Motivation and Emotion (2019) 43:844–855
https://doi.org/10.1007/s11031-019-09773-x

ORIGINAL PAPER

Impact of social anxiety and social context on college students' emotion regulation strategy use: An experience sampling study

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Published online: 27 May 2019
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Abstract

Socially anxious individuals typically select more avoidant emotion regulation (ER) strategies than non-anxious individuals, contributing to interpersonal difficulties. The present study utilized smartphone-delivered experience sampling over 14 days to assess how actual and desired social situations predicted reports of ER strategy use in 115 undergraduate students with varying levels of social anxiety symptoms. After controlling for multiple comparisons, results indicated that higher (vs. lower) baseline social anxiety symptoms predicted endorsing at least one of the available eight ER strategies relatively more often than reporting no strategy use, in the context of high negative affect. We did not find the hypothesized positive relationship between social anxiety symptoms and endorsements of avoidant- (e.g., expressive suppression) versus engagement-oriented (e.g., cognitive reappraisal) ER strategies in the context of high negative affect. However, state social desire interacted with trait social anxiety at high negative affect to predict the use of an ER strategy, although the simple effects analyses at high and low levels of social desire were not statistically reliable. Collectively, our results demonstrate the importance of considering both trait-level social anxiety symptoms and in-the-moment social context when studying ER strategy selection. The importance of assessing intrinsic motivational goals and beliefs in the context of ER strategy use is also discussed.

Keywords Social anxiety · Emotion regulation · Ecological momentary assessment

Socially anxious individuals experience an intense fear of scrutiny by others (Hofmann 2007) and report higher negative affect, expressive suppression (i.e., trying not to show or feel emotions), and avoidance in social situations (Kashdan and Steger 2006; Kashdan et al. 2013). What is not yet well understood is how socially anxious individuals try to manage these challenging and complex emotional experiences and social interactions as they naturally arise throughout their day-to-day lives. Understanding these in-the-moment efforts to manage emotions is essential to determine under what conditions differences or deficits occur, which can then be targeted in treatment for social anxiety. In the current study, individuals with varying levels of social anxiety symptoms reported whether or not they were in a social situation (based on responses to a question about who they were "interacting with"), the extent to which they desired to be in a social situation (based on responses to a question about wanting "to be alone or with others"), their state negative affect, and whether or not they were engaging in a number of emotion regulation (ER) strategies throughout the day for up to two weeks using smartphone-based experience sampling. This approach allowed for examination of how ER strategy selection during periods of relatively high negative affect varies as a function of trait-level social anxiety symptoms (ranging from non-anxious to severely anxious), as well as state social context (whether or not a person is in a social situation, and extent the person desires to be in a social situation).

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s11031-019-09773-x) contains supplementary material, which is available to authorized users.

Data that support the findings of this study are available at the Open Science Foundation, www.osf.io/yxqka.

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The process model views any conscious or unconscious attempt to modulate emotional experiences or situations as an ER strategy (Gross 2014). This means that a broad range of strategies can be studied under one model, including emotion-focused approaches, that try to alter one's emotional reaction to a situation, and problem-focused coping approaches, that try to change the situation. Research shows that people tend to use multiple strategies in response to the same emotional stressor (Daros et al. 2018) and that strategies tend to group together in ways that are related to their shared effectiveness (i.e., the extent the strategies help modulate affect in a desired and goal-consistent way) and their shared associations with symptoms of mental disorders (see Aldao 2013). Thus, it may be helpful to study *clusters* of strategies rather than only one or two at a time. A recent experience sampling study found two data-driven between-subjects clusters: (1) *avoidant* ER strategies, which involve the avoidance or inhibition of emotional experiences or situations, such as thought suppression or distraction (i.e., trying not to attend to one's thoughts, or actively trying to think about something else), and (2) *engagement* ER strategies, which involve actively engaging with an emotional experience or situation, such as acceptance or cognitive reappraisal (i.e., being open and attentive to one's thoughts, or trying to think about the situation differently; McMahon and Naragon-Gainey 2019). In the current study, we found two similar clusters using a data-driven approach and use the same avoidant and engagement labels.

Social anxiety and ER strategy selection

Social anxiety is characterized by cognitive biases and high negative emotional reactivity before, during, and after social situations (Hofmann 2007), which may impact the selection of ER strategies. Socially anxious individuals tend to self-report using avoidant ER strategies more often, such as expressive suppression and avoidance of anxiety-provoking social situations, to reduce attracting the attention and scrutiny of others (Goldin et al. 2014). Further, socially anxious individuals report using engagement ER strategies, such as cognitive reappraisal, less often (Werner et al. 2011). This research suggests that trait social anxiety may also be positively associated with avoidant (vs. engagement) ER strategy use in daily life, perhaps because socially anxious individuals would prefer to distract from challenging emotional experiences rather than processing them more in-depth.

Beyond the *type* of ER strategy selected (engagement or avoidant), social anxiety may also influence *when* ER strategies are used. Because humans are social beings and typically desire community, proximity with others is thought to serve as its own self-regulatory strategy for healthy individuals by attenuating the negative effects of stressful situations (e.g., Beckes and Coan 2011). Yet, given socially anxious individuals fear social encounters, they may experience fewer benefits from proximity with others than would otherwise be expected. In line with this idea, there is evidence that higher trait anxiety is associated with less neural activation in response to a stressor when alone than when with a close friend, while the opposite pattern was true for low anxious individuals (Maresh et al. 2013). These neural response patterns indicate that socially anxious people may experience higher levels of stress *when around others* during a negative experience, while non-socially anxious individuals may experience more stress *when alone*. Given these contextual differences, trait social anxiety may be positively associated with making more attempts to regulate their emotions when with others compared to when alone (because of greater perceived need for regulation).

Social anxiety may also influence *how often* ER is attempted. Because high socially anxious individuals have difficulty tolerating negative affect (Herbert and Cardaciotto 2005; Kashdan et al. 2013), they may implement more ER strategies than less socially anxious individuals to reduce these unwanted feelings, even at comparable levels of negative affect. On the other hand, research indicates that social anxiety disorder is associated with beliefs about lacking control over emotional experiences (e.g., De Castella et al. 2014). Notably, these low regulatory self-efficacy beliefs have been shown to be negatively associated with using cognitive reappraisal in unselected individuals (Ford et al. 2018). Thus, in contrast to predictions stemming from research on low negative affect tolerance, low regulatory self-efficacy findings suggest socially anxious individuals do not feel they will be efficacious in regulating their emotions, and therefore may not try to regulate (though this issue is complex as low regulatory self-efficacy beliefs have also been positively associated with avoidant-oriented ER strategy use; De Castella et al. 2018). Thus, there are competing hypotheses about whether social anxiety will be associated with more or less frequent use of ER strategies.

Collectively, previous research suggests that social anxiety may be linked to multiple problems with ER strategy selection and implementation, which can have consequences. An overreliance on avoidant ER can lead to paradoxical increases in physiological arousal and unwanted thoughts and feelings, and prevent habituation to unpleasant situations (Butler et al. 2003; Hofmann et al. 2009; Roemer and Borkovec 1994). Moreover, avoidant ER appears to reduce cognitive performance during laboratory procedures (Hayes et al. 1996; Richards and Gross 2000). ER strategy selection within social anxiety may therefore be more limited to strategies that bring immediate relief from unpleasant stimuli, but which can perpetuate social anxiety in the long term.

Social interactions and ER strategy selection

Beyond individual differences tied to trait social anxiety, in-the-moment social context likely influences ER strategy use as well. Social interactions can provide excellent opportunities for implementing effective engagement ER strategies (Marroquín 2011), given that social partners can help generate alternative interpretations, brainstorm potential solutions to a problem, provide information that contradicts negatively biased thoughts, or provide alternate reinforcers that help recover from negative emotional events. Moreover, given the costs of poorly regulating emotions when with others (e.g., alienating people due to expressions of anger), there could be greater motivation to regulate, though this will presumably depend on stress experienced when in social situations (e.g., Maresh et al. 2013). Given both the extra requirements and the extra occasions for ER within social situations, it is expected that being around others will make it more likely people use ER strategies, across the range of social anxiety symptoms, compared to being alone.

It is less clear whether there will be proportionally more avoidant or more engagement ER strategies used with others, given that there are both more opportunities for engagement but also more reasons to suppress with others because of potential interpersonal consequences of not managing negative affect and likely greater opportunities for distraction with others. Along these lines, reports of cognitive reappraisal (an engagement ER strategy) and distraction (an avoidant ER strategy) did not differ whether people were alone or in a social context (English et al. 2017). However, the same study found that expressive suppression was used more often in a social context compared to being alone. With these mixed findings in consideration, we expected more *frequent* ER strategy use when people were with others (vs. alone) but did not predict differences in the *type* of ER strategies, because both avoidant and engagement strategies seem likely to be implemented depending on an individual's goals in the moment.

Desire for social interaction and ER strategy selection

Being in a social context may be experienced very differently depending on whether one desires to be in a social interaction at that moment or not. To our knowledge, no one has previously examined how in-the-moment social desire relates to whether or not ER occurs and what types of strategies are used, despite increasing interest in how ER strategies relate to social motivations (see Tamir 2016). While socially anxious people do typically desire social interactions, they are less likely to initiate or pursue them because they fear humiliation and rejection (Beidel et al. 1999). Social anxiety is therefore characterized by competing motivations to approach and connect with others but also to avoid anxiety-inducing social situations (Baumeister and Leary 1995). Illustrating this complex relationship, Brown et al. (2007) reported that while symptoms of social anxiety were positively associated with stronger preferences to be alone when with others, they did not report less of a desire to be with others when alone. Thus, how social desire relates to ER strategy selection is an open question, but one that may have important implications for helping socially anxious individuals overcome their difficulties making healthy ER choices.

Overview of study and hypotheses

Although previous experience sampling studies have been valuable in understanding the experiences of socially anxious individuals, they typically assess daily, rather than momentary, ER strategy use and often focus on one or just a few ER strategies (e.g., Blalock et al. 2016; Kashdan et al. 2013, 2014). The present study used smartphone-delivered experience sampling to investigate how being in a social situation (i.e., being alone or with others), social desire (i.e., desire to be alone vs. with others), and trait social anxiety (self-reported at baseline) predict momentary use of up to eight ER strategies over 14 days in college students. This approach can reduce potential distortions in delayed recall and evaluation of emotional experiences (Robinson and Clore 2002), an issue especially relevant given socially anxious individuals are prone to negatively biased information processing (Hofmann 2007). The study aimed to predict whether or not participants report using an ER strategy when experiencing negative affect and, if so, whether participants endorse using relatively more avoidant compared to engagement ER strategies. We focused on ER strategy reports specifically when participants reported relatively high negative affect (based on their personal affective range), given negative affect likely increases motivation to regulate affective experiences (Tamir 2016) and because social anxiety is particularly associated with problems with regulating negative emotion.

Given the novelty of our methodological approach, we first examined relationships between social anxiety symptoms and social context (both whether or not participants reported being in a social situation and social desire) during instances of heightened negative affect. We then considered the primary questions about how social anxiety and social context would predict ER strategy use. We hypothesized that trait social anxiety would be positively associated with: (1a)

reporting more avoidant- versus engagement-oriented ER strategies and (1b) more use of ER strategies when with others versus alone. Competing hypotheses (1c) were outlined for whether social anxiety would be associated with more or less frequent use of any (vs. no) ER strategy. Further, we predicted that being in social situations (vs. being alone) would be associated with: (2a) a higher ratio of using any (vs. no) ER strategy regardless of social anxiety symptoms, while (2b) endorsement of avoidant relative to engagement ER strategies was an exploratory test. Finally, given limited previous research, the effects of social desire on ER strategy use (3) were exploratory, as were (4) most of the interactive effects of social anxiety symptoms, social situations, and social desire on ER strategy use. This study provides a novel opportunity to examine how social anxiety symptoms relate to ER strategy selection in real time and considers the impact of in-the-moment desired and actual social situations on ER, allowing for an unusually rich contextual understanding of social influences on the regulation of emotion.

Method

Participants

Undergraduate students ($n = 157$) consented to participate in the study in exchange for course credit and/or payment. Participants were recruited through advertisements sent to a university email listserv for undergraduate students and through a psychology research participant pool. Due to technical issues with the smartphone application (e.g., incompatible operating system), some participants ($n = 12$) did not complete the experience sampling portion of the study and others provided unusable data or very few assessments (< 6.00%, $n = 29$). These participants were removed from the analyses, leaving a final sample of 115 individuals ($M_{age} = 19.09$, $SD = 1.41$, $range_{age} = 18–27$, 66.09% female). The self-reported racial and ethnic composition of the final sample was White (55.65%), Asian (26.09%), Black (5.22%), Multiracial (3.48%), Latinx/Hispanic (2.61%), and Other (6.09%). There were no significant demographic differences among the variables tested between participants who were retained versus removed from the analyses (all $ps > .23$). The socioeconomic status of participants was above the national average, with a median annual household income of $100,000–149,000 ($n = 25$); 28 participants reported incomes below this value, while 31 reported incomes above, and a further 31 participants elected not to respond to this question.

Procedure

The university's ethics review board approved the study. Participants consented to take part in a 2-week smartphone monitoring study to examine thoughts and feelings as they interacted in their daily environment. At the baseline laboratory session, participants provided informed consent and completed several self-report measures. At the end of the baseline session, research assistants helped participants install a smartphone application called Sensus (Xiong et al. 2016) from the App Store (iPhone devices) or Google Play Store (Android devices). Sensus was programmed to prompt participants six times per day between the hours of 9:00 a.m. and 9:00 p.m., sending surveys to be completed randomly between six 2-h windows (e.g., 9:00 a.m. to 11:00 a.m., 11:00 a.m. to 1:00 p.m., etc.). Surveys stayed open for only 30 min to ensure we captured relatively in-the-moment experiences, which is an assumption inherent to experience sampling. Participants were only reminded once with an additional prompt before the survey closed. Sensus worked best when the application was left open, so we asked participants to refrain from closing the application by "swiping away," restarting their device, or updating their smartphone. Participants were given instructions to reopen the application if it was closed and were reminded via email to ensure that their application was running. Nevertheless, these and other technical issues prevented some individuals from getting all six prompts per day and the reminders. Before participants left the baseline testing session, we explained the basis for each survey question and answered any questions they had about them or the smartphone application. On average, the 115 participants retained in the analyses completed 2.37 ($SD = 1.45$) surveys per day for a total of 3813 surveys and an average of 33.00 ($SD = 20.00$) surveys completed by each participant.[1]

Measures[2]

Social anxiety symptoms

At a baseline session prior to the 2-week monitoring period, symptoms of social anxiety were assessed using the Social

[1] There were no demographic differences (i.e., age, gender, and race/ethnicity) in response rates for those who completed 2 or fewer surveys per day ($n = 50$) versus those who responded to more than 2 surveys per day ($n = 65$; all $ps > .43$). We thank an anonymous reviewer for raising this concern.

[2] These measures are part of a larger parent study assessing a range of cognitive and emotional variables. A full list of measures is available from the first author. In addition to the variables reported, we separately ran analyses examining self-reported closeness of interaction partners, but due to space constraints and this variable not being central to the primary focus of this manuscript, we do not report those analyses here.

Interaction Anxiety Scale (SIAS; Mattick and Clarke 1998). Participants rated the degree to which they agreed with 20 statements on a 0 ("not at all characteristic of me") to 4 ("extremely characteristic of me") scale, with excellent internal consistency (α = .83) in the present sample. The sum of each response, with three reverse scored items, was used to create an overall index of social anxiety severity (M = 27.30, SD = 9.05, range = 11–51). Scores of 34 or higher on the SIAS suggest clinically-elevated social anxiety symptoms (24.38% of the current sample scored above this cut point).

State affect and social interactions To assess momentary affect, each experience sampling survey asked, "How negative are you feeling?" (1 = "not at all" to 100 = "very negative"). Positive affect was also assessed but not analyzed for this paper given our focus on ER strategy selection during periods of relatively negative affect. The presence of a social situation was assessed by asking participants, "Who are you interacting with?" to which they could respond "no one" (i.e., alone) or "with others" [i.e., with family member(s), romantic partner/close friend, classmate/coworker, acquaintance/stranger, other]. We dichotomized answers to this question to create a social situation variable on which participants could be compared when they were alone or with others. Participants also responded to the question, "How much do you want to be alone or with others right now?" (1 = "I very much want to be alone" to 100 = "Very much want to be with others") when completing each survey. We operationalized this variable as social desire, which could vary regardless of whether an individual was in a social situation or alone.

ER strategies During each experience sampling survey, we asked participants to report on whether they were using a range of eight ER strategies, which we developed based on previous literature on coping and ER (Carver et al. 1989; Gross 2014). We allowed individuals to select more than one strategy at a time, consistent with research suggesting people often endorse more than one strategy in response to the same emotional stressor (Daros et al. 2018). Each survey asked participants if they were "doing any of the following (if anything) to change [their] thoughts or feelings" at that moment. Participants could specify up to eight ER strategies, or they could report "not trying to change [my] thoughts/feelings," which always appeared at the bottom of this survey page (the other options were randomized). ER strategies were presented to participants using lay-person descriptions: emotional suppression ("trying to ignore or push away thoughts/feelings"); expressive suppression ("trying to hide your inner thoughts/feelings"); distraction ("trying to distract yourself from thoughts/feelings"). The following engagement ER strategies were also assessed: introspection ("thinking a lot about your thoughts/feelings"); problem-solving ("coming up with a concrete plan for action"); cognitive reappraisal ("changing your perspective on something"); acceptance ("trying to accept/acknowledge my thoughts/feelings"); and seeking advice ("seeking advice or comfort from others"). There is evidence that these dichotomous endorsements are predictive of standard self-report measures of ER strategy use (e.g., Blalock et al. 2016). During the baseline laboratory session, we trained individuals to answer this question by carefully considering each option before selecting the "not trying" option.[3]

Data reduction and statistical plan

Not surprisingly, each individual ER strategy was endorsed with low frequency given the large number of strategies assessed. Thus, we used a principal component analysis (promax rotation with Kaiser normalization) to derive clusters of ER strategies that could be subjected to analysis. The Kaiser–Meyer–Olkin measure verified the sampling adequacy for the analysis (KMO = .61; Hutcheson and Sofroniou 1999) and the two emerging components explained 35.80% of the total variance, with a correlation between the two clusters of .09. During the preparation of this manuscript, we found that our clusters replicated findings of a recently published study that also used a data-driven approach to arrive at two clusters termed "avoidant" and "engagement" ER (McMahon and Naragon-Gainey 2019). These labels also corresponded well to our clusters. Our engagement ER cluster consisted of introspection (loading = .58), advice seeking (.62), cognitive reappraisal (.49), problem-solving (.52), and acceptance (.53), which all involve interacting with the thoughts/feelings in some way (e.g., thinking about them, opening up to them, and/or making an action plan tied to them). Our avoidant ER cluster consisted of expressive suppression (.55), emotional suppression (.65), and distraction (.76), which all involve attempts to disengage from inner thoughts/feelings in order to prevent or inhibit them (e.g., reducing the experience of them, not letting them show, and/or trying not to attend to

[3] Participants may have differed in their endorsement of "no ER" over the course of the study, potentially signalling non-compliance. We attempted to address this concern by assessing the use of "no ER" before and after 1 week in the study. There was only about a 10% increase in using this option after being in the study for 1 week and only 57 out of 115 participants displayed an increase (49.56%). The other participants either reported the same or fewer endorsements of "no ER" after 1 week. We also looked at the rate of selecting "no ER" per day, per participant (on average), where we found a relatively normal distribution of responses from 0 to 100% (i.e., some participants always reported that they were regulating). This pattern suggests that the distribution of individual differences in frequency of ER strategy use follows a predictable pattern, where some participants are more likely to report regulation while others are less likely. We thank an anonymous reviewer for raising these concerns.

Table 1 Descriptive statistics and zero-order correlations of trait and experience sampling variables of interest in the present study

Variable	Mean	SD	Range	Median	Pearson correlations, r						
					1	2	3	4	5	6	7
1 Trait social anxiety (SIAS)	27.30	9.05	11–51	25.00	–	.29	− .31	− .27	.04	.19	− .05
2 Negative affect	32.57	14.35	1.61–74.25	32.31	–	–	− .39	− .02	.23	.33	.16
3 Social desire (desire to be alone or with others)	53.48	14.75	11.36–90.77	52.90	–	–	–	.41	.18	.03	.22
4 Social situation (alone vs. with others)	.51	.19	.07–1.00	.54	–	–	–	–	.30	.25	.30
5 Any ER	.42	.30	.00–1.00	.36	–	–	–	–	–	.63	.93
6 Avoidant ER	.16	.17	.00–1.00	.11	–	–	–	–	–	–	.43
7 Engagement ER	.34	.27	.00–1.00	.28	–	–	–	–	–	–	–

Descriptive statistics were calculated by aggregating the means per participant for each variable (except trait social anxiety, where there was only one score per person) and then calculating the mean and descriptive statistics across participants. These calculations were completed using the data before selecting high negative affect observations ($n = 3693$) but after removal of surveys that contained errors related to the validity of the questions (e.g., two responses that were not compatible). Zero-order correlations for our no ER variable ($M = .58$, $SD = .30$, $Median = .64$) are equal to the reciprocal of our any ER variable

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them). Participants could technically endorse using "no ER" at the same time as reporting one or more of the available eight ER strategies (or none of the above). We attributed such responses to participant and/or technical error and removed these from statistical analyses ($n = 120$), leaving 3693 surveys. We present the descriptive statistics and zero-order correlations between experience sampling variables of interest in Table 1.

Data consisted of multiple observations nested within individual participants, thus data were analyzed using a multilevel random coefficient modeling approach. Time variant variables at Level 1 (e.g., state social desire, ER strategy use) were person-mean centered and standardized to create between-person effects, while time invariant variables at Level 2 (e.g., trait SIAS, age, sex, race/ethnicity) were grand-mean centered. We coded each of the following four variables as 1 if the response fit that category and 0 if not: no ER, any ER (representing the use of any, rather than the sum, of the eight ER strategies), avoidant ER (the use of any of the three avoidant ER strategies), and engagement ER (the use of any of the five engagement ER strategies).[4] We then combined the no ER and any ER variables (given the way we set up the data, these variables were reciprocals) to create one dependent variable and combined the engagement ER and avoidant ER variables to create a second dependent variable. Our main analyses relied on two generalized linear mixed models: Model 1 used orthogonal contrasts (i.e., − 1 vs. 1) to compare the frequency of "no ER" (reference category) to "any ER" endorsements (which could not be endorsed at the same time); and Model 2 used orthogonal contrasts (i.e., − 1 vs. 1) to compare the frequency of "engagement ER" (reference category) to "avoidant ER" (which could be endorsed at the same time). Additional models were used to investigate how social anxiety symptoms predicted state social desire and whether individuals were in a social situation or alone.

To capture heightened negative affect, we standardized negative affect scores within each person and then defined high negative affect observations as those that were .52 standard deviations above each person's personal mean (corresponding to the 70th percentile). This method allows for variability across people in the absolute negativity of their experiences but also considers the relatively low level of negative affectivity reported by participants on average (i.e., the mean level of negative affect across the full dataset was 31.70). We chose this cutoff a priori because it allowed us to retain a reasonable number of values to complete the statistical analyses and because we were aiming to select a round number (i.e., we discussed options like 60% or 70% but did not entertain using something like 63%). Each participant contributed to the final selection of observations used for analyses, but the number of observations contributed by each person varied (i.e., 1–31).

Although the present study was primarily interested in ER strategy use under heightened negative affect, we realize that analyses under a range of negative affect scores (i.e., low and high) may be of interest to some readers. We therefore

[4] While preparing this manuscript, an additional statistical method was attempted that incorporated weighting of the individual strategies within avoidant ER and engagement ER clusters. That is, given that there were a different number of ER strategies per cluster (i.e., three avoidant and five engagement), the selection of "distraction" could be assigned a higher weight versus "cognitive reappraisal" (i.e., one-third vs. one-fifth). A downside to this approach is that the orthogonal contrasts required six additional sets of codes that we were unable to exclude in the generalized linear mixed model, adding a high number of variables and tests (i.e., 54) to our models. For simplicity and ease of interpretation, we retained the analyses described in the "Methods" section and provide the results of this secondary analytic method in the Supplementary Materials section for transparency.

Table 2 Effects of social anxiety, social situation, social desire, and their interactions on ER strategy use

	b	SE	Z	p	Holm $p_{corrected}$
Model 1: any ER versus no ER (baseline)					
Intercept for baseline strategy condition	− .07	.10	− .76	.45	> .99
Main effect of strategy contrast	.15	.14	1.08	.28	> .99
Social anxiety	**.37**	**.09**	**2.90**	**.004**	**.032**
Social situation	.14	.20	.71	.48	> .99
Social desire	.09	.14	.64	.53	> .99
Social anxiety × social desire	**.37**	**.12**	**2.95**	**.003**	**.027**
Social anxiety × social situation	− .07	.20	− .34	.74	> .99
Social desire × social situation	− .20	.20	− 1.01	.31	> .99
Social situation × social desire × social anxiety	− .18	.19	− .96	.33	> .99
Model 2: avoidant ER versus engagement ER (baseline)					
Intercept for baseline strategy condition	1.23	.16	7.46	< .001	.001
Main effect of strategy contrast	**− .84**	**.12**	**− 5.00**	**< .001**	**.008**
Social anxiety	.30	.15	2.07	.04	.24
Social situation	− .16	.24	− .68	.50	> .99
Social desire	− .35	.16	− 2.20	.03	.21
Social anxiety × social desire	− .09	.14	− .70	.48	> .99
Social anxiety × social situation	.001	.23	.004	.97	> .99
Social desire × social situation	.21	.24	.89	.38	> .99
Social situation × social desire × social anxiety	.14	.21	.66	.51	> .99

The number of times that participants endorsed no ER, any ER, engagement ER or avoidant ER (no = not endorsed, yes = endorsed) are as follows: no ER (no = 463, yes = 511), any ER (no = 511, yes = 463), avoidant ER (no = 739, yes = 235), and engagement ER (no = 605, yes = 369). Bolded statistical values emphasize significant fixed effect findings

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present the same analyses using all levels of negative affect in the Supplementary Materials section.

To account for multiple comparisons within our large statistical models, we applied the Holm correction for multiple tests (Aicken and Gensler 1996), and the corrected *p*-values are noted within Table 2. All statistical analyses and data visualization were completed using R, version 3.4.3 Revised (R Core Team 2017-11-30). In accordance with open data sharing practices, we have uploaded the dataset used for the analyses onto a repository website: www.osf.io/yxqka.

Results

Descriptive statistics

For the 974 observations that reflected high negative affect, participants endorsed using any ER on 52.46% of surveys, with rates of avoidant ER and engagement ER at 24.12% and 37.89%, respectively. Participants endorsed both clusters on 9.54% of included observations. When participants endorsed using an ER strategy, they most often selected one ER strategy (57.53%), but also commonly endorsed two (28.77%) or more ER strategies (13.70%). The ratio of endorsing any versus no ER was not related to age, $b = -.01$, $SE = .09$, $Z(114) = -.14$, 95% CI [− .19, .17], $p = .89$, or gender, $b = -5.13$, $SE = 2.69$, $Z(114) = -1.91$, 95% CI [− 10.40, .14], $p = .06$. Age was negatively associated with endorsing avoidant versus engagement ER (i.e., older individuals endorsed more engagement vs. avoidant ER), $b = -.26$, $SE = .13$, $Z(114) = -2.00$, 95% CI [− .51, − .01], $p = .045$. Males also endorsed proportionally higher rates of avoidant versus engagement ER compared to females, $b = -10.81$, $SE = 3.49$, $Z(114) = -3.10$, 95% CI [− 17.65, − 3.97], $p = .002$.

Not surprisingly, even when examining each person's most negative affect scores, social anxiety symptoms were positively associated with *raw* negative affect scores, $b = 4.87$, $SE = 1.61$, $t(113) = 3.03$, 95% CI [1.69, 8.07], $p = .003$. However, state social desire ($b = .04$, $SE = .38$, $t(835) = .12$, 95% CI [− .70, .79], $p = .91$) and the frequency of being in social situations ($b = .83$, $SE = .75$, $t(835) = 1.10$, 95% CI [− .65, 2.31], $p = .27$) were not significantly related to raw negative affect score.

Relationships between social anxiety, social desire, and social situations

To evaluate relationships between social anxiety symptoms and social context when measured via EMA (vs. by questionnaire or in the laboratory as had occurred in prior studies), separate regressions were conducted relating SIAS scores to the continuous social desire ratings, and to the proportion of responses in which the participant indicated being in social situations versus alone. During periods of heightened negative affect, social anxiety symptoms were negatively associated with level of social desire, $b = -3.65$, $SE = 1.64$, $t(113) = -2.23$, 95% CI [− 6.90, − .41], $p = .03$, but unrelated to reports of being in social situations versus alone, $b = -.13$, $SE = .10$, $Z(114) = -1.31$, 95% CI [− .32, .06], $p = .19$.

Effects of social anxiety, social situations, and social desire on ER strategy endorsements

For hypotheses 1–4, we simultaneously entered our three independent variables as main effects (social anxiety symptoms, social situation, and social desire) and their two- and three-way interactions to predict ER strategies. Results are presented for two models, each testing a specific contrast: (1) any ER versus no ER, and (2) avoidant versus engagement ER (see Table 2 for statistics).

Model 1: Any ER versus no ER

Independent of the social anxiety and social context predictors, the main effect indicated no difference between endorsements of any versus no ER strategy (i.e., they were relatively similar in frequency). Even after controlling for multiple comparisons, there was a main effect of trait social anxiety, whereby SIAS scores were positively associated with reporting any (vs. no) ER strategy use, but this main effect was subsumed in an interaction with social desire. Counter to prediction, being in a social situation was not associated with reporting greater use of any versus no ER strategy. The exploratory analysis examining level of social desire indicated it also was not associated with reporting greater use of any versus no ER strategy.

There was a significant Social Anxiety × Social Desire interaction, with visual inspection suggesting that social anxiety symptoms were positively associated with reporting any (vs. no) ER strategy use when social desire was higher (vs. lower; see Fig. 1). To further probe the structure of the interaction, we computed simple effects at instances of high and low social desire, defined as ± 1 SD above and below the mean (Aiken and West 1991). At both high ($b = .42$, $p = .12$) and low levels ($b = -.23$, $p = .21$) of social desire, there was no reliable relationship between ER strategy use and social anxiety symptoms, other than the fact that the slopes were in opposite direction. Results indicate that trait social anxiety symptoms interact with state social desire to influence general ER strategy use, although the propensity to engage in differential rates of any ER (vs. no ER) was not statistically reliable. All other two- and three-way interactions were not statistically significant.

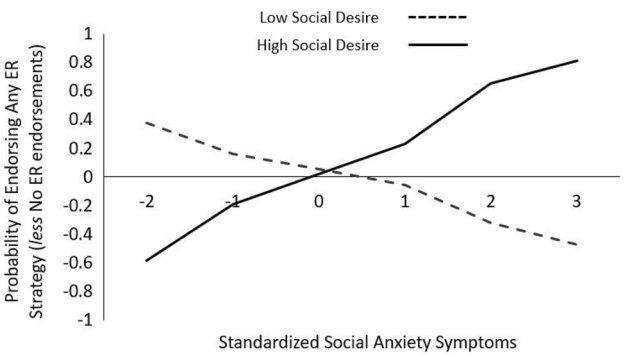

Fig. 1 *ER* emotion regulation. Interaction between trait social anxiety symptoms (standardized from − 2 to + 3) and in-the-moment social desire on reporting any ER (vs. endorsing no ER). Positive values indicate higher any ER compared to no ER endorsements, while negative values indicate higher no ER compared to any ER endorsements. Data for high and low levels of social desire were obtained at standardized values of + 4 and − 4 for the purpose of visualization. The simple effects calculations were obtained using data 1 SD above and below the mean

Model 2: Avoidant ER versus engagement ER

Independent of the social anxiety and social context predictors, the main effect for contrast indicated that avoidant ER strategies were endorsed significantly less frequently than engagement ER strategies even after controlling for multiple comparisons. Counter to prediction, our main effect of social anxiety did not remain significant after corrections. Also counter to prediction, being in a social situation was not associated with using different proportions of avoidant versus engagement ER, which had been an exploratory question. After corrections were applied, higher state social desire did not significantly relate to more engagement versus avoidant ER strategy use. All other two- and three-way interactions were not statistically significant.

Discussion

The present study assessed how trait social anxiety, in-the-moment desire for social interaction, and being in actual social situations predicted ER strategy use in undergraduate students during times of relative negative affect. To our knowledge, this is one of the first studies to incorporate

smartphone-delivered experience sampling in the study of social predictors and their impact on the use of ER strategies throughout the day. In line with previous research, social anxiety symptoms were negatively associated with social desire (Beidel et al. 1999; Brown et al. 2007). However, social anxiety was not associated with greater likelihood of being alone versus in a social situation during periods of negative affect (perhaps because negative affect is likely to occur when in social situations that trigger fears of negative evaluation for socially anxious individuals, so the typical protective effects of social situations are not as pronounced). In support of our hypotheses, social anxiety symptoms were positively associated with endorsements of any ER strategy (vs. no ER) in the context of high negative affect. However, after correcting for multiple comparisons, social anxiety symptoms were no longer associated with a hypothesized higher use of avoidant relative to engagement ER strategies. State social desire also interacted with social anxiety symptoms to predict the use of any ER compared to no ER strategy. However, when we examined the relationships between social anxiety and ER strategy use at high and low levels of social desire, no statistically reliable relationship emerged. Nevertheless, these findings point to the importance of examining both trait and state social context to understand ER strategy use.

Predicting any ER strategy versus no ER strategy

Although the simple effect analyses at high and low levels of desire were not statistically reliable, trait social desire produced an interaction with social anxiety symptoms in the context of high negative affect. This interaction effect was not dependent on whether individuals were alone or around others, suggesting that desire for social interaction (perhaps even more than the actual social situation) can influence how social anxiety impacts ER strategy use. These results support research suggesting that people may implement ER strategies differently depending on the saliency of individual goals and motivations (English et al. 2017; Tamir 2016). Given that social situations are often anxiety-provoking for socially anxious individuals, there may be greater motivation for socially anxious individuals to engage in ER when social desire is high (vs. low) in an effort to successfully navigate these situations. This could occur both when alone but desiring social interaction (such as when preparing to navigate a social encounter) and when actually in a social interaction to help it go smoothly. Similarly, this enhanced ER motivation could occur either when goals related to promoting social connectedness are activated or when goals related to reducing social threat are activated (e.g., Blascovich et al. 1999). These different goals might lead to distinct patterns of physiological reactivity and specific ER strategy selection, which would be interesting to examine in future research to better understand the underlying processes driving the observed interaction.

We did not find the hypothesized main effect for higher use of ER strategies in social situations compared to being alone in the context of high negative affect. We expected this given a previous review outlining the facilitative properties of social situations in the use of engagement-oriented ER strategies (Marroquín 2011), but also the general tendency for people to use avoidant strategies to maintain social standards when with others (e.g., suppressing emotions to maintain workplace harmony; see English et al. 2013). Rather, our results suggest that people tend to use ER strategies with equal frequency when alone compared to when they are around others, at least on average. It will be interesting in future work to evaluate the social interaction context more specifically (e.g., whether the person was in a conversation vs. merely being "around others") to determine how social interactions might influence ER strategy use. Also, examining this question among general and clinical populations will be helpful to learn what aspects of the current findings are specific to college student life.

Predicting avoidant ER versus engagement ER

After statistically controlling for multiple comparisons, we did not find the hypothesized positive relationship between social anxiety symptoms and use of avoidant versus engagement ER strategies in the context of high negative affect (however, see our supplementary analyses at all levels of negative affect where we did find the effect, even after corrections for multiple comparisons). Previous self-report and experience sampling studies demonstrate that people with social anxiety disorder endorse higher frequencies of expressive suppression and experiential avoidance, and lower frequencies of cognitive reappraisal (e.g., Blalock et al. 2016; Goldin et al. 2014; Kashdan and Steger 2006). However, these studies did not always control for within-person negative affect levels (for exception, see Kashdan et al. 2013) and often relied on once daily reports on ER strategy use, rather than sampling in real-time repeatedly throughout the day as occurred in the current study. Our empirically derived ER strategy clusters also included a wider variety of ER strategies than previous studies, which typically measure only one or two strategies over time. In the present study, we found that *momentary* use of avoidant ER (vs. engagement ER) was not associated with social anxiety symptoms at high negative affect, after controlling for several social contextual variables. It is possible that individuals with all levels of social anxiety symptoms simply use more ER strategies at high negative affect, such that we lost any clear effect. Research suggests that the general propensity to engage in

ER likely increases as unwanted negative emotions increase (Tamir 2016); thus, our ability to detect avoidant versus engagement ER differences may have been reduced because participants may be motivated to regulate in a variety of ways at high negative affect. Power may have also played a role in the finding (note, the effect was no longer significant after correcting for multiple comparisons).

Further work determining under what conditions socially anxious individuals apply avoidant ER (vs. engagement) strategies will be valuable, especially given there are affective, cognitive, and interpersonal costs related to the use of avoidant ER strategies, such as expressive suppression (e.g., Srivastava et al. 2009). For example, college students who reported higher rates of expressive suppression over the course of their first year in college also reported lower social support, less closeness to others, and lower social satisfaction. In future studies, it may helpful to directly assess in-the-moment reasons for why a given ER strategy is or is not selected. Because studies suggest that low regulatory self-efficacy beliefs are elevated in socially anxious patients compared to non-clinical control participants (De Castella et al. 2014), which are also positively associated with higher avoidant ER selection in normative samples (e.g., De Castella et al. 2018), there may be important differences as to why socially anxious individuals choose certain ER strategies in certain situations more than others. Thus, future experience sampling studies would benefit from studying the motivational and belief systems surrounding when, where, and why an individual decides to engage in ER. Of course, a challenge for the field will be figuring out how to assess these more abstract constructs in an unobtrusive way so that user burden is kept low (see Mohr et al. 2017).

Limitations and future directions

There are a number of limitations to consider regarding the current study in light of the novel methodology. The study recruited a relatively homogeneous sample of college students, with above average socioeconomic status and with roughly one-quarter meeting clinically significant levels of social anxiety symptoms based on established cut points on the SIAS. Therefore, the present results require further replication in more diverse, as well as clinical, samples to increase generalizability. We believe it is important to study college students, however, given that anxiety disorders and other forms of mental illness often emerge in this age group (Kessler et al. 2005), and it is often a time of increased independence in decision-making about emotional functioning. Moreover, we defined social situations rather crudely (i.e., alone vs. with others) and we were unable to fully determine the nature of participants' social context at the prompts (e.g., extent and quality of social interaction occurring) given the need to keep the number of questions low to manage user burden. The determination of a social interaction may require additional questions about what was happening at the time of the survey (e.g., talking with someone or simply around others) and we were limited by the number of questions we could ask at one time. Nevertheless, we were interested in people's subjective impression of whether they were in a social situation because that impression is likely to be a big part of what triggers the relevant fears of negative evaluation.

Although we attempted to increase the ecological validity of the study with experience sampling, our surveys still rely on participants being able to self-report on their emotional experiences. Research indicates that some individuals find this more difficult than others (Robinson and Clore 2002), and this difficulty may be exacerbated in the context of mental illness (Kashdan et al. 2015). Moreover, we attempted to assess ER strategy use at high negative affect, but this is hard to define in an objective way and, using our approach, meant participants contributed different numbers of observations to the final analyses. There are multiple ways to select which observations might reflect negative affect (e.g., choosing a raw score cut point, or taking each persons' top 30% of unstandardized responses) which could lead to different results given they would identify a different subset of the data as the "negative affect" trials being analyzed. We focused on each person's idiographic use of the scale, rather than using a threshold based on raw scores. There was also a limitation in our "no ER" variable, given that participants may have used other strategies that were simply not listed in our surveys (inflating this value) or they may have learned that it was easier to report using "no ER" to get through the surveys faster (however, we found that this response only increased 10% after week 1). We could not confirm whether this represented increased non-compliance or simply increased reports of no strategy use during the moments assessed. We also found that the rate of selecting "no ER" per day, per participant (on average), was relatively normally distributed potentially reflecting individual differences.

A final limitation is that our participants completed roughly 40% of the intended surveys. This seemed largely due to participants not returning surveys within the 30-min time limit placed on survey responses. Tied to this, given we limited our sampling schedule between 9:00 a.m. and 9:00 p.m., we potentially missed additional times when our participants had more free time, were not attending to class or studying, and perhaps were interacting with others in the late evenings and early mornings. Other issues, such as technological issues in transmitting survey prompts and a demanding experience sampling design, and relatively low compensation may have reduced response rates. Notwithstanding, a recent review of experience sampling studies on mobile devices found response rates to range from 17 to 100% (Van Berkel et al. 2017), suggesting our results

are within that broad range and our future work is actively considering each of these limitations to improve compliance rates.

Conclusions

Despite these limitations, the findings of this study help to illuminate the context-specific relationships between socially anxiety symptoms and real-time ER strategy use. As smartphones become increasingly available and more powerful, the use of this technology with experience sampling designs may prove useful in future studies of individuals with social anxiety (and other forms of mental illness) to understand their selection and implementation of different ER strategies, and ultimately, to help them to regulate more effectively.

Funding This study was supported by a University of Virginia Postdoctoral and Predoctoral Fellowship Grant awarded to the two senior authors, and a R01MH113752 Grant to the final author.

Compliance with ethical standards

Conflict of interest All authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the Ethical Standards of the Institutional and/or National Research Committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent Informed consent was obtained from all individual participants included in the study.

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