Emotional response patterns during social threat in individuals with generalized social anxiety disorder and non-anxious controls

David A. Moscovitcha,*, Michael K. Suvakb, Stefan G. Hofmannb

a Department of Psychology, University of Waterloo, 200 University Ave. West, Waterloo, Ontario, Canada N2L 3G1
b National Center for PTSD, VA Boston Healthcare System, United States

c Department of Psychology, Boston University, United States

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A B S T R A C T

Patterns of synchrony in repeated measures of heart rate, skin conductance levels, negative affect, and positive affect were investigated in patients with social anxiety disorder and non-anxious controls during a speech task. Despite expected low levels of absolute concordance between measures of affect and arousal overall, results revealed clearly defined and specific patterns of emotional response coherence that distinguished between the two groups and depended on the types of measures used. Specifically, findings demonstrated that (a) for both patients and controls, increased heart rate was significantly synchronized with increased negative affect, with patients showing overall stronger levels of synchrony between these two measures than controls; (b) for controls only, increased heart rate was significantly synchronized with increased positive affect; and (c) for patients only, increased skin conductance was significantly synchronized with both increased negative affect and decreased positive affect. These findings are discussed in relation to current conceptualizations of the construct of emotion as well as directions for future research and potential implications for clinical practice.

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1. Introduction

The nature of the relationship between peripheral autonomic arousal and subjective affective experience in social anxiety disorder (SAD) is complex. According to contemporary cognitive models of SAD, social anxiety is driven, at least in part, by negative attributions that individuals make about the likelihood and social costs of displaying publicly observable symptoms of physiological arousal (Clark & Wells, 1995; Hofmann, 2007; Rapee & Heimberg, 1997). Indeed, many socially anxious individuals report that they are afraid of social situations because they might display observable signs of anxiety, such as blushing, sweating, or shaking (e.g., Bögels, Mulkens, & de Jong, 1997; Moscovitch, 2009). Studies have found that highly socially anxious individuals are more likely to believe that outward appearance accurately reflects internal physiological arousal (e.g., Wild, Clark, Ehlers, & McManus, 2008). They overestimate the extent to which other people notice their symptoms of anxiety (Borkovec, Wall, & Stone, 1974; McEwan & Devins, 1983), and perceive that others interpret these symptoms in an overly negative manner (Roth, Antony, & Swinson, 2001; Voncken, Alden, & Bögels, 2007).

Yet, previous studies of emotional response coherence in socially anxious participants have found low within-subject correlations of subjective distress and physiological arousal across both social and non-social tasks (Cuthbert et al., 2003; Edelmann & Baker, 2002; Lang & McTeague, 2009; Mauss, Wilhelm, & Gross, 2004). For example, Mauss et al. (2004) found that subjective anxiety ratings (on a 0-10 scale) were uncorrelated with several different measures of arousal in highly socially anxious individuals during a public speech (controlling for baseline levels of anxiety and arousal). Similarly, Edelmann and Baker (2002) reported low within-subject correlations of physiological responses and perceived physiological responses among individuals with SAD and clinical and non-clinical controls. Thus, despite theoretical models that predict strong coupling between subjective reports of anxiety and physiological arousal in social anxiety, the data from the extant literature reflect a high level of emotional response discordance (see also Mauss, Levenson, McCarter, Wilhelm, & Gross, 2005). Indeed, in SAD, as in other anxiety disorders, the absolute degree of concordance (at one point in time) or synchrony (concurrent changes from one time point to another) between measures of subjective distress and physiological reactivity appears to be modest, at best (Cook, Melamed, Cuthbert, McNeil, & Lang, 1988; Lang, 1978).

It is possible to interpret these emotional discordance data in a number of different ways. According to some (e.g., Hodgson & Rachman, 1974; Lang, 1994; Rachman & Hodgson, 1974), discor-
dance supports the notion that there are separate emotion response systems (i.e., verbal-cognitive, physiological, and behavioral) that co-exist with each other but vary largely independently of one another. Others (e.g., Zinbarg, 1998) have argued that the structure of emotion is inherently hierarchical and, as such, is comprised of higher order latent emotional constructs that direct and coordinate lower level outputs in information processing, behavior, and physiology. Accordingly, one should not expect the observable indicators of lower level outputs to be perfectly, or even strongly, correlated with each other because they are influenced by a multitude of factors, including measure variance, that are expected to constrain their overall level of concordance. More radically, Russell (e.g., 2003, 2009) contends that individual emotional events are simply “psychological constructions” that consist of a collection of components that may come together in different ways at different times in different people, but that it is not necessary to presume the existence of any unitary construct of emotion that underlies and drives such components and their interrelationships.

Thus, one of the central challenges of emotion theory and research today is to better understand how the components of emotional response patterns are organized in relation to each other and identify factors that may account for individual differences in synchrony and desynchrony between these components (e.g., Cacioppo, Berntson, & Klein, 1992; Lang & McTeague, 2009; Lang, 1985, 1994; Matsumoto, Nezlek, & Koopmann, 2007). In the present study, we wished to extend the investigation of emotional response coherence in social anxiety beyond simply observing how strongly correlated single measures of distress and arousal are at single time points, to examining the nature of the patterns of association between multiple measures of affect and arousal across multiple time points during social threat.

Among the anxiety disorders, social anxiety disorder (SAD) is unique in its affective profile, as it is characterized not only by increased levels of negative affect, as are the other anxiety disorders, but also uniquely by diminished levels of positive affect (e.g., Brown, Chorpita, & Barlow, 1998; Brown, Silvia, Myin-Germeys, & Kwapil, 2007; Kashdan, 2007; Naragon-Gainey, Watson, & Markon, 2009). However, few, if any studies, have investigated how the characteristic affective profile of SAD, including both increases in negative affect and decreases in positive affect, might synchronize across time. As such, the current study was designed to examine the role of psychopathology as a potential moderator of such differences. Toward this end, the current study was designed to document significant effects that would emerge, with an eye toward continuing to move the emotion debate away from the question of whether there is or is not synchrony between measures of affect and arousal, and toward questions about the nature of, and factors accounting for, individual differences in patterns of emotional synchrony, as advocated by other emotion scholars (e.g., Matsumoto et al., 2007).

2. Materials and methods

2.1. Participants

The sample consisted of 39 individuals with a DSM-IV diagnosis of generalized SAD and 39 non-anxious control participants. Most clinical participants (n = 29) were recruited through a large community outpatient clinic in Northeastern United States. The remaining clinical participants (n = 10) and all control participants were recruited from the surrounding community via newspaper, Internet, and flyer advertisements. All clinical participants were diagnosed by doctoral student interviewers using the Anxiety Disorders Interview Schedule for DSM-IV (ADIS-IV; Di Nardo, Brown, & Barlow, 1994). Interviewers were trained according to the procedures in Brown, Di Nardo, Lehman, and Campbell (2001). Non outpatient clinical participants and all non-clinical participants were screened over the phone and subsequently evaluated with the ADIS-IV. Potential clinical participants were excluded if they were actively psychotic, manic, suicidal, homicidal, or substance-abusing, were currently receiving psychotherapeutic treatment, or had made a change in their medication status within the previous month. Nineteen eligible clinical participants declined participation. The most common reasons for declining participation were too busy to participate (n = 8) and apprehension about some aspect of the study procedure (n = 7). Control participants were included in the study if they had no current DSM-IV disorders and endorsed no significant symptoms of social anxiety.

All participants in the clinical sample received a principal diagnosis of generalized SAD (i.e., if there were multiple diagnoses, symptoms of SAD were associated with the highest clinical severity rating) and all participated in the present study before beginning treatment. The most frequent comorbid diagnoses were major depressive disorder (n = 10), dysthymic disorder (n = 8), generalized anxiety disorder (n = 6), panic disorder with agoraphobia (n = 4), specific phobia (n = 4), and obsessive-compulsive disorder (n = 3). Of the overall sample, the majority was male (61.5%) and average age was 30.62 (SD = 10.30, range = 18–63). Sixty-eight percent of participants were Caucasian, with remaining participants identifying as Asian (10.3%), African-American (9.0%), Hispanic (2.6%), and Other (e.g., biracial; 10.3%). Median annual income was $25,000 (USD), and participants completed an average of 16.06 (SD = 2.32; range = 11–23) years of education. Clinical and control participants did not differ in age, t (76) = .50, p > .62, years of education, t (76) = .51, p > .12, or ethnicity, x2 (6, n = 78) = 3.11, p > .80. Each group was comprised of 24 men and 15 women.

2.2. Procedure

Participants were tested individually after providing informed consent. They were seated in a laboratory room facing a video camera, which stood in front of a one-way mirror. The experimenter affixed the heart rate and skin conductance sensors and moved into an adjacent room behind the one-way mirror, from where communication with participants occurred via intercom. First, participants sat quietly for a 5-minute initial baseline period, after which they completed measures of the Positive and Negative Affect Schedule–State Version (PANAS-S; Watson, Clark, & Tellegen, 1988). Participants were then informed that they would be required to give an impromptu 10-minute videotaped speech on randomly...
chosen topics, which would be observed by the experimenter and later judged for quality by objective evaluators. Participants were informed that the objective evaluators knew nothing about them, their group status, or the purpose of the experiment. After this first anticipation phase, participants provided ratings on the PANAS-S. All participants were then given more detailed speech instructions, which were modeled after Beidel, Turner, Jacob, and Cooley (1989). They were asked to speak for 10 minutes. Following these instructions, all participants sat quietly for a second 3-minute anticipation phase, after which they provided a third set of ratings on the PANAS-S. Then, all participants were given a sheet of paper containing three speech topics (capital punishment, abortion, and cloning), and asked to begin their speech. Following their speech, participants reported on their affective states during the speech by completing a fourth set of ratings on the PANAS-S. Finally, participants sat quietly for a 3-minute recovery phase, after which they completed their fifth and final ratings on the PANAS-S.

2.3. Self-report measurement of emotional states

Positive and Negative Affect Scales: State Version (PANAS-S; Watson et al., 1988). The PANAS is a 20-item scale consisting of adjectives that describe mood states. Instructions ask participants to rate the degree to which they felt each mood state currently on a scale from 0 to 4 (0 = very slightly or not at all to 4 = extremely). The questionnaire is divided into two subscales measuring positive affect (PANAS-P; e.g., “interested,” “proud”) and negative affect (PANAS-N; e.g., “distressed,” “ashamed”). The PANAS is widely used in experimental studies and has good reliability and validity (Mackinnon et al., 1999; Watson et al., 1988).

2.4. Autonomic measurement of emotional states

Heart rate (HR) and skin conductance (SC) levels were measured with equipment and software designed by the James Long Company (JLC; Caroga Lake, NY) and with the data-acquisition program Snap-Master™ for Windows. Electrocardiogram (ECG) and SC levels were measured continuously during the experiment. The physiological measures were digitized at 512 samples per second with a 31-channel A/D converter operating at a resolution of 12 bits and with an input range of ±2.5 V to ±2.5 V. Amplification rates, high-pass filter (HPF), and low-pass filter (LPF) settings were as follows: ECG (gain = 500, HPF = 0.1 Hz, LPF = 1000 Hz) and SC (gain = 0.1 V/μS, HPF = none/DC, LPF = 10 Hz, 6 dB/octave, single pole RC). For additional information on computer-assisted record-ings of psychophysiological indicators, readers are referred to Cacioppo, Tassinary, and Berntson (2007). During the collection of physiological data, onset and termination of periods of interest were defined using an event marker that was engaged manually by the experimenter at the appropriate times. Average values of HR and SC were computed for each period of interest (i.e., baseline, two anticipation periods, speech, and recovery).

The grounded, referenced ECG was recorded via two disposable, resting, conductive adhesive electrodes (CDI UMP3-P). The active sites were measured on the skin surface of the right and left sides of participants’ lower rib cage. Target skin areas were cleansed with alcohol swabs and allowed to dry. ECG signals were amplified using a JLC Bioamplifier Output Box and SA Instrumentation Bioamplifiers from JLC. HR data were analyzed using the ECGWave program by JLC, a computer program that employs an algorithm to detect R-waves and examine the data for artifacts. Artifacts were manually corrected with a mouse to remove R-wave identification marks that were incorrectly specified (e.g., a movement artifact that the computer coded as an R-wave) or to score R-waves that were missed by automated detection. HR was calculated as the number of R-waves per minute.

SC was measured using two Ag-AgCl electrodes (UFI 1081FG) filled with electroconductive gel (Electro-Gel) and placed onto the palmar side of the middle phalanges of the third and fourth fingers of the left hand. Participants washed their hands with water before the electrodes were attached. SC was averaged over one second intervals and are reported here in microsiemens.

3. Data analyses and results

3.1. Data analytic strategy

We conducted multi-level regression analyses with the software program Hierarchical Linear and Non-Linear Modeling (HLM6; Raudenbush et al., 2005) to examine the relationship between self-reported affect and psychophysiological arousal in the clinical and control groups across the five phases of the study and whether this relationship varied as a function of diagnostic status. The numerous benefits of utilizing a multi-level approach to analyze psychophysiological data were recently discussed by Kristjansson, Kircher, and Webb (2007). Multi-level regression, which has been developed to analyze nested or hierarchical data structures (Raudenbush & Bryk, 2002), is well suited to examine congruence between two variables and ascertain whether or not this congruence varies in meaningful ways as a function of other predictor variables.

Multi-level regression analyses can be conceptualized as consisting of multiple components, one for each level of nesting. In the current study, repeated measures – i.e., negative affect (NA), positive affect (PA), and psychophysiological recordings of HR and SC – were nested within individuals. The level-1 component of the analyses consisted of examining the relationship between self-report measures of affect and psychophysiological measures of arousal. The level-2 component of the model consisted of examining whether or not the individual differences variable (diagnostic status) significantly predicted the level-1 relationships.

For measures of both negative and positive affect, a series of analyses were conducted with HR and SC separately. Step 1 consisted of examining each psychophysiological measure separately as a level-1 predictor of each self-report measure. Step 2 consisted of adding Group to the level-2 component of the model to examine whether the relationships between each psychophysiological and self-report measure varied as a function of diagnostic status. Finally, in Step 3, we controlled for overall psychophysiological and subjective reactivity by including these as covariates in the prediction of the psychophysiological/self-report relationship. These reactivity variables were derived by identifying the maximum and minimum values of each self-report and physiological variable across the five phases of the study for each participant and subtracting the minimum value from the maximum value, thereby creating a reactivity value for each of the study variables (e.g., HRR, SCr, NAr, and PAR in Table 1).
Table 1

Psychophysiological measures of arousal as predictors of self-reported affect within an HLM framework.

<table>
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<td>–</td>
<td>–0.35</td>
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</table>

Notes: SC: skin conductance; HR: heart rate; NA: negative affect; PA: positive affect; Con: controls; Clin: clinical participants; lower-case r in variables 4 and 5 signifies a reactivity variable (max. minus min. values for that variable; see Section 3.1, for detailed description); B: unstandardized regression coefficient; t: associated t-statistic; pr: partial regression coefficient (.10 = small, .24 = medium, .37 = large); ss: sigma squared (analogous to an R\(^2\) value in regression).

In Step 2, the coefficient and associated information for the psychophysiological variable × group interaction are presented on the first line, and lines 2 and 3 represent the associations between the psychophysiological variable and the outcome for the control and clinical groups, respectively.

In Step 3, the coefficient and associated information for the psychophysiological variable × group interaction are presented on the first line, lines 2 and 3 represent the associations between the psychophysiological variable and the outcome for the control and clinical groups, respectively, when holding the two reactivity variables constant at the mean level of reactivity, and the fourth and fifth lines represent the impact of reactivity on the psychophysiological variable/outcome relationship.

As recommended by Cohen, Cohen, West, and Aiken (2003), all main effects were included in the analyses. We report the partial regression coefficients (pr) for each coefficient. Kirk (1996) suggested .10, .24, and .37 for small, medium, and large effect sizes respectively. In Step 1 of each analyses, we report the change in sigma square (ss), which represents how much of the within-subjects variance is accounted for by the level-1 psychophysiological variables (analogous to an R\(^2\) value in regression).

3.2. Results

Means and standard errors for each of the four measures across experimental phases and participant groups are displayed in Figs. 1 and 2 for descriptive purposes. A detailed summary of the multi-level regression analyses and results is presented in Table 1.

3.2.1. Relation between HR and affect

Step 1 of these analyses examined the overall relationships between HR and self-reported NA and PA. As depicted in Table 1, HR was a significant predictor of NA, with HR accounting for a modest 11% of the variance in NA. On the other hand, HR did not significantly predict PA. Step 2 indicated that both of the arousal/affect relationships (HR/NA and HR/PA) significantly varied as a function of Group. Although HR was associated with NA in both groups, this relationship was significantly stronger among individuals with SAD. A different pattern emerged for the relationship between HR and PA: whereas the control group exhibited a significant positive relationship between HR and PA, such that higher levels of HR were associated with higher levels of PA, no significant HR/PA relationship emerged among participants with SAD. Step 3 indicated that these relationships remained significant after controlling for overall reactivity levels (i.e., the relationships between HR, on one hand, and PA and NA, on the other, were affected minimally by includ-
Changes in heart rate (beats per minute) and skin conductance levels (microsiemens) across time for participants with generalized social anxiety disorder (patients) and controls.

Fig. 1.

Changes in negative affect (PANAS-N) and positive affect (PANAS-P) across time for participants with generalized social anxiety disorder (patients) and controls.

Fig. 2.

3.2.2. Relation between SC and affect
In Step 1, SC was a significant overall predictor of NA, with SC accounting for 10% of the variance in NA. On the other hand, SC did not significantly predict PA. In Step 2, both of the arousal/affect relationships (SC/NA and SC/PA) significantly varied as a function of Group, with SC significantly predicting NA and PA only among individuals with SAD. For individuals with SAD, higher levels of SC were associated with higher levels of NA and lower levels of PA. No significant SC/affect relationships emerged among control participants. Step 3 indicated that these relationships remained significant after controlling for overall reactivity levels.

3.2.3. Summary of results
Overall, the results can be summarized as follows:

1. For healthy controls, increases in HR across time were significantly synchronized with both increases in NA and increases in PA. Conversely, for individuals with SAD, increases in HR were significantly synchronized with increases in NA only. HR–NA synchrony was significantly stronger for SAD patients than for controls.

2. For healthy controls, changes in SC were synchronized neither with changes in NA nor with changes in PA. Conversely, for individuals with SAD, increases in SC were significantly synchronized with both increases in NA and decreases in PA.

3. The observed patterns of affect-arousal synchrony were affected very minimally by including overall reactivity levels as a covariate, suggesting that the results were not due to greater reactivity in one group relative to the other.

4. Discussion
Results of the present study suggest there are specific patterns of affect-arousal synchrony that distinguish socially anxious from non-anxious individuals during social threat, and that such patterns depend on the types of measures that are used to assess different dimensions of emotional experience. Although, as predicted, there was a modest degree of overall convergence between any two measures of affect and arousal in both groups, the patterns of coherence between affect and arousal differed in a theoretically meaningful way across the two groups. During the speech task, increases in HR were associated with increases in NA for both SAD patients and controls. However, for controls but not patients, increases in HR were also associated with increases in PA. For patients but not controls, increases in SC were associated with increases in NA and decreases in PA.

The observed group differences in the types of subjective affective responses that correspond with increases in HR and SC are consistent with the notion, originally proposed by Schachter and Singer (1962), that it is not bodily arousal per se, but rather one’s subjective interpretation of one’s arousal, which determines the nature of
one’s emotional experience. Because individuals with SAD perceive themselves as being socially incompetent, unattractive, and visibly anxious (see Moscovitch, 2009; Moscovitch, Antony, & Swinson, 2009) and view social situations as harbingers of humiliation, rejection, and potential social exclusion (Clark & Wells, 1995; Rapee & Heimberg, 1997; Rodebaugh, 2008), their experience of increased arousal within a social context is likely to correspond with increased feelings of subjective distress and diminished feelings of positive affect (i.e., reduced enthusiasm, determination, pride, etc.). Non-anxious individuals confronting a challenging social performance situation are also likely to experience at least moderate increases in arousal and subjective distress. However, because such individuals tend to perceive themselves as being significantly more socially competent, attractive, and visibly composed than those with SAD (e.g., Moscovitch, Antony, et al., 2009, Moscovitch, Orr, Rowa, Gehring Reimer, & Antony, 2009), their experience of increased arousal is also uniquely linked with the subjective experience of positive affect. That is, they view the social situation as a challenge but also as an opportunity to publicly display to others the positive qualities they believe are true about themselves.

Our study design would have been strengthened by including reliability checks on SAD diagnoses, repeated assessment of behavioral emotional responses that corresponded with our measures of affect and arousal, subjective measures of participants’ reactions to the speech topics, and a control group of clinical participants with a diagnosis other than SAD. In the context of the present design, it is impossible to disentangle the possible effects of the patients’ comorbid diagnoses on the observed patterns of emotional synchrony. Notwithstanding its limitations, however, the current study did build on previous work in this area in a number of positive ways (see Mauss et al., 2004, for a detailed discussion of problems that have hampered previous studies). Specifically, our data collection incorporated multiple, repeated measures of physiological arousal and both negative and positive subjective affective judgments across time. In addition, the anxious participants included in the present study were sampled from a DSM-IV patient population that had been carefully assessed and diagnosed by trained evaluators whose judgments have been shown to be reliable in previous investigations (Brown et al., 2001). Moreover, we used a standardized emotion induction procedure that was matched to clinical participants’ particular concerns (Stein et al., 2000), has been widely recognized and used in previous studies as a valid and reliable task for eliciting social anxiety (e.g., Beidel et al., 1989), and was carefully managed and monitored in laboratory setting. Finally, we chose a data analytic approach (multi-level regression analyses) that could robustly handle the data within a time-series design, flexibly control for missing data across participants and time points, and account for non-linear relationships between variables.

To further deepen investigation of individual differences and psychopathology in the study of emotional response coherence, future studies are needed to replicate and extend these findings across other contexts and groups of participants. It will be important to replicate the present study within the context of an enhanced study design that examines patterns in synchrony between specific subjective emotional states and physiological arousal within both social and non-social threat tasks in participants with a principal diagnosis of SAD as well as those with affective psychopathology other than SAD. Of particular interest is whether patients with other anxiety disorders would show the same trends in affect- arousal synchrony documented here and whether these patterns of synchrony are bound to specific contexts or tasks that relate to the nature of the underlying affective problem (e.g., whereas the specific patterns of synchrony documented here might be observed for participants with SAD during a social task, they may not be elicited during panic-related, OCD-related, or depression-related threat inductions; similarly, the speech task may be effective at eliciting such patterns of emotional responding for participants with SAD, but not for those with another principal anxiety diagnosis in which giving a speech is not viewed as being threatening).

Subsequent studies might also investigate the extent to which patterns of response coherence in SAD might change following exposure to efficacious psychological treatments, such as cognitive behavioral therapy. Contrary to the influential hypothesis of emotional processing theory (Foá & Kozak, 1986; Foá & McNally, 1996; see Moscovitch, Antony, et al., 2009, Moscovitch, Orr, et al., 2009 for a review of this literature), reductions in the absolute degree of physiological arousal appear to be a poor indicator of successful treatment response across the anxiety disorders (see Craske et al., 2008). However, it is possible that changes in patterns of response coherence as a result of treatment might be an indicator that corresponds more reliably to real changes that occur during therapy in patients’ underlying bioinformational network of emotional memories (Lang, 1979). Additional research is required to test this intriguing hypothesis.

Author note

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References


