Bias or reality? : negative perceptions of ambiguous social cues, social performance and physical arousal in socially anxious youth

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Chapter 5

Subjective and Objective Arousal Correspondence in High and Low Socially Anxious Youth: The Role of Task Stressfulness and Self-monitoring

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Abstract

Studies have shown that the correspondence between subjective and objective measures of physiological arousal during social-evaluative tasks is weak, particularly in high socially anxious individuals. This suggests that high anxious persons are unable to accurately estimate their physiological arousal. The aim of the present study was to investigate the subjective-objective arousal correspondence in detail by examining the role of (a) task stressfulness, and (b) self-monitoring processes. Sixty-eight high (HSA) and 68 low (LSA) socially anxious youth took part in a public speaking task, which included a less stressful (pre-speech) and more stressful (speech) phase. Subjective experience of nervousness, heart rate and sweaty palms were measured as well as the accompanying objective variables salivary cortisol, actual heart rate, and skin conductance. Participants also completed questionnaires measuring 3 self-monitoring processes: expected performance thoughts, emotion-focused coping and self-focused attention. For HSA, but not LSA participants the correspondence was stronger in the low versus the high stressful phase. Furthermore, self-monitoring processes could not satisfactorily explain why the correspondence was low in HSA participants during the stressful phase. Findings suggest that level of task stressfulness should be taken into account when studying subjective-objective arousal correspondence in high anxious youth.

Introduction

According to the DSM-IV, individuals with social phobia (or social anxiety disorder) frequently experience physiological symptoms of anxiety such as sweating and palpitations in feared social or performance situations (American Psychiatric Association, 1994). The most common physiological symptoms social phobics complain of are blushing, sweating and heart rate increase (Fahlén, 1996; Reich, Noyes, & Yates, 1988). Cognitive models of social phobia (Clark & Wells, 1995; Rapee & Heimberg, 1997) also give physiological symptoms of anxiety a prominent position by emphasizing how social phobics are concerned about the visibility of their arousal during a social-evaluative situation. For social phobics symptoms of arousal are a potential source of negative evaluation and danger, and this can lead to an over-representation of these symptoms (Clark & Wells, 1995; Rapee & Heimberg, 1997).

Although socially anxious individuals compared to nonanxious individuals consistently report greater state anxiety and perceive stronger physiological arousal during social-evaluative situations, the evidence for corresponding group differences in objective physiological activation, for example, heart rate and skin conductance, is weak (e.g., Anderson & Hope, 2009; Mauss, Wilhelm, & Gross, 2004). This suggests that high socially anxious individuals are unable to accurately estimate their actual physiological arousal during an anxiety-provoking situation. The aim of the current article is to investigate the correspondence between subjective and objective physiological responses during a social-evaluative situation in more detail by examining the role of (a) task stressfulness, and (b) self-monitoring processes.

Degree of Correspondence between Subjective and Objective Arousal

It is generally well accepted that anxiety and fear consist of three main components: the subjective experience, physiological changes and behavioural responses (Rachman, 2004). The issue of (a lack of) correspondence among these components is not new. For example, Lang (1970), a key researcher and theorizer in the subject of fear, described the relation between subjective and objective physiological responses as imperfect. And in 1968, Weinstein, Averill, Opton, and Lazarus who reanalyzed data from six studies reported correlations ranging from -.15 to .31 between self-reported stress and skin conductance or heart rate. In general, there is not much consistency in the degree of correspondence between different measures reported within studies either. For example, in a study with 40 medical or nursing students Steptoe and Noll (1997) reported a moderate correspondence between self-reported sweaty hands and skin conductance level (r = .53) but only a low correspondence between self-reported heart rate and actual heart rate (r = .17).

More recently, Mauss et al. (2004) reviewed 21 studies measuring objective physiological responses among high and low trait socially anxious adults in the context of social anxiety-provoking tasks. The majority of these studies also collected information about the subjective component of anxiety, either in terms of experienced state anxiety or self-reported physiological arousal. These studies revealed a consistent pattern of greater state anxiety and perceived physiological arousal in high versus low trait anxious participants from baseline to task phases (Mauss et al., 2004). However, the results concerning actual physiological arousal were inconsistent, with approximately half of studies reporting greater physiological activation in high versus low anxious groups and the other half finding no differences.

In their empirical study using a speech task, Mauss et al. (2004) reported significantly greater state anxiety and self-reported physiological activation during the speech in the high versus low socially anxious group. In contrast, the high and low anxiety groups showed very similar physiological activation on a number of measures including heart rate, skin conductance and blood pressure. Recently, this pattern of group differences for subjective arousal coupled with an absence of group differences for actual physiological activation during an anxiety-provoking task was replicated in a sample of adolescents (Anderson & Hope, 2009). Thus, it appears that socially anxious adults and adolescents alike perceive greater physiological activation than their low anxious counterparts during social-evaluative situations, yet this is not matched by stronger objective physiological responses in high anxious individuals.

The lack of correspondence between subjective and objective arousal measures in high anxious individuals is supported by correlational research. Mauss et al. (2004)

computed correlations between the change from baseline to speech scores on self-perceived arousal (racing heart, blushing, sweaty palms and shortness of breath) and actual physiological arousal (heart rate, facial blush, skin conductance level, and respiratory rate) for the high (n = 47) and low socially anxious (n = 50) group separately. Correlations among self-perceived and actual physiological arousal measures were low and nonsignificant (r's < .25) in the high anxious group. However, in the low anxious group the correlations were generally higher and four of the 16 were significant (Mauss et al., 2004). For example, self-perceived racing heart correlated .46 with actual heart rate, indicating a moderate degree of correspondence between these measures. Thus, it appears that low socially anxious individuals are better able to estimate their physiological arousal during a social-evaluative task than high socially anxious individuals. This raises the question of why the correspondence is particularly weak among high socially anxious groups. In the following sections, we (a) propose that task stressfulness needs to be taken into account when examining subjective-objective arousal correspondence, and (b) present a possible explanation for the weak correspondence, namely the influence of self-monitoring processes.

Task Stressfulness and Trait Anxiety

One factor that could influence the correspondence between subjective and objective arousal is the stressfulness of the task, or the level of elicited state anxiety. Instead of only focusing on the effects of trait anxiety some studies in related research domains also take state anxiety level and the interaction between trait and state anxiety into account. For example, MacLeod and Mathews (1988) studied the attentional response to emotionally threatening stimuli in high and low trait anxious subjects during an examination period. Participants were tested using a dot probe task twice, once 12 weeks before the examination (T1) and again in the week before the examination (T2). As expected, state anxiety increased significantly from T1 to T2 in both the high and low trait anxiety groups. The most relevant finding of this study, however, is that at T1 both high and low anxiety groups showed attentional avoidance of examination related threat words, whereas at T2 opposite effects were observed in high as compared to low anxious participants. Whereas low anxious participants continued to show attentional avoidance of examination threat words at T2, the high anxious group showed attentional vigilance. Hence, the attentional bias to threat related information occurred in the high trait anxious group only under the condition of high state anxiety; this is the crux of the trait by state interaction hypothesis (Mercado Carretié, Tapia, & Gómez-Jarabo, 2006).

In contrast to studies in the research fields of attentional bias (e.g., Rutherford, MacLeod, & Campbell, 2004), academic performance (e.g., Owens, 2009) and cognitive tasks (e.g., Wenzel & Holt, 2003), to the best of our knowledge, no study has taken both trait and state anxiety level into account when examining the correspondence between subjective and objective arousal. Studies typically select high and low trait socially anxious groups and focus on the most stressful phase of a social evaluative task (e.g., Anderson & Hope, 2009; Baggett, Saab, & Carver, 1996; Beidel, Turner, Dancu, 1985; Mauss et al., 2004). However, in order to better understand factors related to the awareness of bodily symptoms in high socially anxious persons, it might be useful to first analyze the correspondence during less stressful as compared to more stressful phases of a social-evaluative task. The present study therefore considers the influence of both trait and state anxiety on the degree of concordance between subjective and objective physiological arousal in high and low socially anxious youth.

Self-monitoring Processes and Subjective-Objective Correspondence

Cognitive theories of social phobia emphasize the role of self-monitoring during social-evaluative situations in maintaining the disorder (Clark & Wells, 1995; Rapee & Heimberg, 1997). Clark and Wells (1995) propose that when social phobics are concerned about negative evaluation from others they engage in “detailed monitoring and observation of themselves” (p. 70). This monitoring includes attention to internal information such as somatic responses, negative thoughts, images and feelings (Clark & Wells, 1995; Wild, Clark, Ehlers, & McManus, 2008). Heightened self-monitoring is proposed to increase socially anxious individuals’ awareness of their physiological arousal particularly under anxiety provoking conditions (Anderson & Hope, 2009). Because symptoms of physiological arousal (e.g., sweating) are key candidates for potential negative evaluation from others, socially anxious persons will over-estimate these symptoms (Rapee & Heimberg, 1997). For example, an increase in cheek temperature may lead to the incorrect inference that one is blushing profusely. This over-representation leads to reports of increased arousal in high versus low anxious individuals in the absence of actual physiological differences (Anderson & Hope, 2009).

There is evidence to support the cognitive models' premise that monitoring of internal information is characteristic of high socially anxious individuals. For example, using questionnaires high socially anxious persons report greater self-focused attention during social-evaluative situations than their low anxious counterparts (e.g., Hodson, McManus, Clark, & Doll, 2008; Perowne & Mansell, 2002). Baggett et al. (1996) reported significant differences between high and low speech anxious groups on an emotional awareness coping response, during preparation and presentation phases of a speech task. High speech anxious individuals were more likely to become absorbed in their negative emotions and aware of their distress throughout the two phases than the low anxious individuals. A tendency to monitor (negative) thoughts is supported by studies investigating anticipatory processing of social events. For example, a study by Vassilopoulos (2004) indicated that prior to a social event high anxious persons are more preoccupied with event-related thoughts than low anxious persons. In answer to the question, "Did you find yourself thinking about the event a lot?" the high socially anxious group scored 80 on a scale between 0 and 100 compared to 50 in the low social anxiety group (Vassilopoulos, 2004). In a similar vein, Hinrichsen and Clark (2003) using a semi-structured interview and questionnaire as measures of anticipatory processing showed that high socially anxious students pay greater attention to thoughts of avoidance and past failures in similar situations than their low anxious peers.

Indirect support for the notion that the discordance between measures of subjective and objective physiological arousal could be explained by self-monitoring of one's internal state is provided by Wild et al.'s (2008) study. Participants took part in a conversation with a confederate and were given false feedback about their objective arousal level by means of vibrations to the chest. In the increase condition participants were told that the vibrations indicated increased arousal, in the decrease condition vibrations indicated low arousal, and in the control condition participants were told that the vibrations were not relevant to the experiment. Participants who were led to believe that their arousal level was increasing throughout the conversation reported significantly more state anxiety and perceived their conversation as less successful than participants in the decrease and control conditions. More importantly, these participants reported experiencing more bodily sensations than participants in the other two conditions despite the fact that the information they received was false (Wild et al., 2008).

The Present Study

From the current literature it is unclear why there is a lack of correspondence between subjective and objective measures of arousal during a stressful task, particularly among high socially anxious individuals. The present study is designed to gain more insight into this issue in a nonclinical sample of high and low socially anxious youth. In accordance with previous studies in this field we used a public speaking task, the Leiden-PST (Westenberg et al., 2009). In contrast to other speech tasks the Leiden-PST is not impromptu: Participants are informed of the nature of the task one week before it takes place and are encouraged to prepare for the speech. Unlike impromptu speech tasks the Leiden-PST elicits a certain degree of stress during the baseline. This is evidenced by elevated baseline values, relative to the recovery phase, for self-reported nervousness and physiological arousal, actual heart rate and cortisol level (the anticipation effect) in a sample of normally developing early adolescents (Westenberg et al., 2009). Furthermore, in that study's sample the change from baseline to speech phase (i.e., the task effect) yielded a significant increase in the aforementioned parameters and also skin conductance. Hence, an advantage of the Leiden-PST is that it allows for the differentiated investigation of subjective and objective arousal correspondence during a relatively less stressful phase (pre-speech) and more stressful phase (speech) of the task.

The first aim of the current study is to investigate whether the pre-speech and speech effects found by Westenberg et al. (2009) in a normal sample are also present in youth with either high or low levels of social anxiety. Furthermore, from the results on these high and low social anxiety groups it will be made clear whether we are able to replicate the results of previous studies in this domain (e.g., Anderson & Hope, 2009;

Mauss et al., 2004) regarding anxiety group differences on subjective and objective physiological arousal during a speech task. As far as objective arousal is concerned, heart rate (HR) and skin conductance (SC) were used to measure the Autonomic Nervous System (ANS) response. In addition, we included the other stress system component, the Hypothalamus-Pituitary-Adrenal (HPA)-axis, by measuring salivary cortisol. Cortisol is suggested to reflect anxiety and nervousness in socially demanding situations (e.g., Rohleder, Beulen, Chen, Wolf, & Kirschbaum, 2007). The accompanying subjective arousal measures were, respectively, self reports on how quickly the heart was beating, sweatiness of the palms, and feelings of nervousness.

Based on current literature we expected (a) that both high and low anxiety groups would show a pre-speech effect and an even larger speech effect, relative to recovery values, on both subjective and objective measures; and (b) that anxiety group differences would be found for all three subjective arousal measures, with higher ratings in the high socially anxious group, and no group differences for actual heart rate and skin conductance. Due to inconclusive results regarding social anxiety group differences in cortisol responses to a social stressor (see e.g., van Veen et al., 2008) we did not make a specific prediction for this arousal measure.

We then come to the principal aim of this study, namely, to address the role of both task stressfulness and self-monitoring processes in the weak subjective-objective arousal correspondence. Consequently, we set out to investigate (1) if the correspondence between subjective and objective arousal is stronger during the less stressful (pre-speech) phase than during the more stressful (speech) phase of a public speaking task, particularly in high anxious youth. This question is based on results from other studies (e.g., MacLeod & Mathews, 1988; Owens, 2009; Rutherford et al., 2004) that suggest a change in high anxious individuals' actions only under high stress conditions. By including different task phases we improve upon previous research regarding subjective-objective arousal correspondence in which the state by trait anxiety interaction was not taken into account (e.g., Mauss et al., 2004); (2) the role of self-monitoring of one's thoughts, feelings and bodily responses during a social-evaluative task in the discordance between subjective and objective arousal. More specifically, we examined the relative importance of self-monitoring variables compared to objective physiological arousal in predicting subjective arousal during the speech phase.

Based on the current literature, we chose to investigate three self-monitoring variables: negative performance expectations (Hirsch & Clark, 2004; Spence, Donovan, & Brechman-Toussaint, 1999), emotion-focused coping (Carver, Scheier, & Weintraub, 1989) and self-focused attention (Woody, Chambless, & Glass, 1997).

Method

Participants

A total of 136 low and high socially anxious children and adolescents (age range 9-17 years) participated. These participants were selected from the Social Anxiety and Normal Development (SAND) study's (Westenberg et al., 2009) larger community sample (N = 327). The larger sample represented a wide range of scores on the Social Anxiety Scale for Adolescents (SAS-A; La Greca & Lopez, 1998). The selection of low and high socially anxious youth is described in detail elsewhere (Miers, Blöte, Bokhorst, & Westenberg, 2009). The mean SAS-A score for the high anxious group was 58.84 (SD = 7.44) and for controls 29.56 (SD = 2.91), a significant difference $t(87.10) = 30.23$, $p < .001$. Mean age for the high anxious group was 12.88 years (SD = 2.05) and for the control group 12.49 years (SD = 2.45), a nonsignificant difference. Informed parental consent and assent from participants themselves was obtained in writing. The SAND study was approved by Leiden University Medical Centre's Medical Ethical Committee.

Materials

Subjective arousal.

A Visual Analogue Scale (VAS; Davey, Barratt, Butow, & Deeks, 2007) was used to assess subjectively experienced arousal. Participants were asked to rate three arousal responses on a 10 cm line: how nervous they felt, how fast their heart was beating and how sweaty their palms were. The point marked by the participant was measured in millimeters. Two types of arousal scores were utilized in this study: separate scores for each individual arousal response and a mean subjective arousal score per task phase (see Procedure section). The latter was calculated by averaging scores over the three arousal questions per task phase. Internal consistency (Cronbach's alpha) for the mean arousal score in the larger sample was > .74 for all task phases.

Social Anxiety Scale for Adolescents (SAS-A).

The Dutch translation (Koot & Utens, unpublished) of the Social Anxiety Scale for Adolescents (SAS-A; La Greca & Lopez, 1998) provided the measure of social evaluative anxiety. A 22 item instrument, the SAS-A contains 18 descriptions of social fears (e.g., "I worry about what other kids think of me" and "I get nervous when I meet new kids") and 4 filler items (e.g., "I like to read"). Respondents are asked to rate each item according to the degree to which the item "is true for you" (1 = *not at all*, 5 = *all the time*). Scores on the SAS-A can range between 18 and 90. The SAS-A has good internal consistency (La Greca & Lopez, 1998) and it was excellent in the larger sample of the present study, $\alpha = .94$.

Measure of Expected Performance (ExP; Spence et al., 1999).

To measure negative performance expectations we used a Dutch translation of Spence et al.'s (1999) cognitive measure, referred to in this study as "ExP". This questionnaire measures participants' overall expectation of performance quality during the speech. The original version includes five questions, for example "Compared to other kids your age, how good do you think you will be at giving a speech?" Two of these questions ask the participant how they expect to be judged by others. For the current study these were divided up to ask how same age peers and a teacher would judge the performance. For example, "How good do you think other kids your age watching the video will think you are at giving a speech?" For the question asking about the teacher's judgment, "other kids your age" is replaced by "teacher". This adjustment increased the total number of items to seven. Items are rated using a 5-point scale (1 = lowest performance expectation, 5 = highest performance expectation). One item was omitted (asking participant how scared he or she is about the upcoming speech) because of its conceptual overlap with the VAS nervousness question. Internal consistency of the remaining 6 items as measured in the larger sample was good (Cronbach's α = .76).

Emotion-focused Coping (Penley & Tomaka, 2002).

To measure emotion-focused coping a Dutch translation of Penley and Tomaka's Coping (2002) questionnaire was used. The questionnaire asks participants to indicate things they may have done or thought during rehearsal for the speech on a 4-point scale ranging from *Didn't do this at all* to *Did this a lot*. The original version contains 48 items, six of which measure emotional awareness and regulation coping (Cronbach's α = .78; Penley & Tomaka, 2002). This version was adapted and shortened for use in the SAND study's youth sample and contains 23 items. Four items tap awareness of and desire to regulate negative emotions (e.g., "I focused on regulating my nerves" and "I thought about the emotions I was feeling"). The internal consistency of the emotion awareness subscale in the present study's larger sample was adequate (Cronbach's α = .64).

Self-focused Attention (Woody et al., 1997).

The degree to which participants engaged in self-focused attention during the speech task was measured with a Dutch translation of the Focus of Attention Questionnaire (FAQ; Woody et al., 1997). The FAQ consists of two subscales: self-focused attention and other-focused attention. In the present study only the self-focused attention subscale is used and it contains five items. An example item is "I was focusing on my internal bodily reactions (for example, heart rate)." Each item is rated on a 5-point scale ranging from *not at all* to *totally* according to how much the participant's attention matched the item description. Previous studies have reported acceptable internal consistency in adult (Woody et al., 1997) and youth samples (Hodson et al., 2008).

In the current study's larger sample, all 5 items yielded a Cronbach's alpha of .52. As indicated by the reliability analysis we removed the item "I was focusing on what I would say or do next". This increased the internal consistency to an adequate α of .61.

Physiological reactivity.

A Biopac ambulatory measuring system (MP150: Biopac Systems Inc., US) was used to continuously measure heart rate and skin conductance. HR was monitored using a precordial lead. SC was measured by means of two Ag/AgCl electrodes, positioned on the middle phalanxes of the forefinger and the middle finger of the nondominant hand. Physiological data was sent telemetrically to the MP150 data acquisition system. Data acquisition was monitored continuously by the researcher using AcqKnowledge software (Biopac Systems Inc., US).

After visual inspection, and based on quality of data (e.g., unreliability due to movement artifacts), 3 min segments were selected for the three phases relevant to this study: pre-speech, speech and recovery. The segments were selected based on the best quality of continuous data within the time window of each task phase. If, for example, a period began with a relatively high number of moving artifacts due to physical unrest, we selected a more reliable time series, within the defined time window, starting a bit later (Westenberg et al., 2009). Using AcqKnowledge software average HR (beats per minute) and average SC (μSiemens) were calculated for these segments.

Neuroendocrine response.

Saliva samples were collected by passively drooling saliva into a plastic tube (0.5 ml Salicap) using a short straw. To control for the natural decline of cortisol levels during the day, all participants were tested at the same time in the afternoon starting at 14:15 h, when cortisol concentrations are relatively low and sensitive for external stimulation (Nicolson, 2008). The determination of cortisol was performed with a competitive electrochemiluminescence immunoassay (ECLIA: Roche Diagnostics, Mannheim, Germany), with a minimal detection limit of 0.5 nmol/L. The distribution of raw cortisol scores was highly skewed hence for the statistical analyses cortisol scores were transformed by a natural log-transformation (Nicolson, 2008). To facilitate interpretability of the data, raw average cortisol values are provided in Table 5.1.

Procedure

A complete description of the procedure followed in this study is described in Westenberg et al. (2009). Participants took part in the Leiden-PST that included two sessions at the university, one week apart. During the first session (pre-session) participants completed the SAS-A and ExP. Participants were also given some details about the public speaking task including its topic, how long they would have to talk for, and that they should prepare for it as they would for a school presentation.

The second session (speech session) involved participants giving a 5 min presentation on the type of films they like and/or dislike and explaining why, using an example of a film to illustrate their reasoning. At the start of this session participants were connected to the BioPac equipment and from this point on HR and SC were monitored continuously for the duration of the entire session.

The speech session began with the pre-speech phase during which participants watched a nature video for 25 min. For 20 min participants remained seated and for the last 5 min participants were instructed to stand without moving the body too much. Standing baseline was the segment used for the pre-speech phase measure of HR and SC. After standing for 5 min participants were asked to fill in the first VAS (VAS moment 1, pre-speech) and the first saliva sample was collected. Following this was the preparation phase involving an instruction period of 3 min and a 5 min rehearsal period. The instructions highlighted the social-evaluative nature of the task (full instructions are available on request from the first author). During this phase, participants stood in front of a life-size projection screen 1.5 m by 2 m.

For the speech phase participants remained standing and gave their speech in front of a pre-recorded audience consisting of eight age-matched peers and a teacher (Westenberg et al., 2009). The speech lasted 5 min and afterwards participants immediately sat down and completed VAS moment 2 (asking about during the speech), the FAQ and Coping questionnaire. A 3 min segment of HR and SC data selected from these 5 min was used for the speech phase. Three saliva samples (samples 2 through 4) were collected and a short interview with the researcher was conducted. Following this the recovery phase commenced. This final phase lasted 10 min during which time the participants continued to watch the nature film while seated. A 3 min segment of HR and

SC data toward the end of this period was selected for the recovery phase. Two saliva samples (5 and 6) were collected during the recovery phase. When the 10 min recovery phase was over VAS moment 3 (recovery) was completed and the last saliva sample (sample 7) was collected. Finally, the researcher went into the participant room and removed the physiological apparatus.

In sum, a total of seven saliva samples were collected during the speech session: sample 1 at the end of the pre-speech phase, samples 2 through 6 after the speech and sample 7 at the end of the recovery phase. Five saliva samples (i.e., samples 2 through 6) were taken after the speech task to account for the fact that individuals differ in the timing of the cortisol response to a stressful event, that is, there are marked differences in latency to the 'peak response' (Gunnar & Talge, 2007). Hence, following Newman, O'Connor and Conner (2007) the peak value after the speech was taken as the best index of the individual stress response.

For the speech session participants were not allowed to eat, have coffee or caffeinated soft drinks, consume dairy products, drink alcohol, smoke tobacco, or take intensive physical exercise after 13:15 h as this could potentially affect physiological responses (Fichera & Andreassi, 2000). When probed at the beginning of the speech session, only five of the 136 participants indicated that they ate, smoked, or had a caffeinated soft-drink after 13:15 h. Three of these participants also reported the use of oral contraceptives; an additional four girls without a potentially disturbing consumption pattern reported using oral contraceptives. To circumvent possible unwanted effects of an inappropriate consumption pattern or oral contraceptive use on physiological and neuroendocrinological measures (Fichera & Andreassi, 2000; Kirschbaum, Kudielka, Gaab, Schommer, & Hellhammer, 1999) we removed participants (n = 9) meeting either criterion from all analyses described below. This left 127 participants, 61 in the low anxious group and 66 in the high anxious group.

Data Analyses

The first study aim of investigating (a) the pre-speech and speech effects of the Leiden-PST in high and low anxiety groups and (b) replicating previously reported anxiety group differences on subjective and objective arousal was tested with repeated measures ANOVAs. We performed three 2 (Anxiety Group [high, low]) by 3 (Task Phase [pre-speech, speech, recovery]) ANOVAs on individual VAS scores (i.e., separate scores for subjective nervousness, heart rate and sweaty palms) with repeated measures on task phase. Next, we conducted three similar 2 (anxiety group) by 3 (task phase) ANOVAs on objective physiology measures of HR, SC and cortisol, with repeated measures on task phase. A significant overall task phase effect was followed up with paired samples *t*-tests to verify that the pre-speech phase elicits less state anxiety than the speech phase and more state anxiety than the recovery phase. A significant interaction between anxiety group and task phase was followed up with independent *t*-tests for each task phase separately to test whether high anxious participants differed from low anxious participants.

For these repeated measures ANOVAs we initially included gender and age group (9-12 years and 13-17 years) as between subjects variables. Neither gender nor age interacted significantly with anxiety group, therefore all repeated measures ANOVAs were conducted again without gender and age. The results of these analyses are reported. Multivariate test statistics are reported to avoid "the controversy surrounding the sphericity assumption" for univariate statistics (Green & Salkind, 2005, p. 233). Sample sizes for separate analyses may differ slightly due to missing values.

For the principal study aim regarding the role of task stressfulness and self-monitoring processes in the subjective-objective arousal correspondence two multiple regressions were conducted, one for the pre-speech and one for the speech phase. Each multiple regression included the mean subjective arousal score (i.e., nervousness, heart rate and sweaty palms combined) as the outcome variable and the three objective arousal variables, HR, SC and cortisol, as predictor variables. The relative importance of self-monitoring was examined only in the speech phase multiple regression. The three self-monitoring variables were therefore entered altogether in a second step after the objective arousal variables had been entered in the first step. These multiple regressions were conducted for each anxiety group separately.

For ease of comparability over the task phases, these regression analyses included only those participants who had complete data on subjective and objective variables at both pre-speech and speech. From the 127 participants, 15 were removed leaving 112 participants, 59 in the high anxious group and 53 in the low anxious group.

For the regression analyses we chose to use raw rather than difference scores because the Leiden-PST does not include a standard baseline phase during which participants are completely at rest (they are already aware of the task during pre-speech). This choice is corroborated by the fact that in the study of Mauss et al. (2004), correlations between subjective and objective physiology were the same for raw and difference scores.

Results

Pre-speech and Speech Effects in High and Low Anxious Youth

Table 5.1 presents the means and standard deviations for the subjective and objective variables across the three task phases by anxiety group. A significant effect of task phase was found for self-reported nervousness, $F(2, 120) = 344.33$, $p < .001$, $\eta_p^2 = .85$; self-reported heart rate, $F(2, 120) = 192.53$, $p < .001$, $\eta_p^2 = .76$; and self-reported sweaty palms, $F(2, 120) = 74.82$, $p < .001$, $\eta_p^2 = .56$. Significant effects of task phase were also found for HR, $F(2, 123) = 383.47$, $p < .001$, $\eta_p^2 = .86$, SC, $F(2, 121) = 51.39$, $p < .001$, $\eta_p^2 = .46$, and cortisol, $F(2, 115) = 78.28$, $p < .001$, $\eta_p^2 = .58$. Follow-up paired samples *t*-tests collapsed across anxiety groups verified all expected pre-speech and speech phase effects (*p*s < .001) except for one measure, namely SC. The pre-speech phase was significantly less stressful than the speech phase, and significantly more stressful than the recovery phase, for all subjective and objective arousal measures except SC, which did not show the expected reduction from pre-speech to recovery.

Social Anxiety Group Differences on Subjective and Objective Physiological Arousal

The main effect of anxiety group was significant for all three subjective arousal measures. The high socially anxious group reported more nervousness, $F(1, 121) = 17.68$, $p < .001$, $\eta_p^2 = .13$, a higher heart-rate, $F(1, 121) = 8.88$, $p < .01$, $\eta_p^2 = .07$, and sweatier palms, $F(1, 121) = 6.55$, $p < .02$, $\eta_p^2 = .05$, as compared to the low anxious

Table 5.1

Means and SDs for Subjective and Objective Physiology During Pre-speech, Speech and Recovery Phases by Anxiety Group

	High anxious		Low anxious	
	M (*SD*)	*n*	*M* (*SD*)	*n*
Subjective Physiology				
Pre-speech Nervousness	47.30(26.03)		33.92(20.92)	
Speech Nervousness	74.58(24.49)	64	58.29(27.02)	59
Recovery Nervousness	10.20(15.09)		4.85(7.01)	
Pre-speech Heart rate	42.23(22.31)		26.69(19.95)	
Speech Heart rate	62.62(26.89)	64	54.59(25.60)	59
Recovery Heart rate	12.84(14.45)		10.49(15.38)	
Pre-speech Sweaty palms	25.58(26.17)		14.71(19.13)	
Speech Sweaty palms	45.36(33.69)	64	35.80(27.55)	59
Recovery Sweaty palms	11.50(15.90)		5.68(12.69)	
Objective Physiology				
Pre-speech HR (bpm)	93.84(12.08)		94.25(11.38)	
Speech HR (bpm)	103.84(15.65)	66	103.62(15.94)	60
Recovery HR (bpm)	76.28(12.58)		76.10(9.44)	
Pre-speech SC (μS)	8.17(3.58)		8.33(3.46)	
Speech SC (μS)	9.95(3.81)	66	10.56(4.10)	58
Recovery SC (μS)	8.55(3.69)		8.66(3.78)	
Pre-speech Cortisol (nmol/L)	8.07(5.47)		8.36(4.74)	
Speech Cortisol (nmol/L)	9.98(5.73)	60	9.80(4.69)	58
Recovery Cortisol (nmol/L)	6.85(3.98)		6.51(4.39)	

group. In addition, the Phase x Anxiety Group interaction was significant for self-reported nervousness, $F(2, 120) = 3.43$, $p < .05$, $\eta_p^2 = .05$, and heart rate, $F(2, 120) = 6.86$, $p < .01$, $\eta_p^2 = .10$. As shown in Table 5.1 these interactions reflect an absence of group differences at the recovery phase coupled with the high anxious group reporting greater nervousness and a higher heart rate than the low anxious group during the pre-speech and speech phases. In contrast, as can be seen from Table 5.1 anxiety groups had very similar HR, SC and cortisol levels during each of the three task phases.

In sum, these results replicate current literature by showing significant social anxiety group differences for subjective arousal and an absence of group differences for HR and SC. In addition, our results show that high and low anxious groups do not differ in cortisol level at the pre-speech, speech or recovery phase either.

Role of Task Stressfulness and Self-monitoring in Subjective-Objective Correspondence

Prior to conducting the two multiple regression analyses intercorrelations among the relevant predictor variables were computed for each anxiety group. For the high anxious group, SC at pre-speech correlated almost significantly with cortisol, $r = .25$ ($p = .05$). The remaining correlations for pre-speech measures were low and nonsignificant (rs < .16, ps > .25). In the low anxious group, the intercorrelations among objective arousal measures at pre-speech were low and nonsignificant (rs < .10, ps > .53).

For the speech phase, the majority of the intercorrelations were low and nonsignificant (see Table 5.2). The strongest intercorrelation in both anxiety groups was between self-focused attention and emotion-focused coping, however the magnitude of this intercorrelation does not imply that multicollinearity is a problem (Field, 2000).

Role of Task Stressfulness

Tables 5.3 and 5.4 present the results of the multiple regression analyses investigating if the correspondence between subjective and objective arousal is stronger during the less stressful (pre-speech) phase than during the more stressful (speech) phase of a public speaking task, particularly in high anxious youth. These results are evaluated per anxiety group below.

Table 5.2

Intercorrelations Among Predictor Variables for Speech Phase and Means (SDs) for self-monitoring variables by Anxiety Group

	1	2	3	4	5	6	High *M* (*SD*)	Low *M* (*SD*)
1. HR	-	.11	.33*	.03	.15	.23		
2. SC	*.08*	-	.20	-.16	.09	.03		
3. Cortisol peak	*.17*	*.16*	-	.01	.01	-.01		
4. ExP	*.00*	*.33**	*-.12*	-	-.31*	-.23	3.05(0.53)	3.36(0.38)
5. SFA	*-.04*	*-.04*	*.07*	*.04*	-	.42**	2.41(0.91)	2.03(0.70)
6. EmCop	*.09*	*-.16*	*-.06*	*.17*	*.45***	-	2.31(0.69)	1.91(0.69)

Note. Correlations for high anxious group presented in top half, correlations for low anxious presented in bottom half of table. HR = Heart rate, SC = Skin conductance. ExP = Expected Performance, SFA = self-focused attention, EmCop = Emotion-focused coping. * $p < .05$. ** $p < .01$.

High Anxious Group.

In the high anxious group, pre-speech subjective arousal was significantly predicted by the objective arousal measures, $R^2 = .15$, $F(3, 55) = 3.23$, $p < .05$. The partial correlations (*pr*) show that greater subjective arousal during this task phase was associated with higher HR, SC and cortisol levels, although not one predictor reached significance (see Table 5.3). In contrast, during the speech phase the objective arousal measures did not significantly predict subjective arousal ($R^2 = .06$; see Table 5.4).

Low Anxious Group.

For the low anxious group, the regression model for pre-speech subjective arousal produced an R^2 of .18 (Table 5.4). This model was significant, $F(3, 49) = 3.55$, $p < .05$. The strongest contributor was SC, with greater SC associated with higher self-reported arousal during the pre-speech phase. Cortisol just missed significance as a predictor, however the direction of the *pr* with subjective arousal was the same as for SC. HR was positively, but less strongly related to subjective arousal. Similarly, the regression model for subjective arousal during the speech phase produced an R^2 of .19 which is significant, $F(3, 49) = 3.74$, $p < .02$ (Table 5.4). SC was again the only significant predictor; however HR and cortisol both had a positive association with subjective arousal.

In sum, the results show that for the high anxious group, the correspondence between subjective and objective physiological arousal is dependent on task stressfulness. The correspondence was almost three times as large in the less stressful phase of the task as in the more stressful phase. In the less stressful phase, the correspondence between objective and subjective arousal was similar to that in the low anxious group. In the more stressful phase, however, the correspondence in the high anxious group was much lower.

Table 5.3

Multiple Regression of Mean Subjective Arousal during Pre-Speech on Objective Heart Rate, Skin Conductance and Cortisol by Anxiety Group

	R^2	*B*	*SE B*	β	*r*	*pr*
High Anxious	.15*					
HR		0.21	0.20	.14	.18	.15
SC		1.16	0.69	.22	.28	.22
Cortisol		6.60	3.86	.22	.30	.23
Low Anxious	.18*					
HR		0.17	0.18	.12	.17	.13
SC		1.38	0.61	.30*	.32	.31
Cortisol		7.54	4.10	.24[a]	.27	.25

Note. HR = Heart rate, SC = Skin conductance.

* $p < .05$. [a] $p = .07$.

Role of Self-monitoring

A preliminary look at the mean scores of the self-monitoring variables per anxiety group (Table 5.2) showed that the high anxious group had more negative performance expectations, engaged in more emotion-focused coping, and were more

Table 5.4

Multiple Regression of Mean Subjective Arousal during Speech on Objective Heart Rate, Skin Conductance, Cortisol and Self-monitoring Variables by Anxiety Group

	R^2 Δ	*B*	*SE B*	β	*r*	*pr*
High Anxious						
Step 1	.06					
HR		0.04	0.21	.02	.01	.02
SC		1.50	0.85	.24	.22	.23
Cortisol peak		-4.43	5.52	-.11	-.06	-.11
Step 2	.17*					
HR		-0.09	0.20	-.06	.01	-.06
SC		1.23	0.80	.19	.22	.21
Cortisol peak		-2.87	5.15	-.07	-.06	-.08
ExP		-7.88	5.96	-.17	-.30	-.18
SFA		1.92	3.71	.07	.26	.07
EmCop		11.03	4.96	.31*	.37	.30
Low Anxious						
Step 1	.19*					
HR		0.19	0.18	.14	.20	.15
SC		1.51	0.69	.29*	.34	.30
Cortisol peak		10.23	6.29	.22	.29	.23
Step 2	.25**					
HR		0.14	0.15	.10	.20	.13
SC		2.01	0.65	.38**	.34	.41
Cortisol peak		10.14	5.54	.21	.29	.26
ExP		-3.19	6.99	-.06	.12	-.07
SFA		5.15	4.00	.16	.34	.19
EmCop		13.49	4.21	.42**	.42	.43

Note. HR = Heart rate, SC = Skin conductance. ExP = Expected Performance, SFA = self-focused attention, EmCop = Emotion-focused coping.

* $p < .05$. ** $p < .01$.

self-focused than the low anxious group (*F*s > 6, *p*s ≤ .01, η_p^2s ≥ .05). Table 5.4, Step 2 presents results on the role of the self-monitoring variables in the discordance between subjective and objective arousal. We will evaluate these results per anxiety group.

High anxious group.

For the high anxious group, the inclusion of self-monitoring variables to objective physiology produced a significant increase in the R^2 of .17. This increase was significant, $F(6, 52) = 2.60$, $p = .028$. Of the self-monitoring variables, only emotion-focused coping significantly predicted subjective arousal. The positive *pr* indicated that the more the participant tried to keep their emotions under control and focused on their nervousness during the 5 min before the speech began, the greater their self-reported arousal during the speech. Self-focused attention and performance expectations showed moderate, statistically significant zero-order *r*'s with subjective arousal, however when entered into the model with the other variables, the *pr*'s show that they did not make a statistically unique contribution to subjective arousal.

Low anxious group.

For the low anxious group, the addition of the self-monitoring variables to objective physiology yielded a significant increase in explained variance, $R^2\Delta = .25$, $F(6, 46) = 5.89$, $p < .001$. Of the self-monitoring variables, only emotion focused coping made a statistically unique contribution. As with the high anxious group, the direction of the *pr* suggests that greater use of the emotion focused coping strategy during the 5 min rehearsal phase is related to higher self-reported arousal during the task. In the second step, SC remained a statistically significant predictor of subjective arousal.

In sum, after accounting for the contribution of objective arousal during the speech phase, the self-monitoring variables explained a significant proportion of subjective arousal in high and low anxious youth. However, in contrast to expectations based on cognitive theories of social anxiety disorder (Clark & Wells, 1995; Rapee & Heimberg, 1997) the role of self-monitoring variables was not greater in the high versus the low socially anxious group.

Discussion

The goal of the current study was to learn more about the coherence between subjective and objective measures of physiological arousal during a social-evaluative task, in high and low socially anxious youth. The principal aim was (a) to investigate whether the degree of coherence is influenced by task stressfulness (following the trait by state interaction model; MacLeod & Mathews, 1988); and (b) to evaluate the importance of self-monitoring processes (Clark & Wells, 1995; Rapee & Heimberg, 1997) in explaining the weak subjective-objective correspondence in high socially anxious youth. Before discussing the principal findings, we address the first study aim regarding (a) pre-speech and speech effects of the Leiden-PST (Westenberg et al., 2009) in high and low socially anxious youth and (b) replication of anxiety group differences on subjective and objective physiological arousal (Anderson & Hope, 2009; Mauss et al., 2004).

As anticipated, our results showed that for both high and low socially anxious youth the pre-speech phase elicited less subjectively experienced nervousness, racing heart and sweaty palms and lower actual heart rate, skin conductance and cortisol level than the speech phase. The results also verify that both high and low socially anxious youth experienced more stress, and their physiological activity was elevated, in the phase leading up to the speech than in the recovery phase.

In addition, and in line with previous research our results supported the differential results concerning anxiety group differences on subjective and objective arousal (e.g., Anderson & Hope, 2009; Baggett et al., 1996; Edelmann & Baker, 2002; Mauss et al., 2004). That is, high anxious youth reported significantly more nervousness, a faster heart rate and sweatier palms than low anxious youth, but anxiety groups did not differ on actual heart rate and skin conductance. The lack of anxiety group differences for actual physiological arousal does not agree with some other studies in adult and youth samples (e.g., Beidel et al., 1985; Levin et al., 1993; Matthews, Manuck, & Saab, 1986). However, as noted by Mauss et al. (2004) and Anderson and Hope (2009), in these studies the anxiety group difference was often located in just one response domain, during only one phase of the task, or could be accounted for by postural changes. Extending studies that measure either ANS or HPA-axis responses to social stressors we simultaneously examined salivary cortisol as well as heart rate and skin conductance. Paralleling the results for ANS activity, we did not find evidence for a stronger HPA-axis response to the speech task in high anxious compared to low anxious youth. This result is in line with findings of previous studies using a public speaking challenge in clinical groups of socially anxious adolescents (Martel et al., 1999) and adults (Levin et al., 1993).

Task Stressfulness and Trait Anxiety

By investigating the concordance between subjective and objective arousal during two phases of a speech task varying in the level of stressfulness, we show that only under a high state anxiety level is the awareness of physiological arousal hindered in high socially anxious youth. When state anxiety was relatively low, high anxious youth were able to estimate their actual arousal as well as their low anxious counterparts. For low socially anxious youth the correspondence was not influenced by task stressfulness: the level of concordance was similar for the two state anxiety levels. Hence, in line with the interaction hypothesis (MacLeod & Mathews, 1988) a high level of both trait and state anxiety detrimentally affected the estimation of physiological arousal. These findings extend previous studies investigating the subjective-objective correspondence (e.g., Edelmann & Baker, 2002; Mauss et al., 2004) in which trait social anxiety differences were examined but only under the condition of high state anxiety.

Given that this is the first study to examine the interaction between state and trait anxiety in relation to subjective-objective arousal correspondence it is important to replicate the findings in samples of high or even clinical socially anxious youth and adults. It would be interesting to investigate whether there is a point in the stress level where subjective-objective coherence abruptly disappears or, alternatively, whether the correspondence gradually weakens.

Self-monitoring processes and Subjective-Objective Correspondence

Self-monitoring of internal information during feared social situations has previously been put forward as a reason for the discrepant findings regarding anxiety group differences on subjective and objective arousal measures (Anderson & Hope, 2009;

Mauss et al., 2004). Our findings do indicate that in high anxious youth, self-monitoring processes are relatively more important than actual physiological arousal to the prediction of subjective arousal during the stressful speech phase. As found in the present and previous studies (e.g., Hodson et al., 2008; Baggett et al., 1996; Vassilopolous, 2004) high anxious individuals engage in more self-monitoring of their internal state than low anxious persons, hence self-monitoring processes could play a greater role in the subjective-objective arousal coherence in high versus low socially anxious groups. Yet, our findings indicate that self-monitoring processes do not differentiate between the two groups as far as the prediction of subjective-objective correspondence is concerned. This conclusion would be strengthened by replication, particularly because the internal consistency of the emotion-focused coping and self-focused attention measures was only moderate in the present study.

Limitations and Suggestions for Further Research

There are some limitations to this study that need to be mentioned. The results in relation to self-monitoring processes might have been different if all these variables were measured during the task itself instead of at different moments. However, we chose not to question participants about self-monitoring during the speech in order to avoid interfering with or priming their natural cognitive processes. The retrospective report of cognitions, and other variables such as state anxiety and physiological arousal, is an inherent limitation of studies of this type. Yet, it is plausible that stronger effects might be found if self-monitoring variables were measured online, during the speech.

The present study used nonclinical youth with self-reported high social anxiety. It is unclear how strong or weak the subjective-objective arousal correspondence is in youth with social phobia and to what extent social phobics base their estimation of physiological arousal on monitoring of internal information. Replication in a group of clinically diagnosed youth is thus crucial in order to generalize the present findings to clinical populations.

Our findings could not answer the question why high anxious youth seem unable to use their physiological cues to estimate their own arousal when the stress level is high. A possible explanation could be that working memory is disrupted during the high stress phase and that this interferes in high anxious youth's awareness of actual arousal. Working memory is said to mediate the relation between trait anxiety and cognitive performance (see Owens, Stevenson, Norgate, & Hadwin, 2008) whereby cognitive storage and processing resources in working memory are detrimentally affected. It has been shown that the negative association between trait anxiety and academic performance is partially mediated by working memory (Owens et al., 2008). Moreover, the effects are enhanced under conditions of heightened stress (Owens, 2009). Perhaps, due to the increased state anxiety experienced during the speech, high socially anxious individuals' working memory function is diminished, whereby information received from the senses cannot be efficiently coordinated (Logie, 1999). This may interfere in the ability to accurately perceive physiological cues and hence lead to discordance between measures of subjective and objective arousal.

Another interesting variable investigated by Anderson and Hope (2009) is anxiety sensitivity. Anxiety sensitivity is defined as the "fear of anxiety-related sensations due to beliefs that such sensations will lead to catastrophic outcomes" (Walsh, Stewart, McLaughlin, & Comeau, 2004, p. 696). Anderson and Hope found that adolescents diagnosed with social phobia report being more afraid of experiencing physiological arousal than their low anxious counterparts. However, the authors did not investigate the relative importance of anxiety sensitivity, compared with actual arousal, to self-reported arousal. It would therefore be fruitful for future research to include a measure of anxiety sensitivity in order to examine whether the negative appraisal of physiological activation translates into an increased perception of arousal, relative to actual physiological responses.

In the present study, skin conductance seemed to be the most crucial physiological response for estimating subjective arousal. Of the three objective arousal measures, skin conductance was the single strongest partial predictor of self-reported arousal. These findings contrast with previous studies conducted with adult samples in which the strongest correlation was found between self-reported racing heart and actual heart rate (Edelmann & Baker, 2002; Mauss et al., 2004; Steptoe & Vögele, 1992). Further research is required in order to establish whether awareness of physiological arousal is determined by different response domains in youth and adults.

When describing the observed dissociation between objective and subjective arousal responses, previous authors referred to "distorted cognitive processing of physiological activation" (Mauss et al., 2004, p. 655) and a "misperception of physiological arousal" (Anderson & Hope, 2009, p. 19). Generally, social anxiety disorder is characterized by information processing biases (Hirsch & Clark, 2004), for example the underestimation of one's social performance relative to evaluations by objective observers (e.g., Alden & Wallace, 1995; Cartwright-Hatton, Tschernitz, & Gomersall, 2005). Socially anxious individuals' overestimation of their arousal could just be another manifestation of their more general negative cognitive bias. It would be worthwhile to study how an arousal bias relates to other information processing biases and whether biases in different domains, such as physiological arousal or social performance, exist independently of – or coincide with – each other.

Finally, a strong point of the present study is that we are able to rule out the possibility that the perception of anxious arousal by high anxious youth is affected by negative feedback from the audience. In the Anderson and Hope (2009) study participants performed their speech in front of a live audience. In this context, one cannot be sure that even slight behavioral reactions from the audience are seen by high anxious persons as evidence of their poor performance and visible anxiety (Perowne & Mansell, 2002), which in turn may lead to an overestimation of arousal. Thus, the current study's use of a pre-recorded audience with, as a consequence, an absence of audience interaction lends preliminary support to the notion that self-reported arousal in high anxious individuals is not driven by external processes but by biased internal, cognitive processes (Mauss et al., 2004).

To conclude, the present study's results do not entirely fit with the cognitive models of social phobia (Clark & Wells, 1995; Rapee & Heimberg, 1997) because the role of self-monitoring processes in predicting subjective arousal was similar across high and low anxious youth (see also Wild et al., 2008). Given that high anxious youth appeared to use the actual physiological cues during the less stressful pre-speech phase but not the stressful speech phase, we recommend that future studies take high and low levels of trait and state anxiety into account when examining the coherence between subjective and objective responses to social tasks.