Evaluating the effects of stress reduction exercises employing mild tremors: a pilot study.

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March 8, 2009

Abstract

Body tremors are commonly experienced during or immediately following stressful events. They are generally perceived as a pathological expression of stress and used as a diagnostic feature of the Diagnostic and Statistical Manual of Mental Disorders DSM-IV-TR (Text Revision). However the etiology, purpose and potential therapeutic value of these tremors have received little attention.

An interdisciplinary research project was conducted to examine the effects of exercise induced tremors. Sixty-one students (33 control group, 28 intervention group) volunteered to participate in this research. After performing the exercise routine six times over a two week period, the STAI X-1 showed a significant reduction ($p < .05$) in anxiety-present and an increase in anxiety-absent in both the subscale and total scores. The Heart Rate Variability (HRV) data showed changes in the desired direction. These results suggest that these tremors might have therapeutic values for post-stressor recovery.

Key words: bodily tremors; neurogenic tremors; stress; stress response; exercise.

Introduction

It is not uncommon in many cultures to hear phrases such as: "I was so frightened my jaw was quivering." "My hands were shaking so badly I couldn't calm myself down." "My legs were trembling as I gave my speech." "I was so angry I shook." These experiences of shaking or tremoring are so common that they are recognized as diagnostic features of Panic Attacks (300.21), Social Phobias (300.23), Generalized Anxiety Disorder (300.02), and Post Traumatic Stress Disorder (309.89) in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association [APA], 2000). These tremors are best defined as *neurogenic* tremors as they are a neurological response to stressful situations. They are a primordial somatic experience originating in the natural processes of the brain's procedural memory system that is part of the genetic composition of the human body (Scaer, 2005).

The physical sensation of neurogenic tremors is most commonly described as a mild vibration or shaking of the muscles. Although muscle tremors have been researched as physiological responses of the body in the fields of athletic performance (Cardinale & Bosco, 2003; Torvinen et al., 2002; Bosco et al., 1999; Issurin, & Tenenbaum, 1999) and physical therapy (Bosco, Cardinale, & Tsarpela, 1999; Bosco et el., 2000), there is less research on the psychotherapeutic potential of these tremors. Two neurologists who have written most extensively about the possible psychotherapeutic value of these tremors are Dr. Robert Scaer (2005) and Dr. Peter Levine (1997). They believe that humans have been socialized out of this naturally occurring response. Because the tremors are uncomfortable and are experienced as an 'uncontrollable' behavior, they are deemed as socially unacceptable and should be avoided (Levine, 1997). Due to the psychological discomfort of the uncontrollable nature of neurogenic tremors, our culture avoids this physiological reaction or even anesthetizes it through the consumption of medicine, alcohol or other substances (Levine, 1997).

This current social thought is reinforced by the medical field in which these tremors have often been associated with a reduced ability to cope with stressful situations (Günther, Köster, Lücking, & Scheidt, 2004). Due to the prevailing ideology that tremors are a pathological expression of the human condition, little research or consideration has been given to the possibility of the potential therapeutic nature of bodily tremors (Koller et al., 1989). Until the prevailing thought of the pathological expression of these tremors is reconsidered, research into the value of these tremors will remain scarce.

The research on tremors as a potential therapeutic response to stressors was first explored in animals by Selye (1973). His research demonstrated that animals have a natural tremoring reaction following stressful or traumatic events. He was also the first researcher to discover that these tremors seem to have an adaptive advantage for the animal. His research with baby chicks demonstrated that chicks that were deliberately stressed and allowed to have their natural tremoring reaction were more resilient to subsequent stressful events than those who were not allowed to have their natural tremoring reaction (Selye, 1956). His work was the precursor to the non-specific response of the human organism to stressors.

Neuro-physiological studies in animal experimentation have already demonstrated that physiological shock occurs during the time of a traumatic event. This shock produces a sharp and immediate biochemical reaction in the animal causing the secretion of protective hormones (Deuschl, Raethjen, Lindemann & Krack, 2001). The increase in protective hormones is accompanied by a high energetic charge in the musculature of the body. This provides the organism with the ability to create a fight/flight or freeze response. The human animal has this same reaction to a perceived threat or danger (LeDoux, 1996). However, the difference between the human animal and other mammalian species is that after a traumatic event has ended for animals in the wild, they utilize an innate 'trembling' mechanism that discharges this high biochemical and neuromuscular charge from the body thereby facilitating a spontaneous recovery from the traumatic event (Muggenthaler, 2001; Scaer, 2001; Levine, 1997). This trembling mechanism according to animal researchers provides animals in the wild with a built-in immunity to post traumatic stress disorder (PTSD) that enables them to return to normal life after a highly charged life-threatening experience without developing PTSD symptoms (Levine, 1997). Muggenthaler (2001) offers additional theoretical insight into these tremors exhibited by animals. She observed that these tremors involve an expenditure of energy at a particularly vulnerable time of recovery from physical stress. Since animals do not expend energy uselessly during a threatening or stressful event, it would indicate then that these tremors are somehow involved in the survival process. She believes that for these tremors to have survived the evolution of the species, there must be a survival advantage to this behavior.

Research Method

The research of tremors among athletes and in the field of physical therapy was performed by using machines that generated varying frequencies of tremors (Cardinale, Wakeling, & Viru, 2005; Kerschn-Schindl et al. 2001; Bosco et el., 2000; Bosco, Cardinale, & Tsarpela, 1999). However, this research project attempted to demonstrate that naturally occurring tremors in the muscles of humans without the use of machines were capable of reducing stress levels. Therefore, a natural method for eliciting bodily tremors was designed for this research project (Berceli, 2005; Berceli & Napoli, 2007; Berceli, 2008).

In order to isolate the effects of the tremors the research was designed in such a manner that both the intervention and the control groups would perform the same series of exercises. The difference between the two groups was that the intervention group was encouraged to allow the tremors to happen while the control group was directed to stop the exercises when the tremors occurred. The working hypothesis was that the tremors, separate from the exercise routine itself, would be capable of significantly reducing stress levels in the body. There would then be a measurable difference between the intervention group and the control group. This measurable difference would be observable in both the physiological measure - Heart Rate Variability (HRV) and the self-report measures - State-Trait Anxiety Inventory (STAIX -1).

Research design

The research consisted of (n=61) college students (n=33 control, n= 28 treatment). Each research subject was randomly assigned to either the treatment group (exercises that produced body tremors) or to the control group (exercises that did not produce body tremors). Both groups of subjects were required to perform a series of three 1/2-hour exercise sessions each week for a two week period (total of 3 hours). A total of six research assistants (RA) guided the subjects through the exercises so as to eliminate any potential bias of the RA with the subjects.

Heart rate variability (Lipsenthal, 2004; Cohen, 1998; Van Ravenswaaij-Arts et al., 1993; Herd, 1991) was used to demonstrate the interplay between the sympathetic nervous system (SNS; fight/flight response) and parasympathetic nervous system (PNS; calm/relaxation response). The state-trait anxiety inventory ([STAI X-1]; Spielberger, Gorsuch, Lushene, Vagg,

& Jacobs, 1983) was used to measure the perceived anxiety level of the subjects. The STAIX-1 consists of ten anxiety-absent questions and ten anxiety-present questions.

Findings and results

Standard statistical tests were conducted to assess the extent to which this exercise routine may have affected the psychological and/or physiological variables between pre-test and post-test scores. A series of Paired-samples *t* tests were conducted for each measure to identify within-group variations. The same subjects were tested twice – before and after treatment. The Statistical Package for the Social Sciences (SPSS) was used for all data analysis including the descriptive statistics. The statistically acceptable 95% confidence interval was used in all analysis.

State-Trait Anxiety Inventory (STAI X-1) results

The STAI X-1 scores were divided into the two sub-categories (*anxiety-present*, *anxiety-absent*) for individual paired-sample *t*-test analysis. A *t*-test was conducted to evaluate the pre- and post-test scores for each subcategory (Table 1). The results of the *anxiety-present* subcategory indicated that the treatment group reported significantly more anxiety at pre-test (M = 16.18, SD = 5.62) than post-test (M = 13.07, SD = 3.21), $t(27) = 3.23$, $p < .01$. This suggests that the participants experienced significantly less anxiety after the treatment. The control group also reported less anxiety after treatment but the scores were not significant. The pre-test scores of (M = 14.61, SD = 4.90), were only slightly higher than the post-test scores (M = 14.27, SD = 5.67), $t(32)= .25$, $p= .80$.

The *t*-test for the subcategory of *anxiety-absent* demonstrated a significant reduction in anxiety for the treatment group. The pre-test scores for *anxiety-absent* (M = 29.61, SD = 6.44) for the treatment group were significantly lower than the post-test *anxiety-absent* scores (*M* =32.11, *SD* = 4.57), *t*(27) = -2.08, *p*= <.05. The increase in *anxiety-absent* scores indicates a decrease in anxiety levels at post-test. The combination of the two scores for the treatment group reflects a reduction in *anxiety-present* and an increase in *anxiety-absent*. The control group also demonstrated a change in *anxiety-absent.* The pre-test scores (*M*=30.61, *SD*= 4.83), for the control group were slightly lower than the post-test scores (*M*=32.12, *SD*=6.73), *t*(32)= -1.35, *p*=.19. Since both the treatment and control groups demonstrated a change in the same direction, these scores seem to be more statistically significant and dependable. The scores indicate a reported change in the physical and emotional states of the participants from both groups. It is particularly important to note the higher mean levels of the *anxiety-absent* scores. Although the participants were less certain about the present amount of anxiety they were experiencing, they were much more certain about the absence of anxiety they were experiencing. This is the first indicator that the tremors may have had a positive effect in reducing anxiety. They might also have had a positive effect in helping the individual identify their state of anxiety or calmness. This reinforces prior studies that suggest the effects of exercises may assist the individual in identifying their emotional and or physical state (Scully, Kremer, Meade, Graham, & Dudgeon, 1998).

By combining the total scores of the STAI X-1, it is possible to compare the overall effect of *anxiety-present* and *anxiety-absent* ratings. When combining the total scores for *anxiety-present*, the *anxiety-absent* scores are reversed. The opposite is also true. When combining the total scores to determine the amount of *anxiety-absent,* the *anxiety-present* scores are reversed.

The total scores of the *anxiety-present* measure at pre-test for the treatment group (*M* = 36.57, *SD* = 11.17) were significantly higher than the post-*anxiety-present* measure (*M* = 30.96, *SD* = 6.67), $t(27) = 2.97$, $p < .01$. This is consistent with the sub-scores of *anxiety-present* scores previously noted.

The control group also had a change in *anxiety-present.* The pre-test scores revealed (*M*= 34.00, *SD*= 8.11) a slightly lower level of anxiety than at post-test (*M*= 49.39, *SD*= 6.12), $t(32) = -1.71$, $p = .51$. This would suggest that the students reported higher anxiety after completing the exercises which is contrary to the hypothesis.

To determine the total score for *anxiety-absent*, the *anxiety-present* scores were reversed. The total score of pre- and post-*anxiety-absent* were reflective of reduced anxiety. Pre-*anxiety-absent* scores for the treatment group (*M* = 63.43, *SD* = 11.17) were significantly higher at post-test (*M* = 69.04, *SD* = 6.67), $t(27) = -2.97$, $p < .05$. This suggests that the participants reported statistically significant lower levels of anxiety after treatment. This is consistent with the sub-group results of *anxiety-absent* reviewed above. This could suggest that the intervention of the tremors actually reduced the noticeable levels of anxiety among the participants.

The *anxiety-absent* scores for the control group at pre-test (*M*=66.00, *SD*= 8.11), were slightly lower than the post-test scores (*M*= 67.85, *SD*= 10.84), $t(32) = -.92$, $p = .37$. This suggests that the students in the control group reported experiencing more anxiety at post-test.

However, the fact that these scores show consistency with both pre- and post-test scores of the treatment and control groups provides us with a possible glimpse that this measure might reflect more accurately the perceived sense of anxiety of the participants. It also happens to reflect the desired outcome of the hypothesis - that the subjects who performed the exercises with tremors reported a greater reduction of anxiety than those who performed the exercises that did not evoke tremors.

Heart Rate Variability (HRV) results

Although the total number of participants in the research was 61, due to inaccurate collection of HRV data 22 subjects did not have HRV data for analysis. For this reason, there will be a difference in the total number (n=39) of subjects (treatment group n= 21; control group n= 18) in the final statistical analysis reported in the HRV tables. The same subjects were tested twice – before and after treatment.

Subjects strapped a Polar Precision S810i heart rate monitor around their chests prior to performing the exercise routine. A wrist-band designed to collect the data from the polar monitor was placed on the subject's wrist. The subjects wore the device throughout the testing procedure so that the HRV could be monitored and the data collected by the watch. The data was downloaded after each session from the wrist-band using software from the same company for the computer analysis.

The two major spectral components of HRV are: high-frequency (HF) (0.15-0.40Hz) and low-frequency (LF) (0.04-0.15Hz). The HF reflects the degree to which Parasympathetic Nervous System (PNS) controls heart rate variability. If the statistical outcome has higher scores at post-test, this indicates that the PNS is more dominant and the levels of stress are lower. The LF reflects both sympathetic and parasympathetic activity. For this reason, it is necessary to divide the LF by the HF. The result is the degree of sympathetic activity of the heart rate (McMillan, & Burr, 2004, chap. 24). In this case, a higher number at post-test indicates greater sympathetic activity indicating greater stress. A Paired-sample *t*-test analysis was conducted to determine the differences between pre- and post-test results (Table 2).

The high-frequency (HF) pre- and post-test results of the treatment group (*n*=21) indicated that there was an increase in PNS response at post-test indicating a reduction in heart stress response. However, the difference was not significant. The pre-test scores (M = 1483.71, SD = 959.09) were slightly lower than the post-test scores (M = 1564.43, SD = 921.82), $t(20) = -.32$, $p = .75$.

An analysis of the high-frequency results of the control group (*n*=18), also revealed an increase in PNS response indicating a reduction in heart stress response between pre- and post-test. The pre-test scores (M = 1085.52, SD = 1046.71) were lower than the post-test scores (M = 1371.14, SD = 1105.10), $t(17) = -.79$, $p = .44$.

Although both the treatment and control groups demonstrated increased PNS response indicating increased relaxation, the degree of relaxation for the control group was slightly stronger. Since these scores were registered during the period of time that the participants were resting on the floor, it would seem that those who were resting without tremors felt more relaxed than those who were resting on the floor and tremoring. This difference can be the result of misunderstanding the tremor response. It may have been anxiety provoking for the participants thereby reducing the degree to which they could relax into the rest position. For these students, it might be necessary to provide some form of explanation of the tremor response to ally their own potentially anxiety provoking interpretations.

A statistical review of the LF/HF scores was also conducted to determine the degree of sympathetic activity. A higher number at post-test indicates an increase in heart rate stress. The

LF/HF pre-test scores for the treatment group (*M* = 177.75, *SD* = 97.25) were slightly higher than the post-test scores (*M* = 157.81, *SD* = 91.10), $t(20) = .86$, $p = .40$. The decreased heart rate score at post-test indicates that there was a reduction in sympathetic activity. Although the heart rate of the participants did register a more relaxed state, it was not statistically significant.

An analysis of the LF/HF results of the control group (n=18), revealed an increase in SNS response indicating an increase in heart stress response between pre- and post-test. The pre-test scores (*M* = 80.11, *SD* = 31.87) were lower than the post-test scores (*M* = 115.51, *SD* = 62.88), $t(17) = -2.27$, p=<.05. There was a statistically significant increase in sympathetic activity. This is a bit confusing since the high-frequency revealed an increase in relaxation of the parasympathetic response. This suggests that although the control group found resting on the floor relaxing, it was not relaxing enough to provide a significant degree of heart rate reduction.

Conclusion

The purpose of the study was to examine the effects of the natural tremoring response on stress reduction. This is the first study of its kind to systematically examine neurogenic tremors evoked by this specific exercise routine. However, the results of the study were not entirely conclusive. Since there are no previous studies that have examined the statistical analysis of neurogenic tremors, the results of this study will have to be viewed solely without comparison.

The (STAI X-1) anxiety-absent sub-score and total score of the intervention group indicated a statistically significant reduction in anxiety. This was reconfirmed by the sub-score and total scores of the anxiety-present category. The control group demonstrated change in the desired direction as well but it was not significant.

The HRV data consisted of numerous data drops and inaccurate data measurements that weakened the accuracy of the HRV measure. The reason for the inaccurate data collection could stem from the HRV process used in the study. Each student was instructed to go to the bathroom to apply their own heart rate monitors. This required the student to moisten two pads on the inside of the belt and attach it securely to their chest under their clothing. There was no control over the amount of moisture used or the degree of tightness of the belt around the chest. Both of these could have affected the monitor's ability to collect the data correctly. It may have been more accurate to have these monitors applied by the RAs but this might have required additional IRB approval because of the need to touch the participant.

The heart rate data that was accurately collected showed an improvement in the desired direction of increased parasympathetic activity for both the control group and the treatment group. This indicates greater calmness being reported by both groups, however there was no statistical significance for either group.

Discussion and Recommendations

With only moderately significant outcomes, the results of the present study must be interpreted cautiously. There were several threats to the validity of the study such as selection bias, hypothesis guessing and treatment reliability. All of these should be taken into consideration when attempting additional research on this method. However, there are several positive directions that future research could explore as a result of the findings of this pilot study.

Future research should continue to investigate the association between neurogenic tremors and stress reduction. Since this is the only study of its kind, and the research was done with numerous researchers, it would be advisable to reproduce the study with a single researcher to ensure a more controlled exercise routine. It would also be advisable to use more conclusive physiological measures such as blood analysis.

The concept for this research project originated from 15 years of anecdotal evidence gathered by the successful application of this technique in several war-torn countries in Africa and the Middle East. It was primarily used for the reduction of hyper-arousal symptoms commonly experienced in PTSD: difficulty sleeping, exaggerated startle response, irritability, disturbing memories, and detachment (American Psychiatric Association, 2000). This technique received the same positive response (verbal and written) from both military and civilian populations. This might suggest that the elicitation of neurogenic tremors has a more apparent affect on individuals experiencing higher degrees of stress or trauma. Since this research was conducted with college students whose degree of stress and/or trauma may be considerably lower than individuals experiencing political violence, the degree of change may have been less noticeable and therefore less able to be detected by the measures used in this research.

These exercises could also be researched with our present military population since PTSD has been clearly identified as one of the biggest problems facing active duty military returning from Operation Enduring Freedom (OEF) and Operation Iraqi Freedom (OIF) (Gupta, 2004; Hoge et al., 2004; Friedman, 2006). Many military personnel are often hesitant to admit to experiencing symptoms of PTSD because it could harm their careers, cause them to have difficulties with their peers or superiors, or be a stigmatizing admission of an inherent weakness of character (Gupta, 2004). However, since military personnel are familiar with exercise they may find it less threatening than the prospect of counseling or medications. In light of the prevalence of PTSD among the military personnel and the hesitation to seek appropriate medical care, a methodology for PTSD prevention and recovery that can be applied to this large-scale population, can be self-directed, may be immediately effective and can also be integrated into the lives of normal military activity is needed. Successful research into a body based prevention and recovery process for the reduction of stress and PTSD symptoms would prove to be of paramount importance. If a body-based method can be designed, it would be both personnel-efficient and cost-effective.

Implications

The populations that might noticeably benefit from this type of intervention are people who are engaged in trauma inducing professions such as: police officers, fire fighters, emergency medical teams and other types of emergency personnel or first responders. Likewise, survivors of natural disasters or large-scale traumas such as school shootings or other public acts of violence may benefit from an immediate intervention that can be easily taught and applied to large populations at a single time. Survivors of long-term stress or trauma that is often found in domestic violence, sexual abuse, child abuse or neglect might also find these exercises more useful as an immediate release of tension and anxiety.

Since this exercise routine activates tremors in the body simply through physical exercise, it is able to transcend cultural barriers of language and ego self-concepts that are often hindrances when attempting to apply therapeutic modalities to diverse cultures. It can also be demonstrated to large populations at a single time. In this regard, it could be used by international relief agencies personnel who are often rapid responders to global natural disasters. Since it does not require the expertise of trained professionals, local populations can be taught how to perform the exercises thereby being able to continue utilizing the exercises after medical or foreign professionals have left the disaster scene.

The compelling question of the potentially positive effects of neurogenic tremors on the emotional and perhaps physiological dimensions of humans should continue to be investigated. A better understanding of neurogenic tremors may help develop physical exercise routines that can maximize the benefits of self-directed relaxation techniques.

By focusing on the individuals' natural restorative mechanisms, every traumatized individual becomes capable of some degree of self-healing. By teaching the individual how to activate these restorative mechanisms, entire populations can be guided through a self-healing process. This process can be easily taught and used effectively in schools, hospitals, institutions and organizations of diverse ethnic groups, languages and cultures. These exercises can be easily learned and are immediately effective. They can be integrated into a daily exercise routine as an appealing body based prevention and recovery process. In this regard, an effective, self-administered healing method is essential to deal with the types of mass trauma (Fullerton, 2004; Prager, 2003; Webb, 2003; Ahern et al., 2002; Kalayjian, & Jaeger, 1995), cultural trauma (Sztompka, 2000, p. 449), and trans-generational trauma (Fossion, et al., 2003; Gardner, 1999; Rowland-Klein & Dunlop, 1998; & Motta & Jamie, 1997) we are presently experiencing as a global family.

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Table 1

Samples t-test for STAI X-1 pre/post-test results: Treatment and control groups.

	Pre-Test Scores		Post-Test Scores		Alpha Levels
	M	*SD*	*M*	*SD*	
Anxiety-present (subcategory -10)					
Treatment group	16.18	5.62	13.07	3.21	<.01**
Control group	14.61	4.90	14.27	5.67	.80
Anxiety-absent (subcategory - 10)					
Treatment group	29.61	6.44	32.11	4.57	<.05*
Control group	30.61	4.83	32.12	6.73	.19
Anxiety-present (total score - 20)					
Treatment group	36.57	11.17	30.96	6.67	<.01**
Control group	34.00	8.11	49.39	6.12	.51
Anxiety-absent (total score - 20)					
Treatment group	63.43	11.17	69.04	6.67	<.05*
Control group	66.00	8.11	67.85	10.84	.37

*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table 2

Paired samples t-test for HRV pre/post-test results: Treatment and control groups.

	Pre-Test Scores		Post-Test Scores		Alpha Levels
	M	*SD*	*M*	*SD*	
Treatment Group					
HF	1483.71	959.09	1564.43	921.82	.75
LF/HF	177.75	97.25	157.81	91.10	.40
Control Group					
HF	1085.52	1046.71	1371.14	1105.10	.44
LF/HF	80.11	31.87	115.51	62.88	<.05*