

Original Research Article

Effect of computerized biofeedback relaxation on stress related physiological parameters

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ABSTRACT

Background: Mental health diseases such as insomnia, anxiety, stress and depression all have a close relationship with the autonomic nervous system. The physiological parameters of autonomic activity viz. galvanic skin resistance, electromyography, respiration and pulse rate can be regulated with the help of computerized biofeedback relaxation training. The main objective of this study was to see the effect of computerized biofeedback relaxation training on psychophysiological parameters of autonomic activity.

Methods: In the present study 40 high stress post graduate students were selected. All participants were randomly divided into two group i.e. computerized biofeedback relaxation training (group-1) and placebo group (group-2). Forehead muscle tension, respiration rate, pulse rate and galvanic skin resistance were assessed, and inventories measuring stress were administered pre-randomization. Descriptive, Paired sample 't' test, F-test and Mann-Whitney U test were used to analyze the data with the help of SPSS 16 version.

Results: Biofeedback group reported a significant change in muscle tension ($p=0.27$), respiration rate ($p=0.01$) and galvanic skin response ($p=0.35$) after relaxation but at the same time control group reported moderate increase in muscle tension. Additionally, the computerized biofeedback group was able to maintain the stress level while the control group had a significant increase in the stress level over the 10 days of relaxation training.

Conclusions: Biofeedback relaxation useful alternative therapy for management of stress and emotional disturbance in graduate students. During a stressful period this may also be helpful to promote overall psychological health.

Keywords: Stress, Computerized biofeedback relaxation training, Galvanic skin resistance, Electromyography, Respiration rate, Pulse rate

INTRODUCTION

Prevalence of Non-communicable diseases is at upsurge even after government's meticulous efforts on part of early diagnosis and treatment. Mental health problems are no different. In India also, nearly 9% of the population are affected by one or more type of mental health problems. According to the National commission macroeconomics and health (NCMH) 6.5% of the Indian population has some form of serious mental disorders.

WHO reported that India has one of the highest case of depression in the world approximately 8-12% of Indians suffer from depression in any phase of life. Stress and anxiety are significant predictor for psychological and physiological illness similar to mental stress associated with the damage of cognitive function.¹⁻⁵ There is a very important need to find other innovative methods for the management of mental health problems.

Physiological parameters of humans such as heart rate, galvanic skin response (GSR) and facial expressions are

highly related to the level of stress.⁶⁻⁹ Two types of the pattern have been developed for the assessment of stress level: questionnaire and physiological measurements. Physiological measurements, such as galvanic skin response (GSR), electrocardiogram (ECG), electromyogram (EMG), blood pressure (BP), skin temperature (ST), blood volume pulse (BVP), respiration rate (RR) and electroencephalogram (EEG) are an indicator of mental stress.¹⁰⁻¹⁵

Sharma et al reported that some computer game stress was positively related to the physiological parameters (GSR, EMG, PR).¹⁶ There are various alternative treatment modalities available for the management of mental health problems but they have not been used frequently in the Indian scenario. Biofeedback relaxation training is one such method that helps a person to learn and modify the physiological activity to improve health and performance.¹⁷ Biofeedback is the technique of using monitoring devices that measure and gives "feedback" of autonomic activity; (e.g., respiration rate, muscles tense, pulse rate, galvanic skin response, or temperature), allowing gaining some voluntary control over those functions. The audio feedback is a pure tone and the visual biofeedback is a graphic green bar. Biofeedback relaxation training has been utilized to help with various conditions including anxiety, asthma, attention deficit hyperactivity disorder, chronic pain, depression, epilepsy, headache, hypertension, insomnia, irritable bowel syndrome, posttraumatic stress disorder, stroke, and urinary incontinence.¹⁸

To the best of our knowledge, the effect of computerized biofeedback relaxation training on stress levels has been investigated in the past by many studies but only few have investigated through the measurement of physiological parameters. The present study was planned to investigate the effects of computerized biofeedback relaxation training on the stress level with the help of specific physiological parameters that are associated with stress.

METHODS

An institution based single blinded randomized controlled trial was conducted among the postgraduate students of Pt. RSU University. The study duration was from July 2018 to May 2019. A total of 50 students were approached resulting in a sample of 40 students randomly selected. Based on a priori power analysis by G*Power, 40 participants were needed for this study. Using parameters of 0.05 alpha, 0.50 large effect size, and 0.7 power, the sample size needed per group for t-tests was 20 participants.

Inclusion criteria

Inclusion criterion for current study was; all post graduate students who are studying in different teaching department of Pt. RSU University and willing to

participate in the study after written consent were selected.

Exclusion criteria

Exclusion criteria for current study were participants diagnosed with mental illness, non-communicable disease and not willing to participate in the study.

Randomization

After the enrollement of the participants, following the random sequence generation technique these 40 participants were divided into two groups as experimental group and control group, each constitute 20 participants. Computerized biofeedback relaxation training (n=20) was given in experimental group and not given to control group. The CONSORT diagram showing the flow of participants through each stage of the trial is show in (Figure 1).

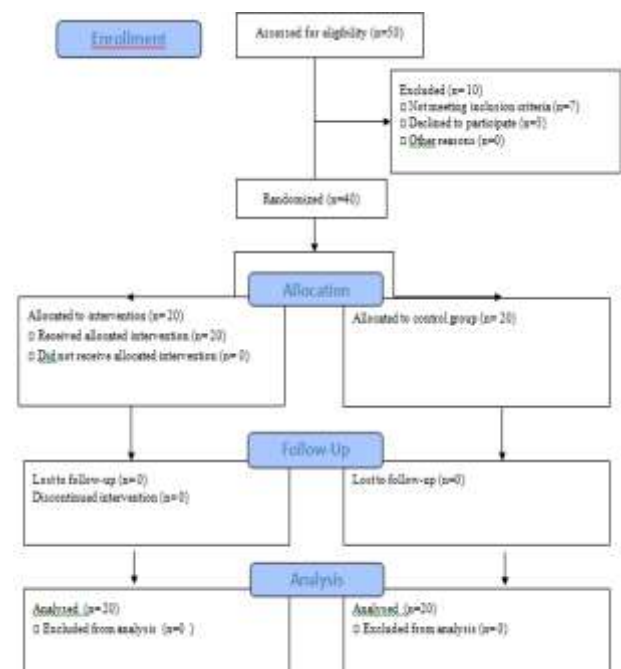


Figure 1: CONSORT diagram showing the flow of participants.

Tools

Perceived stress scale (PSS): the perceived stress in the present study was measured by the perceived stress scale (PSS). The PSS is valid and reliable tool developed by Cohen, Kamarck, and Mermelstein, (1983). The PSS is a 10-item self-report tool that has been used to provide a global measure of perceived stress in daily life.¹⁹ Computerized Biofeedback: Computerized psycho-feedback apparatus (CBF-206) was used for the relaxation training and measurement of electromyogram (EMG), galvanic skin resistance (GSR), respiratory rate (RR) and pulse rate.

Procedure

Before starting the experiment we obtained signed-written consent forms from all subjects who participated in the experiment. After the assessment of stress, the 40 high stress participants were randomly divided into two groups through random sequence generation technique using computer. Group-1 biofeedback relaxation (n=20) and group-2 placebo group (not use relaxation, n=20). Before starting the experiment the nature and possible consequences of the study were explained to participants. The subject was made to sit comfortably on a chair, Psycho-biofeedback was placed in front of the subject. A baseline record of the EMG, GSR, PR, RR were measured simultaneously, on a computerized Psychofeedback apparatus (CBF-206). The electrode for EMG recording was placed on the forehead (frontalis muscle), for GSR on the left index and ring finger, for pulse rate recording on the left thumb. The electrodes for respiration rate was attached to a belt which was worn around the chest. All the parameters were then again recorded after the 10 days from the experimental group and placebo group. The experiment was done in the laboratory of the psychology department (Pt .R.S.U. Raipur,) India. The psycho-biofeedback equipment was located in an isolated room which had, quiet, and comfortable. The same room and psycho-biofeedback Equipment was used for all participants. During this experiment, the participants of the experimental group were instructed to reduce the intensity and frequency of the sound increase the number of glowing green bars along with digital numbers as well as avoid getting the red bars to glow.

Placebo intervention

Group II participants received the placebo intervention. Some common and natural activities (viz. reading newspaper, discussion on the current situation of Indian politics and sports) are included in the placebo intervention.²⁰

Statistical analysis

Data obtained were statistically analyzed with the help of the SPSS (16th) version. Descriptive, paired sample 't' test, F-test, Mann-Whitney U test were used.

RESULTS

The overall participants age range was between 20 and 24 years old (mean-21.27, SD-1.18), the biofeedback group age range was between 20 and 24 years old (mean-21.30; SD-1.17) while on control group was between 21 and 24 (mean-21.25; SD-1.20). The participants were mostly male (n=25), with ten women (25.0%) in biofeedback group and five women (12.5%) in control group, while there was 10 (25.0%) and 15 (37.5%) males respectively.

The Kolmogorov-Smirnov test was used to determine the normal distribution of data. Due to the normality of data distribution, parametric tests were used to analyze the data. In analyzing the data, descriptive statistics including mean, standard deviation and inferential statistics, including a set of variance (ANOVA) and t-test for two dependent samples were used.

It was observed from the mean value and 't' value of physiological status the t-value was not significant at 0.05 level thus it can be said that there is no significant difference between pre and post condition of the physiological status of the control group participants (Table 1).

Table 1: The distribution of participants in experimental and control group in phases I, II & III.

Groups	Phase I	Phase II	Phase III
Experimental N=20	(O1)	(X1)	(O2)
Control N=20	(O3)	(X2)	(O4)

O1 and O3-pre test (base line value of gsr, emg, resp, pulse and stress) prior to the 10 days, O2 and O4-post test (wave value of GSR, EMG, RESP, and PULSE) after the 10 days, X1 and X2 - experimental and placebo intervention.

It was observed from the mean value and 't' value of physiological status that the 't' value of EMG, GSR and RR was significant at 0.05, 0.05 and 0.01 level thus it can be said that there is difference between pre and post condition of EMG, GSR and RR level of the participants. The pulse rate value obtained in pre and post condition shows that post condition pulse rate is low (Table 2).

The physiological status of experimental and placebo group in post condition is shown in (Figure 2). The 'F' value of EMG, (F=10.600) GSR (F=12.367) RR (F=8.653) were significant at 0.05 level thus it can be said that there is significant difference between experimental and control group in post condition. The 'F' value of PR (F=0.653) was not significant at 0.05. The mean value obtained in post condition shows that EMG, RR high and GSR low in placebo group compare to the experimental group (Figure 2).

After the experiment, the verbal report of the anxiety symptoms among participants from both the group was taken. The subjects were asked following questions; how frequently you feel these problems during and after this experiment? A problem in anxiety: yes/sometime/no, difficulty in concentration: yes/sometime/no, aggression: yes/sometime/no, abnormality in heart rate: yes/sometime/no, abnormality in respiration: yes/sometime/no, stress in mussels with headache: yes/sometime/no.

The nonparametric test viz. Mann-Whitney U test, was worked out to find the significance of the difference between psychophysiological symptoms of the control group and psychophysiological symptoms of experimental group.

The mean rank of experimental group on problem in anxiety: difficulty in concentration: aggression: abnormality in heart rate: abnormality in respiration and muscle tension with headache (6.84), (7.15), (7.00) (7.20), (6.30), (7.90) were lower compare to the control group (13.12), (14.45), (12.00) (14.70), (14.20), (15.10) in all psychophysiological symptoms (Table 3). Experimental group differ significantly from control group at 0.01 level ($U=7.5$, $Z=-3.574$, $p<0.01$), ($U=12.5$,

$Z=-3.156$, $p<0.01$), ($U=14.0$, $Z=-2.337$, $p<0.01$), ($U=13.0$, $Z=-2.894$, $p<0.01$), ($U=12.0$, $Z=-3.124$, $p<0.01$), ($U=7.0$, $Z=-3.465$, $p<0.01$) (Table 3). The present findings on the biofeedback relaxation instrument are also validated in the verbal report of the participants in terms of anxiety, concentration, aggression, abnormality in heart rate, abnormality in respiration and stress in mussels with headache.

Table 2: Mean, SD, minimum-maximum and t-value of pre-physiological status and post physiological status of control group.

Variables	Condition	Mean	SD	Min-Max	t value	P value
EMG	Pre	62.20	19.02	34-109	1.748	0.457
	Post	74.40	44.15	45-181		
GSR	Pre	388	90.32	176-4102	1.154	0.157
	Post	335	85.28	158-4102		
RR	Pre	23.21	5.81	16-31	0.365	0.624
	Post	20.35	4.54	11-38		
Pulse rate	Pre	83.00	46.80	63-89	0.030	0.977
	Post	82.90	62.16	62-93		

Table 3: Mean, SD, minimum-maximum and t-value of pre-physiological status and post physiological status of experimental group.

Variables	Condition	Mean	SD	Min-Max	t value	P value
EMG	Pre	67.80	17.15	28-77	-3.938	0.027
	Post	41.80	12.24	33-136		
GSR	Pre	244	40.31	135-4102	2.084	0.035
	Post	377	160.70	316-4102		
RR	Pre	26.22	3.21	16-27	-4.915	0.001
	Post	14.80	5.34	10-40		
Pulse rate	Pre	88.00	21.97	67-97	-0.875	0.055
	Post	80.40	20.51	65-81		

Table 4: Comparison of the impact of computerized biofeedback relaxation on psycho physiological symptoms between experimental and control group.

	Group	N	Mean rank	Some of rank	Mann-Whitney U	Wilcoxon W	Z	P value
Problem in anxiety	Experimental	40	6.84	48.54	7.5	62.500	-3.574	0.001
	Control		13.12	161.51				
Difficulty in concentration	Experimental	40	7.15	41.50	12.5	68.500	-3.156	0.004
	Control		14.45	168.50				
Aggression:	Experimental	40	7.00	70.00	14.0	70.000	-2.337	0.006
	Control		12.00	120.00				
Abnormality in heart rate	Experimental	40	7.20	42.00	13.0	67.000	-2.894	0.010
	Control		14.70	159.00				
Abnormality in respiration	Experimental	40	6.30	53.00	12.0	64.000	-3.124	0.008
	Control		14.20	157.00				
Stress in mussels with headache	Experimental	40	7.90	49.00	7.0	61.00	-3.465	0.001
	Control		15.10	151.00				

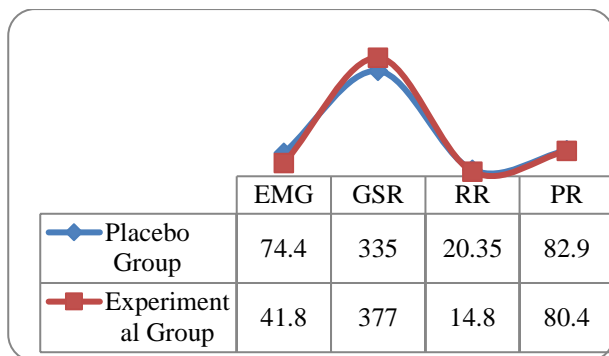


Figure 2: Graphical presentation of the physiological status on post test condition of the experimental and placebo group.

DISCUSSION

The present study shows that the wave value of Physiological parameters (EMG, RR) of participants who practice biofeedback relaxation training was lower compared to control subjects (Table 2, Figure 2) Even if, the control group also changes the small level of physiological response (Table 1), but the difference is not significant at any level of confidence (Table 1). Pre to post treatment comparison for biofeedback groups revealed statistically significant increase in GSR values, while control group showed non-significant changes. The results of the study, biofeedback relaxation training effect on stress parameter can be compared to other reports available on various relaxation effects as they are similar, several studies found that the significant effect of relaxation on ANS activity with reference of GSR, EMG and RR.^{21,22} Hence indicating the significant effect of biofeedback relaxation on stress in them. The participants who used biofeedback relaxation training produced a significant change in physiological parameters. The post-test score of the experimental group and the placebo group were also compared. Both the groups are different with regards to the physiological status (Figure 2). The electromyography is an indicator of sympathetic activity, denoting muscle tension, feedback of EMG is the process of monitoring and displaying to an individual the ongoing contraction patterns generated by his or her skeletal muscles. Since stress is stored in the form of muscle tension, EMG is found to be raised in the event of stress. The comparison of the effect of relaxation training on the psychophysiological status between the experimental and placebo group is indicated in (Table 3). The mean rank value of the Problem in anxiety, Difficulty in concentration, Aggression, Abnormality in heart rate, Abnormality in respiration and Stress in mussels with headache is higher respected in the experimental group than the control group all verbal Psychophysiological symptoms of an experimental group differ significantly from the control group at 0.01 level. Almost the same findings have been reported in another study.^{23,24} The main reason for the changes in stress related parameters after biofeedback relaxation because emotional state is an affected by the adrenaline or epinephrine hormone during

response of stress the hormones adrenaline and cortisol are released, and the sympathetic nervous system is activated, after that perspiration, heartbeat, breathing rate increasing and constricting blood vessels to get more oxygen in the blood, and more blood to the core of the body instead of the extremities.²⁵ The study indicated that four weeks of relaxation training has an effect on HPA-axis by decreasing the level of salivary cortisol as a reliable physiological marker of stress.²⁶

CONCLUSION

Biofeedback relaxation is a useful alternative therapy for management of stress with reducing symptoms of emotional disturbance in graduate students. During stressful period this may, also helpful to promote overall psychological health. Current study supports the use of biofeedback relaxation in patients with emotional disturbance. Further research is necessary to determine the long-term effects of biofeedback relaxation and the effects of mood on patients' responses to treatment.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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