Appears in Cognition & Emotion

DOI: 10.1080/02699931.2013.832654

Published online: 17 September 2013

To cite this article: Caroline Durlik, Gary Brown & Manos Tsakiris, Cognition & Emotion (2013): Enhanced interoceptive awareness during anticipation of public speaking is associated with fear of negative evaluation, Cognition & Emotion, DOI: 10.1080/02699931.2013.832654

To link to this article: http://dx.doi.org/10.1080/02699931.2013.832654

Enhanced interoceptive awareness during anticipation of public speaking is associated with Fear of Negative Evaluation

Caroline Durlik\*, Gary Brown& Manos Tsakiris

Department of Psychology, Royal Holloway, University of London, UK

\*Corresponding author: Caroline Durlik, Department of Psychology, Royal Holloway, University of London, Egham, Surrey, UK. Tel. +44(0)1784276551, Fax. +44(0)1784434347, E-mail: [Caroline.Durlik.2011@live.rhul.ac.uk](mailto:Caroline.Durlik.2011@live.rhul.ac.uk)

Acknowledgments

This study was funded by the European Platform for Life Sciences, Mind Sciences and Humanities, Volkswagen Foundation Research Grant (II/85 064 )to MT.

Abstract

Interoceptive awareness (IA)—the ability to detect internal body signals—has been linked to various aspects of emotional processing. However, it has been examined mostly as a trait variable, with few studies also investigating state dependent fluctuations in IA. Based on the known positive correlation between IA and emotional reactivity, negative affectivity, and trait anxiety, the current study examined whether IA, as indexed by heartbeat detection accuracy, would change during an anxiety-provoking situation. Participants in the experimental condition, in which they anticipated giving a speech in front of a small audience, displayed significant IA increases from baseline to anticipation. Enhancement in IA was positively correlated with Fear of Negative Evaluation. Implications of the results are discussed in relation to role of trait and state IA in emotional experience.

*Keywords:* interoception, public speaking, social anxiety

**Introduction**

Interoception has been suggested to play a central role in the experience of emotion (Damasio, 2010). Several lines of investigation support the notion that emotional experience is mediated by interoceptive awareness (IA)—the ability to accurately perceive internal body signals (Critchley, Hamm, Harmon-Jones, 2011). Research on interoception in emotion processing has focused primarily on visceroperception—the perception of signals arising from the inner organs of the body (e.g., heart beats, respiration rate, etc.)—most commonly using individuals’ accuracy scores on heartbeat perception tasks (e.g., Schandry, 1981), to index their IA. Recent empirical findings suggest a positive link between IA and the intensity of emotional experience, as reflected, for example, by subjective ratings of arousal (e.g., Pollatos, Traut-Mattausch, Schroeder & Schandry 2007) and patterns of electroencephalographic (EEG) activity during processing of emotional stimuli (Herbert, Pollatos & Schandry, 2007). Moreover, the same brain regions that have been tied to interoception, such as the insula, the anterior cingulate cortex, and the somatosensory cortex (e.g., Critchley, Wiens, Rotshtein, Öhman & Dolan, 2004) have also been associated with the subjective experience of emotion (e.g., Damasio, Grabowski, Bechara, Damasio, Ponto, Parvizi & Hichwa, 2000). Lastly, interoceptive awareness has been linked to affective psychopathology, as several studies have identified an inverse relationship between IA and depression (e.g., Dunn, Dalgleish, Ogilvie & Lawrence, 2007), and a direct association of IA and anxiety (see Domschke, Stevens, Pfleiderer & Gerlach, 2010, for a review). Accordingly, IA seems to constitute an important individual difference variable (Ludwick-Rosenthal & Neufeld, 1985) in the empirical investigation of affective experience.

Most studies have viewed IA as a static individual difference variable (e.g., Schandry, 1981) and have left unexamined the potential for state-dependent fluctuations in IA. However, increasing evidence from recent research on the mechanisms of IA suggests that it can be regarded as both: state and trait variable. Specifically, although IA is relatively stable over time (e.g., Antony, Meadows, Brown & Barlow, 1994), it fluctuates significantly during heightened physical activity, as found by Antony, Brown, Craske, Barlow, Mitchell and Meadows (1995), or in situations of heightened self-focus, as found by Ainley, Tajadura-Jiménez, Fotopoulou and Tsakiris (2012), who observed an increase in IA during mirror self-observation in people with low IA. This evidence suggests that an individual might possess a certain level of interoceptive ability, which may fluctuate in response to the state of the organism at a particular moment in time. Given the numerous research findings that highlight the importance of IA in emotional processing, further investigations are necessary to examine not only the effects of inter-individual variability in IA on emotional processing in various affective contexts, but also the effects of emotion-eliciting stimuli and emotional states on state IA.

Up-to-date, only one study has examined potential changes in state IA in an emotion-eliciting situation. Stevens, Gerlach, Cludius, Silkens, Craske, and Hermann (2011) measured IA before and during public speaking anticipation in individuals high and low in social anxiety. Contrary to their predictions, the authors failed to find significant differences from baseline to anticipation in either group, although they did find an increase in accuracy from baseline to the first heartbeat counting trial of the anticipation phase, in both groups. Because this result was not replicated when analyzing all heartbeat counting trials of the anticipation phase, and because of the lack of a control condition, it is not clear whether enhanced IA in the first trial represented a statistical artifact or a meaningful difference reflecting a very short-lived change in state IA brought about by the manipulation. As Stevens et al. have investigated the effect of public speaking anticipation on IA without taking into consideration individual differences in baseline interoceptive ability, they left unexamined the possibility that state IA increased during speech anticipation in participants with low baseline heartbeat perception accuracy, and not in participants with high baseline heartbeat perception accuracy. Moreover, because the focus of the investigation was solely on individuals high and low in social anxiety—those who either feared negative evaluation significantly more, or significantly less than an average individual—the results cannot be generalized to the normal population of individuals falling on a continuum with regards to their social fears. Nevertheless, the results of the study by Stevens et al. suggest that emotional states might, indeed, have a general effect on state IA, necessitating further empirical investigation of this research question.

As anticipation of public speaking has been found to be effective at inducing social anxiety (e.g., Hinrichsen & Clark, 2003; Moscovitch, Suvak, & Hofmann, 2010; Stevens et al., 2011), the current study utilized the speech anticipation manipulation to examine the stability of IA under emotional influences, such as anticipatory anxiety. The assessment of IA was performed in the absence of mirrors, video-cameras, and any other tools that may increase self-focus, and consequently enhance IA (e.g., Ainley et al., 2012), in order to ensure any effect on IA observed is due to the speech anticipation manipulation, and not to any other variable. In line with findings from several neuroimagining studies that demonstrated increased insula activation during anticipation of emotionally aversive visual stimuli (Simmons, Matthews, Stein & Paulus, 2004; Simmons, Stein, Strigo, Arce, Hitchcock & Paulus, 2011; Simmons, Strigo, Matthews, Paulus & Stein, 2006), as well as the findings of Stevens et al.(2011) indicating increased IA in the first trial of speech anticipation, we hypothesized that in the current study, the speech anticipation manipulation will bring about an enhancement in state IA. More specifically, we predicted that participants will show higher accuracy on the heartbeat counting task during speech anticipation, as compared to baseline, and that this enhancement will be stronger for participants with higher fear of negative evaluation, who are likely to be more affected by the speech anticipation manipulation. Lastly, as Ainley et al. (2012) found that state IA tends to remain stable in individuals with high baseline interoceptive ability, and change significantly only in individuals with low baseline interoceptive ability, we hypothesize that the speech anticipation manipulation will enhance state IA more, if not only, in individuals with low baseline IA.

**Methods**

Participants

62 (42 female) undergraduate students at Royal Holloway, University of London provided informed consent to participate in this study that was approved by the Departmental Ethics Committee. Participants were randomly assigned to either the experimental (N=32) or control condition (N=30). The groups did not differ significantly on variables such as age, gender, body mass index, baseline interoceptive awareness, and self-report measures of anxiety and depression (see Table 1).

----------------------------------------------------------------------------------------------------------------

Insert Table 1 about here

----------------------------------------------------------------------------------------------------------------

Measures

*Self-Report Measures*

Participants were asked to provide demographic information, and to complete the State-Trait Inventory of Cognitive and Somatic Anxiety Scale (STICSA; Ree, French, MacLeod & Locke, 2008), Anxiety Sensitivity Index-3 (ASI-3; Taylor, Zvolensky, Cox, Deacon, Heimberg, Ledley, . . .Cardenas, 2007). Brief Fear of Negative Evaluation-Straightforward Items (BFNE-S; Rodebaugh, Woods, Thissen, Heimberg, Chambless & Rapee, 2004), Liebowitz Social Anxiety Scale (LSAS; Liebowitz, 1987), and Depression Anxiety and Stress Scale-Depression subscale (DASS-Depression; Lovibond & Lovibond, 1995). Participants reported their anxiety and calmness levels on a Visual Analogue Scale (VAS).

*Interoceptive Awareness*

IA was assessed at baseline and during the period of anticipation via heartbeat perception, using the Mental Tracking Method (Schandry, 1981). Participants were instructed to mentally count their heartbeats from the moment they received an audiovisual computer-generated cue: ‘Go!’ until they received an otherwise identical cue: ‘Stop!’ and then to type the number of heartbeats they had counted into the computer program. The heartbeat counting task consisted of a four-trial block: 25-second, 35-second, 45-second, and 100-second trials, presented in a random order. The single 4-trial block was administered at baseline, and during anticipation. In the baseline IA assessment, a 10-second training trial was also administered prior to the 4-trials constituting the heartbeat counting task in order to familiarize participants with the task. Heartbeat signals were acquired with a piezo-electric pulse transducer, fitted to the participant’s left index finger and connected to a physiological data unit (26T PowerLab, AD Instruments), sampling at 1kHz, which recorded the derived electrical signal onto a second PC running LabChart6 software (AD Instruments). Throughout the assessment, participants were not permitted to take their pulse, nor was information regarding the length of individual trials or feedback regarding participants’ performance given. The task was programmed using Presentation software (Neurobehavioural Systems: [www.neurobs.com](http://www.neurobs.com)).

Procedure

Prior to in-lab participation, participants provided online their demographic information, STICSA-Trait, BFNE-S, LSAS, and DASS-Depression. Before the questionnaire commenced, participants were given basic information about the study that was essential to provide informed consent to participate, yet that did not disclose any details that could affect the effectiveness of the main manipulation itself. All participants were informed they will have to “engage in a brief behavioural task” once in-lab, but they will be free to withdraw at any point in time, if they wish to, without penalty. Further, participants were informed that they did not have to answer any questions that they felt uncomfortable with, and that the information they would provide will be kept completely confidential and anonymous. Participants in both conditions were given the exact same information, and instructions.

Upon arrival to the lab, participants were given a hard copy of the information sheet, and have signed the informed consent form. In-lab, each participant completed STICSA-State, and ASI followed by the first assessment of IA, counterbalanced with Time 1 VAS mood ratings. Then, by way of a distracter, participants answered five questions about Britain in the context of European Union, afterwards providing Time 2 VAS mood ratings (aimed at verifying that no change took place in mood prior to the main manipulation).Up until this point, the all details of the procedure were exactly the same for participants in both experimental and control conditions.

Subsequently, in the experimental group, the experimenter told participants that they would be given three minutes to prepare a 10-minute speech on the pros and cons of animal use in research, to present in front of a small audience and videocamera in a nearby room right after completion of remaining computer-administered tasks. Participants were then given scrap paper and a pen in order to prepare the speech. Instead, in the control group, the experimenter gave participants a list of arguments for and against the use of animals in research, and instructed them to read the arguments for three minutes, without worrying about getting through all of the points. The control participants were told that they would share their general impressions of the arguments with the experimenter, after having completed the remaining computer-administered tasks.

After the manipulation, each participant was asked to perform one more IA task, counterbalanced with Time 3 VAS mood ratings. It is important to note that the two IA assessments were administered in a counterbalanced order with the VAS mood ratings in order to account for possible short-lived effect of the manipulation on IA, at the same time ensuring that the measure of mood change due to the manipulation was not confounded by the administration of the IA task before the VAS ratings.

Lastly, each participant was informed that the study had come to an end, and the deception was explained to each participant. Participants in both of the conditions were asked debriefing questions about the believability of the manipulation, the distress evoked by the manipulation, and about their attitude toward the use of animals in research. Participants were then asked to reiterate their consent for their data to be retained and used in the study.

Data Analysis

Heartbeat perception scores were computed as follows:

Perception score = 1/4 Σ (1-(| actual heartbeats – reported heartbeats |) / actual heartbeats).

The resulting scores varied between 0 and 1, with higher scores indicating better heartbeat detection accuracy, reflecting a smaller difference between perceived and actual heartbeats.

Self-reported anxiety and calmness VAS scores were stable between Time 1 and 2 and so were averaged, yielding baseline anxiety score and baseline calmness score. VAS scores at Time 3 were used as the post-manipulation scores. Baseline and post-manipulation anxiety and (reverse-scored) calmness scores were averaged into overall baseline and post-manipulation scores, with higher values indicating a more anxious mood.

Difference scores for the dependent variables were calculated by subtracting the baseline scores for IA, HR, and self-rated anxious mood from the post-manipulation scores for the same variables. Outliers were excluded if the z-score for the dependent variable by condition was > ±2.58. Six outliers were excluded on this basis, leaving a final sample of 28 in the experimental condition (8 males, and 20 females) and 28 in the control condition (10 males and 18 females).

Effects of the experimental manipulation on the dependent variables were compared using repeated measures ANOVAs with Phase (baseline and anticipation) as the within-subject factor and Group (experimental versus control), and Counterbalancing order (IA before VAS versus IA after VAS) as between-subject factors. Where the assumption of compound symmetry was violated, degrees of freedom were adjusted using the Greenhouse-Geisser correction. Also, where variables were found to be non-normally distributed, transformations were used to normalize the data.

**Results**

The first analysis tested the effect of our anticipation manipulation on anxiety ratings. Average self-rated anxious mood was analyzed in a 2 x 2 x 2 mixed ANOVA with Phase (baseline and anticipation) as the within-subjects factor, and Condition (experimental or control) and Counterbalancing order (IA before VAS versus IA after VAS) as between-subject factors. As there was no main effect of Counterbalancing order (F (1, 51) = .153, *p* = .697), nor interaction effect of Counterbalancing order and condition (F(1,51) = 1.653, *p* = .204) on mood, this between-subjects factor was removed from the analysis. There was a main effect of Phase (F (1, 54) = 27.827, *p* < .001, *η2p* = .340), no main effect of condition (F (1, 54) = 3.321, *p* = .074, *η2p* = .058) and an interaction effect between the Condition and Phase (F (1, 54) = 54.145, *p* < .001, *η2p* = .501). Pairwise t-tests revealed a significant increase in self-rated anxious mood from baseline to speech anticipation found only in the experimental (t (27) = -1.854, *p* < .001, Cohen’s d = -.714) but not in the control condition (t (27) = 1.647, *p* = .111), confirming that our manipulation was successful in inducing anxiety.

We then investigated changes in average heart rate in a 2 x 2 ANOVA with Phase (baseline and anticipation) as the within-subjects factor, and Condition (experimental or control) as between-subject factors. There was no main effect of Phase (F (1, 54) = .892, *p* = .349), nor interaction effect between the Condition and Phase (F (1, 54) = .990, *p* = .326). Thus, average heart rate did not change during the course of the experiment.

Heartbeat perception accuracy during the anticipation phase was then analyzed in a 2 x 2 ANCOVA with Condition (experimental or control), and Counterbalancing order (IA before VAS versus IA after VAS) as between-subject factors, and Baseline IA as a covariate. As there was no main effect of Counterbalancing order (F (1,50) = .139, *p* = .711), nor interaction effect of Counterbalancing order and condition (F (1,50) = .191, *p* = .664) on IA, this between-subjects factor was removed from the analysis. The one-way ANCOVA revealed a main effect of Condition on IA during anticipation after controlling for baseline IA (F (1, 52) = 5.589, *p* = .022, *η2p =* .097) with heartbeat perception accuracy being significantly higher during the experimental speech anticipation than during the control anticipation. There was no interaction effect of baseline IA and Condition on IA during anticipation (F (1, 52) = 2.707, p = .106).

We then investigated a potential for moderation of the effect of condition on IA during anticipation by Fear of Negative Evaluation, using a hierarchical multiple regression analysis. The model (see Table 2a) predicted IA during anticipation from condition, Fear of Negative Evaluation, and their product (along with IA at baseline as a covariate).The overall model was significant and predicted 73.8% of the variance in IA during anticipation (*F* (4, 51) = 35.844, *p* <.0001, *R2* = .7376). Multicollinearity diagnostics were assessed and were within an acceptable range. In the first step, baseline IA, condition, and Fear of Negative Evaluation values were included. These variables accounted for a significant amount of variance in anticipation IA scores (*R2* = .736, *F* (3, 52) = 48.268, *p* < .001). Fear of Negative Evaluation marginally predicted IA scores during anticipation (*β* = .311, *t* (54) = 1.896, *p* = .064). The interaction term of condition and Fear of Negative Evaluation was entered in the second step to test for moderation, but did not significantly add to the amount of variance accounted for (Δ*R2* = .0018, Δ*F* (1, 51) = .359, *p* = .552, *β* = .044) indicating that the effect of condition on IA during anticipation was not dependent on level of Fear of Negative Evaluation.

----------------------------------------------------------------------------------------------------------------

Insert Table 2

----------------------------------------------------------------------------------------------------------------

In order to investigate for predictors of change in dependent variables, as well as to examine the relationship between the dependent variables themselves we conducted correlation analyses. Because heartbeat perception and mood changed only for the experimental group, change scores of IA, mood and Fear of Negative Evaluation scores for participants in the experimental condition only were analyzed. The correlations revealed Fear of Negative Evaluation to be significantly associated with both change in mood (r = .350, *p* = .034), and IA (r = .365, *p* = .028). Change in mood did not significantly correlate with change in IA (r = .201, *p* = .152). Correlations were also performed on dependent variable change scores and LSAS scores. Because the sample was a healthy sample, the LSAS scores were not normally distributed, and 86% of the sample scored below 55 (the minimum score indicating social anxiety). When these scores were excluded though (4 cases), the distribution was normal. LSAS scores were correlated with IA change (r = .432, *p* = .018), but not with mood change (r = .078, *p* = .358). LSAS scores and BFNE scores were only moderately correlated (r = .308, p = .071) at a level which was not statistically significant (1-tailed).

Lastly, we investigated whether the association between Fear of Negative Evaluation and mood in the experimental condition is moderated by baseline IA by again employing a hierarchical multiple regression analysis. The model (see Table 2b) predicted anxious mood from Fear of Negative Evaluation, baseline IA, and their product (along with anxious mood at baseline as a covariate). The overall model predicted 65% of the variance in anxious mood during anticipation (*F* (4, 23) = 10.676, *p* <.0001, *R2* = .6500). Multicollinearity diagnostics were assessed and were within an acceptable range. In the first step, baseline mood, Fear of Negative Evaluation, and baseline IA values were included. These variables accounted for a significant amount of variance in anticipation IA scores (*R2* = .650, *F* (3, 24) = 14.840, *p* < .001). Fear of Negative Evaluation was a significant predictor of anxious mood scores during anticipation (*β* = .311, *t* (27) = 2.345, *p* = .028). Baseline IA was not a significant predictor of anxious mood at anticipation (*β* = .182, *t* (27) = 1.359, *p* = .187). The interaction term of Fear of Negative Evaluation and baseline IA was entered in the second step to test for moderation, but did not significantly add to the amount of variance accounted for (Δ*R2* < .001, Δ*F* (1, 23) = .015, *p* = .905, *β* = -.019) indicating that the association between Fear of Negative Evaluation and anxious mood during the anticipation in the experimental condition was not dependent on baseline IA.

**Discussion**

The current study investigated changes in IA due to exposure to an anxiety-provoking situation using a public speaking anticipation paradigm. As hypothesized, participants in the experimental condition who completed a second heartbeat detection task while anticipating giving a speech were significantly more accurate during anticipation than individuals in the control condition. This result supports the prediction that a state anxiety manipulation would bring about heightened IA. Even though heart rate did not significantly differ from baseline to anticipation, we assume the manipulation did not fail, as indicated by self-rated mood of participants in the experimental condition. Moreover, there is evidence from research showing the possibility of a lack of correspondence between objective and subjective measures of arousal (Miers, Blote, Sumter, Kallen, & Westenberg, 2011) or anxiety (Bacow, May, Choate-Summers, Pincus, & Mattis, 2010). Perhaps individuals in the present study were more anxious cognitively, as indicated by self-rated mood, rather than physiologically, as reflected by lack of heart rate response. Since the present manipulation had an effect on self-rated anxious mood, and on the dependent variable of IA, we do not assume the lack of change in heart rate was an index of manipulation failure.

The increase in anxious mood and increase in IA in the experimental condition were both positively correlated with the Fear of Negative Evaluation scores. Interestingly, level of social anxiety, as indexed by LSAS scores, did predict change in IA, but not change in mood due to the manipulation. Mood change and IA change were also not significantly related to one another. Lastly, there were no moderating effects present in the data: Fear of Negative Evaluation did not moderate the relationship between condition and IA during anticipation, and individuals with differing levels of Fear of Negative Evaluation experienced change in IA to the same degree as the result of the experimental manipulation; moreover, baseline IA did not moderate the relationship between Fear of Negative Evaluation and self-rated anxiety in the experimental group, and Fear of Negative Evaluation predicted self-rated anxiety during speech anticipation in individuals of differing baseline IA.

Overall, our findings indicate that IA, although a stable individual variable, is subject to state-dependent fluctuations, as it is affected by emotional states, such as anticipatory anxiety. These findings extend on the results of the study by Stevens et al. (2011), which found an increase in IA in the first trial of speech anticipation. Unlike the study by Stevens et al. we found a significant difference in IA when all trials of the anticipation phase were analyzed. This discrepancy might perhaps be due to differences in sample characteristics of Stevens et al., and the present study. While Stevens et al. sampled only two groups: high social anxiety (high fear of negative evaluation) and low social anxiety (low fear of negative evaluation), we sampled a non-anxious population (as indicated by LSAS scores) falling on a continuum of fear of negative evaluation. Therefore, it is possible that the very high in anxiety, and very low in anxiety participants in the study by Stevens et al. were, respectively, more and less affected by the manipulation than an average individual. Secondly, the speech manipulation procedure was slightly different in the current study. Participants in Stevens et al. were asked to rate how they thought they would appear during the speech in order to elicit anxiety, while participants in the present study were not asked to provide such ratings, instead just being given three minutes to prepare the content of the speech prior to the second IA task. Further, unlike Stevens et al., we counterbalanced the order of the post-manipulation heartbeat detection task and momentary mood ratings in order to account for the potentially short-lived effect of enhanced IA immediately after the manipulation, as reported by Antony et al. (1995) in the context of interoception and physical exercise, and as suggested by Stevens et al. (2011) in their interpretation of their results.

Even though no moderation of the effect of the manipulation on IA by Fear of Negative Evaluation was observed in the present study, our results suggested that the higher the Fear of Negative Evaluation, the larger the increase in IA due to anticipatory anxiety. This would explain why Stevens et al. failed to find a significant difference in IA from baseline to anticipation in the low Fear of Negative Evaluation group (as you would expect a smaller increase in IA in these participants). Further, as the present study sampled non-anxious individuals, the relationship we found between fear of negative evaluation and IA change might not hold for individuals on the upper extreme of Fear of Negative Evaluation (the other group investigated by Stevens et al.), for whom perhaps it might be more difficult to deploy required attentional resources to the IA task in the stressful situation of speech anticipation, or who, alternatively, might be already quite high in IA (as suggested by Stevens et al., and the literature on IA and anxiety (see Domschke et al., 2010 for a review)) and thus might face a “ceiling effect” with regards to enhancement in state IA (as suggested by results of Ainley et al., 2012). Overall, it is important to note that as the sample size of the present study was rather small, and limited to non-anxious participants, we cannot generalize the results to the clinical population of individuals with social anxiety.

Taken together our, results suggest that the speech anticipation manipulation brought about heightened IA, and participants became more accurate at detecting their heartbeats when in the anxiety provoking situation. The fact that higher Fear of Negative Evaluation was associated with a larger increase in IA in the anxiety-provoking situation could be explained by a number of factors, one being increased self-focused attention, as suggested by cognitive theories of social anxiety (Clark & Wells, 1995). Heightened self-focused attention, in this case, could have increased both anxiety (see Jakymin & Harris, 2012 for review) and IA (as suggested by Ainley et al., 2012) in the individuals anticipating the speech, with the degree of the increase in self-focused attention being directly related to the degree of fear of negative evaluation.

At first glance, the correlation between Fear of Negative Evaluation and enhancement in IA provides support for cognitive models of social anxiety (e.g. Clark and Wells, 1995), which suggest that higher fear of negative evaluation is associated with increased self-focus when entering a social situation. These theories imply that better detection of heartbeats might lead to their misinterpretation as symptoms of anxiety and arousal, visible to external observers, consequently, bringing about an increase in anxiety (e.g. Wild et al., 2008). However, our results did not indicate a significant association between enhancement in IA and increase in anxious mood, contradicting the above model. Moreover, the fact that IA increased in all participants, including those with low Fear of Negative Evaluation suggests that the observed IA enhancement might be reflective of a general strategy of the organism to deal with uncertainty (such as experience of anxiety). Indeed, the somatic marker hypothesis (Damasio, 1994, 1999) proposes that more accurate perception of somatic signals under uncertainty might enable more efficient information processing, in this way guiding emotional, behavioural, and cognitive processes, optimizing the individual’s responses in effectively dealing with the faced situation. Unfortunately, the current design does not allow us to ascertain whether the observed enhancement in IA was, or was not consciously perceived by the participants, or whether it would be associated with altered information processing, and cognitive and behavioural responses in the anxiety-provoking situation.

Consequently, mechanisms of change in IA should be subject to further empirical investigation.

Importantly, the present study contributes additional support for a state-trait model of IA, suggesting IA can, indeed, be regarded as both state and trait variable. The evidence from our study indicates that individual level of interoceptive ability is subject to fluctuation as a function of the emotional state of an individual. These results provide a promising direction for future research studies, which should attempt to differentiate between the state and trait facets of IA, and delineate how these operate in various affective contexts. Lastly, while our study focused on the emotion of anticipatory anxiety, future research should examine the effects of a range of affective stimuli, situations, and emotional states on state IA.

References

Ainley, V., Tajadura-Jiménez, A., Fotopoulou, A. & Tsakiris, M. (2012). Looking into myself: The effect of self-focused attention on interoceptive sensitivity. *Psychophysiology.* Article first published online: 14 SEP 2012,

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*(5), 355-371.

Antony, Meadows, Brown & Barlow (1994). Cardiac awareness before and after cognitive-behavioral treatment for panic disorder. *Journal of Anxiety Disorders*, 8, 341-350.

Bacow, T. L., May, J. E., Choate-Summers, M., Pincus, D. B., & Mattis, S. G. (2010). Concordance Between Measures of Anxiety and Physiological Arousal Following Treatment of Panic Disorder in Adolescence. *Child & Family Behavior Therapy, 32*(4), 322-333.

Clark, D. M. & Wells, A. (1995) A cognitive model of social phobia*.* In *Social Phobia – Diagnosis, Assessment, and Treatment* (eds R. G. Heimberg, M. R. Liebowitz, D. Hope, *et al*), pp. 69–93. New York: Guilford.

Critchley, H., Hamm, A., & Harmon-Jones, E. (2011). Interoception and emotion: the return of peripheralism? *Psychophysiology, 48*, S16-S17.

Critchley, H. D., Wiens, S., Rotshtein, P., Öhman, A., & Dolan, R. J. (2004). Neural systems supporting interoceptive awareness. *Nature Neuroscience, 3,* 1049-1056.

Damasio, A.R. (1994). *Descartes’ error: Emotion, reason and the human brain.* New York: Grosset/Putnam.

Damasio, A.R. (1999). *The feeling of what happens. Body and emotion in the making of consciousness.* New York: Harcourt Brace.

Damasio, A.R. (2010). Self Comes to Mind. Constructing the Conscious Brain. London: Heineman.

Damasio, A. R., Grabowski, T. J., Bechara, A., Damasio, H., Ponto, L. L. B., & Hichwa, R. D. (1998). Neural correlates of the experience of emotions. *Society for Neuroscience Abstracts, 24*(1-2), 258.

Domschke, K., Stevens, S., Pfleiderer, B., & Gerlach, A. L. (2010). Interoceptive sensitivity in anxiety and anxiety disorders: An overview and integration of neurobiological findings. *Clinical Psychology Review, 30*(1), 1-11.

Dunn, B. D., Dalgleish, T., Ogilvie, A. D., & Lawrence, A. D. (2007). Heartbeat perception in depression. *Behaviour Research and Therapy, 45*(8), 1921-1930.

Herbert, B. M., Pollatos, O., & Schandry, R. (2007). Interoceptive sensitivity and emotion processing: An EEG study. *International Journal of Psychophysiology, 65*(3), 214-227.

Hinrichsen, H., & Clark, D. M. (2003). Anticipatory processing in social anxiety: two pilot studies. *Journal of Behavior Therapy and Experimental Psychiatry, 34*(3-4), 205-218.

Jakymin, A. K., & Harris, L. M. (2012). Self-focused attention and social anxiety. *Australian Journal of Psychology, 64*(2).

Liebowitz, M. R. (1987). Social phobia. *Klein, D. F. (Ed.). Modern Problems of Pharmacopsychiatry, Vol. 22. Anxiety. Viii+195p. S. Karger Ag: Basel, Switzerland; New York, New York, USA. Illus*, 141-173.

Lovibond, P. F., & Lovibond, S. H. (1995). The structure of negative emotional states – comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories. *Behaviour Research and Therapy, 33*(3), 335-343.

Ludwick-Rosenthal, R., & Neufeld, R.W.J. (1985). Heart rate interoception and emotionality: A study of individual differences. *International Journal of Psychophysiology, 3,* 57-65.

Miers, A. C., Blöte, A.W., Sumter, S.R., Kallen, V.L., & Westenberg, P. M. (2011). [Subjective and objective arousal correspondence and the role of self-monitoring processes in high and low socially anxious youth.](http://www.adolescentdevelopment-leidenuniversity.nl/images/pdf/Miers%20Blote%20Sumter%20Kallen%20Westenberg%20JEp%202011.pdf) Journal of Experimental Psychopathology, 2, 531-550.

Moscovitch, D. A., Suvak, M. K., & Hofmann, S. G. (2010). Emotional response patterns during social threat in individuals with generalized social anxiety disorder and non-anxious controls. *Journal of Anxiety Disorders, 24*(7), 785-791.

Pollatos, O., Traut-Mattausch, E., Schroeder, H., & Schandry, R. (2007). Interoceptive awareness mediates the relationship between anxiety and the intensity of unpleasant feelings. *Journal of Anxiety Disorders, 21*(7), 931-943.

Ree, M. J., French, D., MacLeod, C., & Locke, V. (2008). Distinguishing Cognitive and Somatic Dimensions of State and Trait Anxiety: Development and Validation of the State-Trait Inventory for Cognitive and Somatic Anxiety (STICSA). *Behavioural and Cognitive Psychotherapy, 36*(3), 313-332.

Rodebaugh, T. L., Woods, C. M., Thissen, D. M., Heimberg, R. G., Chambless, D. L., & Rapee, R. M. (2004). More information from fewer questions: The factor structure and item properties of the original and Brief Fear of Negative Evaluation Scale. *Psychological Assessment, 16*, 169-181.

Schandry, R. (1981). Heart beat perception and emotional experience. *Psychophysiology, 18*(4), 483-488.

Simmons, A., Matthews, S. C., Stein, M. B., & Paulus, M. R. (2004). Anticipation of emotionally aversive visual stimuli activates right insula. *Neuroreport, 15*(14), 2261-2265.

Simmons, A., Strigo, I., Matthews, S. C., Paulus, M. P., & Stein, M. B. (2006). Anticipation of aversive visual stimuli is associated with increased insula activation in anxiety-prone subjects. *Biological Psychiatry, 60*(4), 402-409.

Simmons, A. N., Stein, M. B., Strigo, I. A., Arce, E., Hitchcock, C., & Paulus, M. P. (2011). Anxiety Positive Subjects Show Altered Processing in the Anterior Insula During Anticipation of Negative Stimuli. *Human Brain Mapping, 32*(11), 1836-1846.

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*(2), 138-143.

Taylor, S., Zvolensky, M. J., Cox, B. J., Deacon, B., Heimberg, R. G., Ledley, D. R., . . . Cardenas, S. J. (2007). Robust dimensions of anxiety sensitivity: Development and initial validation of the anxiety sensitivity index-3. *Psychological Assessment, 19*(2), 176-188.

Wild, J., Clark, D. M., Ehlers, A., & McManus, F. (2008). Perception of arousal in social

anxiety: effects of false feedback during a social interaction*. Journal of Behavior*

*Therapy and Experimental Psychiatry, 39,*102- 116.

Tables and Figures

Table 1

Demographic characteristics of the sample: means (with standard deviations), and t-test statistics (with degrees of freedom) for group comparisons.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Experimental  (N=28)  Mean (SD) | | Control  (N=28)  Mean (SD) |  | *t* (df)\* |
| Age | 20.04 (2.07) | 20.64 (2.58) | |  | -0.958 (53) |
| BMIa | 21.51 (2.89) | 22.73 (2.93) | |  | -1.505 (50) |
| IA baseline | 0.62 (0.15) | 0.65 (0.15) | |  | -0.883 (54) |
| BFNE-Sb | 11.36 (8.12) | 12.93 (7.04) | |  | 0.774 (54) |
| DASS-Dc | 3.86 (3.69) | 4.64 (3.86) | |  | 0.779 (54) |
| ASId | 16.52 (10.15) | 21.96 (12.00) | |  | -1.814 (53) |
| LSASe | 35.79 (19.19) | 42.07 (23.39) | |  | -1.099 (54) |
| STICSA-Sf | 33.59 (8.41) | 38.96 (11.62) | |  | -1.970 (49.22) |
| STICSA-Tg | 36.61 (8.05) | 36.50 (10.93) | |  | 0.042 (54) |

\*None of the t-test statistics were significant at alpha .05 level

a Body Mass Index; b Brief Fear of Negative Evaluation-Straightforward Items; c Depression Anxiety and Stress Scale-Depression subscale; d  Anxiety Sensitivity Index; e Liebowitz Social Anxiety Scale; f State-Trait Inventory of Cognitive and Somatic Anxiety Scale- State subscale; f State-Trait Inventory of Cognitive and Somatic Anxiety Scale-Trait subscale

Table 2.

Moderated regression analyses.

1. Hierarchical multiple regression analysis predicting interoceptive awareness during anticipation from condition, Fear of Negative Evaluation, and interaction of condition and Fear of Negative Evaluation, and controlling for baseline IA.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | | Correlations | | | |
| Predictor | Δ*R2* | β | | Zero-order | Partial | Part |
| Step 1 | .736\*\*\* |  | |  |  |  |
| IA1 |  | .866\*\*\* | | .814 | .855 | .847 |
| condition |  | .255\*\*\* | | .137 | .439 | .251 |
| BFNE-II |  | .138† | | -.027 | .254 | .135 |
| Step 2 | .002 |  | |  |  |  |
| Condition x BFNE-II |  | .044 | | -.152 | .084 | .043 |
| Total *R2* | .738\*\*\* |  | |  |  |  |

*Note. N* =56.IA1 = baseline interoceptive awareness, BFNE-II = Fear of Negative Evaluation.

†*p* < .1, \*\*\**p* < .001

b) Hierarchical multiple regression analysis predicting anxious mood during anticipation in the experimental group from Fear of Negative Evaluation, baseline IA, and interaction of Fear of Negative Evaluation and baseline IA, and controlling for anxious mood at baseline.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  |  | | Correlations | | | |
| Predictor | Δ*R2* | β | | Zero-order | Partial | Part |
| Step 1 | .650\*\*\* |  | |  |  |  |
| Mood 1 |  | .738\*\*\* | | .752 | .771 | .717 |
| BFNE-II |  | .311\* | | .365 | .432 | .283 |
| IA 1 |  | .182 | | -.102 | .267 | .164 |
| Step 2 | <.001 |  | |  |  |  |
| BFNE-II x IA1 |  | -.121 | | -.253 | -.025 | -.015 |
| Total *R2* | .650\*\*\* |  | |  |  |  |

*Note. N* = 28. Mood 1 = anxious mood at baseline, IA1 = baseline interoceptive awareness, BFNE-II = Fear of Negative Evaluation.

†*p* < .1,\**p* < .05*,* \*\*\**p* < .001