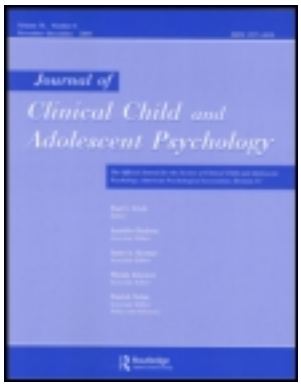

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Biased Perception and Interpretation of Bodily Anxiety Symptoms in Childhood Social Anxiety

Julian Schmitz [a], Jens Blechert [b], Martina Krämer [a], Julia Asbrand [a] & Brunna Tuschen-Caffier [a]

[a] Clinical Psychology and Psychotherapy, University of Freiburg

[b] Clinical Psychology, University of Salzburg

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Julian Schmitz
Clinical Psychology and Psychotherapy, University of Freiburg

Jens Blechert
Clinical Psychology, University of Salzburg

Martina Krämer, Julia Asbrand, and Brunna Tuschen-Caffier
Clinical Psychology and Psychotherapy, University of Freiburg

Cognitive models of social phobia (SP) and empirical evidence in adults suggest that affected individuals overestimate arousal symptoms such as heart rate (HR) during social stress and worry about their visibility in public. To date, little is known about these aspects in childhood social anxiety, an important precursor of the disorder. We assessed perception of—and worry about—HR visibility, actual HR, and subjective anxiety during public speaking in high socially anxious (HSA; $n = 20$) and low socially anxious (LSA; $n = 20$) Caucasian children, aged 10 to 12 years. Symptom visibility was manipulated by making a nonveridical HR feedback tone audible only to the participant (private condition, HR sounds via headphone) or to participant and observers (public condition, HR sounds via speakers). Further, we assessed interoceptive accuracy in a heartbeat counting task. As expected, HSA children perceived their HR as higher than LSA children in both private and public conditions despite similar actual HR and comparable interoceptive accuracy. Public feedback led to more worry about HR visibility only in HSA but not in LSA children. Biased perception and interpretation of bodily anxiety symptoms during social stress manifests early in social anxiety and might therefore play a crucial role in the aggravation of social anxiety and the development of SP. We discuss implications for current theory, clinical practice, and prevention.

INTRODUCTION

Social phobia (SP) refers to a persistent and intensive fear of humiliation by others, leading to significant subjective distress and avoidance of social performance situations and social interactions (American Psychiatric Association, 1994). SP is one of the most common mental disorders in children, with prevalence rates up to 7% (Chavira, Stein, Bailey, & Stein, 2004). Compared to mild levels of social fear and shyness, which are quite commonly found within the average population (e.g., Heiser, Turner, & Beidel, 2003), SP and high levels of social fears are associated with a greater impairment in academic and social functioning, and more often follow a chronic course (Beidel, Turner, & Morris, 1999; Chavira et al., 2004; Turner, Beidel, & Townsley, 1990).

Despite its high clinical relevance, little is known to date about the factors that contribute to the maintenance of the disorder in children (Ollendick & Hirshfeld-Becker, 2002). Current etiological models (e.g., Clark &

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Correspondence should be addressed to Julian Schmitz, Clinical Psychology and Psychotherapy, University of Freiburg, Engelbergerstraße 41, Freiburg 79106, Germany. E-mail: Julian.Schmitz@psychologie.uni-freiburg.de

Wells, 1995) assume an important role of the processing of bodily arousal in the development and manifestation of the disorder: When socially anxious individuals enter a social-evaluative situation, they show an excessive perception of feared anxiety responses, such as bodily symptoms of anxiety (e.g., blushing, trembling, and sweating), due to extensive self-focused attention. In addition, individuals with SP fear in particular that others may notice these symptoms, which they interpret as failure (e.g., ''It is embarrassing if others see how much I blush''). The belief of individuals with SP that their bodily arousal is visible to others then leads to an increase in anxiety.

Bodily Anxiety Symptoms and Actual Arousal: Studies of Socially Anxious Adults

Several studies of socially anxious adults have measured perceived arousal (e.g., experience of racing heart) while assessing their actual arousal (measured by electrocardiogram [ECG]). These studies have mostly found higher perceived bodily arousal during social stress in highly anxious groups but an absence of group differences in actual arousal, which has led to the interpretation of a *biased perception* or overestimation of bodily arousal in these individuals (e.g., Edelmann & Baker, 2002; Grossman, Wilhelm, Kawachi, & Sparrow, 2001; Mauss, Wilhelm, & Gross, 2004). However, in other studies, highly anxious groups differed from low anxious groups in actual heart rate (HR), making inferences on biased versus accurate interoception more difficult (Borkovec, Stone, O'Brien, & Kaloupek, 1974).

Whereas the studies just reviewed were important in demonstrating a potential dissociation of the presence of actual bodily symptoms and their subjective perception in adult social anxiety, they have not addressed whether SPs become more anxious when they believe that their bodily arousal during a social situation is noticed by others (e.g., the ''visibility'' of their symptoms). However, this is a central claim of Clark and Wells's (1995) model. To our knowledge, only one study has tested this prediction to date. Gerlach, Mourlane, and Rist (2004) exposed a group of adult SPs and healthy controls to two social-evaluative tasks during which the visibility (audibility) of their heartbeat was manipulated: during one task, HR biofeedback was presented to participants via headphones (private condition), whereas in the other task it was presented by loudspeakers, well audible to a judging committee (public condition). As predicted by Clark and Wells's model, when the HR was made public, only SP patients showed increased subjective anxiety and an increase of worry about the visibility of the feedback to the observers.

Research on Bodily Symptoms of Social Anxiety in Children: Current Status

Can cognitive models that have been recognized as valid for adults be readily applied to children? There is substantial empirical evidence that some anxiety-related cognitive distortions found in adults with SP (Clark & McManus, 2002) similarly characterize socially anxious children (e.g., negatively biased self-evaluations of performance; Cartwright-Hatton, Tschernitz, & Gomersall, 2005; Krämer, Schmitz, Heinrichs, & Tuschen-Caffier, in press; Spence, Donovan, & Brechman-Toussaint, 1999; Tuschen-Caffier, Kühl, & Bender, 2011). However, other empirical studies have failed to find such cognitive distortions in this age group, presumably as a result of a lower stage of cognitive-emotional development in children (e.g., no group differences in the amount of negative cognitions during social stress; Alfano, Beidel, & Turner, 2006; Beidel, 1991; Bögels & Zigterman, 2000). Thus, the validity of these cognitive models for childhood is currently not clear (Hodson, McManus, Clark, & Doll, 2008).

Regarding psychophysiological response to stressors, empirical studies on samples of high anxious children and adolescents frequently report an abnormal psychophysiological tonic arousal or phasic reactivity/recovery in these groups (e.g., Hastings, Zahn-Waxler, & Usher, 2007; Kagan, Reznick, & Snidman, 1988; Monk et al., 2001; Pine et al., 1998; Schmitz, Krämer, Tuschen-Caffier, Heinrichs, & Blechert, 2011; Turner, Beidel, & Epstein, 1991; Weems, Zakem, Costa, Cannon, & Watts, 2005). However, specific research on the perception and interpretation of bodily arousal during social stress in socially anxious children is scarce. In a recent study by Anderson and Hope (2009), a large sample of *adolescents* with SP, aged 13 to 17 years, and a healthy control group were exposed to two anxiety-provoking tasks while actual physiological arousal (HR, blood pressure) and perceived arousal were simultaneously measured. SP adolescents perceived their bodily arousal as stronger during the tasks but did not differ from the control group in actual physiological arousal. Although these results point to a perception bias for physiological arousal during social stress in *adolescents* with social fears, their validity for *children* is uncertain. Due to ongoing cognitive and emotional development, children take interoceptive information (e.g., HR) into account less often than adolescents and adults when making inferences about anxiety-provoking situations. Rather, children focus more on directly observable cues (e.g., the presence of a feared stimulus; Muris, Merckelbach, Schepers, & Meesters, 2003; Muris, Mayer, Vermeulen, & Hiemstra, 2007). In addition, no study is known to us that investigated whether socially anxious children or adolescents become more anxious when a bodily

anxiety symptom is made visible to others during a social situation. As previously indicated, this knowledge would have implications about the applicability of Clark and Wells's model to children.

Further, there is one interpretative caveat in most previous studies on bodily symptoms in SP: It is possible that the perception of elevated somatic arousal in the absence of group differences in actual activation does not reflect an overestimation of arousal related to self-focused attention, as proposed by Clark and Wells (1995), but group differences in *interoceptive accuracy.* It is known that individuals differ in their ability to perceive autonomic signals such as HR (Pollatos, Herbert, Matthias, & Schandry, 2007). Thus, if high socially anxious individuals are generally impaired in their ability to perceive bodily symptoms, then this might account for group differences in perceived arousal during social stress, without allowing inferences about the assumptions of Clark and Wells's model. The few studies that have assessed interoceptive accuracy in relation to social anxiety in adults have been inconsistent (Antony et al., 1995; Stevens et al., 2011). In children, two recent empirical studies on a community sample and on a sample of trait-anxious twins found that, measured during a heartbeat counting task, children's levels of interoceptive accuracy were associated to panic disorder symptoms but not to social phobia symptoms (Eley, Gregory, Clark, & Ehlers, 2007; Eley, Stirling, Ehlers, Gregory, & Clark, 2004). Although these results suggest that social anxiety in children may not be associated with decreased interoceptive accuracy in the absence of social stress, no published study is known to us that has investigated this issue in a sample of SP children or in children with high levels of social anxiety.

The Present Study

In the present study we exposed a sample of children with high levels of social fears, but without a diagnosis of SP (HSA), and low socially anxious (LSA) children to social-evaluative stress (recounting stories in front of observers) while measuring perceived HR, worry about HR visibility to others, and subjective anxiety. We chose to examine children with high levels of social fears because elevated levels of social anxiety are found to be a potential risk factor for the development of SP (Turner et al., 1990). Further, empirical research suggests that the cognitive distortions found in childhood SP may already exist in samples with high but not clinical levels of social fears (e.g., Kley, Heinrichs, & Tuschen-Caffier, in press; Tuschen-Caffier et al., 2011). We tested the following theoretically derived hypotheses: *First*, we predicted that during social-evaluative stress, HSA children perceive their HR as higher than LSA children (*biased perception hypothesis*) irrespective of HR visibility (Anderson & Hope, 2009; Gerlach et al., 2004; Mauss et al., 2004). Of importance, we assessed whether potential group differences would be attributable to differences in actual HR or interoceptive accuracy. *Second*, we assumed that HSA children would be more worried that others may notice how fast their heart was beating when their HR was made audible to others (public condition) than when it was not audible to others (private condition, *visibility worry hypothesis*), whereas LSA children should not show this modulation—again unrelated to actual HR or interoceptive accuracy (Gerlach et al., 2004). *Third,* we predicted that HSA children would be more anxious when their HR was made public to others than in the private condition, whereas anxiety in LSA children should not be influenced by public feedback (*anxiety hypothesis*; Gerlach et al., 2004). In addition to our specific hypotheses related to HR, we also explored whether HSA children differ from LSA children in their perceptions of and worry about the visibility to others of blushing, sweating, and trembling, which are the most likely visible bodily symptoms of social anxiety (cf. Gerlach, Wilhelm, Gruber, & Roth, 2001).

METHOD

Participants

The current study was approved by the local ethics committee for psychological research. A total of 108 families responded to advertisements in local newspapers, primary and secondary schools, and psychological and medical treatment facilities offering €35 (US$41) for the participation in a study on psychological differences between shy and nonshy children. After having received detailed written information about the aim and procedure of the study, as well as a paper version of the Social Anxiety Scale for Children–Revised (SASC–R; La Greca & Stone, 1993), 73 of these families mailed back the questionnaire and the informed consent form for participation. From these 73 families, 40 children who matched the inclusion criteria were included in the study. All children were Caucasian. In line with previous research (e.g., Cartwright-Hatton et al., 2005), participants were assigned to either the HSA or LSA group ($n = 20$ each), based on the cut-off scores on the SASC–R suggested by La Greca and Stone (1993): HSA ≥ 54 for male participants, ≥ 50 for female participants; LSA ≤ 40 for male participants and ≤ 36 for female participants. The SASC–R is a self-report measure that assesses social anxiety symptoms in children with total scores ranging from 18 to 90. The SASC–R has satisfactory test–retest reliability (0.67) and internal consistency (0.76; La Greca, Kraslow Dandes, Wick, Shaw, & Stone, 1988). Children respond to each item using a 5-point Likert-type scale

ranging from 1 (*not at all*) to 5 (*all the time*). The scale is moderately correlated with general measures of anxiety, self-perceptions of social confidence, teacher ratings of anxiety withdrawal, and peer nominations of popularity (Ginsburg, La Greca, & Silverman, 1998). The internal consistency of the SASC–R in the current sample was excellent ($\alpha = .928$). Although all children in the HSA group were selected for high levels of social anxiety, it was not formally assessed whether they met the criteria for a diagnosis of SP (e.g., by a structured interview).

Exclusion criteria for all children included medical conditions that might affect the physiological systems investigated (e.g., asthma), the use of medication that could alter physiological responses (e.g., methylphenidate), or when participants' SASC–R scores were between 37 and 49 for girls and between 41 and 53 for boys. Furthermore, to limit other psychopathological influences (e.g., ADHD), children who were reported to have received a lifetime diagnosis of a mental disorder in the past (e.g., through a medical practitioner) were excluded. Participant characteristics can be found in Table 1.

Psychometric Measures

The Child Depression Inventory (CDI; Kovacs, 1985) assesses the cognitive, affective, and behavioral symptoms of depression in childhood. Total scores range from 0 to 52 with a recommended cut-off score at 19. Internal consistency and test–retest reliability estimates are acceptable, and the CDI shows good discriminant and convergent validity (Carey, Faulstich, Gresham, Ruggiero, & Enyart, 1987).

The Child Behavior Checklist (CBCL; Achenbach, 1991) is a parent-report measure for emotional and behavioral problems in children and adolescents. It includes various *DSM*–oriented syndromes and competence scales that can be grouped into internalizing or externalizing scales. The CBCL has shown good levels of internal consistency, test–retest reliability and an acceptable convergent validity (e.g., Achenbach, 1991).

All psychometric measures showed excellent to good internal consistency in the current sample (CBCL $\alpha = .922$; CDI $\alpha = .800$).

TABLE 1
Participant Characteristics

	HSA[a]	*LSA*[a]	*Statistics*
Age	11.0 (0.76)	11.1 (0.83)	$t(38) = 0.39$, *ns*
% Female	60	45	$\chi^2(1) = 0.91$, *ns*
% Elementary School	15	15	$\chi^2(1) = 0.00$, *ns*
BMI–SDS	0.39 (1.03)	0.30 (1.04)	$t(38) = 0.22$, *ns*
SASC–R	61.4 (7.64)	30.6 (8.75)	$t(38) = 11.84^{***}$
CDI	15.1 (8.92)	10.3 (12.46)	$t(38) = 0.69$, *ns*
CBCL	64.0 (8.62)	49.7 (8.60)	$t(38) = 5.26^{***}$
–Externalizing	56.1 (11.01)	52.6 (8.70)	$t(38) = 1.31$, *ns*
–Internalizing	68.9 (9.47)	50.9 (7.64)	$t(38) = 6.62^{***}$

Note: HSA = high social anxiety group; LSA = low social anxiety group; BMI–SDS = body mass index–standard deviation scores; SASC–R = Social Anxiety Scale for Children–Revised; CBCL = Child Behavior Checklist (T values); CDI = Child Depression Inventory. [a]$n = 20$. $^{***}p < .01$.

Psychophysiological Measures

The ECG was recorded at 400 Hz using the Varioport-II data recording system for psychophysiological measurements (Becker Meditec, Karlsruhe, Germany), streamed to disk and displayed on a PC monitor for online monitoring of data quality. Data inspection and manual artefact rejection was performed offline using ANSLAB psychophysiological analysis software (Wilhelm & Peyk, 2005). Beat-to-beat HR was then averaged within each of the experimental phases (baseline, private/public; see next).

Procedure

After arriving at the laboratory, children were given 30 min to habituate to the laboratory setting. During this period, children and their accompanying parents filled out several questionnaires on demographics and psychopathology. Afterward, parents left the laboratory and children were guided to the sound-attenuated, temperature-controlled experimental room; seated in a comfortable armchair; and equipped with electrodes. During a 5-min baseline period, children watched a relaxing videotape (see Figure 1 for an illustration of the procedure). Upon completion of the baseline phase, participants rated their current subjective level of anxiety, from 0 (*no anxiety*) to 10 (*extreme anxiety*), and received instructions regarding the upcoming tasks. Prior to each of the following *two* social performance tasks, children listened to one of two 9-min short stories (order counterbalanced; stories about a little boy called Jeremy James written by David H. Wilson and shortened by us: "Tim's Birthday Party," an account of Tim's eventful birthday party, and "Monkeys and Lions," the story of a visit to an unusual safari park). The children were then instructed to recount each story for 3 min in front of a committee of two unknown adults.[1] To further increase the social-evaluative character of the task, the experimenter instructed children to perform better than other children

[1]Female/male undergraduate students in psychology served as observers and were blind to the study hypotheses. It was ensured that participating children had no contact with the observers prior to the beginning of the experimental session. There were no significant effects as regards the covariation of the children's and the observers' gender on all dependent variables ($ps > .298$). In a pilot study with 18 children aged 9 to 12 years, the tasks proved to elicit robust social-evaluative stress. Furthermore, both stories were rated as equally difficult ($p > .320$).

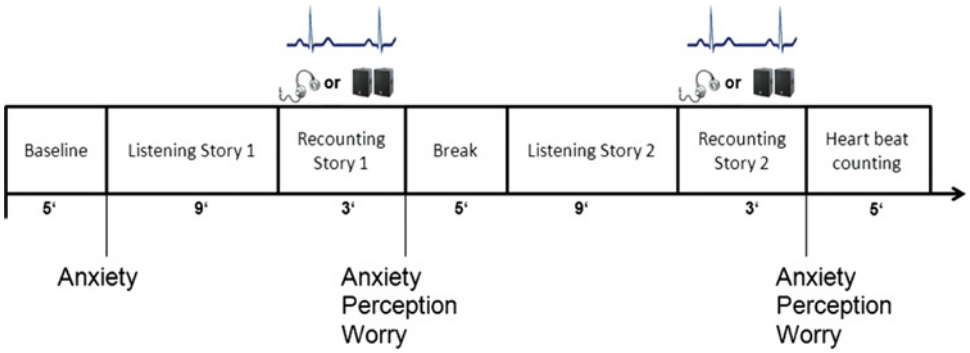

FIGURE 1 Procedure (figure appear in color online).

their age and that other children would rate their performance based on a video of their story (Spence et al., 1999). If children stopped talking before the end of the task, the committee asked them to proceed while the observers maintained a neutral facial impression.

During both tasks, the sounds of a nonveridical HR feedback of around 97 beats per minute were presented corresponding to an elevated HR as observed under social-evaluative threat in a group of socially phobic children the same age as our sample.[2] The feedback was the sound of a beating heart. This sound was generated by recording from a custom-made audio feedback module (Becker Meditech, Karlsruhe, Germany), attached to the ECG recording unit of the Varioport-II. In the *private condition*, children recounted the story while hearing the HR feedback via one in-ear headphone placed in the children's right ear, which was not audible by the committee. In the *public condition*, children recounted the story while hearing the HR feedback via speakers, which was therefore audible by the committee. The order of the private and the public condition was counterbalanced across groups. It is important to note that, contrary to previous research, we used nonveridical feedback. In case of actual group differences on HR levels, veridical feedback would represent a confound that would render the groups imbalanced in terms of their perceived arousal and its visibility to the observers.

At the end of each task, the observers left the room, children rated their maximum level of anxiety in the last 3 min, their perceived HR intensity (''How strongly did you feel your heartbeat during the task?''; 0 [*not at all*] to 10 [*extremely*]) and their worry about their HR (''How much did it worry you that the committee noticed how fast your heart was beating?''; 0 [*not at all*] to 10 [*extremely*]). In addition, the perception of and worry about other visible anxiety symptoms (trembling, blushing, and sweating) were assessed separately for each symptom and then integrated in two composite scores (alpha among measures .737–.867; cf. Gerlach et al., 2004).

Heartbeat Counting Task

Following the second recounting task and a 2-min resting period, a heartbeat counting task was performed to evaluate the children's interoceptive accuracy independent of social-evaluative stress. In this task, children were asked to silently count their heartbeats during three signaled intervals (25, 35, and 45 s) and were told not to take their pulse or to use any other strategies such as holding their breath (for a detailed description, see Eley et al., 2004). The number of counted heartbeats in relation to actual heartbeats served as a measure of interoceptive accuracy ($1/3\sum$(1-(recorded heartbeats – counted heartbeats)/recorded heartbeats); cf. Pollatos et al., 2007).

Following the heartbeat counting task, all children were thoroughly debriefed about the degree of deception and the reasons for this before being picked up by their parents.

Statistical Analyses

HR, subjective anxiety, perception of HR, worry about the visibility of HR, perception of other symptoms, and worry about other symptoms during the private and public conditions were subjected to separate 2 (Group: HSA; LSA) × 2 (Condition: private; public) analyses of variance (ANOVAs) with repeated measures on condition.[3] Scores from the heartbeat counting task were compared using an independent sample *t* test. For the

[2]The average HR of socially phobic children during the first 3 min of a social-evaluative task (Schmitz et al., 2011). A manipulation check revealed that all children believed that the feedback represented their actual heartbeat.

[3]There were no significant differences in all demographic or psychometric variables between the two subgroups (private–public/public–private) in the HSA or the LSA groups, $ps > .239$.

perception of and worry about HR, we controlled for actual levels of physical arousal by including actual HR as a changing covariate. This was done by separately regressing perception of HR on actual HR during the public and private conditions and submitting the residuals to the repeated measures ANOVA (see Winer, 1971, for more detail on the use of changing covariates in repeated measure designs). In addition, we controlled for interoceptive accuracy by including the scores from the heartbeat counting task as a continuous covariate in the ANOVAs for perception of and worry about HR. Preliminary analyses revealed that task order, participant gender, and participant age did not interact with group. Therefore they were dropped from subsequent analyses. Cohen's f is reported as effect size measure for significant ANOVA results, Cohen's d for t tests. The significance level was set at $\alpha = .05$.

RESULTS

Demographics and Psychometric Measures

As presented in Table 1, HSA and LSA children were successfully matched as regards age, gender, education and body mass index; standard deviation scores were set according to national norms (measured by meter and scale). Children of the HSA group showed significantly higher levels on the SASC–R and the Internalizing subscale of the CBCL. Groups did not differ either on CDI scores nor on the CBCL Externalizing subscale.[3]

Perception Hypothesis: Children of the HSA Group Perceive Their HR as Higher Than LSA Children, Independent from Actual Levels of HR and Interoceptive Accuracy

Perception of HR. The HSA children perceived their heartbeat as higher than the LSA group during both the private and the public condition (Figure 2C), indicated by a significant main effect of group (HSA, LSA), $F(1, 38) = 5.88$, $p = .020$, $f = .393$. The main effect of condition (private, public) as well as its interaction with group was nonsignificant, Fs < 1.54, ps $> .462$.

Actual HR. HR levels during social stress for HSA and LSA children are presented in Figure 2A. There were no significant main effects of group or condition and no Condition × Group interaction, Fs < 1.00, ps $> .508$.

Interoceptive accuracy. Group scores did not differ in the heartbeat counting task, $t(38) = 0.80$, $p = .425$; see Figure 2B.

Perception of HR—Controlling for actual HR and interoceptive accuracy. To evaluate whether the perception of higher HR in HSA children was due to subthreshold group differences in HR or interoceptive accuracy, HR during the private and public conditions (changing covariate) and scores for interoceptive accuracy from the heartbeat counting task (continuous

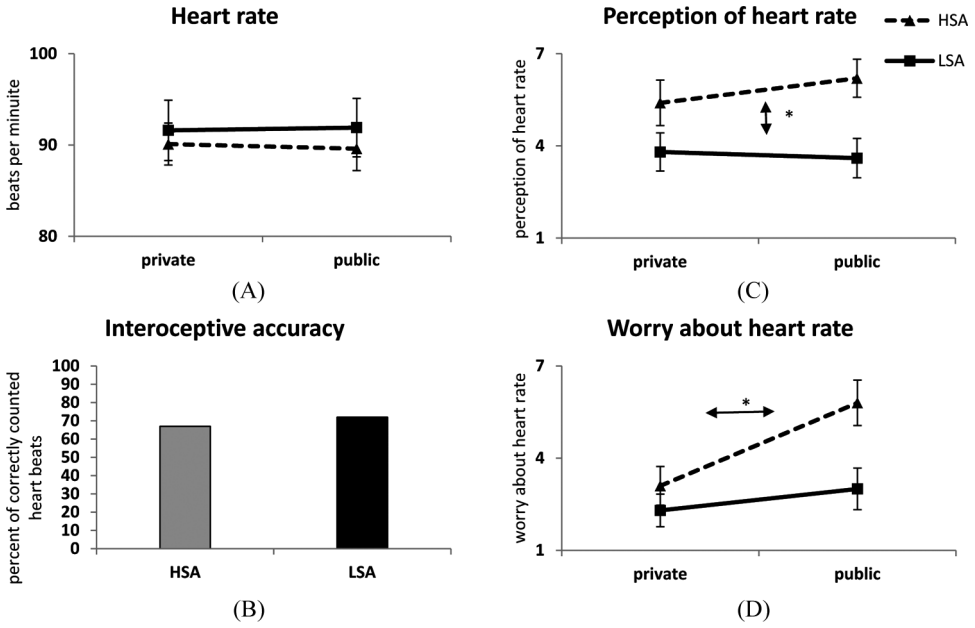

FIGURE 2 Means and standard errors for heart rate, perception of heart rate, worry about heart rate during private/public condition and scores of interoceptive accuracy from the heartbeat counting task.

covariate) were included into the analysis separately. However, the results from the initial ANOVA remained unchanged, main effect of group, $p = .019$ and $p = .016$, respectively.

Consistent with the first hypothesis, we found higher perceptions of HR in HSA children when compared to the LSA group unrelated to actual HR levels and interoceptive accuracy.

Worry Visibility Hypothesis: HSA Children Are More Worried When Their HR is Made Public Than When It Is Private. LSA Children Do Not Show this Modulation

Worry about HR visibility. Regarding worry about HR feedback, there was a main effect of group, $F(1, 38) = 4.97$, $p = .032$, $f = .362$; a main effect of condition, $F(1, 38) = 17.6$, $p < .001$, $\eta^2 = .318$; and a Group × Condition interaction, $F(1, 38) = 6.11$, $p = .018$, $f = .401$; see Figure 2D. Post hoc paired t tests revealed that only HSA children showed an increase of worry about HR from the private to the public condition, $t(19) = 4.61$, $p < .001$, $d = 0.87$, which was not significant in LSA children, $t(19) = 1.25$, $p = .225$.

Worry about HR—Controlling for actual HR and interoceptive accuracy. Effects for group and the Group × Condition interaction remained unchanged when actual levels of HR and heartbeat counting scores were included as covariates, $p = .048$, $p = .022$, $p = .034$, and $p = .025$, respectively.

In line with the second hypothesis, when HR was made public, it led to more worry about its visibility to others only in HSA but not in LSA children. This effect was not related to actual HR levels or interoceptive accuracy.[4]

Anxiety Hypothesis: HSA Children Are More Anxious When Their HR is Made Public Than When It is Private. Anxiety in LSA Children is Not Influenced by Public Feedback

Subjective anxiety. For subjective anxiety there was a significant main effect of group (HSA: private $M = 5.45$, $SD = 3.08$; public $M = 5.70$, $SD = 3.83$; LSA: private $M = 3.00$, $SD = 2.63$; public $M = 2.70$, $SD = 2.79$), $F(1, 38) = 11.7$, $p = .001$, $f = .555$, revealing higher subjective anxiety scores in the HSA group but no significant main effect of condition or a Condition × Group interaction, Fs < 1.00, ps $> .512$.[5]

Contrary to the third hypothesis, there was no effect of the HR feedback manipulation on subjective anxiety in HSA children.

Exploratory Analyses: Do HSA Children Differ From LSA Children in Their Perception of and Worry about Other Visible Anxiety Symptoms (Blushing, Trembling, and Sweating) during Private and Public Conditions?

Similar to HR, children in the HSA group perceived other anxiety symptoms as stronger than LSA children (HSA: private $M = 3.51$, $SD = 2.25$; public $M = 3.70$, $SD = 2.72$; LSA: private $M = 1.50$, $SD = 1.69$; public $M = 1.90$, $SD = 1.67$), $F(1, 38) = 9.10$, $p = .005$, $f = .461$, and worried more about their visibility (HSA: private $M = 3.75$, $SD = 2.69$; public $M = 3.65$, $SD = 2.83$; LSA: private $M = 1.78$, $SD = 1.97$; public $M = 1.96$, $SD = 2.10$), $F(1, 38) = 6.29$, $p = .016$, $f = .385$. However, these effects were not influenced by private or public HR feedback, main effect condition and Condition × Group interaction, Fs < 1.00, ps $> .246$.

Thus, overestimation of bodily arousal does not seem to be limited to HR but extends to other symptom areas as well. However, because we manipulated the visibility of HR only, we do not know whether the visibility of other symptoms is similarly crucial for social anxiety.

DISCUSSION

The aim of the current study was to evaluate whether childhood social anxiety is associated with a biased perception and interpretation of bodily anxiety symptoms during social stress. Based on the assumptions of Clark and Wells's (1995) theoretical model of adult SP and the results of previous adult and adolescent research (e.g., Anderson & Hope, 2009; Edelmann & Baker, 2002; Gerlach et al., 2004; Grossman et al., 2001; Mauss et al., 2004), we specifically tested whether children with high levels of social anxiety would perceive their HR as higher than nonanxious controls during two social-evaluative tasks (recounting two stories), and whether actual HR and interoceptive accuracy, as measured by a heartbeat counting task, could account for this. Furthermore, by making a bodily anxiety symptom (HR) visible to others, we tested whether this would lead to increased worry about HR visibility to others and

[4]To evaluate in an exploratory manner whether group differences in HR perception were due to more worry about HR visibility, scores for worry about HR during private and public condition were included in the analysis as a changing covariate, and the main effect of group no longer reached significance, $F(1, 38) = 1.40$, $p = .243$.

[5]Preliminary analysis revealed no baseline group differences on HR (HSA = 79.8 bpm, LSA = 78.3 bpm) or subjective anxiety (HSA = 1.20, LSA = 0.70), ps $> .198$, and a robust reactivity to both tasks on these measures (ps $< .001$).

increased anxiety in HSA but not in LSA children. Therefore, during one task, a nonveridical HR feedback was made audible only to the children (private condition), whereas in the other task it was audible to unknown observers as well (public condition).

Perception Hypothesis: Children of the HSA Group Perceive Their HR as Higher Than LSA Children, Independent of Actual HR Levels and Interoceptive Accuracy

In line with our first hypothesis, children of the HSA group perceived a higher HR than children of the LSA group, regardless of the condition. This was true despite comparable actual HR levels. The finding of a biased perception of bodily arousal in our HSA group during social-evaluative stress fits the results of previous studies on adult and adolescent samples (Anderson & Hope, 2009; Edelmann & Baker, 2002; Gerlach et al., 2004; Mauss et al., 2004) and is in keeping with Clark and Wells's (1995) theoretical model of SP. In line with the idea that exaggerated perception of bodily arousal could be the result of extensive worry that others might notice how anxious one is, group differences in HR perception decreased in magnitude when we statistically controlled for group differences in the children's worry about HR visibility (also see Footnote 4).

It is important to note that the present study addressed a potential confound in this kind of research by controlling for differences in interoceptive accuracy. HSA children perceived their HR as higher during the task, whereas there were no group differences in actual HR during the task and in interoceptive accuracy during rest—as measured by a heartbeat counting task. Thus, biased perception of physiological arousal in our socially anxious children was not the result of impaired interoceptive accuracy but more likely caused by increased worrying. One should note that overestimation of HR and intact interoceptive accuracy are not a contradiction. The former occurs under acute stress, whereas the latter occurs in the absence of stress and underfocused attention (Mauss et al., 2004; Pollatos et al., 2007).

Worry Visibility Hypothesis: HSA Children Are More Worried When Their HR is Made Public Than When It is Private. LSA Children Do Not Show this Modulation

In line with our second hypothesis, making HR audible to the observers led to an increase of worry about HR visibility only in HSA but not in LSA children. It is important to note that this effect was not accounted by actual HR levels or interoceptive accuracy. For other anxiety symptoms, we found more worrying about blushing, trembling, and sweating in HSA children across the conditions. This finding is in keeping with the results of adult research (Gerlach et al., 2004) and Clark and Wells's (1995) model, which assumes that socially anxious individuals worry more than non-SPs about the visibility of their bodily anxiety symptoms and that this worry increases if they believe that their bodily symptoms can be perceived by others. The fact that both groups did not differ, either in their actual HR levels or in the speed of the HR feedback, further supports the idea that as early as in childhood, socially anxious individuals overestimate how perceivable their bodily arousal is for others.

Anxiety Hypothesis: HSA Children Are More Anxious When Their HR is Made Public Than When It is Heard in Private. Anxiety in LSA Children is Not Influenced by Public Feedback

Contrary to our third hypothesis and the findings of Gerlach and colleagues (2004) on a sample of SP adults, public HR feedback did not lead to more anxiety in HSA children. Clark and Wells (1995) suggested that if a socially anxious individual believes that a bodily symptom of fear is visible to others, this leads to more anxiety because it is interpreted as a sign of social failure (e.g., "It is embarrassing if others see how anxious I am"). There are several conceivable explanations for this divergent finding.

First, we assessed high socially anxious children, but it remains uncertain whether social fears in our HSA group were clinically relevant. It may be possible that as social fears become more severe, the worry about bodily symptoms and state anxiety become more closely related. However, one should note that scores of social anxiety in the current sample (HSA; $M = 61.4$) were even higher compared to those reported in samples of children with SP (e.g., $M = 47.2$; Schmitz, Krämer, Blechert, & Tuschen-Caffier, 2010), which may contradict this argument. Second, contrary to our study, Gerlach and others (2004) used a social task in which task performance (appearing as "cool" as possible) was strongly related to the audibility of the feedback to others. It is possible that making the HR public to the observers led to a belief of task failure in participants ("My heart is racing, I don't seem cool—I have failed!"), which led to a stronger increase in anxiety in the clinical group, as it is known that socially anxious individuals are particularly concerned about their performance in social situations (American Psychiatric Association, 1994). Third, developmental differences between the samples might explain the differences. In a study by Muris, Merckelbach, and van Spauwen (2003) on a community sample of children aged 8 to 12 years, participants rated the levels of danger perceived in several stories based on objective (e.g., social

exclusion) and somatic information (e.g., occurrence of a bodily anxiety symptom) contained in the scripts. Contrary to results from adult samples (e.g., Arntz, Rauner, & van den Hout, 1995), children with high trait anxiety did not differ from a low anxiety group in their use of bodily information (e.g., racing heart) for the evaluation of the level of script danger when an objective piece of information about situational danger was already included. The authors concluded that children—contrary to adults—may focus mainly on the most salient situational information when making judgments of situational danger. Thus, directly observable information could be more relevant than interoceptive information because, during childhood, the ability for emotional reasoning—which is the interference of emotions resulting from interoceptive information—is still under development (Muris et al., 2007). For our data, this could imply that anxiety ratings in our HSA group were mainly based on objective danger information (the presence of an unknown committee) and not influenced by interoceptive information, namely, the HR feedback.

Limitations and Implications for Research, Policy, and Practice

For the evaluation of our results, several limitations must be acknowledged. First, children in our study were selected as either high or low socially anxious, and our results may not generalize to children with social anxiety disorder. Further, in line with previous research (cf. Cartwright-Hatton et al., 2005; La Greca & Stone, 1993), we recruited HSA and LSA children based on cut-off scores for high and low social anxiety on a self-report questionnaire. Another approach is to select extreme groups based on upper and lower quartiles (e.g., Hodson et al., 2008; Mauss et al., 2004; Miers, Blöte, Bokhorst, & Michiel Westenberg, 2009). However, using solely self-report measures for the identification of low and high anxious groups may be problematic in any case, because group differences between HSA and LSA children on the dependent variables could be the result of shared method variance. This would imply that statistical main effects of group (but not interactions) on the subjective ratings could be a function of the fact that the grouping variable was based on children's subjective reports of their anxious states when in social situations. A potential solution to reduce this problem would be the use of a multimodal diagnostic interview (e.g., K-SADS) in which clinicians—as a result of separate interviews with children and parents as well as from their own observations—determine whether a child meets the diagnostic criteria for SP or not (e.g., Spence et al., 1999; Tuschen-Caffier et al., 2011). In addition, the dependent variables in our study (worry, perception, and subjective anxiety) were assessed through children's self-reports, and for the evaluation of our results it should be taken into account that the ratings of HSA children could have been influenced by their fear of negative evaluation through the experimenter.

Other concerns related to our sample could be that only Caucasian children participated in our study. There is empirical evidence that the expression of social anxiety differs between ethnical groups (e.g., Hofmann, Anu Asnaani, & Hinton, 2010), and it is conceivable that cultural differences exist in the extent to which bodily anxiety symptoms play a role in the maintenance of social fears. In addition, the sample size of 20 per group that was used was relatively small, and statistical power was therefore only moderate. Consequently, future studies should replicate our findings in larger and ethnically more diverse samples of SP children, including a comprehensive clinical assessment of social fears. Further, even though a manipulation check revealed that all children believed in the validity of the faked feedback, making a heartbeat audible to others is a rather artificial situation because the HR is normally not heard by an audience or interaction partners. Because our results revealed that HSA children also worry more about other visible bodily symptoms, the manipulation of the visibility of other symptoms such as blushing (e.g., by manipulating the visibility of high resolution videos of face color) or sweating might be an interesting future direction.

Several implications for the treatment of social anxiety in children bear emphasis. Biofeedback procedures could be used to correct biased perceptions of bodily arousal in socially anxious children. Further, overconcern regarding visibility of these symptoms might be treated in video-assisted role plays. Public health programs and school-based interventions might educate high-risk children on the relationship of actual arousal, perceived arousal, and visibility of symptoms (''What you feel is not always what others see'') in addition to reframing the presence of arousal symptoms during social performance situations (''Arousal gives you energy'').

REFERENCES

Achenbach, T. M. (1991). *Manual for the Child Behavior Checklist 4–18 and 1991 Profile*. Burlington: University of Vermont, Department of Psychiatry.

Alfano, C. A., Beidel, D. C., & Turner, S. M. (2006). Cognitive correlates of social phobia among children and adolescents. *Journal of Abnormal Child Psychology*, *34*, 189–201. doi:10.1007/s10802-005-9012-9

American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

Anderson, E. R., & Hope, D. A. (2009). The relationship among social phobia, objective and perceived physiological reactivity, and anxiety sensitivity in an adolescent population. *Journal of Anxiety Disorders*, *23*(1), 18–26. doi:10.1016/j.janxdis.2008.03.011

Antony, M. M., Brown, T. A., Craske, M. G., Barlow, D. H., Mitchell, W. B., & Meadows, E. A. (1995). Accuracy of heartbeat perception in panic disorder, social phobia, and nonanxious subjects. *Journal of Anxiety Disorders*, *9*, 355–371.

Arntz, A., Rauner, M., & van den Hout, M. (1995). "If I feel anxious, there must be danger": ex-consequentia reasoning in inferring danger in anxiety disorders. *Behaviour Research and Therapy*, *33*, 917–925.

Beidel, D. C. (1991). Social phobia and overanxious disorder in school-age children. *Journal of the American Academy of Child and Adolescent Psychiatry*, *30*, 545–552. doi:10.1097/00004583-199107000-00003

Beidel, D. C., Turner, S. M., & Morris, T. L. (1999). Psychopathology of childhood social phobia. *Journal of the American Academy of Child and Adolescent Psychiatry*, *38*, 643–650. doi:10.1097/00004583-199906000-00010

Bögels, S. M., & Zigterman, D. (2000). Dysfunctional cognitions in children with social phobia, separation anxiety disorder, and generalized anxiety disorder. *Journal of Abnormal Child Psychology*, *28*, 205–211.

Borkovec, T. D., Stone, N. M., O'Brien, G., & Kaloupek, D. G. (1974). Evaluation of clinically relevant target behavior for analog outcome research. *Behavior Therapy*, *5*, 503–513.

Carey, M. P., Faulstich, M., Gresham, F., Ruggiero, L., & Enyart, P. (1987). Children's depression inventory: Construct and discriminant validity across clinical and nonreferred control populations. *Journal of Consulting and Clinical Psychology*, *55*, 755–767.

Cartwright-Hatton, S., Tschernitz, N., & Gomersall, H. (2005). Social anxiety in children: social skills deficit, or cognitive distortion? *Behaviour Research and Therapy*, *43*(1), 131–141. doi:10.1016/j.brat.2003.12.003

Chavira, D. A., Stein, M. B., Bailey, K., & Stein, M. T. (2004). Child anxiety in primary care: prevalent but untreated. *Depression and Anxiety*, *20*, 155–164. doi:10.1002/da.20039

Clark, D. M., & McManus, F. (2002). Information processing in social phobia. *Biological Psychiatry*, *51*(1), 92–100.

Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg (Ed.), *Social phobia: diagnosis, assessment, and treatment* (pp. 69–93). New York: Guilford.

Edelmann, R. J., & Baker, S. R. (2002). Self-reported and actual physiological responses in social phobia. *The British journal of clinical psychology/the British Psychological Society*, *41*(Pt 1), 1–14.

Eley, T. C., Gregory, A. M., Clark, D. M., & Ehlers, A. (2007). Feeling anxious: a twin study of panic/somatic ratings, anxiety sensitivity and heartbeat perception in children. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *48*, 1184–1191. doi:10.1111/j.1469-7610.2007.01838.x

Eley, T. C., Stirling, L., Ehlers, A., Gregory, A. M., & Clark, D. M. (2004). Heart-beat perception, panic/somatic symptoms and anxiety sensitivity in children. *Behaviour Research and Therapy*, *42*, 439–448. doi:10.1016/S0005-7967(03)00152-9

Gerlach, A. L., Mourlane, D., & Rist, F. (2004). Public and private heart rate feedback in social phobia: A manipulation of anxiety visibility. *Cognitive Behaviour Therapy*, *33*(1), 36–45.

Gerlach, A. L., Wilhelm, F. H., Gruber, K., & Roth, W. T. (2001). Blushing and physiological arousability in social phobia. *Journal of Abnormal Psychology*, *110*, 247–258.

Ginsburg, G., La Greca, A. M., & Silverman, W. S. (1998). Social anxiety in children with anxiety disorders: Relations with social and emotional functioning. *Journal of Abnormal Child Psychology*, *26*(3), 83–94.

Grossman, P., Wilhelm, F. H., Kawachi, I., & Sparrow, D. (2001). Gender differences in psychophysiological responses to speech stress among older social phobics: Congruence and incongruence between self-evaluative and cardiovascular reactions. *Psychosomatic Medicine*, *63*, 765–777.

Hastings, P., Zahn-Waxler, C., & Usher, B. (2007). Cardiovascular and affective responses to social stress in adolescents with internalizing and externalizing problems. *International Journal of Behavioral Development*, *31*(1), 77–87.

Heiser, N. A., Turner, S. M., & Beidel, D. C. (2003). Shyness: relationship to social phobia and other psychiatric disorders. *Behaviour Research and Therapy*, *41*, 209–221.

Hodson, K. J., McManus, F. V., Clark, D. M., & Doll, H. (2008). Can Clark and Wells' (1995) cognitive model of social phobia be applied to young people. *Behavioural and Cognitive Psychotherapy*, *36*, 449–461.

Hofmann, S. G., Anu Asnaani, M. A., & Hinton, D. E. (2010). Cultural aspects in social anxiety and social anxiety disorder. *Depression and Anxiety*, *27*, 1117–1127. doi:10.1002/da.20759

Kagan, J., Reznick, J. S., & Snidman, N. (1988). Biological bases of childhood shyness. *Science (New York, N. Y.)*, *240*(4849), 167–171.

Kley, H., Heinrichs, N., & Tuschen-Caffier, B. (in press). Manipulating self-focused attention in children with social anxiety disorder and in socially anxious and non-anxious children. *Journal of Experimental Psychopathology*. doi:10.5127/jep.014511

Kovacs, M. (1985). The Children's Depression Inventory (CDI). *Psychopharmacology Bulletin*, *21*, 995–999.

Krämer, M., Schmitz, J., Heinrichs, N., & Tuschen-Caffier, B. (in press). Self-evaluation, social and cognitive performance in children with social phobia. *Journal of Experimental Psychopathology*. doi:10.5127/jep.0016311

La Greca, A., Kraslow Dandes, S., Wick, P., Shaw, K., & Stone, W. (1988). Development of the Social Anxiety Scale for children: reliability and concurrent validity. *Journal of Clinical Child Psychology*, *17*(1), 84–91.

La Greca, A. M., & Stone, W. L. (1993). Social Anxiety Scale for Children–Revised: Factor structure and concurrent validity. *Journal of Clinical Child Psychology*, *22*(1), 17–27.

Mauss, I. B., Wilhelm, F. H., & Gross, J. J. (2004). Is there less to social anxiety than meets the eye? Emotional experience, expression, and bodily responding. *Cognition and Emotion*, *18*, 631–662.

Miers, A. C., Blöte, A. W., Bokhorst, C. L., & Michiel Westenberg, P. (2009). Negative self-evaluations and the relation to performance level in socially anxious children and adolescents. *Behaviour Research and Therapy*, *47*, 1043–1049. doi:10.1016/j.brat.2009.07.017

Monk, C., Kovelenko, P., Ellman, L. M., Sloan, R. P., Bagiella, E., Gorman, J. M., & Pine, D. S. (2001). Enhanced stress reactivity in paediatric anxiety disorders: implications for future cardiovascular health. *The International Journal of Neuropsychopharmacology*, *4*, 199–206. doi:10.1017/S146114570100236X

Muris, P., Mayer, B., Vermeulen, L., & Hiemstra, H. (2007). Theory-of-mind, cognitive development, and children's interpretation of anxiety-related physical symptoms. *Behaviour Research and Therapy*, *45*, 2121–2132. doi:10.1016/j.brat.2007.02.014

Muris, P., Merckelbach, H., Schepers, S., & Meesters, C. (2003). Anxiety, threat perception abnormalities, and emotional reasoning in nonclinical Dutch children. *Journal of Clinical Child and Adolescent Psychology*, *32*, 453–459.

Muris, P., Merckelbach, H., & van Spauwen, I. (2003). The emotional reasoning heuristic in children. *Behaviour Research and Therapy*, *41*, 261–272.

Ollendick, T. H., & Hirshfeld-Becker, D. R. (2002). The developmental psychopathology of social anxiety disorder. *Biological Psychiatry*, *51*(1), 44–58.

Pine, D. S., Coplan, J. D., Papp, L. A., Klein, R. G., Martinez, J. M., Kovalenko, P., & Gorman, J. M. (1998). Ventilatory physiology of

children and adolescents with anxiety disorders. *Archives of General Psychiatry*, *55*, 123–129.

Pollatos, O., Herbert, B. M., Matthias, E., & Schandry, R. (2007). Heart rate response after emotional picture presentation is modulated by interoceptive awareness. *International Journal of Psychophysiology*, *63*(1), 117–124. doi:10.1016/j.ijpsycho.2006.09.003

Schmitz, J., Krämer, M., Blechert, J., & Tuschen-Caffier, B. (2010). Post-event processing in children with social phobia. *Journal of Abnormal Child Psychology*, *38*, 911–919. doi:10.1007/s10802-010-9421-2

Schmitz, J., Krämer, M., Tuschen-Caffier, B., Heinrichs, N., & Blechert, J. (2011). Restricted autonomic flexibility in children with social phobia. *Journal of Child Psychology and Psychiatry, and Allied Disciplines*, *52*, 1203–1211. doi:10.1111/j.1469-7610.2011.02417.x

Spence, S. H., Donovan, C., & Brechman-Toussaint, M. (1999). Social skills, social outcomes, and cognitive features of childhood social phobia. *Journal of Abnormal Psychology*, *108*, 211–221.

Stevens, S., Gerlach, A. L., Cludius, B., Silkens, A., Craske, M. G., & Hermann, C. (2011). Heartbeat perception in social anxiety before and during speech anticipation. *Behaviour Research and Therapy*, *49*, 138–143.

Turner, S. M., Beidel, D. C., & Epstein, L. H. (1991). Vulnerability and risk for anxiety disorders. *Journal of Anxiety Disorders*, *5*, 151–166.

Turner, S. M., Beidel, D. C., & Townsley, R. M. (1990). Social phobia: Relationship to shyness. *Behaviour Research and Therapy*, *28*, 497–505.

Tuschen-Caffier, B., Kühl, S., & Bender, C. (2011). Cognitive-evaluative features of childhood social anxiety in a performance task. *Journal of Behavior Therapy and Experimental Psychiatry*, *42*, 233–239. doi:10.1016/j.jbtep.2010.12.005

Weems, C. F., Zakem, A. H., Costa, N. M., Cannon, M. F., & Watts, S. E. (2005). Physiological response and childhood anxiety: association with symptoms of anxiety disorders and cognitive bias. *Journal of Clinical Child and Adolescent Psychology*, *34*, 712–723. doi:10.1207/s15374424jccp3404_13

Wilhelm, F. H., & Peyk, P. (2005). ANSLAB: Autonomic Nervous System Laboratory. Retrieved from http://www.sprweb.org

Winer, B. J. (1971). *Statistical principles in experimental design* (2nd ed.). New York: McGraw-Hill.