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Extremely shy & genetically close : investigating neurobiological endophenotypes of social anxiety disorder

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Chapter 7

Not intended, still embarrassed: social anxiety is related to increased levels of embarrassment in response to unintentional social norm violations

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ABSTRACT

Background

Social anxiety disorder (SAD) is associated with altered social norm (SN) processing: SAD patients rate stories on SN violations as more inappropriate and more embarrassing than healthy participants, with the most prominent effect for stories on unintentional SN violations (i.e. committing a blunder). Until now it's unknown how levels of social anxiety (SA) are related to ratings of SN violations in the general population, in which SA-symptoms are present at a continuum. More insight in this relationship could improve our understanding of the symptom profile of SAD. Therefore, we investigated the relation between ratings of SN violations and SA-levels in the general population.

Methods

Adults and adolescents ($n = 87$) performed the revised Social Norm Processing Task (SNPT-R) and completed self-report questionnaires on social anxiety. Repeated measures ANCOVAs were used to investigate the effect of SA on the ratings of inappropriateness and embarrassment.

Results

As hypothesized, participants with higher SA-levels rated SN violations as more inappropriate and more embarrassing. Whereas participants with low-to-intermediate SA-levels rated unintentional SN violations as less embarrassing than intentional SN violations, participants with high SA-levels (z -score SA ≥ 1.6) rated unintentional SN violations as equally embarrassing as intentional SN-violations.

Conclusions

These findings indicate that increased embarrassment for unintentional SN violations is an important characteristic of social anxiety. These high levels of embarrassment are likely related to the debilitating concern of socially-anxious people that their skills and behavior do not meet expectations of others, and to their fear of blundering. This concern might be an important target for future therapeutic interventions.

INTRODUCTION

Social anxiety (SA) is an emotion that is experienced by most people with some regularity. Typically, people want to make a good impression when they are in a social situation, and when committing a blunder in the presence of others, people tend to feel embarrassed or ashamed. However, the experience of social anxiety varies between people, ranging from discomfort in specific social situations for some individuals to an intense fear in almost all social situations for others (Miskovic & Schmidt, 2012). At the upper end of this 'continuum of social anxiety' (Rapee & Spence, 2004) lies social anxiety disorder (SAD), a psychiatric condition which is, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), characterized by an intense fear of being negatively evaluated in social situations (American Psychiatric Association, 2013). This fear of social-evaluative stimuli (Wong & Rapee, 2016), which is out of proportion to the actual threat and to the sociocultural context (Heimberg et al., 2014; Leichsenring & Leweke, 2017) leads to the avoidance of social situations and results in significant disturbances in a person's everyday life (American Psychiatric Association, 2013; Stein & Stein, 2008). The typical onset of SAD is during childhood or adolescence and several environmental as well as intrinsic factors like genetic influences, biological factors as well as cognitive biases interact in the development of the disorder (Spence & Rapee, 2016).

Previous studies have indicated that SAD patients experience disturbances in self-referential processing and have biases concerning the opinion of others about them: they have increased self-portrayal concerns (Moscovitch et al., 2013), for example when it concerns their social rank (Berger, Keshet, & Gilboa-Schechtman, 2017; Gilboa-Schechtman et al., 2017) or their own social performance (Gavric, Moscovitch, Rowa, & McCabe, 2017; Glazier & Alden, 2017), they overestimate the negative consequences of their own social blunders (Moscovitch, Waechter, Bielak, Rowa, & McCabe, 2015), and are characterized by negatively biased learning about themselves from social feedback (Koban et al., 2017). Furthermore, clinical SAD is associated with an increased belief in negative interpretations of social situations (Loscalzo, Giannini, & Miers, 2017), and SAD patients focus predominantly on potentially embarrassing events when they evaluate themselves in a social context (Blair & Blair, 2012). Such negative self-beliefs, which are already present in adolescents with SAD (Blöte, Miers, Heyne, Clark, & Westenberg, 2014; Schreiber & Steil, 2013), are related to increased negative emotions like fear and anxiety, and induce maladaptive behavioral responses like safety behaviors, which, consecutively, lead to the maintenance of social anxiety (Goldin, Manber-Ball, Werner, Heimberg, & Gross, 2009; Piccirillo, Dryman, & Heimberg, 2016). It has been argued that SAD patients are 'uniquely and primarily concerned about characteristics of self that they perceive as being deficient or contrary to perceived societal expectations or norms' (Moscovitch, 2009). According to this view, one of the main concerns of SAD patients is the fear that they will unintentionally

commit an embarrassing behavioral blunder in a social situation (Moscovitch, 2009), which let us to hypothesize that social anxiety is specifically related to the experience of increased embarrassment in reaction to unintentional social norm violations.

This idea was previously examined by investigating the behavioral data of a functional magnetic resonance imaging (fMRI) study using the social norm processing task (SNPT) (Blair et al., 2010). In this task, participants read three types of short stories: stories describing neutral social situations, stories on unintentional social norm (SN) transgressions (i.e. committing a blunder) and stories describing intentional SN transgressions (i.e. breaking conventional rules) and they are asked to imagine themselves in the situation described. Subsequently, participants rate the stories on inappropriateness and embarrassment. Thereby, the SNPT enables investigating the effect of intention on these ratings. Blair and colleagues (2010) showed that, while SAD patients had higher self-reported levels of inappropriateness and embarrassment across all conditions, the effect of SAD was most pronounced for unintentional SN violations: adult patients with generalized SAD ($n = 16$) rated these unintentional transgressions as significantly more embarrassing when compared to healthy participants ($n = 16$). Furthermore, the fMRI analyses revealed that reading the unintentional stories evoked increased activation in the ventromedial prefrontal cortex in SAD. This activation was considered to represent increased self-referential processing and was taken to indicate that SAD patients judge unintentional SN violations as more self-relevant than healthy participants (Blair et al., 2010).

The results of this study (Blair et al., 2010), which was the first, and, to the best of our knowledge, the only study to date investigating the difference between processing intentional and unintentional SN violations in SAD, provide important initial evidence that the intention underlying a SN violation is a determining factor in the experience of embarrassment in social anxiety: although SAD patients reported higher embarrassment for all social situations, they differed most from control participants when they considered unintentional transgressions (Blair et al., 2010). However, the sample size of the study was relatively small. In addition, participants performed an 'impersonal' version of the SNPT, in which the stories described behavior of an unknown character like 'Joanna' (cf. Berthoz et al., 2002)), as a result of which it could be questioned whether the ratings reflect the participants' opinion about their own SN violations. Furthermore, it is unknown if the effect of intention on the level of embarrassment also holds for participants with higher SA-levels in the general population.

Here, we investigated the relation between self-reported SA and behavioral ratings of SN violations in a sample of adults and adolescents from the general population ($n = 87$), using the revised Social Norm Processing Task (SNPT-R) (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017a). In the SNPT-R, the three types of stories were written in second-person, in order to let the ratings reflect how participants think about their own SN viola-

tions. Data of this sample on the SNPT-R have been published previously (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017a).

Based on previous work (Blair et al., 2010), we hypothesized that higher SA-levels within the general population would be predictive of a general effect of SA, reflected by higher ratings of inappropriateness and embarrassment for all stories and of an intention-specific effect of SA, namely an even more pronounced increase in embarrassment ratings for stories on unintentional SN violations. More insight in this relationship could help further unravel mechanisms involved in the etiology and maintenance of social anxiety and may identify potential novel targets for prevention and intervention.

METHODS

Participants

Participants were adults and adolescents from the general population ($n = 87$; age range 12.5 – 32.6 y), the same as those described previously (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017a); details of the inclusion procedure are described in the *Supplemental Methods*. They had Dutch as their first language and were free of past and present psychopathology as assessed by a self-report questionnaire. After explanation of the procedure, all participants (and in case of minors below 18 years of age, both parents) signed informed consent according to the Declaration of Helsinki. The Psychology Research Ethics Committee of Leiden University approved the experiment.

Social Norm Processing Task

Participants performed the revised Social Norm Processing Task (SNPT-R), described in detail previously (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017a). The SNPT-R consists of two phases (*Figure 6.1*).

In the first phase, participants read three types of short stories: stories on situations in which no social norm (SN) was violated (neutral condition; for example: ‘You are baking an apple pie with your friends. You use the amount of sugar the recipe calls for’), stories describing unintentional SN violations (unintentional condition; ‘You are baking an apple pie with your friends. You use salt instead of sugar without realizing’) and stories outlining intentional SN violations (intentional condition; ‘You are baking an apple pie with your friends. You use salt instead of sugar as a joke’). Stories in the unintentional and intentional condition described relatively innocent violations of conventional social norms, in situations where at least one other person was present. The intentional and unintentional stories differed only in the intention of the actor, while the actual result of the violation (for example: a distasteful cake) was kept as much as possible the same. Stories were written in second-person and participants were instructed to imagine themselves in the situations,

in order to maximize their personal involvement (cf. (Finger et al., 2006)). Therefore, four age- and gender specific versions of the task were used: for boys < 18 years, girls < 18 years, men \geq 18 years and women \geq 18 years. The task consisted of 78 stories and a full list of stories is provided in *Supplemental Table S6.1* (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017a). We refer the reader to this work and to the Open Science Framework (OSF) project (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017b) for more details on task parameters and scripts for task presentation.

Secondly, there was an unannounced rating-phase, in which participants were asked to rate all stories on a five-point Likert scale on embarrassment (from 1, not embarrassing at all, to 5, extremely embarrassing) and inappropriateness (from 1, not inappropriate at all, to 5, extremely inappropriate). These ratings were the output measures used in this study.

Both phases of the SNPT-R were presented using E-Prime software (version 2.0.10, Psychology Software Tools; available at osf.io/pt4qt (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017b)).

Self-report questionnaires

As there exists, to the best of our knowledge, no instrument which is suitable to reliably assess the level of social anxiety in both adults and adolescents, two questionnaires were used to determine social anxiety: depending on their age, participants completed the self-report version of the Liebowitz Social Anxiety Scale (LSAS) (Heimberg et al., 1999) or the Social Anxiety Scale for Adolescents (SAS-A) (La Greca & Lopez, 1998). The LSAS is a questionnaire for adults measuring fear in and avoidance of situations that are likely to elicit social anxiety (Fresco et al., 2001; Heimberg et al., 1999). The SAS-A (La Greca & Lopez, 1998) measures social anxiety in adolescents, with satisfactory levels of internal consistency (Miers et al., 2013).

Boys and girls did not differ in self-reported SA as measured with the SAS-A (independent-samples t-test: $t(27) = -0.41, p = 0.69$), while women reported significantly more SA-symptoms compared to men, as measured with the LSAS ($t(56) = -3.24, p = 0.002$) (cf. (Asher, Asnaani, & Aderka, 2017; Carleton et al., 2007; Duke, Krishnan, Faith, & Storch, 2006; Ingles, La Greca, Marzo, Garcia-Lopez, & Garcia-Fernandez, 2010; Turk et al., 1998)) (*Table 7.1*). Because we aimed to investigate the relation between self-reported SA and ratings on the SNPT-R within each group of participants (boys < 18 years; girls < 18 years; men \geq 18 years; women \geq 18 years), rather than over the whole sample (an analysis which could be influenced by age- and gender differences), we normalized the scores on the LSAS and SAS-A within each group and used the z-scores (SA-z) for further analyses. The validity of this measure was established by additional analyses, separate for the adolescent and adult sample, using the original LSAS and SAS-A scores; in these analyses, we observed in general the same pattern of results as described in the Results section. Furthermore,

exploratory analyses indicated no significant interactions between SA-*z*, age group (adult vs. adolescents) and behavioral ratings.

After *z*-standardizing the scores on the LSAS and SAS-A within each group, one participant (male) was considered an outlier (SA-*z* = 3.27) and removed from subsequent analyses (remaining sample: $n = 86$).

Procedure

The experiment took place at the Faculty of Social and Behavioral Sciences, Leiden University, the Netherlands (adult participants) and at a secondary school in the Netherlands (adolescent participants). Participants performed both phases of the SNPT-R and the self-report questionnaires on a laptop in a quiet environment.

Data analysis

Statistical analyses of the ratings of embarrassment and inappropriateness for the SNPT-R stories were performed using IBM SPSS Statistics for Mac (Version 24.0). The relationships between behavioral ratings of inappropriateness and embarrassment and social anxiety were investigated using repeated measures ANCOVAs with condition (intentional; unintentional; neutral) as within-subjects factor and SA-*z* as covariate. Significant effects of condition were further investigated using paired-samples *t*-tests; significant effects of SA-*z* were examined using separate regression analyses for each condition (independent variable: SA-*z*; dependent variables: ratings), while significant interactions between condition and SA-*z* were explored using regression analyses with the difference scores of the ratings as dependent variables (e.g., $\Delta\text{Intentional_unintentional} = \text{intentional score} - \text{unintentional score}$). For reasons of completeness and in line with the analyses reported previously (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017a), we repeated the above described ANCOVAs with group (based on the four versions of the task; group 1: boys < 18 years; group 2: girls < 18 years; group 3: men \geq 18 years; group 4: women \geq 18 years) as additional between-subjects factor. Results of these analyses are summarized in *Supplemental Table S7.1* and *Supplemental Table S7.2* and discussed in the *Supplemental Results*. For all analyses, significance level was set at $p \leq 0.05$; Greenhouse–Geisser correction was used when the assumption of sphericity was violated.

RESULTS

Participants

Characteristics of the participants, divided into four groups based on the age- and gender-specific versions of the SNPT-R, are summarized in *Table 7.1*. Data are also available at osf.io/j58yc/ (Bas-Hoogendam, van Steenbergen, van der Wee, & Westenberg, 2017a). Using

literature-based cutoff scores, 8 adults (14% of the adult sample; LSAS score ≥ 60 (Mennin et al., 2002)) and 2 adolescents (7 % of the adolescent sample; SAS-A score ≥ 50 (Storch et al., 2004)) met the criteria for generalized SAD.

Table 7.1 Characteristics participants.

	Boys (<i>n</i> = 13)	Girls (<i>n</i> = 16)	Men (<i>n</i> = 29)	Women (<i>n</i> = 29)
Age (years)	14.0 \pm 1.2 (12.7 - 16.5)	14.2 \pm 1.4 (12.5 - 17.0)	21.1 \pm 3.1 (18.5 - 32.6)	19.2 \pm 1.2 (18.1 - 24.1)
Social anxiety				
SAS-A	36.3 \pm 9.2 (20 - 54)	37.6 \pm 8.2 (26 - 56)	n.a	n.a
LSAS	n.a	n.a	31.0 \pm 17.1 (2 - 87)	47.3 \pm 21.0 (16 - 89)

Abbreviations

LSAS: Liebowitz Social Anxiety Scale (Heimberg et al., 1999); SAS-A: Social Anxiety Scale for Adolescents (La Greca & Lopez, 1998); n.a: not applicable.

Footnote

Values represent mean \pm standard deviation (range).

Relationship between ratings and self-reported social anxiety

Ratings of inappropriateness and embarrassment on the SNPT-R are summarized in *Table 7.2*; for group-specific ratings, we refer the reader to (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017a).

Table 7.2 Ratings of embarrassment and inappropriateness on the SNPT- R.

	Inappropriateness			Embarrassment		
	<i>Intentional</i>	<i>Unintentional</i>	<i>Neutral</i>	<i>Intentional</i>	<i>Unintentional</i>	<i>Neutral</i>
Total sample	4.42 \pm 0.36	2.93 \pm 0.51	1.29 \pm 0.20	3.83 \pm 0.67	3.50 \pm 0.56	1.25 \pm 0.21

Footnote

Values represent mean \pm standard deviation.

Inappropriateness

A repeated measures ANCOVA (condition-by-SA-z) on inappropriateness ratings indicated a main effect of condition ($F(1.8,149.5) = 2230.9, p < 0.001$, partial $\eta^2 = 0.97$), a main effect of SA-z ($F(1,84) = 7.1, p = 0.009$, partial $\eta^2 = 0.08$), and an interaction between condition and SA-z ($F(1.8,149.5) = 3.9, p = 0.026$, partial $\eta^2 = 0.05$). Paired-samples t-tests revealed that intentional stories were rated more inappropriate than unintentional stories ($t(85) = 27.4, p < 0.001$) and unintentional stories as more inappropriate than neutral stories ($t(85) = 33.6, p < 0.001$), as reported previously (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017a).

As illustrated in *Figure 7.1* (left panel), subsequent regression analyses revealed positive relationships between SA-*z* and ratings of inappropriateness in the unintentional ($\beta = 0.30, p = 0.005$; 95 % confidence interval (CI): 0.10 – 0.55) and neutral condition ($\beta = 0.25, p = 0.020$; 95 % CI: 0.04 – 0.50), but not in the intentional condition ($\beta = 0.085, ns$; 95 % CI: -0.14 – 0.33). The interaction between SA-*z* and condition was further investigated using regression analyses on difference scores. Results showed that SA-*z* was positively related to Δ Unintentional_intentional ($\beta = 0.24, p = 0.024$; 95 % CI: 0.04 - 0.49) and to Δ Unintentional_neutral ($\beta = 0.23, p = 0.033$; 95 % CI: 0.20 – 0.48), but not related to Δ Intentional_neutral ($\beta = -0.05, ns$; 95 % CI: -0.29–0.18). These findings indicate that the slope of the regression line for the relationship between SA-*z* and inappropriateness in the unintentional condition is significantly steeper when compared to the slopes of the

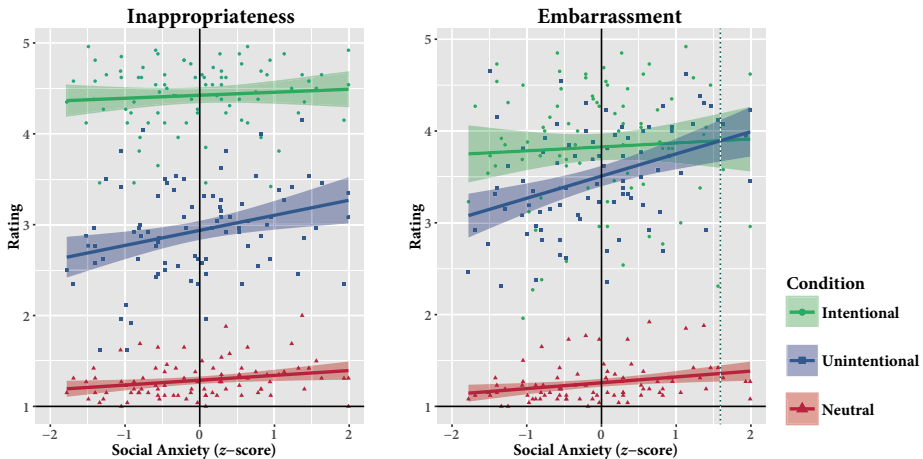


Figure 7.1 Relationships between social anxiety (*z*-standardized) and ratings on the SNPT-R. Shaded areas represent 95% confidence intervals.

regression lines for the relationships between SA-*z* and inappropriateness in the intentional and neutral condition.

Embarrassment

A repeated measures ANCOVA on the ratings of embarrassment showed a main effect of condition ($F(1.8,151.0) = 909.9, p < 0.001$, partial $\eta^2 = 0.92$), a main effect of SA-*z* ($F(1,84) = 7.4, p = 0.008$, partial $\eta^2 = 0.08$), and an interaction between condition and SA-*z* ($F(1.8,151.0) = 4.7, p = 0.013$, partial $\eta^2 = 0.05$). Intentional stories were rated as more embarrassing than unintentional stories ($t(85) = 4.5, p < 0.001$) and unintentional stories as more embarrassing than neutral stories ($t(85) = 39.9, p < 0.001$) (Bas-Hoogendam, van Steenberg, Kreuk, et al., 2017a).

Regression analyses revealed significant positive relationships between SA-*z* and embarrassment in the unintentional condition ($\beta = 0.40$, $p < 0.001$; 95 % CI: 0.22 – 0.65) and the neutral condition ($\beta = 0.28$, $p = 0.008$; 95 % CI: 0.08 – 0.53), but not between SA-*z* and embarrassment in the intentional condition ($\beta = 0.06$, ns; 95 % CI: -0.17 – 0.30) (*Figure 7.1*, right panel). The interaction between SA-*z* and condition was further investigated using regression analyses on difference scores. Results showed a significant positive relationship between SA-*z* and Δ Unintentional_intentional ($\beta = 0.28$, $p = 0.01$; 95 % CI: 0.07 - 0.53), a positive relationship with Δ Unintentional_neutral ($\beta = 0.32$, $p = 0.003$; 95 % CI: 0.12 – 0.57), but no relationship between SA-*z* and Δ Intentional_neutral ($\beta = -0.03$, ns; 95 % CI: -0.27 – 0.20). Again, these findings indicate that the effect of SA-*z* is most pronounced (i.e., steepest slope) on the embarrassment ratings in the unintentional condition. Interestingly, the regression lines depicting the relationships between SA-*z* and embarrassment on the intentional and unintentional condition intersect at intermediate-to-high SA-levels (SA-*z* = 1.6; *Figure 7.1*, right panel): while individuals with low SA-levels give lower embarrassment scores for unintentional versus intentional SN transgressions, this effect disappears with increasing levels of social anxiety and is no longer significant at high SA-levels in our sample.

DISCUSSION

We investigated the relationship between self-reported levels of social anxiety (SA) and behavioral ratings on the revised Social Norm Processing Task (SNPT-R) in adults and adolescents from the general population. Previous research showed that patients with social anxiety disorder (SAD) rated all SNPT-stories as significantly more inappropriate and more embarrassing compared to healthy participants, with the most noticeable effect for the unintentional condition (Blair et al., 2010). These findings support the hypothesis proposed by Moscovitch (2009) that one of the main concerns of SAD patients is the fear that they will unintentionally commit an embarrassing behavioral blunder in a social situation. Building upon this work, we predicted a general effect of SA, namely, that higher SA-levels in the general population would be associated with higher ratings of inappropriateness and embarrassment. Furthermore, we expected to find an intention-specific effect of SA, reflected by a more pronounced effect of SA on embarrassment ratings for stories on unintentional SN violations.

These hypotheses were confirmed: overall, participants with higher SA-levels rated the stories as more inappropriate and more embarrassing (*Figure 7.1*), while subsequent regression analyses revealed how this general effect of SA was related to the different conditions of the inappropriateness and embarrassment ratings. In the intentional condition, inappropriateness and embarrassment ratings were unrelated to SA, suggesting that SA did not influence people's basic judgment of SN violations: breaking conventional rules is

simply considered 'not done' and evokes embarrassment independent of the level of SA. However, SA-levels were positively related to inappropriateness and embarrassment in the neutral condition, which might reflect the general tendency of socially-anxious individuals to feel uncomfortable in social situations (Miskovic & Schmidt, 2012). The strongest positive relationships were present between SA-levels and ratings of inappropriateness and embarrassment in the unintentional condition. Importantly, we found an intention-specific effect of SA for embarrassment when comparing the unintentional and intentional conditions. While participants with low-to-intermediate SA-levels rated stories on unintentional SN violations as less embarrassing than stories describing intentional SN violations, participants with high SA-levels (z -score SA ≥ 1.6) rated unintentional SN violations as equally embarrassing as intentional SN violations (Figure 7.1, right panel). In other words, participants with lower SA-levels distinguish between breaking conventional rules and committing a blunder in their embarrassment ratings: they take the intention underlying the transgression into account and report less embarrassment when the action was unintentional. However, participants with higher SA-levels do not make this distinction. Note that this intention-specific effect of SA was not found for inappropriateness: individuals with higher SA-levels did still distinguish between intentional and unintentional SN violations with respect to inappropriateness.

These findings hint at a dissimilarity in the cognitive and affective evaluation of SN violations: at the cognitive level (evaluation of inappropriateness), individuals with high SA-levels are not all that different from those with low SA-levels; at the affective level (evaluation of embarrassment), however, they fail to make the distinction between intentional and unintentional SN violations. This increased experience of embarrassment could contribute to the development and maintenance of SAD, as embarrassment is a self-conscious emotion with two sides: although it is a prosocial emotion signaling the recognition of misbehavior and holding the promise that the mistake will not happen again, it also represents negative self-evaluations (Feinberg et al., 2012; Jankowski & Takahashi, 2014; Miller, 2014). When embarrassment occurs too often and too intensely, these negative self-evaluations can lead to an overestimation of the extent to which a misstep is important to others, to misplaced and needless concerns about other people's judgment, and to timid, passive behavior (Miller, 2007) – a tendency that characterizes socially-anxious people.

The results reported here extend those of Blair and colleagues (Blair et al., 2010), by showing that the aberrant behavioral response to unintentional SN violations observed in SAD patients is also present in participants from the general population with high SA-levels. Furthermore, our finding of increased embarrassment for unintentional SN violations is in line with previous work, which indicated that both SAD patients as well as participants with high SA-levels overestimate the negative consequences of unintentional social blunders (Moscovitch, Rodebaugh, & Hesch, 2012; Moscovitch et al., 2015). In addition, our results link to the idea that both negative interpretation biases as well as disordered self-referential

processing, at the cognitive and neural level, are important characteristics of SA (Abraham et al., 2013; Blair, Geraci, Otero, et al., 2011; Blair & Blair, 2012; Boehme, Miltner, et al., 2015; Clark & McManus, 2002; Giménez et al., 2012; Hirsch & Clark, 2004; Kreifelts et al., 2014; Miers et al., 2008; Morrison & Heimberg, 2013; Müller-Pinzler et al., 2015; Ziv et al., 2013). Furthermore, studies have indicated that SA is associated with increased levels of perfectionism, especially with heightened concerns over making mistakes (Antony, Purdon, Huta, & Swinson, 1998; Ashbaugh et al., 2007; Cox & Chen, 2015; Newby et al., 2017) and with high levels of self-criticism (Cox, Fleet, & Stein, 2004). Together with these observations, our results support the idea that participants with high SA-levels are characterized by a fear of blundering in a social situation and by a strong concern that their skills and behavior do not meet perceived societal expectations (Moscovitch, 2009). Thereby, our findings contribute to understanding the symptom profile in at-risk populations and in SAD patients, and could aid in improving preventive and therapeutic interventions for this disorder. Cognitive behavioral therapy could, for example, challenge the concern of patients that their self-characteristics are deficient and do not satisfy societal norms, and help patients to realize that the consequences of unintentional blunders are probably not as bad as they consider them to be (Moscovitch, 2009). This is of importance, given that the increased experience of embarrassment leads to maladaptive coping strategies like avoidance and safety behaviors, which are maintaining factors of SAD (Hofmann, 2007; Piccirillo et al., 2016; Wong & Rapee, 2016).

A limitation of the present study is the relatively small sample size, especially given the fact that participants were divided into four groups based on the versions of the SNPT-R (versions for respectively boys, girls, men and women). Especially the number of included adolescents is limited, as a result of which we were unable to investigate whether age influences the relationship between SA and embarrassment. Given that adolescence is a critical time period for the onset of SAD (Haller et al., 2015), a longitudinal study on a large sample of adolescents could give more insight in the role of embarrassment in the development of SAD. In addition, the presence of past and present psychopathology in the sample was only assessed by self-report, which could lead to an underestimation of psychopathology. For example, SAD patients are often underestimating their condition and refrain from consulting their general practitioner, which may lead to underdiagnosis (Dingemans et al., 2001). Actually, ten participants of the current sample met the criteria for generalized SAD as based on the cutoff scores for the LSAS and SAS-A (Mennin et al., 2002; Storch et al., 2004), but due to the lack of structured clinical interview, these diagnoses could not be confirmed by a clinician.

Furthermore, we did not acquire neuroimaging data, thus we could not relate our data to neural activity (cf. (Blair et al., 2010)). Future imaging studies could investigate whether SA-levels alter activation in brain regions involved in SN processing. Because increased activation in the ventromedial prefrontal cortex in SAD patients in response to unintentional

SN violations has been reported (Blair et al., 2010), we hypothesize that higher SA-levels are related to differential activation within this region. Such an experiment could provide more insight in the neural basis of the altered SN processing associated with high SA-levels. Furthermore, family studies involving SAD patients as well as their relatives could investigate whether altered SN processing and the associated neural pattern are heritable characteristics, representing an endophenotype of SAD (Bas-Hoogendam et al., 2014a, 2016). This could enhance our understanding of the familial component of SAD.

CONCLUSIONS

To conclude, the data presented here show that high levels of social anxiety in the general population are associated with increased embarrassment for unintentional social norm violations. Although the generalizability of our results might be limited by the relatively small sample size, these findings provide more insight in the core fear of socially-anxious individuals and offer clues for therapeutic interventions.

SUPPLEMENTAL METHODS

Participants

Participants were recruited via flyers, in-class announcements and by word of mouth and tested between November 2014 and December 2015 (adults: November - December 2014; adolescents: June 2015 - December 2015). Adolescents were recruited at a secondary school in the Netherlands; adults were students from Leiden University, Faculty of Social and Behavioral Sciences. After performing the experiment, participants were debriefed about the aim of the study and they received a compensation for partaking in the experiment (adults: study credits; adolescents: chocolate bar).

Ninety-four participants signed up for the current experiment; four participants were excluded from participation because they did not meet the selection criteria ($n = 3$: present medication use; $n = 1$: present physical disorder). Furthermore, data from three participants were excluded from the analyses because they performed a version of the SNPT-R that did not match their age. Therefore, the total sample size of the present study was 87 participants.

SUPPLEMENTAL RESULTS

ANCOVAs including group as between-subjects factor

The results of the ANCOVAs (summarized in *Supplemental Table S7.1* and *Supplemental Table S7.2*), including group as a between-subject factor, show that the effects of SA-z on the ratings of inappropriateness and embarrassment, as well as the interactions between SA-z and condition, are comparable to the effects reported in the main text of the paper.

Furthermore, the significant effects of group (both on the ratings of inappropriateness as well as on the ratings of embarrassment) and the interactions between group and condition, are in line with the results reported previously (Bas-Hoogendam, van Steenbergen, Kreuk, et al., 2017a). However, neither the SA-z-by-group-by-condition interactions, nor the SA-z-by-group interactions, reached significance. We take these findings as an indication that the effects of SA-z, as described in the paper, are not influenced by group.

SUPPLEMENTAL TABLES

Supplemental Table S7.1 ANCOVA Condition x group, with SA-z as covariate – inappropriateness ratings.

Within-subjects effects	F	<i>p</i>	Partial η^2
Main effect condition	$F(1.6, 127.9) = 2065.3$	$p < 0.001$	0.96
Interaction condition x SA-z	$F(1.6, 127.9) = 4.3$	$p = 0.022$	0.05
Interaction condition x group	$F(4.9, 127.9) = 3.3$	$p = 0.008$	0.11
Interaction condition x group x SA-z	$F(4.9, 127.9) = 0.8$	$p = 0.53$	0.03
Between-subjects effects			
Main effect SA-z	$F(1, 78) = 7.5$	$p = 0.008$	0.09
Main effect group	$F(3, 78) = 4.2$	$p = 0.008$	0.14
Interaction SA-z x group	$F(3, 78) = 0.1$	$p = 0.94$	0.005

Footnote

In line with Bas-Hoogendam et al. (2017), group is based on the version of the *SNPT-R*: group 1: boys < 18 years of age; group 2: girls < 18 years of age; group 3: men \geq 18 years of age; group 4: women \geq 18 years of age.

Supplemental Table S7.2 ANCOVA Condition x group, with SA-z as covariate – embarrassment ratings.

Within-subjects effects	F	<i>p</i>	Partial η^2
Main effect condition	$F(1.6, 127.7) = 837.6$	$p < 0.001$	0.92
Interaction condition x SA-z	$F(1.6, 127.7) = 5.9$	$p = 0.006$	0.07
Interaction condition x group	$F(4.9, 127.7) = 2.7$	$p = 0.03$	0.09
Interaction condition x group x SA-z	$F(4.9, 127.7) = 1.8$	$p = 0.11$	0.07
Between-subjects effects			
Main effect SA-z	$F(1, 78) = 10.7$	$p = 0.002$	0.12
Main effect group	$F(3, 78) = 7.5$	$p < 0.001$	0.22
Interaction SA-z x group	$F(3, 78) = 0.9$	$p = 0.42$	0.04

Footnote

In line with Bas-Hoogendam et al. (2017), group is based on the version of the *SNPT-R*: group 1: boys < 18 years of age; group 2: girls < 18 years of age; group 3: men \geq 18 years of age; group 4: women \geq 18 years of age.

