Trends in Psychiatry and Psychotherapy

Original Article

Trait vs. state anxiety in different threatening situations

Ansiedade traço versus ansiedade estado em diferentes situações de ameaça

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Abstract

Objective: Anxiety as a uni- or multidimensional construct has been under discussion. The unidimensional approach assumes that there is a general trait anxiety, which predisposes the individuals to increases in state anxiety in various threatening situations. In this case, there should be a correlation between state and trait anxiety in any situation of threat. Therefore, the aim of this study was to investigate the correlation between trait and state anxiety in participants exposed to two different anxiogenic situations: interpersonal threat (Video-Monitored Stroop Test – VMST) and physical threat (third molar extraction – TME).
Methods: Participants with various levels of trait anxiety (general trait: State-Trait Anxiety Inventory – STAI, Hospital Anxiety and Depression Scale; specific trait: Social Phobia Inventory, Dental Anxiety Scale) had their anxious state evaluated (STAI, self-evaluation of tension level, heart rate, electromyogram activity) before, during and after the VMST or the TME.
Results: In VMST, trait anxiety correlated to state anxiety (psychological parameters) in all test phases. However, in TME, the only trait measurement that correlated to state anxiety (psychological parameters) was the Dental Anxiety Scale.
Conclusion: Trait anxiety correlates positively to state anxiety in situations of interpersonal threat, but not of physical threat.
Keywords: Anxiety, test anxiety scale, personality.

Resumo

Objetivo: A ansiedade como um construto uni ou multidimensional tem estado em discussão. A abordagem unidimensional presume que há uma ansiedade-traço geral, a qual predispõe o indivíduo a aumentar a ansiedade-estado em situações de ameaça. Neste caso, deveria existir uma correlação entre estado e traço ansioso em diferentes situações ameaçadoras. Portanto, o objetivo deste estudo foi avaliar a correlação entre ansiedade-traço e ansiedade-estado em participantes que foram expostos a duas situações ansiogênicas diferentes: ameaça interpessoal (Teste de Stroop Monitorado por Vídeo – TSMV) e ameaça física (exodontia do terceiro molar – ETM).
Métodos: Participantes com vários níveis de ansiedade-traço (traço geral: Inventário de Ansiedade Traço-Estado – IDATE; Escala Hospitalar de Ansiedade e Depressão; traço específico: Inventário de Fobia Social, Escala de Ansiedade Dental de Corah) tiveram seus estados ansiosos avaliados (IDATE, escala analógica de tensão, frequência cardíaca, eletromiografia) antes, durante e depois do TSMV ou da ETM.
Resultados: No TSMV, a ansiedade-traço correlacionou-se com a ansiedade-estado (parâmetros psicológicos) em todas as fases do teste. Entretanto, na ETM, a única medida de traço que se correlacionou com a ansiedade-estado (parâmetros psicológicos) foi a Escala de Ansiedade Dental de Corah.
Conclusão: A ansiedade-traço correlaciona-se positivamente com a ansiedade-estado em situações de ameaça interpessoal, mas não de ameaça física.
Descritores: Ansiedade, personalidade, escala de ansiedade frente a teste.

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Submitted Jul 04 2016, accepted for publication Jan 15 2017.

Suggested citation: Leal PC, Goes TC, da Silva LC, Teixeira-Silva F. Trait vs. state anxiety in different threatening situations. Trends Psychiatry Psychother. 2017;39(3):147-157. Epub 14 Aug 2017. http://dx.doi.org/10.1590/2237-6089-2016-0044

Introduction

Behavior is motivated by emotions, which have a significant impact on health and psychological well-being. Usually, emotions interact motivating the individual to satisfy goals or decrease conflicts. However, when certain emotions, such as anxiety, persist beyond their usefulness, they become pathological.[1] Currently anxiety is one of the most common mental disorders, with high levels of chronicity, distress and functional impairment.[2]

Anxiety is defined as an organic response, characterized by apprehension and increased surveillance in situations of uncertain danger or potential threats to the integrity of the organism.[3,4] Yet, in the study of anxiety, there are two complementary concepts: a psychophysiological state (state anxiety) and a personality trait (trait anxiety). State anxiety reflects the psychological and physiological transient reactions directly related to adverse situations in a specific moment. In contrast, the term trait anxiety refers to a trait of personality, describing individual differences related to a tendency to present state anxiety. Trait anxiety is, therefore, relatively stable over time[5] and considered an important characteristic of patients with anxiety disorders, as they present higher trait anxiety in comparison to healthy individuals.[6]

This distinction between state and trait anxiety is an important conceptual development in anxiety assessment and can be attributed to the work of Spielberger et al.[7] According to those authors, anxiety is a unidimensional construct; as a result, the higher the trait anxiety, the higher the state anxiety in different situations of threat. However, some studies contest this idea, indicating that both state and trait anxiety should each be conceptualized as multidimensional constructs.

According to Endler & Parker,[8] both trait and state anxiety are multidimensional in nature, i.e., there represent individual differences in the predisposition to experience anxiety in specific types of threatening situations. These researchers have identified two dimensions of state anxiety (cognitive-worry and autonomic-emotional), and four main facets of trait anxiety associated with specific situations: i) social evaluation threat, ii) physical danger threat, iii) ambiguous threat, and iv) threat in innocuous situations or daily routines.[9] The same authors are now proposing an expansion of the trait anxiety concept to include self-disclosure trait anxiety and separation trait anxiety as a supplement to the existing focus on the social evaluation facet.[9]

Despite these conceptual controversies in the scientific community, since the development of the Spielberger State-Trait Anxiety Inventory (STAI)[7] for use in research studies, this has become the most commonly used self-report measure of anxiety.[10] As a result, most of the anxiety assessment is relying on Spielberger's unidimensional approach. Finding out if this is actually the best approach is of great scientific interest.

One good way of addressing this question would be through correlational studies: if anxiety is a unidimensional construct, a correlation between trait and state anxiety should be seen in any threatening situation. Interestingly, in animal studies, this correlation has not been observed.[11] It is well accepted that the behavioral responses and brain mechanisms related to anxiety are so indispensable to survival that they must have evolved early in the evolution of mammals and remained highly conserved. However, the concepts of trait and state anxiety in animal models are open to criticism, as it can be argued that it is difficult to assess trait anxiety in the absence of state anxiety in "naturally anxious" animals (high anxious trait), as some apparently neutral situations could, in fact, be anxiogenic to these individuals.[12] Therefore, the question remains, but a reliable way to answer it would be using, instead of animals, human experimental models.

The aim of the present study was to evaluate the correlation between trait and state anxiety in healthy human volunteers exposed to distinct anxiogenic situations. In order to do that, two independent correlational studies were performed: 1) Experiment I – volunteers exposed to an interpersonal threat, the Video-Monitored Stroop Test (VMST); and 2) Experiment II – volunteers exposed to a physical threat, third molar extraction (TME).

Method

Participants

For Experiment I (VMST), participants were recruited through electronic and print advertisements posted on the university's official website and on notice boards at various sites within the university campus. For Experiment II (TME), individuals referred for TME at the university's dental clinic were personally invited to participate in the study by a researcher.

A total of 75 male volunteers (Experiment I: 45; Experiment II: 30), aged between 18 and 30 years, were evaluated using a general and psychiatric evaluation questionnaire, structured according to criteria of the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR). Individuals were not included in the study if they presented: 1) possible neurological, psychiatric, metabolic or hormonal disorders; 2) chronic use of any medicine. Six volunteers (all from Experiment I) were not included as they possibly presented a psychiatric disorder, while 12 (Experiment I: 2; Experiment II: 10) were excluded from the study for not attending the second appointment (test day). As a result, 30 volunteers participated in Experiment I (mean age ± standard deviation [SD] = 20.9±2.1 years) and 20 volunteers in Experiment II (mean age ± SD = 22.1±4.24 years). The majority of participants were undergraduate students (Experiment I: 100%; Experiment II: 60%); the remainder had finished high school.

The study was approved by the Research Ethics Committee of Universidade Federal de Sergipe, Brazil (decision no. 39794). Written informed consent was obtained from all participants.

Materials and procedures

VMST

The VMST was used as standardized by Teixeira-Silva et al.[13] This test consists of presenting a board to the participant with 100 color naming words, such as blue, green, yellow, red, and violet, randomly distributed over a 10×10 matrix. Each word is printed in a color different than its meaning. To perform the task, the participant has to say, as quickly as possible and in the sequence presented, the names of the colors seen, but not the colors designated by the words.

The task has to be performed in two minutes (maximum) and any errors are signaled with a bell. Skipping a color in the sequence, hesitation in saying the color name, and saying the color name rather than its ink are all considered errors. The whole test is video-recorded and presented to the participants on a monitor during the test. Instructions are given to the volunteers using a CD recording, which leads them to believe that a group of professionals, located in another room, is observing them and will evaluate their performance.

TME

TME was used as a real-life stress situation. This surgery is recognized as an anxiogenic condition and has been extensively used in clinical trials to evaluate the effects of anxiolytic, sedative and analgesic drugs, due to the fact that dental anxiety is considered a situational and anticipatory anxiety.[14-18]

Psychological measurements

State-Trait Anxiety Inventory (STAI)[7]

This inventory consists of 40 statements about the feelings of the participant, divided into two parts. In Part I (20 statements), volunteers are instructed to indicate the intensity of their feelings of anxiety at a particular moment (state anxiety), using scores ranging from 1 (absolutely not) to 4 (very much). In Part II (other 20 statements), volunteers describe how they generally feel (trait anxiety) by reporting the frequency of their symptoms of anxiety, again using scores ranging from 1 (hardly ever) to 4 (often). The total score of each part may range between 20 and 80, with higher scores indicating higher levels of anxiety. A validated Portuguese version of the STAI was used[19] to assess state anxiety (Part I, STAI-state) and general trait anxiety (Part II, STAI-trait).

Self-evaluation of tension level (STL)

Assessment of the volunteers' subjective tension level was made using a numerical scale ranging from 0 (totally relaxed) to 10 (extremely tense). Subjective tension was considered an aspect of state anxiety.

Social Phobia Inventory (SPIN)

This instrument consists of 17 items that evaluate performance situations and social interaction. For each item of the inventory, volunteers indicate the intensity of the conditions that bothered them in the last week using a scale ranging from 0 (nothing) to 4 (extremely). The total score may range from 0 to 68. Scores > 19 indicate the presence of symptoms consistent with social phobia. The Portuguese version, translated and validated by Vilete et al.,[20] was used to assess trait anxiety related to social evaluation.

Hospital Anxiety and Depression Scale (HAD)

The HAD has 14 items, seven for the assessment of anxiety (HAD-A) and another seven for depression (HAD-D), with scores ranging from 0 (never) to 3 (often) for each item. The Portuguese version, translated and validated by Botega et al.,[21] was used to assess general trait anxiety. Participants were instructed to answer the questions according to how they generally felt, rather than how they felt in the past week. With these slightly modified instructions, HAD presents good stability over time (unpublished data), measuring trait rather than state anxiety.

Dental Anxiety Scale (DAS)

This scale contains four multiple-choice items that assess the patient's subjective reactions about going to the dentist. Each item may be scored from 1 (calm) to 5 (terrified). Total scores may vary from 4 to 20. Scores < 12 are considered to indicate low anxiety, 12-14 moderate anxiety, and > 14 high anxiety. This scale was used to assess trait anxiety related to receiving dental care. The Portuguese version was translated and validated by Hu et al.[22]

Physiological measurements

The recordings were made using a computerized system for monitoring physiological responses (I-330-C2+ Physiological Monitoring System, J&J Engineering, USA). Heart rate (HR) was derived from two active Ag/AgCl electrodes placed on the thorax and one ground Ag/AgCl electrode placed on the abdomen. Electromyogram activity (EMG) was derived from two active Ag/AgCl electrodes placed on the gastrocnemius muscle (part of the fight-or-flight response) of the non-dominant leg.

Procedure

Two experiments were performed. In both of them, volunteers had their psychological and physiological parameters evaluated before, during and after an anxiogenic situation. Data from each of these phases were confronted with scores of trait anxiety, in order to assess a possible correlation between trait and state anxiety.

Experiment I – VMST

Volunteers individually attended the laboratory on two consecutive days. The first day was used for adaptation and the second day for the actual test. The experiment was performed in a quiet room with the room temperature ranging between 22 and 25ºC.

On the first day, the participant was taken to the experiment room, which was already organized and equipped with the necessary apparatus for the execution of the test. After filling in a consent form and resting for about five minutes, the participant was subjected to the psychological evaluations (STAI, SPIN, HAD and STL) and then to five minutes of physiological recordings (HR, EMG).

On the second day, the participant was subjected to the anxiogenic situation of the VMST. Before being given the test instructions, they had their psychological (STAI-state and STL) and physiological (HR and EMG for 30 seconds) parameters evaluated. These data were labelled as the "before" experimental phase. After listening to the recorded instructions, the participant then performed the task, during which their physiological measurements were continuously recorded. After 50 words, a pause was made for a second set of psychological evaluations. These new data were labelled as the "during" experimental phase. Immediately following the evaluations, the test was restarted and continued up to the last color or until the end of the scheduled time, but no physiological data were recorded in this period. The participant then rested for five minutes, after which all the physiological (for 30 seconds) and psychological parameters were evaluated again. This final set of data was labelled as the "after" experimental phase.

Experiment II – TME

After an appointment with a dentist, subjects requiring extraction of their third molars were invited to participate in the study. After filling in a consent form, they had their psychological parameters (STAI, DAS, HAD and STL) evaluated.

On the day set for the surgery, volunteers stayed in a room adjacent to the dental operating room, with the room temperature ranging between 22 and 25ºC. They were subjected to the psychological evaluations (STAI-state, STL) and then to five minutes of physiological recordings (HR, EMG). This data collection served as an adaptation to the measurement instruments.

Subsequently, volunteers were taken to the dentist chair. Before the beginning of the surgery, they had their psychological (STAI-state, STL) and physiological (30 seconds) parameters evaluated. These data were labelled as the "before" experimental phase. Immediately after these measurements, surgery started and physiological parameters were continuously monitored, from the moment the volunteer opened their mouth to the moment of suture. At this point, surgical procedures were interrupted so that the psychological parameters could be evaluated. These data were labelled as the "during" experimental phase. Immediately following the evaluations, surgery was restarted and concluded. The participant then rested for five minutes, after which all the physiological (30 seconds) and psychological parameters were again evaluated. This final set of data was labelled as the "after" experimental phase.

Statistical analysis

The data collected during the adaptation phase were not analyzed, as this situation was only intended to habituate the participants to the environment and apparatus that would be used during the test.

In both experiments, the results collected on the test day were first analyzed using Kolmogorov-Smirnov's test for distribution normality and Mauchly's test for sphericity or Bartlet's test for homoscedasticity. No impediments to the use of parametric tests were found for any of the evaluated parameters. A level of significance of 5% was considered.

To confirm the anxiogenic character of VMST and TME, psychological and physiological parameters were analyzed using one-way analysis variance (ANOVA) for repeated measures (before, during and after), followed by Tukey's test. To assess the influence of previous exposure to TME, two-way ANOVA (factor 1: situation [before, during, after]; factor 2: exposure [no previous exposure or previous exposure]) was performed.

Correlational analyses were conducted using Pearson's correlation test. STAI-trait, DAS, HAD and

SPIN scores were confronted with STAI-state, STL, HR and EMG results in each experimental phase (before, during and after). Correlation was classified, according to Spitzer & Endicott,[23] into low ($r < 0.50$), moderate ($0.50 \leq r \leq 0.75$) and high ($r > 0.75$).

To verify the homogeneity of the anxious trait among the participants of the two experiments, the Student *t* test was performed, comparing STAI-trait and HAD-A scores of the two groups.

Results

To facilitate the visualization of results, graphs were plotted representing the profile of responses given by the volunteers, with the experimental phase "before" being considered as the "zero" point for changes induced by the test. Because the analyses involved repeated measures in the same individual, representation of dispersion of data provides little information; therefore, error bars were omitted from the graphs. Means and SDs of the absolute values obtained for each of the psychological and physiological parameters evaluated are presented in Table 1.

General trait anxiety

No significant differences ($t_{[48]} = 0.31$, $p = 0.75$) were found between mean STAI-trait scores of participants involved in Experiment I (35.9±12.52) vs. Experiment II (36.85±18.74). The same was observed for HAD-A scores ($t_{[48]} = 0.78$, $p = 0.43$; 5.16±4.31 vs. 6.05±7.28).

Experiment I – VMST

Anxiogenic effect of VMST

STAI-state (Figure 1). State anxiety changed significantly throughout the test ($F_{[2,58]} = 20.06$, $p < 0.0001$). The anxiety level increased during the task ($p = 0.0001$) and decreased after it ($p = 0.0001$), returning to basal levels.

STL (Figure 1). STL changed significantly throughout the test ($F_{[2,58]} = 17.50$, $p < 0.0001$). STL scores increased during the task ($p = 0.0001$) and decreased after it ($p = 0.0001$), returning to basal levels.

HR (Figure 2). HR changed significantly in response to the test ($F_{[2,56]} = 21.41$, $p < 0.0001$). The number of beats per minute increased during the task ($p = 0.0001$) and decreased after it ($p = 0.0001$), returning to basal levels.

EMG (Figure 2). EMG changed significantly in response to the test ($F_{[2,56]} = 11.53$, $p < 0.0001$). Muscle tension increased during the task ($p = 0.0003$) and decreased after it ($p = 0.0003$), returning to basal levels.

Correlational study of VMST

STAI-trait (Table 2). STAI-trait correlated to STAI-state before ($r = 0.56$, $p = 0.001$), during ($r = 0.66$, $p < 0.001$) and after ($r = 0.50$, $p = 0.005$) the VMST. It also correlated to STL, but only during ($r = 0.63$, $p < 0.001$) and after the test ($r = 0.37$, $p = 0.043$). No significant correlations between STAI-trait and physiological parameters were found in any of the experimental phases.

HAD-A (Table 2). HAD-A correlated to STAI-state before ($r = 0.63$, $p < 0.001$), during ($r = 0.67$, $p < 0.001$) and after ($r = 0.52$, $p = 0.003$) the VMST. It also correlated to STL, but only before ($r = 0.43$, $p = 0.001$) and after ($r = 0.55$, $p = 0.001$) the test. No significant correlations between HAD-A and physiological parameters were found in any of the experimental phases.

HAD-D (Table 2). HAD-D correlated to STAI-state before ($r = 0.48$, $p = 0.007$), during ($r = 0.55$, $p = 0.002$) and after ($r = 0.48$, $p = 0.007$) the VMST. It also

Table 1 - Summary of absolute values obtained in VMST and TME

Experiment/parameters	Before	During	After
VMST			
STAI-state	31.8±6.3	38.2±8.8	32.9±6.7
STL	2.5±1.5	3.7±2.1	2.4±1.6
HR	72.8±11.0	103.0±37.2	73.8±10.6
EMG	1.8±2.5	2.7±3.1	1.8±2.4
TME			
STAI-state	43.5±11.9	45.2±12.7	37.9±8.1
STL	5.0±2.9	6.4±2.5	3.5±2.9
HR	77.0±12.3	80.1±11.5	71.8±9.7
EMG	5.4±5.3	6.7±3.6	5.7±4.0

Data presented as mean ± standard deviation.
EMG = electromyogram activity; HR = heart rate; STAI = State-Trait Anxiety Inventory; STL = Self-evaluation of tension level; TME = third molar extraction; VMST = Video-Monitored Stroop Test.

correlated to STL before (r = 0.50, p = 0.005), during (r = 0.52, p = 0.004) and after (r = 0.39, p = 0.033) the test. No significant correlations between HAD-D and physiological parameters were found in any of the experimental phases.

SPIN (Table 2). SPIN correlated to STAI-state before (r = 0.42, p = 0.022), during (r = 0.74, p < 0.001) and after (r = 0.63, p < 0.001) the VMST. It also correlated to STL, but only during (r = 0.57, p = 0.001) and after (r = 0.41, p = 0.023) the test. No significant correlations between SPIN and physiological parameters were found in any of the experimental phases.

Experiment II – TME

Anxiogenic effect of TME

STAI-state (Figure 1). State anxiety changed significantly throughout the test ($F_{[2,38]}$ = 7.27, p = 0.002). The levels of anxiety before and during surgery did not differ, but the anxious state diminished after the surgical procedure (p = 0.002 in relation to both before and during surgery).

STL (Figure 1). STL changed significantly throughout the test ($F_{[2,38]}$ = 23.32, p < 0.0001). STL scores increased during surgery (p = 0.005) and decreased after it (p = 0.0001), returning to basal levels.

HR (Figure 2). HR changed significantly in response to the test ($F_{[2,38]}$ = 14.92, p < 0.001). The number of beats per minute before and during surgery was not different, but it decreased after the surgical procedure (p < 0.001 in relation to both before and after surgery).

EMG (Figure 2). EMG did not change over the test period ($F_{[2,38]}$ = 0.83, p = 0.445).

Influence of previous exposure to TME

The interaction between exposure and situation was not significant (Table 3): STAI-state ($F_{[2,36]}$ = 0.18, p = 0.834), STL ($F_{[2,36]}$ = 1.68, p = 0.20), HR ($F_{[2,36]}$

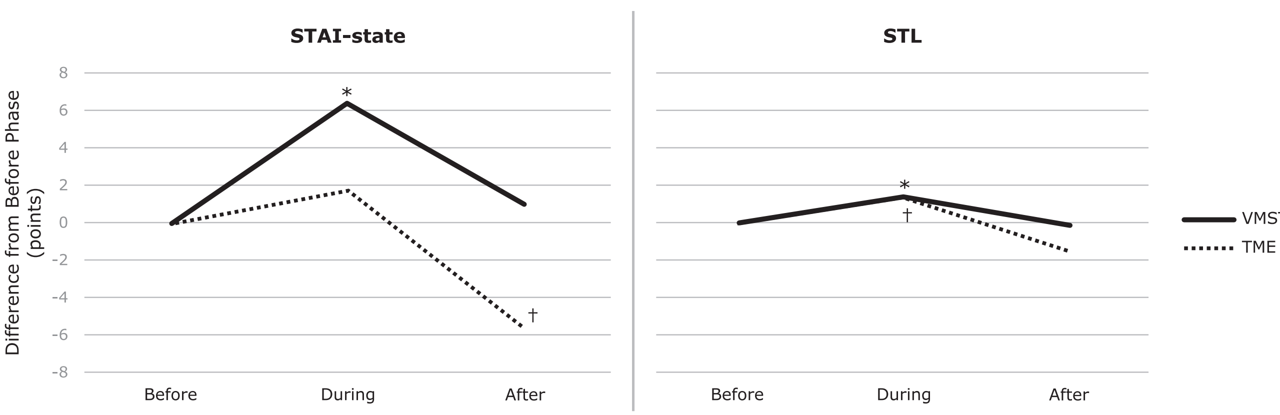

Figure 1 - Profile of STAI-state and STL in response to VMST and TME. STAI = State-Trait Anxiety Inventory; STL = Self-evaluation of tension level; TME = third molar extraction; VMST = Video-Monitored Stroop Test. * p = 0.0001, † p ≤ 0.005.

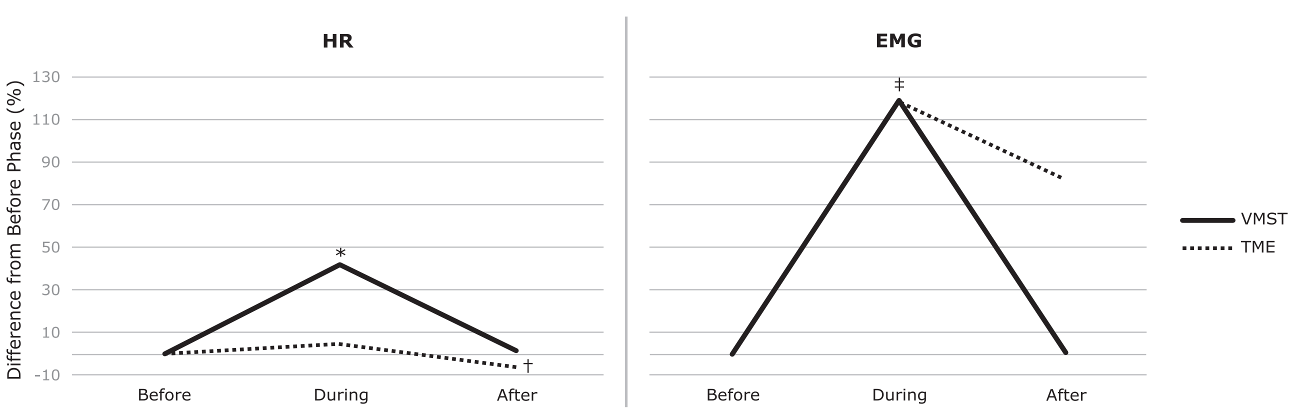

Figure 2 - Profile of HR and gastrocnemius muscle EMG in response to VMST and TME. EMG = electromyogram activity; HR = heart rate; TME = third molar extraction; VMST = Video-Monitored Stroop Test. * p = 0.0001, † p ≤ 0.001, ‡ p = 0.0003.

= 0.76, p = 0.475) and EMG ($F_{[2,36]}$ = 0.41, p = 0.664). Therefore, the two factors were analyzed individually. The exposure effect was not significant: STAI-state ($F_{[1,18]}$ = 0.22, p = 0.642), STL ($F_{[1,18]}$ = 0.003, p = 0.951), HR ($F_{[1,18]}$ = 0.01, p = 0.938) and EMG ($F_{[1,18]}$ = 0.11, p = 0.741). The situation effect was significant as previously described.

Correlational study of TME

STAI-trait, HAD-A and HAD-D (Table 4). None of these scales correlated to any state anxiety parameter (STAI-state, STL, HR, or EMG).

DAS (Table 4). DAS correlated to STAI-state before (r = 0.62, p = 0.003) and during (r = 0.50, p = 0.02) surgery. It also correlated to STL before (r = 0.65, p = 0.001) and during (r = 0.59, p = 0.006) surgery. No significant correlations between DAS and physiological parameters were found in any experimental phase.

Discussion

According to Spielberger et al.,[7] individuals with high levels of trait anxiety would be more susceptible to stress, responding to several situations as if they were dangerous or threatening, showing state anxiety reactions more frequently and with greater intensity than those with low trait anxiety. Thus, anxiety would be a unidimensional construct, and those individuals with higher levels of trait anxiety would present, on average, higher levels of state anxiety in different threatening situations.

For a better understanding of this premise, and due to controversies in the scientific community about the concept of anxiety as either a uni- or a multidimensional construct, the present study evaluated the correlation between trait anxiety and state anxiety in healthy humans exposed to two distinct anxiogenic situations: the VMST – a condition of interpersonal threat (Experiment I); and TME – a condition of physical threat (Experiment II).

The results of Experiment I showed that the VMST induced reversible increases in the values of both psychological (state anxiety and subjective tension) and physiological (heart rate and gastrocnemius tension) parameters, confirming the anxiogenic character of the test and corroborating previous data.[13,24,25]

At this point, it is worth mentioning that the anxiety evaluated in the "before" experimental phase of the VMST is considered as an anticipatory anxiety, triggered by the subject's concern in relation to novelty. Conversely, the anxiety observed in the "during" experimental phase is due to the anxiogenic character of the test, as the individual considers their performance in the test

Table 2 - Pearson's correlation coefficients between trait and state anxiety parameters observed in Experiment I (Video-Monitored Stroop Test)

	STAI-trait	SPIN	HAD-A	HAD-D
STAI-state				
Before	0.56*[M]	0.42†[L]	0.63*[M]	0.48†[L]
During	0.66*[M]	0.74*[M]	0.67*[M]	0.55*[M]
After	0.50*[M]	0.63*[M]	0.52*[M]	0.48†[L]
STL				
Before	0.35	0.39	0.43*[L]	0.50*[M]
During	0.63*[M]	0.57*[M]	0.55*[M]	0.52*[M]
After	0.37†[L]	0.41†[L]	0.32	0.39†[L]
HR				
Before	0.15	0.17	0.14	0.08
During	0.12	0.16	0.01	-0.17
After	0.14	0.14	0.08	0.11
EMG				
Before	-0.15	-0.12	-0.09	-0.27
During	-0.12	-0.15	-0.12	-0.28
After	-0.14	-0.14	-0.05	-0.25

EMG = electromyogram activity; HAD-A = Hospital Anxiety and Depression Scale – Anxiety; HAD-D = Hospital Anxiety and Depression Scale – Depression; HR = heart rate; STAI = State-Trait Anxiety Inventory; SPIN = Social Phobia Inventory; STL = Self-evaluation of tension level.
Correlation classification according to Spitzer & Endicott[22]: [H] = high; [M] = moderate; [L] = low.
* p < 0.005; † p < 0.05.

Table 3 - Summary of absolute values according to previous exposure to TME

	No previous exposure to TME (n = 11)	Previous exposure to TME (n = 9)
STAI-state		
Before	45.3±9.3	42.0±13.9
During	45.7±11.6	44.8±14.1
After	39.1±10.1	36.9±6.4
STL		
Before	5.3±2.5	4.7±3.3
During	6.4±2.1	6.4±2.8
After	3.0±2.7	3.9±3.2
HR		
Before	78.0±13.4	76.2±11.9
During	79.4±11.6	80.6±11.9
After	70.8±11.7	72.5±8.3
EMG		
Before	4.5±2.9	6.2±6.7
During	6.7±3.7	6.7±3.7
After	5.8±4.3	5.7±4.0

Data are presented as mean ± standard deviation.
EMG = electromyogram activity; HR = heart rate; STAI = State-Trait Anxiety Inventory; STL = Self-evaluation of tension level; TME = third molar extraction.

as a threat to their self-concept and to the opinion of others about them. Finally, the anxiety experienced in the "after" experimental phase is a residual anxiety, still remaining after the response to the test decreases.[13]

Once the anxiogenic character of the VMST was confirmed, the hypothesis that trait anxiety would modulate anxious response (state anxiety) before, during and after the VMST was evaluated using a correlational study. It is important to note that, although a correlational study *per se* does not clarify causal relationship, statistical data cannot be disconnected from methodological limitations, which may restrict the interpretation of what is observed. As the supposed effect cannot precede the supposed cause, the correlations observed here can be interpreted as an influence of trait anxiety on state anxiety, until proven otherwise by the exposure of hidden variables.

The results of the VMST indicated that trait anxiety, as evaluated by both STAI-trait and HAD-A, showed a moderate, positive correlation to state anxiety, as evaluated by STAI-state, in all test phases, and the correlation coefficient was higher during the test. This means that trait anxiety modulates anticipatory, residual and, mainly, reactive state anxiety in the VMST situation. The influence of trait anxiety on reactive anxiety was also evidenced by a moderate, positive correlation found between STAI-trait and STL, and between HAD-A and STL. These findings support the premise of Spielberger et al.[7]

Conversely, the correlation was not perfect, which leads us to understand that the anxious profile evaluated by STAI-trait and HAD-A cannot be considered the only determinant of anxious response. Moreover, the greatest of all correlational indices (r = 0.74) was observed between SPIN and STAI-state during VMST, revealing the importance of the type of anxiogenic stimulus on the genesis of an anxious response.

Facing this observation, it is reasonable to question whether 1) trait anxiety is indeed a unidimensional construct, as believed by Spielberger et al.,[7] and thus can predispose to increases in state anxiety in a variety of threatening situations; or 2) trait anxiety is actually a multifactorial construct, which affects anxious response in different ways depending on the type of threatening stimulus. In this case, the positive correlations found in the VMST experiment would mean that STAI-trait and HAD-A measure anxiety related to threat to self-esteem,[8] which is the kind of anxiety induced by VMST.

Aiming to clarify this question, Experiment II was performed. Anxiety was evaluated in a situation of physical, rather than interpersonal, threat, related to a dental procedure (TME).

The anxiogenic character of TME was confirmed, as the level of state anxiety decreased after surgery. However, as is common in studies of real-life stress, there were difficulties involved in obtaining adequate baseline measures, as the volunteers were aware of the stress they were going to go through, thus presenting

Table 4 - Pearson correlation coefficients between trait and state anxiety parameters observed in Experiment II

	STAI-trait	DAS	HAD-A	HAD-D
STAI-state				
Before	0.30	0.62*^{M}	0.23	0.25
During	0.05	0.50$^{\dagger M}$	-0.02	0.07
After	0.08	0.14	-0.02	0.17
STL				
Before	0.29	0.65*^{M}	0.26	0.35
During	0.39	0.59$^{\dagger M}$	0.41	0.34
After	0.04	0.38	0.22	-0.05
HR				
Before	-0.08	-0.17	-0.21	0.07
During	-0.31	-0.33	-0.22	-0.11
After	-0.21	-0.22	-0.18	-0.21
EMG				
Before	-0.32	-0.17	-0.18	-0.28
During	0.21	-0.15	0.30	0.39
After	-0.05	-0.13	0.08	0.13

DAS = Dental Anxiety Scale; EMG = electromyogram activity; HAD-A = Hospital Anxiety and Depression Scale – Anxiety; HAD-D = Hospital Anxiety and Depression Scale – Depression; HR = heart rate; STAI = State-Trait Anxiety Inventory; STL = Self-evaluation of tension level.
Correlation classification according to Spitzer & Endicott[22]: ^{H} = high; ^{M} = moderate; ^{L} = low.
* $p < 0.005$; † $p < 0.05$.

high levels of anticipatory anxiety.[26] As a result, it was not possible to detect a difference in state anxiety levels before or during the TME.

The same response profile was observed for HR, but not for EMG, which did not change during the procedure. This unexpected result related to gastrocnemius tension level can probably be explained by the position of the patient in the dentist chair and constant voluntary movement of the legs during surgery, which may have interfered with the detection of electromyographic signals.

The hypothesis that trait anxiety would modulate anxious response throughout the TME was assessed using a correlational study. Differently from Experiment I, trait anxiety, as evaluated by STAI-trait or HAD-A, did not correlate with either state anxiety or subjective tension in any of the experimental phases.

The DAS, which evaluated "trait" anxiety specifically related to dental procedures, showed a moderate, positive correlation to both STAI-state and STL before and during surgery. These results are in agreement with a study by Yusa et al.,[14] in which patients with higher DAS scores also had higher STAI-state scores before the TME.

In neither of the two experiments, I or II, correlation was found between trait anxiety scales and physiological parameters in any moment evaluated. Although this lack of correlation could be expected for TME, as the "general" anxious profile showed no influence on state anxiety, the same cannot be said about VMST. The explanation may be related to the volunteers' different levels of fitness, which generate different cardiorespiratory and muscular adaptations, interfering with the level of physiological response to stress. It has already been shown that the level of physiological changes may not reflect the level of subjective anxiety.[13,27]

The different outcomes from the correlational studies of the two experiments have three possible explanations: 1) bias on the execution of Experiment II, as the volunteers were not all naive to the TME procedure – some of them had already removed a third molar before; 2) bias in the design of the STAI-trait instrument, which would tend to evaluate only anxiety related to interpersonal situations of threat; and 3) bias in the concept of trait anxiety as a unidimensional construct.

The first explanation is not likely, as the comparison between individuals not previously exposed vs. previously exposed to TME did not show significant differences in the anxious response to the procedure. This absence of difference has also been demonstrated in previous studies.[14,28]

The second possible explanation requires a little more consideration. To Spielberger et al.,[7] the STAI-trait inventory presents items that describe symptoms of anxiety, such as "I worry too much over something that really doesn't matter" and others that show absence of anxiety, such as "I feel secure."[5] However, some authors have suggested that the items that try to display absence of anxiety may in fact evaluate levels of dysphoric mood that are mostly associated with depression, rather than with anxiety, such as "I wish I could be as happy as others seem to be."[29-31] This characteristic of the STAI could explain why correlations between STAI-trait and STAI-state are found only in situations of social evaluation – social anxiety and depression share come common characteristics, such as shame.[32] In fact, there is a hypothesis that social anxiety and depression are variants of the same disease.[33] Corroborating that hypothesis, the present study found a moderate correlation between HAD-D and STAI-state, and between HAD-D and STL, during the VMST, leading to the interpretation that individuals who had more feelings and attitudes related to depression felt more anxious and tense during the test. In summary, it is possible that STAI-trait is not evaluating trait anxiety, but a trait of depression or negative mood,[30] and consequently, cannot correlate to the state anxiety elicited by a non-interpersonal threat. In this case, the same would have to be said about the HAD-A scale.

Finally, the third possible explanation also deserves a little more attention. According to Vagg et al.,[5] the STAI-trait inventory offers a unidimensional approach to both state and trait anxiety, assuming the existence of a general trait of anxiety and of a predisposition to increased state anxiety in a variety of threatening situations. However, some researchers disagree with this theory. According to Endler & Parker[8] and Endler & Kocovski,[9] both trait and state anxiety are multidimensional constructs, in which trait anxiety has facets (social anxiety, physical danger, ambiguous and daily routine), and state anxiety is only increased if the threatening situation is congruent with the facet of the trait in question. This is the proposition that the present results seem to support. When anxiety was assessed in a situation of social threat, trait anxiety and anxious response were correlated, but this was not observed in the physical threat situation, leading to the interpretation that STAI-trait and HAD-A are sensitive to only one of the two tested anxiety traits, i.e., social anxiety trait. In fact, this analysis revisits an issue approached in the 1960s and 1970s, when researchers discussed the possibility of various scales of trait anxiety related only to situations of social evaluation.[34-36] Despite that debate, until today, STAI is being used as initially proposed, e.g., to evaluate a specific, unidimensional emotion, and it became the gold standard for anxiety assessment, being used in several different types of research.[37]

Considering all this, it becomes clearly important to revisit the concept of trait anxiety. Although the idea of a general anxious trait cannot yet be discarded, simply accepting it would mean that some trait anxiety scales are not adequately assessing this personality trait – including STAI-trait, as it does not correlate to anxious response in physical threat situations, as shown by the data presented here and also in previous studies.[27,38]

Anxiogenic situations other than interpersonal or physical threats still need to be studied before we can discard the hypothesis that scales of "general" trait anxiety are sensitive to all but physical dangers. Women should also be evaluated, as it is evident that there are gender-related influences on all levels of the nervous system, and this certainly reflects on behavior.[39] However, the results presented here point to a difficulty, or perhaps an impossibility, to measure a general trait of anxiety, which would predispose individuals to respond more or less anxiously to any situation of threat. Therefore, it seems more likely that trait anxiety is multifaceted, as proposed by Endler & Parker[8] and Endler & Kocovski.[9] Consequently, caution must be exercised when interpreting the premise of Spielberger et al.[7] and when applying the STAI-trait instrument to classify individuals' profiles as more or less anxious.

Conclusions

Trait anxiety, as measured by STAI-trait and HAD-A, correlates positively to state anxiety in situations of interpersonal threat, but not of physical threat.

Disclosure

No conflicts of interest declared concerning the publication of this article.

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