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Multiple-Response Biofeedback Assisted Relaxation for Generalized Anxiety Disorder

Relajación asistida por biorretroalimentación de respuesta múltiple para el trastorno de ansiedad generalizada

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Among the current interventions for generalized anxiety disorder (GAD), biofeedback-based training has shown efficacy at reducing physiological arousal associated to the anxiety response. Traditional protocols however generally include recordings of a small number of physiological responses. In addition, few studies have explored if biofeedback can impact on cognitive symptoms of GAD such as excessive worry. The purpose of this study was to determine the efficacy of a multiple-response biofeedback training protocol in reducing physiological arousal of GAD and determine if these changes can impact on worry and co-occurring depressive symptoms. Fifteen GAD patients (9 women and 6 men) completed individual treatment comprising eleven biofeedback-assisted sessions. Psychophysiological recordings were taken and excessive worry, as well as anxiety and depressive symptoms were measured before and after training. Friedman ANOVA tests and objective clinical change showed positive effects by reducing levels of excessive worry as well as reported anxiety and depressive symptoms. Improvement also occurred on muscle tension and respiratory amplitude after treatment as supported by previous studies. No significant effects were observed in respiratory rate, heart rate, peripheral temperature or skin conductance. Findings of the present study support biofeedback-based interventions as an effective alternative for GAD and co-occurring depressive symptoms.

Keywords: biofeedback, worry, stress profile, relaxation training, physiological arousal.

Entre las intervenciones para el trastorno de ansiedad generalizada (TAG), la retroalimentación biológica ha demostrado ser eficaz disminuyendo la activación fisiológica asociada a la respuesta de ansiedad. Sin embargo, los protocolos tradicionales registran un número reducido de respuestas y pocos han evaluado el efecto de esta herramienta sobre la sintomatología cognitiva del TAG. El propósito del presente estudio fue determinar la eficacia de un protocolo múltiple basado en retroalimentación biológica sobre la activación fisiológica, además de determinar si estos cambios pueden disminuir la presencia de preocupaciones y sintomatología depresiva asociada. Quince pacientes con TAG (9 mujeres y 6 hombres) completaron un protocolo individual conformado por once sesiones de entrenamiento. Se registraron perfiles psicofisiológicos y se evaluó la presencia se preocupaciones, así como síntomas de ansiedad y depresión antes y después del entrenamiento. El ANOVA de Friedman y el cambio clínico objetivo mostraron disminución significativa en las tres variables al final del entrenamiento. Adicionalmente se observaron efectos positivos sobre tensión muscular y amplitud respiratoria, lo cual concuerda con estudios previos. No se observaron efectos sobre las demás respuestas evaluadas. Estos hallazgos apoyan el empleo de la retroalimentación biológica como una alternativa de tratamiento para el TAG y los síntomas depresivos comórbidos.

Palabras clave: retroalimentación biológica, preocupación, perfil de estrés, relajación, activación fisiológica.

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According to DSM-V, generalized anxiety disorder (GAD) is defined by the presence of excessive and uncontrollable worry related to a variety of areas of functioning (health, money, work, etc.) for no less than six months. Worry in GAD is often accompanied by restlessness, fatigue, concentration difficulties, irritability, muscle tension and sleep disturbances (American Psychiatric Association, 2013). GAD is considered one of the most prevalent anxiety disorders worldwide, in Mexico its lifetime prevalence stands at 0.9% of the general population (Medina-Mora, Borges, Benjet, Lara, & Berglund, 2007), while in Mexico City this disorder shows a prevalence of 3% and 7% for young men and women from 12 to 17 years old (Benjet et al., 2009). In addition to psychological symptoms, anxiety response often includes the activation of the musculoskeletal system as well as the Autonomic Nervous System (ANS), specifically the sympathetic nervous system (SNS) leading to increased heart rate, blood pressure and respiratory rate, as well as decreased peripheral temperature in both, upper and lower extremities as well as increased muscle tension, mainly in frontalis and gastrocnemius, two muscle groups strongly related to stress and anxiety responses (Kaltsas & Chrousos, 2007; McLeod, Hoehn-Saric, & Stefan, 1986; Singh & Sahni, 2000). In the case of GAD, the research literature has shown some inconsistent findings regarding physiological arousal as a feature of this disorder. Studies supporting arousal have reported increased electromyographic activity (EMG) in GAD and panic disorder (PD) patients compared to controls (Hazlett, McLeod, & Hoehn-Saric, 1994; Hoehn-Saric, McLeod, & Zimmerli, 1989; Hoehn-Saric, Hazlett, Pourmotabbed, & McLeod, 1997; Pluess, Conrad, & Wilhelm, 2009). Others have reported increased heart rate in "excessive worriers" compared to controls (Knepp & Friedman, 2008) as well as increased skin conductance responses (SCR) (Kirschner et al., 2016). In contrast, some authors have reported the absence of differences between controls and GAD subjects in sympathetic and cardiac vagal activity (Hammel et al., 2011). These findings are supported by others, who have failed to find differences in autonomic arousal in GAD patients through measures of skin conductance response (SCR), heart rate (HR), blood pressure and respiration (Fisher, Granger, & Newman, 2010; Hoehn-Saric, MacLeod, Funderburk, & Kowalski, 2004; Hoehn-Saric & McLeod, 2000; Roth et al., 2008). Moreover, GAD patients have shown lower values of SCR when compared to non-anxious controls at baseline (Hoehn-Saric et al., 1989; Roth et al., 2008). These contradictory findings have led to wonder whether phsysiological arousal should be conceived as a main feature in diagnosing GAD. One possible explanation for these contradictory findings could be that subjetive reports of physiological arousal usually fail to match the actual reccordings in GAD patients. Although these patients are able to identify the direction of changes in responses like heart rate (an increase or decrease in arousal), they tend to magnify these changes in comparison with non-anxious participants (Hoehn-Saric & McLeod, 2000). This underlines the importance of including pshysiological evaluation to assess arousal. Another possibility is that GAD appears to be predominantly a cognitive disorder, in comparison to other anxiety disorders such as PD.

Among the current interventions for GAD, biofeedback-based training has shown efficacy at reducing physiological arousal associated to the experience of anxiety. One of the first studies that evaluated the efficacy of biofeedback in treating GAD combined feedback-assisted progressive muscle relaxation with cognitive behavioral techniques (CBT) in GAD and PD patients through 18 sessions. Results estimated through EMG and HR recordings showed signifficant decreases in muscle tension for both, GAD and PD patients after treatment while HR showed no differences from pre to post treatment evaluation (Barlow et al., 1984). Another study conducted by Rice, Blanchard and Purcell (1993) examined the efficacy of a four-condition treatment protocol for GAD in which one of the components consisted of frontal EMG feedback. Effects were estimated through HR, frontal EMG activity, skin resistance and peripheral temperature in upper extremities. Pre to post evaluation results showed a slight decrease in EMG activity with little or no change in the other three responses. Recently, Agnihotri, Paul and Sandhu (2007) conducted a study in which patients were assigned to one of three conditions: a) EEG alpha activity training, b) frontal EMG biofeedback training and c) a control condition. Measures of frontal EMG recordings and blood pressure showed significant reductions in both experimental groups while the control group showed no changes from pre to post treatment. Few studies including biofeedback-assisted interventions for generalized anxiety have included psychological measures as an attempt to test if physiological changes can indirectly impact core features of GAD such as worry and perception of physical symptoms of anxiety. The single study found to date addressing this issue evaluated the efficacy of a biofeedback assisted virtual reality-based protocol on worry, physical symptoms of anxiety and heart rate as the main physiological response. According to the authors, no positive effects were reported on the amount of worrisome thoughts (PSWQ) or on heart rate. Reported symptoms of anxiety significantly reduced after treatment as showed by the BAI and the State and Trait Anxiety Inventory (Gorini et al., 2010). Even when worry didn't appear to be affected by treatment, methodological issues as well as lacking of data and analyses description hinder the answer regarding the positive effects of biofeedback on excessive worry.

Even when studies have shown some efficacy at reducing physiological arousal associated to GAD, the majority of them have included only few physiological responses in both training and evaluation. This raises the question of whether the positive effects of biofeedback can be seen in a wider range of responses and whether effects can be potentiated through simultaneous training of multiple physiological responses and if this intervention is also effective in reducing depression symptoms normally co-occurring with GAD (Carter, Wittchen, Pfister, & Kessler, 2001; Grant et al., 2005). Thus, the purpose of the present study was to determine if positive physiological effects of biofeedback could impact worry as well as perceived symptoms of anxiety and depression in a

group of GAD patients, and if physiological effects could be potentiated through a multiple-response biofeedback training.

Method

Participants

Fifteen patients (9 women, 6 men, $\overline{X}_{age}$= 47 years, DS=13.59) from Mexico's National Institute of Psychiatry (*INPRF*) were invited to participate. All patients were diagnosed with GAD using DSM-V criteria by a trained psychiatrist affiliated to the institution and unaware of the purpose of the study. Patients were additionally evaluated for anxiety and depression symptomatology and GAD diagnosis was confirmed through a symptom checklist according to DSM-V criteria conducted by a trained psychologist. All GAD patients were taking prescribed SSRI's antidepressants at the beginning of the study according to institutional norms (See Table 1). Data from patients whose main diagnosis was not GAD and/or whose anxiety symptoms were associated to substance use were excluded from further analysis.

Study design

After signing informed consent, all fifteen patients were individually assigned to a single biofeedback-based intervention consisting of eleven, one-hour sessions in which they received multiple response biofeedback training through five physiological responses: surface electromyographic activity (sEMG), heart rate HR, skin conductance response (SCR), peripheral temperature and respiratory rate and amplitude. Feedback was assisted with three different relaxation techniques: diaphragmatic breathing, progressive muscle relaxation and autogenic training, this sequence was maintained across all interventions. A within subjects design (n=1) was used for conducting the interventions, and statistical analyses were based on within group scores from pre, post and follow-up evaluations aimed to determine physiological and psychological effects after training.

Physiological variables

Surface EMG was measured with three Ag/AgCl disposable electrodes placed on the forehead with one of them aligned with the nasal septum, and the other two one-quarter inch above the eyebrow, directly above the idle position of the iris of the eyes. The MyoScan-Pro sensor's can record sEMG signals from zero up to 2000 microvolts (mV) with an active range of 10 to 500 Hz. For preparation, skin was cleansed with cotton and rubbing alcohol before placing the electrodes; no conductive gel was needed. Frontal placement was chosen since it is considered a good indicator of general emotional state as one of the original sites used in psychophysiological research, particularly in assessing physiological responses to stress and specifically GAD (Hazlett et al., 1994; Hoehn-Saric et al., 1989; Hoehn-Saric, McLeod, & Zimmerli, 1991; McLeod, Hoehn-Saric, & Stefan, 1986). For recording HR a BVP signal was used through photoplethysmography, which bounces infrared light against skin surface and measures the amount of reflected light. The sensor was placed on the index fingertip of the dominant hand after cleaning the area. For SCR two Ag/AgCl disposable electrodes were placed on the middle phalanges of fingers 2 and 4 of the non-dominant hand. Electrodes with a circular contact area were placed directly over the skin after cleaning the contact surface with water; no isotonic solution was required. Skin Conductance was measured in a range from 0 to 30.0 micro Siemens (mS). For peripheral temperature a thermistor was attached with a small piece of surgical tape in the first phalange of the middle finger of the non-dominant hand after cleaning. Input range for this sensor is from 10ºC to 45ºC (50ºF to 115ºF). Finally a self-adjusting elastic band was used for recording respiratory rate and amplitude. Sensor was placed around the abdomen (around the navel). No skin preparation was needed.

Apparatus

For psychophysiological recording, a simultaneous 8-channel ProComp Infiniti amplifier was used with capacity of recording from 20 (8Hz) to 2048 (512Hz) samples/second. Encoder's weight is about 200g and it sizes 130mm x 95mm x 37mm.

Psychophysiological Assessment

Psychophysiological stress profiles were conducted for each participant. Each profile included seven phases of four minutes each, in which patients were individually exposed to alternate states of stress and relaxation, completing a total of 28

Table 1.
Patients' characteristics (N=15).

Sex		Age		Education		Occupation		Civil Status		Treatment	
Men	6	Mean	47	Primary	2	House keeping	3	Married	4	Paroxetine	5
Women	9	Minimum	22	Secondary	3	Employee	8	Single	8	Fluoxetine	3
		Maximum	66	High school	4	Self-employed	2	Cohabiting	3	Citalopram	3
				Technician	1	Unemployed	1			Sertraline	3
				University	4	Student	1			Venlafaxine	1
				Master	1						

Note: Frequency distribution of patients' characteristics.

minutes of recording. The procedural sequence was as follows: a) an initial baseline was recorded in order to allow the patient to relax and get familiar with the novel situation. Instructions were as follows: *"for the next few minutes, we will ask you to remain seated in a comfortable position; close your eyes and relax"*; b) baseline was followed by a computerized version of the Stroop test, a perceptual interference task that reliably induces heightened physiological changes. Instructions for this phase were: *"during the next minutes you will see a list of color words on the screen. Your task consists in saying out loud the color of each word without reading it. Please do it as quickly as you can for the lists will be replaced frequently"*; c) patients were then asked to relax and stay calmed during the next four minutes. The instructions were similar to those at baseline; d) the fourth phase consisted in making arithmetic calculations as a cognitive stressor. The instructions were as follows: *"During the next minutes we will ask you to count backwards from 1081, subtracting seven. Please say the result out loud. Do it as quickly as you can and try not to make any mistakes"*; e) this phase was exactly the same as phases one and three in which patients were asked to remain calmed and relax; f) patients were then exposed to a cognitively stressful situation. The instructions were: *"now we will ask you to worry like you normally do or think about some stressful experience you might have had in the past or might be having right now. Please focus on every detail, especially on the thoughts/worries you experienced"*. This task had the objective to detect physiologic arousal associated to the presence of actual or imagined worry; g) finally, the last four minutes consisted in asking the patient to sit comfortably and relax in the same way he/she did in phases one, three and five.

Psychological assessment

Patients were evaluated for cognitive and somatic symptoms of anxiety and depression before and after receiving training as well as at follow-up (an average of two and a half months later); measures included:

Beck Anxiety Inventory (BAI) adapted version (Robles, Varela, Jurado, & Páez, 2001), which evaluates somatic anxiety through 21 multiple-response items (internal consistency: α=0.83 and test-retest reliability, r=.75).

Penn State Worry Questionnaire (PSWQ), (Meyer, Miller, Metzger, & Borkovec, 1990) which evaluates the presence and difficulty controlling worry through 16 Likert scale items.

Beck's Depression Inventory (BDI) adapted version (Jurado et al., 1998), which evaluates somatic symptomatology of depression through 21 multiple response items (internal consistency: α=0.87).

Biofeedback Training

Training consisted of 11 weakly sessions of 60 minutes approximately in which participants received feedback of 5 physiological responses through the sequence: respiration, HR, sEMG, SCR and peripheral temperature, combined with relaxation techniques (diaphragmatic breathing, progressive muscle relaxation and autogenic training). The first and last sessions were used to assess each patient through the BAI, BDI and PSWQ as well as the psychophysiological stress profile. The remaining nine sessions were divided in groups of three sessions each in order to receive feedback of two responses at a time (training sessions and relaxation techniques are described in table 2).

Shift from one response to the next within training protocol depended on patient's ability to achieve control upon the previous responses, which made the number of overall sessions vary slightly in some cases. Each training session consisted of 5 minutes of initial baseline recording, followed by 30 minutes of feedback and practice in which patients performed each relaxation technique. Then, 5 more minutes of final recording took place for a total of 40 minutes of recording. The first 20 minutes of each session were used to set up and connect the equipment and to explain the basics of each relaxation technique as well as the feedback procedure.

For relaxation practice a recording with guiding instructions was used, this to make sure that intervention was standard for each patient. Two trained psychologists were present during the whole session in order to model the procedures and to clarify or answer questions as needed.

Procedure

On arrival to the to the INPRF facilities, patients were interviewed and evaluated in order to confirm main diagnosis of GAD. After diagnosis confirmation, patients were invited to participate in the study. If they did not accept, the institutional standard group CBT was offered. Those who accepted were given the informed consent explaining the objectives and structure of the intervention; once they consented, patients were scheduled for pre training evaluation through questionnaires and psychophysiological profile. After being evaluated, each patient initiated training sessions until completing training of all 5 physiological responses; then, post evaluations were conducted, after which they were discharged and scheduled for fo-

Table 2.
Intervention Components Across Sessions.

Relaxation technique	Feedback response	Sessions
Diaphragmatic breathing	Respiration and HR	2, 3, 4
Progressive muscle relaxation	EMG activity	5, 6, 7
Autogenic training	SCR and peripheral temperature	8, 9, 10

Note: Treatment procedures by number of sessions assigned.

llow-up evaluations 2 and a half months on average later. Time between post evaluation and follow-up varied slightly across patients due to practical conditions.

Results

Initially a Friedman ANOVA test was performed to examine changes in reported physical symptoms of anxiety and depression as well as the presence of excessive worry across evaluations (pre, post, follow-up). Analysis showed significant positive effects in all measures (BAI, BDI and PSWQ), see table 3.

To analyze these differences, Wilcoxon tests were conducted for pre-post, post-follow-up and pre-follow-up evaluations given the nature of the data. Bonferroni correction was applied in order to reduce type I error; values located under p= .016 were considered statistically significant for these comparisons. These analyses showed a significant reduction of anxiety symptomatology (BAI) from pre (IQR= 16-32) to post treatment evaluations (IQR= 3-20) (z=-3.2, p=0.001). This tendency was observed between pre and follow-up (IQR= 1.75-8.25) measures as well (z=-3.3, p=0.001). No statistical differences were found from post to follow-up measures (z=-2.1, p=0.034). In the case of worry (PSWQ), reduction was significant from pre (IQR= 50-74) to post evaluation (IQR= 36-50) (z=-3.41, p=0.001) as well as from post to follow-up (IQR= 29.7-47.2) (z= -2.1, p=0.035). Depressive symptoms also decreased significantly from pre (IQR= 11-29) to post evaluations (IQR= 3-14) (z=-3.11, p=0.002) and from pre to follow-up (IQR= .75-10) (z=-3.11, p=0.002). No significant differences were found from post to follow-up (z= -1.84, p=0.065).

Given the small number of participants in the study, a second Friedman ANOVA test was used to examine differences in physiological responses (respiratory rate and amplitude, HR, frontal EMG, peripheral temperature and SCR) across all measures (pre, post and follow-up). This analysis compared each phase of the stress profile with its analogue across all three evaluations. Significant differences were found only in respiratory rate in the case of *rest 2* from pre to post treatment (X^2=6.14, p=0.046). Median scores decreased from pre=23.0 (IQR=17.9-26.8) to post evaluation=18.2 (IQR=16.4-21.3). At follow-up respiratory rate remained stable (Median= 18.9; IQR=15.2-24.7). No significant differences were found for the other responses (p > 0.05).

In order to determine the clinical significance for all responses Objective Clinical Change index (OCC) was used (Cardiel, 1994). This analysis examines group clinical significance of each comparison, pre-post and post-follow-up, through every phase of the stress profile; which can be calculated obtaining the difference between post-test and pre-test evaluations and dividing the result by pre-test ones. Clinical significance is determined above .20 (equivalent to 20% change) according to the author (see table 4).

Significant reduction in frontal EMG was observed from pre to post treatment evaluations in all phases of the stress profile, however effects were clinically significant only in phases: *stroop* (Median pre= 5.53 (3.91-6.88); Median post= 4.35 (3.67-5.53)), *rest 1* (Median pre=4.8 (3.37-5.99); Median post=3.01 (2.5-3.82) and *rest 3* (Median pre=5.07 (2.28-5.64); Median post=2.82, (2.03-3.54). At follow-up positive effects were still observed, with no additional improvement. Clinical positive effects were also observed in respiratory amplitude from pre to post treatment evaluation in phases: *rest 1* (Median pre=.87 (.58-2.55); Median post=2.77 (.77-4.43), *rest 2* (Median pre=1.09 (0.6-2.36); Median post=1.09 (.81-4.51), and *rest 3* (Median pre=.74 (.45-2.79); Median post=1.33 (.64-4.52). At follow-up, respiratory amplitude values decreased again, possibly because of a lack of continuous practice. No clinical effects were observed in SCR, peripheral temperature, HR or respiratory rate from pre to post evaluations. At follow-up, only SCR showed a significant decrease in *stroop* activity (Median post=1.9 (1.15-2.76); Median follow-up=1.43 (.89-2.37). Group changes appear in figures 1 and 2.

Figures 3 and 4 show data of two patients, those who showed the highest and the lowest improvements from pre to post evaluations in frontal EMG activity and respiration amplitude, as compared against the group mean.

Discussion

The main purpose of the present study was to determine whether positive physiological effects of biofeedback could impact worry as well as perceived symptoms of anxiety and de-

Table 3.
Friedman ANOVA test for Anxiety, Worry and Depression Symptomatology (N=14).

Table 3
Friedman ANOVA test for Anxiety, Worry and Depression Symptomatology (N=14)

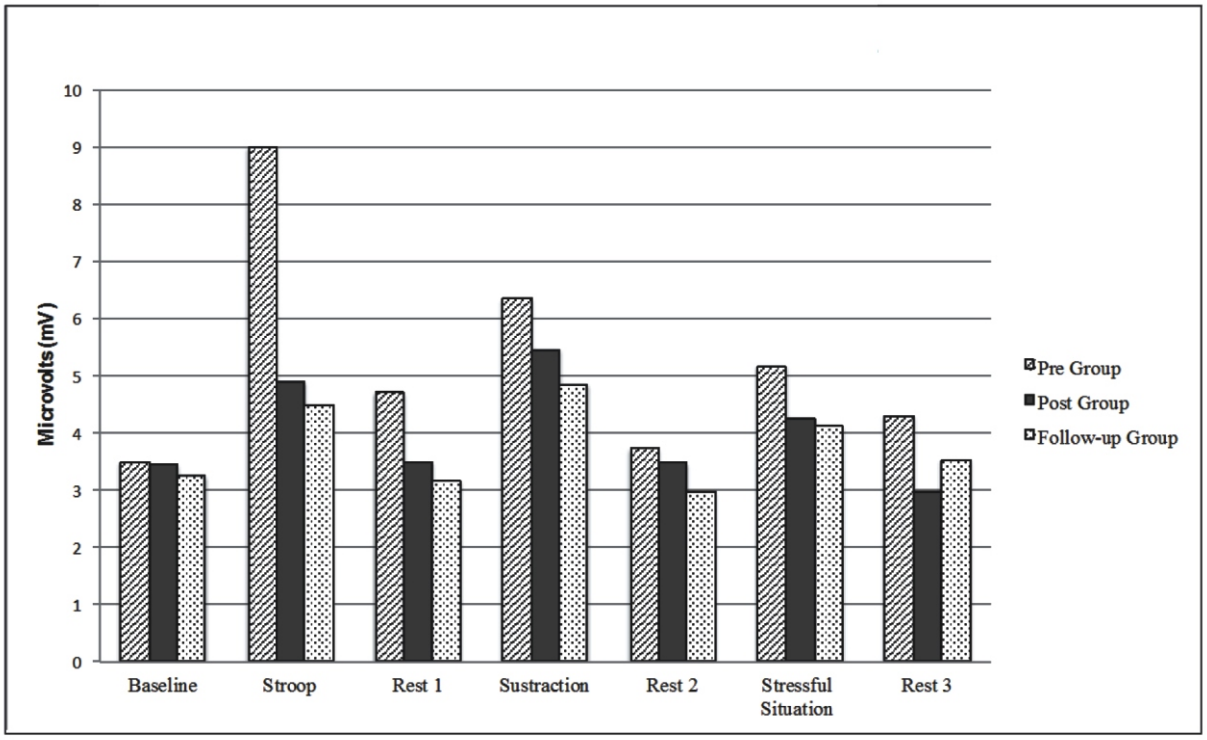
Measures	Pre	Post	Follow.up	x^2	p
BDI	17.5 (12.5-29.75)	8 (4.5-14.25)	4.5(0.75-10)	14.37	**0.001**
BAI	25.5(17.5-32.7)	6.5(2.7-20.2)	5.0(1.7-8.2)	20.76	**<0.001**
PSWQ	64.5(49.7-74.5)	46(35.2-52.5)	39.5(29.7-47.2)	21.92	**<0.001**

Note: Comparisons across evaluations for all three questionnaires. Median outside parenthesis and Inter Quartile Range (IQR) are reported. Data of one participant was excluded from the analysis given the impossibility for collecting follow-up evaluation.

Table 4.
Objective Clinical Change (OCC) scores for all physiological responses.

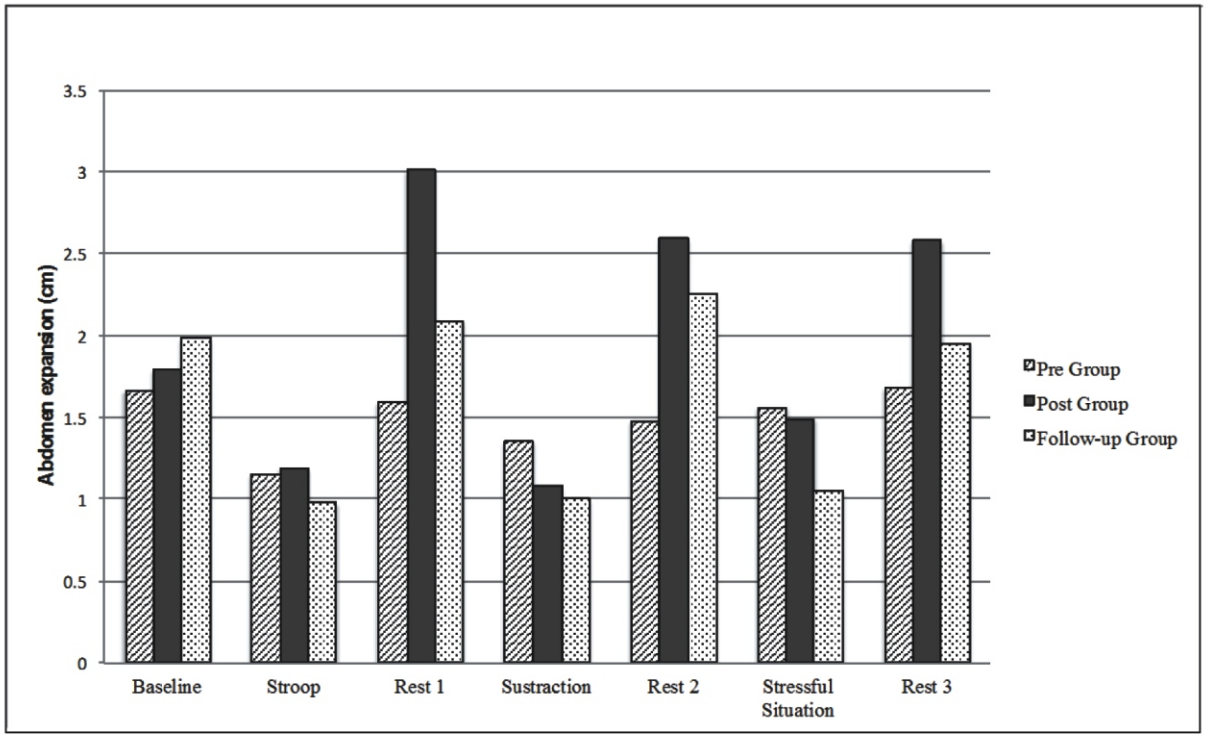
Baseline	Pre-post	Post-FollowUp	*Rest 2*	Pre-post	Post-FollowUp
EMG	-0.010	-0.060	EMG	-0.069	-0.147
Skin conductance	-0.163	0.023	Skin conductance	0.108	0.059
Temperature	0.000	0.004	Temperature	0.000	-0.005
Heart rate	-0.011	-0.042	Heart rate	0.006	-0.057
Respiratory rate	0.074	-0.070	Respiratory rate	-0.178	0.022
Respiratory amplitude	0.077	0.107	Respiratory amplitude	**0.744***	-0.130
Stroop			*Emotional stressor*		
EMG	**-0.454***	-0.087	EMG	-0.176	-0.034
Skin conductance	0.166	**-0.201***	Skin conductance	-0.137	0.021
Temperature	0.002	-0.001	Temperature	0.001	-0.006
Heart rate	0.005	-0.058	Heart rate	-0.003	-0.040
Respiratory rate	-0.083	0.027	Respiratory rate	-0.064	0.090
Respiratory amplitude	0.037	-0.177	Respiratory amplitude	0.045	-0.290
Rest 1			*Rest 3*		
EMG	**-0.258***	-0.097	EMG	**-0.310***	0.185
Skin conductance	0.106	0.026	Skin conductance	-0.035	-0.019
Temperature	0.002	-0.002	Temperature	0.001	-0.005
Heart rate	-0.002	-0.049	Heart rate	-0.008	-0.036
Respiratory rate	-0.195	0.114	Respiratory rate	-0.171	0.256
Respiratory amplitude	**0.886***	-0.334	Respiratory amplitude	**0.574***	-0.242
Subtraction					
EMG	-0.137	-0.113			
Skin conductance	-0.040	0.001			
Temperature	0.001	-0.005			
Heart rate	-0.007	-0.045			
Respiratory rate	-0.016	0.247			
Respiratory amplitude	-0.199	-0.070			

Note: Asterisks show a positive clinical improvement bigger than 20%.



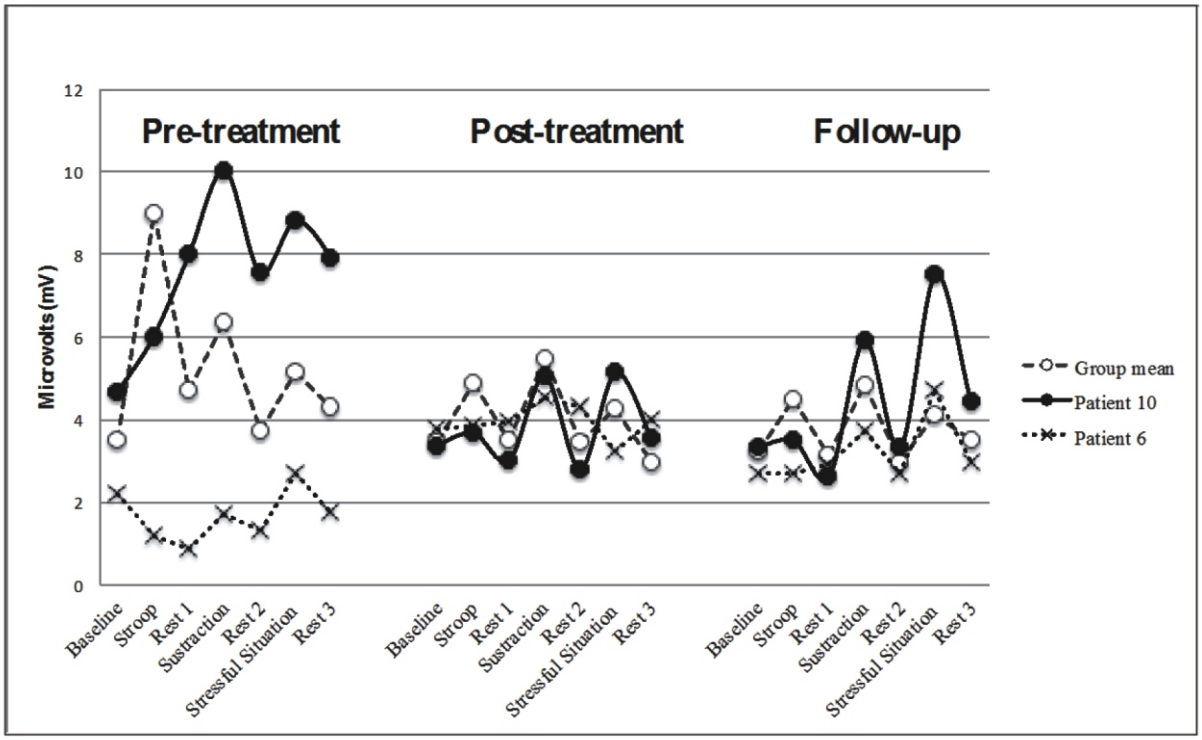
Note: EMG activity decreased from pre to post evaluation in all phases of the stress profile. Reduction continued at follow-up in all phases except in "rest 3".

Figure 1. Frontal EMG Mean Activity Across Evaluations.



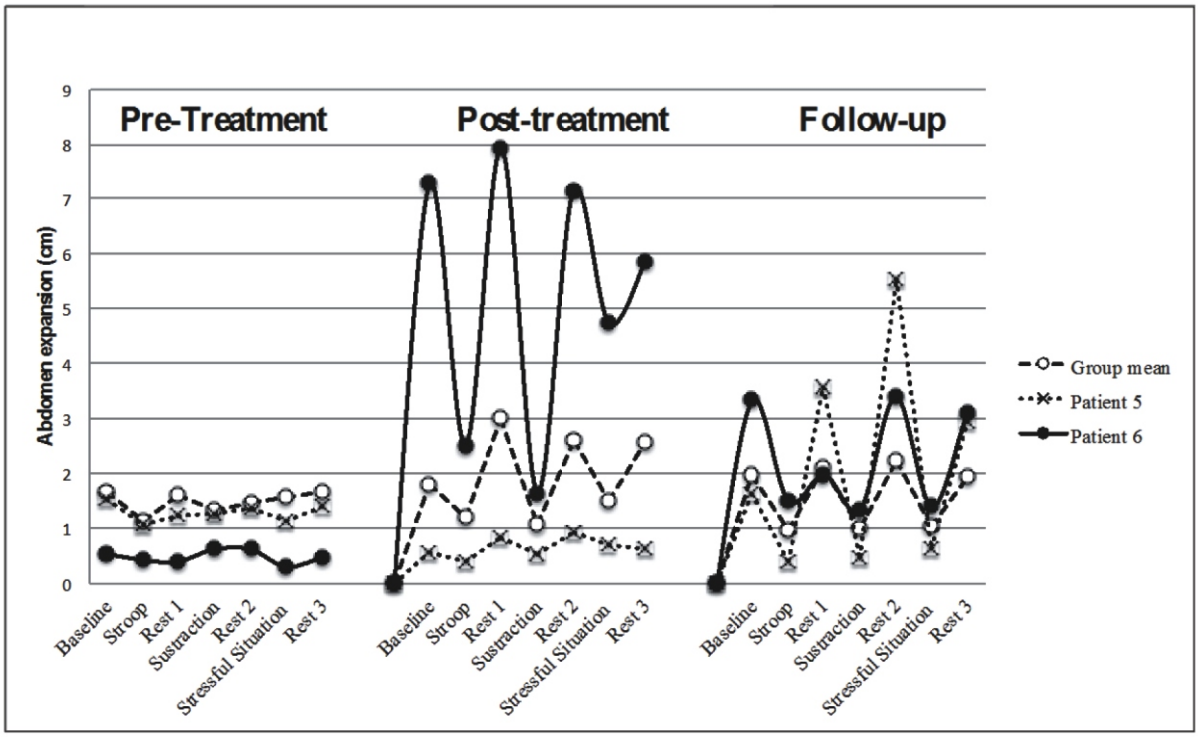
Note: Respiration amplitude increased from the beginning at the end of the profile after biofeedback training.

Figure 2. Respiration Amplitude Mean Across Evaluations.



Note: Group frontal EMG means across evaluations as well as the highest (patient 10) and the lowest improvement (patient 6).

Figure 1. Frontal EMG Mean Activity Across Evaluations.



Note: Group respiratory amplitude means across evaluations as well as the biggest (patient 6) and the lowest improvement (patient 5) from pre to post treatment.

Figure 2. Respiration Amplitude Mean Across Evaluations.

pression in a group of GAD patients, and if physiological effects could be potentiated through a multiple-response biofeedback training.

Results show clinical improvements in the presence of excessive worry as measured by the PSWQ. Scores showed significant reductions in the amount of worrisome thoughts and images after biofeedback training and remained low at follow-up. Some of the thoughts strongly associated with the presence of GAD were "my worries overwhelm me", "I know I should not worry about things, but I just cannot help it", "once I start worrying, I cannot stop" and "I worry all the time" (Meyer et al., 1990). This same trend was observed for reported symptoms of anxiety and depression, both reducing their level from pre to follow-up evaluations, reflecting the minimal amount of symptomatology after biofeedback training according to instrument norms. These findings support the hypothesis regarding biofeedback as an effective treatment for cognitive symptoms of GAD and comorbid depressive symptoms.

The adoption of psychophysiological profiles as a key outcome measure for testing physiological improvement provided the opportunity to analyze not only the level of initial arousal associated to GAD in a wide number of responses, but it also allows to track each response through alternate phases of stress and relaxation, which is normally considered a good indicator of the individual´s self-regulatory skills after repeated exposure to different types of stressors. After analyzing the effects through each of the seven phases within the stress profiles from pre to post stress profiles, only respiratory rate showed a significant reduction at "rest 2", suggesting better auto-regulatory skills after being exposed to a cognitive stressor such as the stroop test. Although no statistical differences were found for the other responses, positive effects occurred in EMG frontal activity and respiratory amplitude after checking for clinical significance (table 4). Although frontal EMG showed a reduction from pre to post treatment in all seven phases of the profile, clinical significance was observed only during "stroop", "rest 1" and "rest 3" conditions, showing not only lower values of arousal during a stress condition but a greater ability to self-regulate stress after being exposed to the stressor. These findings support efficacy of biofeedback at reducing EMG activity in GAD patients (Agnihotri et al., 2007; Barlow et al., 1984; Rice et al., 1993). Clinical positive effects were observed also in respiratory amplitude in all resting phases of the stress profiles, showing increases in each resting phase after training. This increase in amplitude usually reflects a deeper breathing pattern, often associated to states of calm and relaxation (Conde-Pastor & Menéndez, 2000b; Conde-Pastor, Menendez, Sanz, & Abad, 2008; Labrador, De Arce, & Florit, 1996). As shown in figures 1 and 2, lower levels of EMG at "rest 3" compared to "baseline" and higher respiratory amplitude at "rest 3" compared to "baseline" after training indicate greater ability to manage diverse types of stressors, including worrysome thoughts and images, from baseline to the end (rest 3) of the stress profile compared to pre treatment. No clinical effects were found for SCR, peripheral temperature, respiratory rate or HR after training, which is consistent with other findings (Barlow et al., 1984; Rice, Blanchard & Purcell, 1993). This lack of effects could be explained by a "floor effect" given the normal initial values observed in these responses. Modest improvement on these responses supports previous findings suggesting no differences between GAD patients and controls in physiological arousal, and an even lower SCR in GAD sufferers (Fisher et al., 2010; Hammel et al., 2011; Hoehn-Saric, McLeod, & Zimmerli, 1989; Hoehn-Saric & McLeod, 2000; Hoehn-Saric, McLeod, Funderburk, & Kowalski 2004; Roth et al., 2008). By contrast, frontal EMG values in this study appeared to be slightly greater than normative data previously collected (Cram & Engstrom, 1986), which supports previous findings suggesting the presence of increased EMG activity in GAD patients as compared to controls (Hazlett et al., 1994; Hoehn-Saric et al., 1989; Hoehn-Saric, Hazlett, Pourmotabbed, & McLeod, 1997). Increased muscle tension in the present study was observed not only at baseline, but also in every resting phase of the pre-training profile (figure 1), suggesting difficulty at regulating frontal EMG activity after being stressed. At post evaluation, EMG scores decreased significantly. Thus, biofeedback training proved effective at reducing muscle tension as well as increasing respiratory amplitude in this study. At follow-up, EMG values continued to improve while positive effects on respiratory amplitude began to decrease (figure 2), probably due to a lack of consistent practice after completing treatment. As figures 3 and 4 show, EMG and amplitude means seem to hide the actual improvement scores of individual patients. At the end of the study positive effects varied from one patient to another, and from one physiological response to another probably due to individual differences in activation systems in the presence of various types of stressors. In order to have a more accurate idea of how scores were distributed throughout the stress profiles, figures 3 and 4 compare the highest and lowest effects observed after treatment with the group means.

One important issue from this study was its small number of participants, which limits the possibility of results generalization although treatment efficacy is reflected by individual replications. In this regard, this study support previous findings suggesting biofeedback training as an effective tool for treating GAD. We recommend testing this multiple-response biofeedback protocol in a wider sample in order to explore if effects can be potentiated. Another limitation of this study was the institutional policy, which made it impossible to work with unmedicated patients, since all of them were taking SSRI's at the beginning of the study. This could of course have mitigated physiological arousal associated to GAD, partially covering up final results. Nevertheless, since results could be observed clearly in at least two of the physiological responses evaluated, findings are promising. It is possible that effects can be potentiated after controlling for medication.

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