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# Perception of Autonomic Arousal in Social Anxiety: Mechanisms and its Role As a Maintaining Factor

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## Abstract

Cognitive models suggest that perception and subsequent dysfunctional appraisal of somatic sensations might be a major determinant of negative self-evaluations in socially anxious individuals. Research on potential mechanisms of biased interoceptive awareness in social anxiety is limited. Processes that seem to be involved are superior interoceptive accuracy and attentional focus, whereas there is little evidence that perceived arousal might have a basis in actual physiological responses. The present review gives an overview of the current state of knowledge in this area and tries to delineate pathways between interoceptive sensitivity and the maintenance of the disorder.

**Keywords:** Social anxiety, perceived arousal, interoceptive accuracy, self-focus, perception of performance, post-event processing

## Introduction

Psychophysiological research on the effects of trait social anxiety in evaluative task conditions has produced very consistent results for *perceived* physiological arousal, with socially anxious individuals experiencing a greater intensity of symptoms both during

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anticipation of (Gramer, Schild and Lurz, 2012) and confrontation with social stressors (Anderson and Hope, 2009; Edelman and Baker, 2002; Gerlach, Murlane, and Rist, 2004; Gramer et al.; Grossman, Wilhelm, Kawachi, and Sparrow, 2001; Mauss, Wilhelm, and Gross, 2003; 2004; Mulken, de Jong, Dobbelaar, and Bögels, 1999; Thibodeau, Gomez-Perez and Asmundson, 2012). However, with few exceptions (Gerlach et al.; Gramer et al.), these group differences in perceived arousal were accompanied by equivalent *objective* physiological responses (i.e. cardiovascular activation). Furthermore, there is some evidence that heightened subjective distress in socially anxious individuals might be accompanied by reduced cardiovascular activation (Gramer and Saria, 2007; Gramer and Sprintschnik, 2008; Larkin, Ciano-Federoff, and Hammel, 1998). These findings seem to suggest that objective and perceived arousal in trait social anxiety might have a basis in different mechanisms.

Beginning with the pioneering work of Obrist (1981) there has been convincing evidence that cardiovascular activity in evaluative task conditions might be the result of effort and task engagement rather than affective arousal. In particular, research by Wright and coworkers (Wright, 1996; Wright and Kirby, 2001) indicates that effort in demanding performance situations is proportional to experienced task difficulty as long as success is perceived as possible and worthwhile. In situations exceeding perceived coping ability, attenuated cardiovascular activation might be observed. In agreement with these postulations Gramer and coworkers (Gramer and Saria, 2007; Gramer and Sprintschnik, 2008) found socially anxious individuals to exhibit heightened cardiovascular activity in moderately demanding social situations (e.g. speech tasks with low evaluative threat) and to reduce their task engagement and cardiovascular activity under high evaluative threat. Thus, the observed lack of differential physiological reactivity or reduced reactivity of socially anxious individuals might result from abandonment of effort in situations exceeding perceived coping ability.

As regards perceived physiological arousal, some psychophysiological researchers (e.g. Mauss et al., 2004; Mulken et al., 1999) have suggested that these subjective experiences might have a basis in cognitive processes rather than actual physiological effects. In this respect, cognitive behavioral models of trait social anxiety (Clark and Wells, 1995; Rapee and Heimberg, 1997) assume that a specific attentional bias might play a major role in intensifying interoceptive experiences of socially anxious individuals. In particular, Clark and Wells postulate that situations with potential for negative evaluation trigger a shift of attention toward detailed self-monitoring of internal anxiety states. Interoceptive information provided by self-focus is then interpreted as evidence of actual or impending failure to make a favorable outward impression which further exacerbates symptoms of anxiety.

Heightened self-focused attention is considered to be a general characteristic of individuals with psychological disorders (Ingram, 1990) and there is consistent empirical evidence that self-focus is associated with trait social anxiety, both from questionnaire studies (for a review see Bögels and Mansell, 2004) and probe-detection paradigms that compared attention to interoceptive versus external probes (Deiters, Stevens, Hermann and Gerlach, 2013; Mansell, Clark and Ehlers, 2003; Pineles and Mineka, 2005).

Anxiety disorders and anxiety-related phenotypes such as anxiety sensitivity also seem to be characterized by heightened cardiac accuracy, i.e. awareness of actual heartbeat (for a review see Domschke, Stevens, Pfleiderer and Gerlach, 2010). Interoceptive accuracy might be an alternative explanation for heightened perceptions of physiological symptoms in socially anxious individuals. This review will give an overview of the present state of knowledge on the role of perceived physiological arousal in trait social anxiety. It begins with

an evaluation of potential mechanisms contributing to increased self-reports of physiological sensations.

Then, causal effects of perceived arousal on state anxiety and negative self-perceptions are discussed and pathways between interoceptive experiences and the maintenance of the disorder are delineated.

## Mechanisms of Enhanced Perceived Physiological Arousal in Social Anxiety

### Self-Focused Attention

There is little psychophysiological research on the causal effects of self-focused attention in social anxiety. Studies that experimentally manipulated attentional focus mainly evaluated effects on state anxiety and perceptions of performance. Considering that there is substantial coherence between experienced anxiety and perceived physiological arousal (Mauss et al., 2004; Thibodeau et al., 2012), data on state anxiety might also be an important source of information. Research in this area has produced inconsistent results. Several studies suggest that self-focused attention may exacerbate state anxiety (Bögels and Lamers, 2002; Woody, 1996; Woody and Rodriguez, 2000; Zou, Hudson and Rapee, 2007). With one exception (Zou et al.), the detrimental effects of self-directed attention were not specific for participants with high social anxiety, though. Individuals with high and low levels of trait social anxiety were affected by attention manipulation. Some studies found no evidence for a causal role of self-focus. One of them (Bögels, Rijsemus and de Jong, 2002) evaluated the effect of self-focus on both state anxiety and perceived physiological arousal, the other study (Panayiotou and Vrana, 1998) was confined to state anxiety. These discrepant results may partly be an effect of different types of self-focus manipulation. Studies that did obtain a detrimental effect of self-focus on state anxiety utilized instructions to direct attention towards internal self-relevant stimuli, whereas studies which failed to observe an effect manipulated self-focus by placing a mirror or video camera in front of participants. A meta-analysis by Mor and Winquist (2002) found instructions to have a stronger effect on negative affect compared to mirror/video manipulations.

Research on the effects of self-directed attention also has to consider the aspect of *direction of causality*. Negative affect and arousal perceptions may not only be a consequence of self-directed attention, they may also cause increased attention to the self. There is some evidence that negative mood may induce self-focused attention (Salovey, 1992; Wood, Saltzberg and Goldsamt, 1990). As regards physiological arousal, several authors found false heart rate feedback to strengthen self-focus (Makkar and Grisham, 2012; Wells and Papageorgiou, 2001) and Wegner and Giuliano (1980) observed a similar effect for exercise-induced arousal. These findings might suggest a cyclical relationship (Mor and Winquist, 2002). When socially anxious individuals enter a social situation with evaluative features the experience of anxiety and physiological arousal may trigger enhanced self-focus and self-focus in turn may further intensify interoceptive experiences.

Overall, these data do not seem to provide strong support for the assumption that differences in perceived physiological arousal between high and low socially anxious individuals might be the result of attentional bias.

Focusing attention on the self in social situations may increase state anxiety and perceived arousal, but it seems to have this effect in both high and low socially anxious individuals. Considering that socially anxious individuals were found to show a stronger tendency towards self-focus when they have the possibility to allocate their attention freely (Deiters, et al., 2013; Mansell, Clark, and Ehlers, 2003; Pineles and Mineka, 2005) they nonetheless might experience the negative effects of self-focus more strongly. There is some indication, though, that differences in self-directed attention between high and low socially anxious individuals might be confined to stressor anticipation (Deiters et al.) and Woody (1996) found a self-focus manipulation to increase state anxiety in socially phobic individuals only in a passive task condition but not during active speech. Together, the present state of results lends some support to the explanation that attention to internal experiences might partly be involved in perception of physiological arousal. Considering the lack of specificity and variability of results, other mechanisms might contribute to greater reporting of physiological arousal in socially anxious individuals. Superior interoceptive accuracy has been suggested as possible additional solution in this respect (Kroeze, van den Hout, Haenen and Schmidt, 1996).

### Interoceptive Accuracy

Research on interoceptive accuracy in anxiety disorders has mainly been guided by the hypothesis that better perception of physiological symptoms might increase the probability of misinterpretations of somatic cues (Domschke et al., 2010; Stevens et al., 2011). Most studies have concentrated on the cardiovascular system and assessed cardiac accuracy, or awareness of how fast the heart is beating. Several methods have been developed to measure cardiac accuracy. A paradigm developed by Schandry (1981) requires participants to silently count their heartbeats during specified time intervals. This result is then compared to actual heartbeats and a percentage mean error score is calculated (e.g. Pollatos, Traut-Mattausch, Schroeder and Schandry, 2007a). Another approach requires participants to compare externally generated signals to the rhythm of their heartbeats (e.g. Schneider, Ring, and Katkin, 1998). This discrimination task was found to be rather difficult for untrained individuals and it is assumed that this method might prevent the detection of differential effects (Domschke et al.). There is some evidence that cardiac accuracy might be related to differences in cardiovascular activation. Heartbeat detection was found to be improved in situations that elicit heightened cardiovascular reactivity due to physical or emotional stress, compared to less demanding conditions such as rest periods (e.g. Anthony et al., 1995; Pollatos, Herbert, Kaufmann, Auer, and Schandry, 2007b; Stevens et al., 2011). Furthermore, interoceptive accuracy seems to intensify emotional experiences independent of physiological activation. Thus, the lack of coherence between perceived and objective cardiovascular arousal may partly reflect individual differences in cardiac accuracy (Wiens, Mezzacappa and Katkin, 2000).

Research on anxiety disorders has mainly utilized the heartbeat counting paradigm. It has provided rather consistent evidence for increased cardiac accuracy in individuals with

heightened anxiety sensitivity, trait anxiety and panic disorder (for a review see Domschke et al., 2010), and cardiac awareness was found to mediate the relationship between trait anxiety and perceived arousal during presentation of unpleasant pictures (Pollatos et al., 2007a).

Only two studies have assessed heartbeat perception in social anxiety. One of them (Stevens et al., 2011) found high socially anxious individuals to exhibit better heartbeat perception during a rest period and anticipation of a speech stressor. The other study (Anthony et al., 1995) assessed cardiac awareness after a period of exercise and noted no differences between high and low socially anxious individuals. However, self-reported anxiety over heart-related cues was positively correlated with accuracy in heart beat estimation. Overall, perceptual differences between individuals with anxiety disorders and controls were not a function of differing levels of actual cardiovascular arousal (e.g. Richards and Bertram, 2000; Stevens et al.).

This preliminary evidence suggests that interoceptive accuracy might have a role in differential perceived arousal. Further research on trait social anxiety is necessary, though. In this respect it should also be noted that performance on the heartbeat counting task might be determined by processes other than interoceptive sensitivity. A study by Ring and Brener (1996) found that pre-experimental beliefs about the effects of different postural and exercise manipulations on heart rate were an important determinant of counted heart rates, in addition to processing of actual cardiac activity.

Furthermore, pre-experimental beliefs were related to actual heart rate. Applying this result to research on social anxiety, it might be conceived that physiological experiences during periods of heightened anxiety provide a basis for the formation of expectations about physiological responses. These expectations in turn may then be a major determinant of perceived arousal in anxiety eliciting social conditions. There is also some evidence that research in this area may benefit from including anxiety sensitivity, a variable that increases the negative valence of anxiety experiences (Reiss, Peterson, Gursky, and McNally, 1986). This construct shows moderate associations with measures of anxiety-related psychopathology, including social anxiety (Anderson and Hope, 2009; Deacon and Abramowitz, 2006; Thibodeau et al., 2007), and it is consistently related to enhanced cardiac awareness (e.g. Richards and Bertram, 2000; Stewart, Buffett-Jerrot, and Kokaram, 2001). Findings by Thibodeau et al. suggest that anxiety sensitivity may partly explain exaggerated perceptions of arousal and state anxiety in socially anxious individuals.

## **Effects of Perceived Arousal on State Anxiety and Negative Self-Perceptions**

Anxiety patients are considered to rely heavily on internal response information when they evaluate the threatening character of a situation. This “ex-consequencia reasoning” or emotional reasoning (Arntz, Rauner, and van den Hout, 1995) is conceptualized as a key maintaining factor in cognitive models of trait social anxiety (Clark and Wells, 1995; Rapee and Heimberg, 1997).

Empirical evidence from different sources seems to support the importance of internal cues. Research based on correlational designs observed a relationship between retrospective ratings of perceived physiological arousal and overestimation of anxious appearance in

socially anxious, but not in low anxious individuals (Mansell and Clark, 1999). Furthermore, ratings of perceived arousal, but not objective arousal, were found to mediate the relationship between social anxiety and post-task appraisals of coping efficiency (Gramer et al., 2012).

Research that tried to evaluate the causal effect of perceived arousal has produced inconsistent results with respect to the specificity of emotional reasoning. Most of these studies used false feedback regarding an increase or decrease in heart rate to manipulate interoceptive information. The feedback was provided either prior to or during exposure to a social task. Information concerning an increase in heart rate provided *prior* to task exposure was found to lead to heightened state anxiety and negative self-ratings of performance in socially anxious individuals (Papageorgiou and Wells, 2002; Wells and Papageorgiou, 2001). Interoceptive information did not affect low anxious individuals and effects were independent of objective arousal (Papageorgiou and Wells). Online feedback provided *during* task exposure produced more varied results. Several studies found false feedback concerning an increase in heart rate to elicit heightened state anxiety and more negative performance perceptions regardless of level of social anxiety (Makkar and Grisham, 2012; Wild, Clark, Ehlers, and McManus, 2008). One study utilized public vs. private online feedback of veridical heart rate and observed heightened state anxiety and greater worrying about heart rate in socially anxious individuals during public feedback (Gerlach et al., 2004). Feedback conditions had no differential effects in low anxious individuals.

An explanation of these inconsistencies in the specificity of feedback effects has to consider that interoceptive feedback was found to influence self-directed attention (Makkar and Grisham, 2012; Wells and Papageorgiou, 2001). Furthermore, self-focus was observed to mediate the negative effects of interoceptive feedback on state anxiety and performance appraisals (Makkar and Grisham). As suggested by Wild et al. (2008), the salience of online interoceptive feedback may provoke a shift of attention to internal stimuli in all participants. Whereas feedback provided prior to task exposure or situations that allow to allocate attentional resources freely may be more likely to elicit differential effects in self-focus. This interpretation does not seem to correspond to results obtained for feedback of veridical heart rate (Gerlach et al., 2004). However, social demands were rather moderate in this study, (participants were seated and had to appear relaxed while being evaluated) which may have made heart rate information less important for low anxious individuals. An explanation based on self-focus as mechanism implicates that high *and* low socially anxious individuals are characterized by emotional reasoning when attention is drawn to anxiety symptoms (Makkar and Grisham). In this respect, Arntz et al. (1995) found normal controls to infer danger only on the basis of objective information, but not on the basis of anxiety response information. This study utilized scripted information, though. Further research is necessary to clarify this point.

## **Perceived Physiological Arousal and the Maintenance of the Disorder**

According to the model of Clark and Wells (1995) the effects of state anxiety, perceived physiological arousal and related negative self-perceptions may extend beyond the social situation. Individuals with social phobia are considered to engage in a detailed post-task

review of social interactions which is guided by experiences and self-perceptions that were processed during the event. There is consistent empirical evidence for enhanced negative post-event processing in social anxiety (for a review see Brozovich and Heimberg, 2008).

As regards the role of perceived physiological arousal, both correlational studies (Kiko et al., 2012; Laposo and Rector, 2011; Mellings and Alden, 2000) and research on causal effects (Makkar and Grisham, 2012) have observed an impact of interoceptive experiences on the intensity of post-event processing. In this respect, it should also be noted that socially anxious individuals seem to be characterized by a memory bias for anxiety-related physiological symptoms (Ashbaugh and Radomsky, 2009; Mellings and Alden) which may enhance the influence of perceived arousal on post-task rumination. Empirical evidence from different sources suggests that self-focused attention might have a major role in this process. As indicated above, self-focus may enhance the awareness of interoceptive experiences (e.g. Bögels and Lamers, 2002; Woody and Rodriguez, 2000; Zou, Hudson and Rapee, 2007) and there is also some evidence that instructions to pay attention to feelings and body sensations during a conversation may instigate greater negative post-event processing (Gaydukevych and Kocovski, 2012). Furthermore, Makkar and Grisham found self-focus to mediate the effect of perceived physiological arousal on post-event rumination.

The majority of research on determinants of post-event processing has focused on performance perceptions. In keeping with postulations by Clark and Wells (1995) negative self-appraisals of performance were found to be significantly related to post-event rumination (Abbott and Rapee, 2004; Dannahy and Stopa, 2007) and several studies suggest that performance perceptions may mediate the relationship between social anxiety and post-task rumination (Gramer et al., 2012; Perini, Abbott and Rapee, 2006). One study has also indicated a causal role of performance perceptions in post-event rumination by manipulating self-appraisals via feedback (Zou and Abbott, 2012). The importance of negative self-appraisals is further supported by the observation that an improvement of self-perceptions after cognitive behavioral treatment goes along with less negative post-event processing (Abbott and Rapee). In this respect, it should also be noted that post-task rumination was found to maintain or even to worsen negative performance evaluations (Abbott and Rapee, 2004; Brozovich and Heimberg, 2011; Cody and Teachman, 2011). Thus, rumination may be elicited by negative self-appraisals but, when activated, it may in turn reinforce this negative mental representation (Abbott and Rapee). Taken together, both perceived arousal and performance perceptions seem to describe pathways to enhanced post-task rumination. However, as discussed above, several experimental studies have established a causal role for perceived physiological arousal in the formation of negative performance perceptions (Makkar and Grisham, 2012; Papageorgiou and Wells, 2002; Wild et al., 2008). In light of this evidence, a sequential model might be conceived in which perception of interoceptive information influences self-appraisals of performance, which then lead to enhanced negative post-task rumination.

## Conclusion and Further Directions

Overall, this selective review seems to support the central role of perceived physiological arousal for emotional and cognitive processes in trait social anxiety. However, it has also

revealed several areas that are in need of further research. Foremost, the role of interoceptive accuracy for perceived arousal needs to be clarified.

At present there is no information available whether expectations about physiological responses (see Ring and Brener, 1996) might be an additional, or eventually stronger, determinant of interoceptive accuracy and/or perceived arousal in socially anxious individuals. Further studies on the potential mediating (Thibodeau et al., 2007) or moderating influence of anxiety sensitivity also seem to be of importance in this respect. As regards the causal role of self-focused attention for perceived physiological arousal, examination of a cyclical relationship (Mor and Winquist, 2002) between perceived arousal and self-focus over time may promote understanding. The same applies to the relationship between negative performance perceptions and post-task rumination. To date, research on perceived physiological arousal has paid little attention to the fact that there is substantial coherence between state anxiety and perceived physiological arousal (Mauss et al., 2004; Thibodeau et al., 2012). A study by Kiko et al. (2012) suggests that perceived physiological symptoms might no longer predict post-task rumination when state anxiety is controlled for statistically. Future research on the role of perceived arousal in self-evaluations of socially anxious individuals should include state anxiety to evaluate the specific contribution of perceived physiological arousal more clearly.

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