24/7 technical support, and (3) monetary bonuses. Base compensation was \$10, with \$20 bonuses for $\geqslant 70\%$ and $\geqslant 80\%$ compliance, respectively (Total $= \$10–\$50$). In the final sample, EMA compliance was acceptable ($M = 87.9\%$, S.D. $= 6.2\%$, Minimum $= 71.4\%$, Total $= 11\,224$) and unrelated to social anxiety, $p = 0.77$.

### EMA survey

Current NA (*afraid, nervous, worried, hopeless, sad*) and PA (*calm, cheerful, content, enthusiastic, joy, relaxed*) at the time of the survey prompt was rated using a 0 (*not at all*) to 4 (*extremely*) scale. Subjects also indicated their current social context ('*At the time of ping, who was around?*'): alone, close friend(s), family, friend(s), romantic partner, acquaintance(s), co-worker(s), and/ or stranger(s). Composite measures of NA and PA were computed by averaging the relevant items ($\alpha$s $> 0.92$). To enable follow-up assessments of generality, composite anxiety (*afraid, nervous, worried*) and depression (*hopeless, sad*) facet scales were computed ($\alpha$s $> 0.88$). Building on prior work by our group and others (Diener and Seligman, 2002; Shackman et al., 2018), friends, close friends, family, and romantic partners were re-coded as 'Close' companions. Acquaintances, co-workers, and strangers were re-coded as 'Distant' companions. This approach is conceptually similar to the distinction between 'strong' and 'weak' social connections (Granovetter, 1973). Analyses indicated that assessments completed in the presence of a mixture of Close and Distant companions (8%) showed intermediate effects and are omitted from the present report.

### Analytic strategy

The overarching aim of the present study was to understand the joint explanatory influence of Social Anxiety (LSAS) and Social Context (EMA) on real-world Affect (EMA-derived NA, PA). In all cases, hypothesis testing employed a continuous measure of Social Anxiety.

We began by testing whether variation in Social Anxiety prospectively predicts the aggregate amount of time allocated to different social contexts. A standard multivariate mediation framework was then used to test whether relations between Social Anxiety and Social Context were statistically attributable, at least in part, to variation in Social Network Size (e.g. *elevated social anxiety → fewer confidants → less time with close*

*companions*) (Hayes, 2017), where Size was indexed using the MKSSI. As in prior work by our group (Stout et al., 2017), the significance of the indirect effect ('mediation') was assessed using non-parametric bootstrapping (5000 samples). Although the mediation framework provides useful information, it rests on strong assumptions and positive results do not license causal inferences (Bullock et al., 2010; Green et al., 2010). Pirateplots were created using the *yaRrr* package for R (Phillips, 2017). Hotelling's test for dependent correlations was computed using FZT (https://psych.unl.edu/psycrs/statpage/comp.html).

Next, a series of MLMs was implemented in SPSS (version 24.0.0.0) with momentary assessments of Affect and Social Context nested within subjects and intercepts free to vary across subjects. Separate MLMs were computed for NA and PA. Level 2 variables (i.e. Social Anxiety) were mean centered.

The equations defined below outline the basic structure of our final MLMs in standard notation (Raudenbush and Bryk, 2002). At the first level, Affect during EMA $t$ for individual $i$ was modeled as a function of Social Context:

$$\text{Affect}_{ti} = \pi_{0i} + \pi_{1i}(\text{Distant}) + \pi_{2i}(\text{Close}) + e_{ti} \qquad (1)$$

Alone served as the dummy-coded reference category for primary analyses (as in Equation 1). Distant companions served as the reference category for follow-up analyses[3].

At the second level, the association between Social Context and Affect was modeled as a function of individual differences in Social Anxiety:

$$\pi_{0i} = \beta_{00} + \beta_{01}(\text{Anxiety}_i) + r_{0i} \qquad (2)$$

$$\pi_{1i} = \beta_{10} + \beta_{11}(\text{Anxiety}_i) + r_{1i} \qquad (3)$$

$$\pi_{2i} = \beta_{20} + \beta_{21}(\text{Anxiety}_i) + r_{2i} \qquad (4)$$

Conceptually, this enabled us to test prospective relations between Social Anxiety and Affect, cross-sectional relations between EMA-derived measures of Social Context and Affect, and the potentially interactive effects of Social Anxiety and Social Context. We also explored the impact of incorporating variation in the amount of time allocated to different contexts as a nuisance variable. For significant effects, we examined generality across NA facets (i.e. anxious and depressed mood). As an additional validity check, we confirmed that similar results were obtained when two authors independently analyzed the data using SPSS (J.H.) and R (M.G.B.), respectively.

### Results

#### Momentary emotional experience covaries with social context

Consistent with other work in young adults (Larson, 1990; Berry and Hansen, 1996; Shackman et al., 2018), our sample spent slightly more than half their time with others (Close $= 44.1\%$, Distant $= 13.4\%$, Alone $= 42.5\%$), although there were marked individual differences in the amount of time devoted to each social environment (Fig. 2). Individuals who spent more time with close others reported lower average levels of NA ($r = -0.14$, $p = 0.03$) and higher average levels of PA ($r = 0.31$, $p < 0.000$). Conversely, those who spent more time alone reported higher average levels of NA ($r = 0.14$, $p = 0.03$) and lower average levels
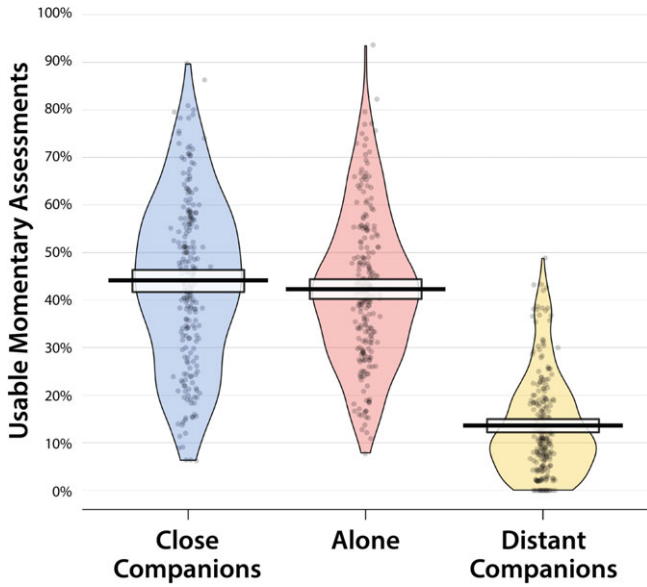
Fig. 2. Percentage of usable momentary assessments acquired in the presence of close companions, distant companions, or alone. Figure depicts the data (*jittered gray points; individual participants*), density distribution (*colored bean plots*), Bayesian 95% highest density interval (HDI; *white bands*), and mean (*black bars*) for each social context. HDIs permit population-generalizable visual inferences about mean differences and were estimated using 1000 samples from a posterior Gaussian distribution.

of PA ($r = -0.28$, $p < 0.001$), replicating past work (e.g. Diener and Seligman, 2002; Oishi *et al.*, 2007; Diener *et al.*, 2018; Rogers *et al.*, 2018; Shackman *et al.*, 2018). The average amount of time spent with distant others was unrelated to average mood ($p$s > 0.20). In sum, individuals who spend more time with close companions report modestly enhanced mood, whereas those who are prone to seclusion show the opposite effect.

### Socially anxious individuals spend less time with close companions and have smaller confidant networks

On average, individuals with higher levels of social anxiety spent significantly less time in the company of close companions ($r = -0.16$, $p = 0.01$) and showed a trend to spend more time alone ($r = 0.13$, $p = 0.06$), consistent with prior work (Alden and Taylor, 2004; Afram and Kashdan, 2015). A mediation analysis suggested that this reflects reduced access to close companions. As shown in Fig. 3, individuals with higher levels of social anxiety report fewer confidants ($a = -0.19$, $p = 0.005$), which is also consistent with prior work (Montgomery *et al.*, 1991; Davidson *et al.*, 1994; La Greca and Lopez, 1998). In turn, individuals with fewer confidants were less likely to be in the presence of close companions ($b = 0.31$, $p < 0.001$) at the time of momentary assessment[4]. Bootstrapped 95% confidence intervals for the indirect effect excluded zero, indicating significant mediation. Likewise, the direct effect of social anxiety on the amount of time spent with close companions was no longer significant after accounting for variation in the number of confidants ($c'$ path in Fig. 3; $p > 0.10$)[5]. Interestingly, social anxiety was not significantly related to the amount of time spent with distant companions ($p = 0.20$), contraindicating a general bias to avoid others. The association between social anxiety and the amount of time allocated to close companions was significantly stronger than that with distant companions, $t_{\text{Hotelling}} = 2.18$, $p = 0.03$.
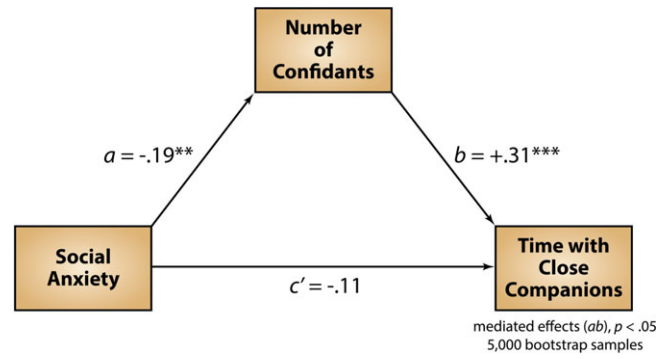


Fig. 3. The negative association between social anxiety and the amount of time with close companions is significantly explained by reduced access to confidants. Figure depicts the corresponding mediation model. Path labels indicate standardized regression coefficients, with $c'$ indicating the coefficient while controlling for variation in the self-reported number of confidants. Socially anxious individuals report fewer confidants, and individuals with fewer confidants were, in turn, less likely to be in the presence of close companions at the time of momentary assessment.

### Social anxiety is associated with diminished real-world emotional experience

MLM analyses demonstrated that social anxiety is associated with reduced quality of real-world emotional experience. Individuals with higher levels of social anxiety report significantly increased NA ($t = 25.2$, $b = 0.12$, s.e. $= 0.005$, $p < 0.001$) and reduced PA ($t = -24.1$, $b = -0.19$, s.e. $= 0.008$, $p < 0.001$), consistent with past research (Kashdan, 2004; Kashdan and Steger, 2006; Kashdan *et al.*, 2013*a*, 2013*b*)[6].

### The quality of momentary emotional experience covaries with the presence of close companions

Relative to seclusion or the presence of distant others, MLM results showed that close companions are associated with lower levels of NA (Alone: $t = -0.7.51$, $b = -0.09$, s.e. $= 0.012$, $p < 0.001$; Distant: $t = -6.71$, $b = -0.10$, s.e. $= 0.015$, $p < 0.001$) and higher levels of PA (Alone: $t = 15.79$, $b = 0.31$, s.e. $= 0.019$, $p < 0.001$; Distant: $t = 15.03$, $b = 0.37$, s.e. $= 0.025$, $p < 0.001$). Relative to seclusion, distant companions are associated with lower levels of PA (PA: $t = -2.59$, $b = -0.06$, s.e. $= 0.024$, $p = 0.01$; NA:$p > 0.30$). Results were similar when controlling for variation in the amount of time allocated to different social contexts (online Supplementary Table S1). These findings reinforce the conclusion that the quality of momentary emotional experience is positively associated with the presence of close friends, family, and romantic partners.

### Socially anxious individuals derive larger emotional benefits from close companions

We next considered the joint impact of social anxiety and social context on momentary mood (Table 1). As shown in the upper panel of Fig. 4, the results of this more comprehensive MLM revealed that socially anxious individuals derive larger emotional benefits – indexed by significantly lower levels of NA – from close companions relative to seclusion (Social Anxiety × Close-Alone, $t = -2.27$, $b = -0.03$, s.e. $= 0.012$, $p = 0.02$). In short, individuals with higher levels of social anxiety tend to experience the least intense, most normative levels of NA in the company of friends, family, and romantic partners. This effect remained significant after controlling for the amount

**Table 1.** The impact of social anxiety and social context on momentary emotional experience

| | NA | | PA | |
|---|---|---|---|---|
| | t | b | t | b |
| Social anxiety | 5.81*** | 0.13 | −4.72*** | −0.19 |
| Close v. alone | −7.56*** | −0.09 | 15.72*** | 0.31 |
| Distant v. alone | 0.98 | 0.01 | −2.57* | −0.06 |
| Social anxiety × close v. alone | −2.27* | −0.03 | −0.13 | −0.00 |
| Social anxiety × distant v. alone | −1.91 | −0.02 | 0.09 | 0.00 |

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

of time allocated to different social contexts (online Supplementary Table S2)[7]. Other interactions were not significant for NA or PA ($p > 0.80$). Social anxiety was not associated with an exaggerated emotional response in the presence of co-workers, strangers, and other distant companions (Fig. 4 and Table 1). The same general pattern of results was evident for analyses focused on the anxious and depressed facets of momentary NA (online Supplementary Tables S3 and S4).

## Discussion

Social anxiety lies on a continuum, from mild to debilitating, and young adults with elevated symptoms of social anxiety are more likely to show significant impairment and develop frank psychopathology. The present study provides new insights into the ways in which real-world emotional experience varies as a function of social anxiety and the social environment. Our results demonstrate that the presence of close companions is associated with lower levels of momentary NA (Fig. 4), including anxiety and depression. Importantly, individuals with higher levels of social anxiety were found to spend significantly less time with close companions and a mediation analysis suggested that this association is partially explained by smaller confidant networks (Fig. 3). Social anxiety was unrelated to the number of assessments completed in the presence of co-workers, strangers, and other distant companions, contraindicating a general social avoidance bias. Although social anxiety at baseline was prospectively associated with a diminished quality of momentary emotional experience (i.e. increased NA and reduced PA), MLM analyses demonstrated that individuals with higher levels of social anxiety derive significantly larger benefits – manifesting as lower levels of NA, anxiety, and depression – from the company of close companions (Fig. 4). In contrast, socially anxious individuals were not disproportionately sensitive to the presence of distant companions (Table 1 and Fig. 4). Indeed, they showed similarly high levels of NA when they were alone. Although social anxiety research and treatment has predominantly focused on responses to novelty and potential threat, our results underscore the centrality of friends, family, and romantic partners. These findings provide a framework for understanding the deleterious consequences of extreme social anxiety and guiding the development of improved interventions.

The present findings extend developmental and laboratory research highlighting the importance of social and interpersonal processes for emotion regulation and mental wellbeing (Maresh et al., 2013; Zaki and Williams, 2013; Coan and Sbarra, 2015; Reeck et al., 2016; Rubin et al., 2018). Our observations motivate the hypothesis that the pervasive NA characteristic of socially anxious young adults partially reflects difficulties forming or maintaining close relationships, consistent with work focused on children and adolescents at risk for developing social anxiety disorder (Ladd et al., 2011; Frenkel et al., 2015; Shackman et al., 2016; Markovic and Bowker, 2017; Rubin et al., 2018). With fewer confidants, socially anxious individuals spend significantly less time with close companions and are less frequent beneficiaries of their mood-enhancing effects (Figs 3 and 4). Socially anxious individuals appear to have an intact capacity for social mood enhancement. Indeed, they show lower levels of NA in the company of close companions, in broad accord with work focused on depressed samples (Rottenberg, 2017). This perspective is also well aligned with evidence from prospective longitudinal studies indicating that close friendships and other kinds of social support and intimacy reduce the risk of developing anxiety symptoms in adolescence and early adulthood (Teachman and Allen, 2007; Rodebaugh, 2009; Tillfors et al., 2012; Frenkel et al., 2015; Narr et al., 2019). Likewise, among patients undergoing treatment for social anxiety, higher levels of perceived social support are associated with a more favorable prognosis (Rapee et al., 2015).

Naturally, our results do not license causal inferences. We cannot rule out the possibility that reduced access to confidants begets higher levels of social anxiety or, more likely, that these two constructs exert bi-directional effects (Rubin et al., 2018). Likewise, it could be that socially anxious individuals actively seek out the company of close companions when they are experiencing lower levels of NA. Nevertheless, randomized laboratory studies reinforce the conclusion that close companions play a key role in mitigating NA. For example, the presence of a close companion has been shown to normalize negative affect and catastrophic cognitions ('I'm going to die') in anxiety patients exposed to a panic-inducing $CO_2$ challenge (Carter et al., 1995) and to normalize behavioral signs of anxiety in socially anxious young adults during a videotaped speech challenge (Pontari, 2009). Taken with the present results, these observations motivate the hypothesis that friends, romantic partners, and family members serve as a regulatory 'prosthesis' for socially anxious individuals.

Relying on close companions is risky. This is particularly true for socially anxious individuals, who tend to experience elevated levels of interpersonal conflict (Cuming and Rapee, 2010) and, among patients, marked impairment of interpersonal relationships (Wittchen et al., 2000; Rapaport et al., 2005; Olatunji et al., 2007; Stein et al., 2017). Relationship distress and dissolution reduces or eliminates the possibility of interpersonal emotion regulation and, ultimately, can contribute to the development, maintenance, and recurrence of psychopathology (Rehman et al., 2008; Marroquin, 2011; Whisman and Baucom, 2012; Baucom et al., 2014). Even in the absence of relationship problems, as young adults transition to full-time employment, marriage, and parenting, social network size naturally begins to decline and more time is spent with distant companions or alone (Larson, 1990; Lansford et al., 1998; Wrzus et al., 2013, 2016; Sander et al., 2017) – effects that may be amplified in more recent cohorts, which tend to allocate less time to face-to-face social interaction and experience elevated levels of loneliness (Twenge et al., 2019). Many middle-aged and older adults report that they have no confidant (McPherson and Smith-Lovin, 2006), depriving them of the emotional benefits of
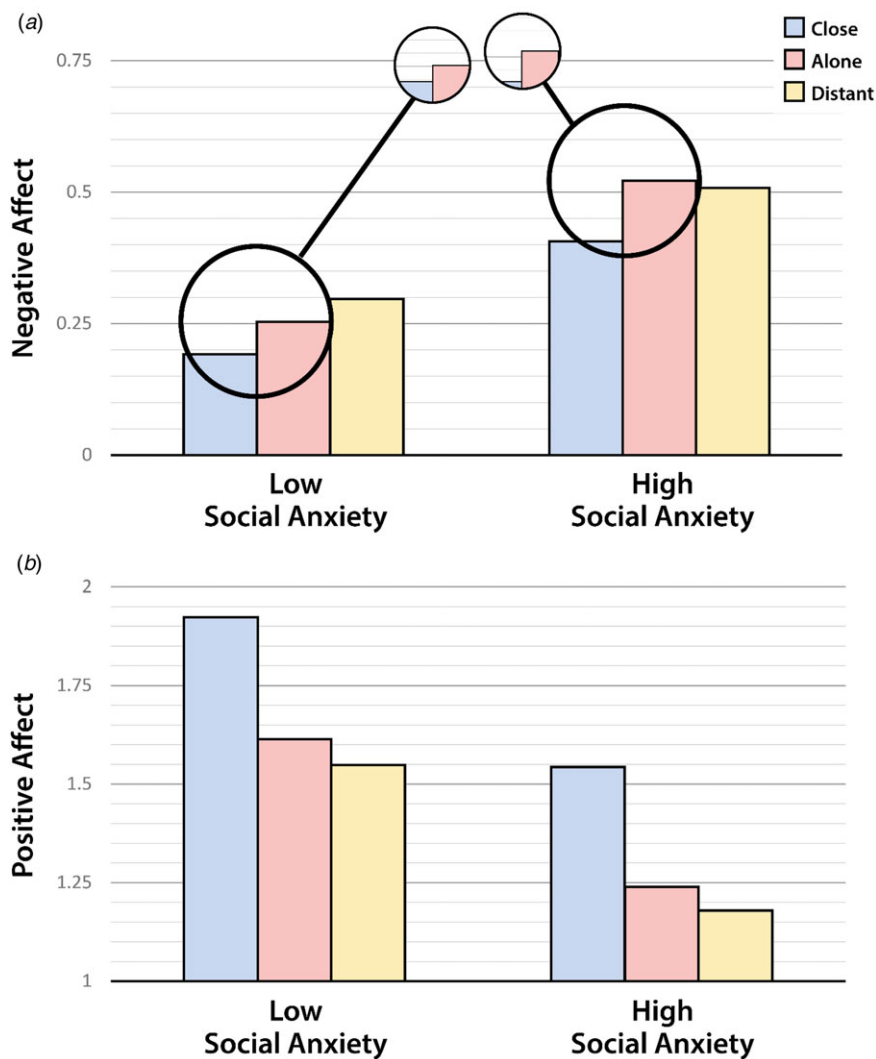
**Fig. 4.** The deleterious impact of social anxiety on momentary emotional experience depends on social context. Individuals with higher levels of social anxiety derive larger emotional benefits – larger decrements in negative affect (NA) – from close companions relative to being alone as shown in the upper panel. Hypothesis testing relied on a continuous measure of social anxiety. For illustrative purposes, predicted values derived from multilevel modeling are depicted for extreme levels (±1 s.d.) of social anxiety.

close companions. This is likely to be exacerbated among individuals with elevated levels of social anxiety, who are less likely to have close friends and more likely to be unmarried by mid-life (Montgomery *et al.*, 1991; Davidson *et al.*, 1994; La Greca and Lopez, 1998). Extending the present approach to earlier and later developmental periods is an important challenge for future research, and prospective-longitudinal studies are likely to be especially fruitful.

Social anxiety is often cast as an increased sensitivity to scrutiny from others, especially unfamiliar others, which manifests as heightened avoidance, fear ('phobia'), and anxiety (American Psychiatric Association, 2013). Our results underscore the need to broaden this perspective. As indexed by EMA, social anxiety was unrelated to the amount of time spent with distant companions. Moreover, socially anxious individuals did not report heightened NA when they were in the presence of distant companions (Table 1 and Fig. 4). This finding suggests that socially anxious individuals tend to experience normative emotional responses to distant companions in the absence of clear signs of rejection, scrutiny, or threat. Another possibility is that hyper-reactivity to strangers is specific to pathological levels of social anxiety or is only evident in a subset of socially anxious individuals. Adjudicating between these accounts represents another important avenue for future research.

From a clinical perspective, these observations suggest that naturally occurring social relationships are a potentially important target for intervention. Existing treatments for social anxiety typically focus on the individual, but our results highlight the value of simultaneously considering the role of close companions and developing supplementary interventions to enhance social connection, acceptance, and support. This could take the form of nurturing social-cognitive skills (e.g. emotional disclosure), cultivating stronger and more frequent ties with existing companions and social networks (e.g. via behavioral activation approaches), or reducing maladaptive thoughts and behaviors (e.g. neediness, overreliance) that promote conflict and rejection (Masi *et al.*, 2011; Cacioppo *et al.*, 2015; Kok and Singer, 2017). The development of smartphone-based interventions would provide a scalable and cost-effective alternative to more traditional modalities. Already, 77% of U.S. adults, and 94% of U.S. adults under the age of 30 own a smartphone (Pew Research Center, 2018). Mobile applications may be particularly useful for individuals who are unable or unwilling to use traditional care delivery systems and for subclinical presentations of social anxiety that do not warrant resource-intensive treatments (Ruscio, 2019). Regardless of delivery method, intervention research would also provide a crucial opportunity for testing the causal contribution of close companions to the everyday experience of social anxiety.

Our results highlight some additional avenues for future research. To understand the generalizability of our inferences, it will be useful to extend the present approach to larger and more representative samples and to populations with more severe symptoms, distress, and impairment. Future EMA studies may benefit from using larger sampling windows or selectively targeting periods of increased stress or disrupted social intimacy (e.g. transition from high school or university, or from university to full-time work) in order to capture a wider range of social interactions and their association with momentary affect. It will also be helpful to examine the nature and quality of naturalistic social interactions – including momentary perceptions of social connection, emotional support, and conflict – in more detail using either EMA (e.g. context- or event-triggered) or behavioral observations. Developing a clearer understanding of the processes that promote heightened levels of NA during periods of solitude – when both social support and social threat are absent (Fig. 4) – is also likely to be useful (Shackman *et al.*, 2016).

In conclusion, the present study suggests that close companions play an important role in the momentary experience of socially anxious young adults. The use of well-established techniques for intensive EMA and a relatively large sample selectively recruited from a pool of more than 6000 young adults increases our confidence in the reproducibility and translational relevance of these findings.

**Supplementary material.** The supplementary material for this article can be found at https://doi.org/10.1017/S0033291719002022.

**Data.** Raw data have been or will be made available via the National Institute of Mental Health's RDoC Database (https://data-archive.nimh.nih.gov/rdocdb).

**Author contributions.** A.J.S. and K.A.D. designed the study. K.A.D., A.S.A., S.I. collected data. K.A.D., S.I., J.H. processed data. J.H., A.J.S., M.G.B., and K.A.D. designed the analytic strategy. J.H., M.G.B., and A.J.S. performed analyses. J.H. drafted the paper. J.H., M.G.B., and A.J.S. created figures and tables. A.J.S. supervised and funded the work. All authors edited the paper and approved the final version.

**Ethical standards.** The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

## Notes

[1] The mean and dispersion of the present sample is similar to that of unselected individuals drawn from the same university population. For example, exploratory analyses of data collected as part of the University of Maryland Department of Psychology's on-line survey during the 2015–2018 academic years ($N = 1596$) revealed that among the subset of respondents 18–19 years old, women reported significantly greater social anxiety ($N = 601$, $M = 46.8$, S.D. = 23.2) than men ($N = 229$, $M = 40.3$, S.D. = 22.7), $t = 3.67$, $p = 0.001$. When the on-line survey data were adjusted to reflect the percentage of women in the EMA study (51.3%), the resulting distribution ($M = 43.6$, Range = 2–122) was similar to the present EMA sample ($M = 41.7$, Range = 1–121).

[2] For descriptive purposes, depression was assessed using the General Depression subscale of the revised Inventory of Depression and Anxiety

Symptoms (IDAS-II) Watson *et al.* (2012). As expected, levels of depression were somewhat elevated in the present sample ($M = 39.9$, S.D. = 12.8), which corresponds to the 60th percentile in U.S. normative data; Nelson *et al.* (2018).

[3] Similar results were obtained using the log-transformed NA scores as a DV (not reported).

[4] The zero-order correlation between self-reported social network size and the proportion of momentary assessments completed in the presence of close companions was $r = 0.29$, $p < 0.001$.

[5] Although the complementary pattern (*elevated social anxiety → fewer confidants → greater solitude*) was evident for a model focused on the amount of time spent alone, we refrain from reporting or interpreting it, given the strong dependency between time allocated to close companions vs. solitude. That is, social contexts were mutually exclusive (Fig 2), and most assessments were completed either in the presence of close companions or alone. From this perspective, the results of the 'alone' model are almost entirely predictable knowing the results of the 'close companions' model.

[6] Momentary NA and PA were negatively correlated within momentary assessments ($t = -18.7$, $b = -0.26$, S.E. = 0.014, $p < 0.001$).

[7] It also remained significant when controlling for variation in depressive symptoms, indexed using the General Depression subscale of the IDAS-II (Social Anxiety × Close-Alone, $t = -2.28$, $b = -0.03$, S.E. = 0.012, $p = 0.02$).

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