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MASSAGE THERAPY REDUCES ANXIETY AND ENHANCES EEG PATTERN OF ALERTNESS AND MATH COMPUTATIONS*

TIFFANY FIELD, GAIL ROBINSON, FRANK SCAFIDI, TOM NAWROCKI, and ALEX GONCALVES

Touch Research Institute, University of Miami School of Medicine

JEFF PICKENS

James Madison University

NATHAN FOX

University of Maryland

SAUL SCHANBERG and CYNTHIA KUHN

Duke University Medical School

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Twenty-six adults were given a chair massage and 24 control group adults were asked to relax *in* the massage chair for 15 minutes, two times per week for five weeks. On the *first* and last days of the study' they were monitored for EEG, before, during and after the sessions. *In* addition, before and after the sessions they Performed math computations, they completed POMS Depression and State Anxiety Scales and they provided a saliva sample for cortisol. At the beginning of the sessions they completed Life Events, Job Stress and Chronic POMS Depression Scales. Group by repeated measures and Post hoc analyses revealed the following: 1)~frontal delta power increased for both groups, suggesting relaxation; 2) the massage group showed decreased frontal alpha and beta power (suggesting enhanced alertness); while the control group showed increased alpha and beta power; 3) the massage group showed increased speed and accuracy on math computations while the control group did not change; 4) anxiety levels were lower following the massage but not the control sessions, although mood State was less depressed following both the massage and control sessions; 5) salivary cortisol levels were lower following the massage but not the control sessions but only on the first day; and at the end of the 5 week period depression scores were lower for both groups but job stress scores were lower only for the massage group.

Keywords: Massage. alertness

Despite the increasing popularity of stress-management programs (Ivancevitch, Matteson, Freedman & Phillips, 1990) very little evaluation research has been done. Most evaluations are based on "professional opinions" and survey studies rather than empirical studies. A recent study on stress in HIV positive men suggested that those who were most stressed gained most from a massage therapy intervention (Ironson, Field, Kumar, Price, Kumar, Hansen & Burman, 1995). Longterm (one month) effects indicated immunological benefits including increased natural killer cell number and natural killer cell cytotoxicity. Massage therapy has also been noted to decrease anxiety and depression as well as cortisol and norepinephrine levels and improve sleep patterns in adolescents with psychiatric problems (Field, Morrow, Valdeon, Larson, Kuhn & Schanberg,

1992). Thus, massage is noted to decrease anxiety and depression based on self-report, behavior observations, salivary cortisol and urinary norepinephrine levels and to enhance immune function.

In the above studies subjects anecdotally reported enhanced alertness instead of the expected soporific effect following massage. The purpose of the present study was to investigate the effects of massage on alertness as measured by accuracy of performance on math computations. The only massage study in the literature that recorded EEG showed *that facial massage* was accompanied by decreased alpha and beta, a pattern that is inconsistent with drowsiness (Jodo, Yamada, Hatayama, Abe & Maruyama, 1988). The EEG alpha was expected similarly to decrease during the chair massage in this study and the behavioral measure of alertness, namely math computation performance, was expected to improve following massages. In addition, anxiety, depression and cortisol levels were expected to decrease as they did in the Field *et al.* (1995) study on disturbed adolescents and the Ironson *et al.* (1995) study on HIV men.

METHOD

Subjects

The subjects were 50 medical faculty and staff members (80% females, M age = 26). The subjects were well-educated (62% college graduate, 12% graduate school, 27% graduate degree). Income was $20,OOO for *58%,* $2~30,OOO for *35%* and greater than $30,OOO for 8%. Forty-six percent of the sample exercised regularly, with moderate numbers exercising once per week (31%), to several times per week (27%), to daily (15%). Of the sample *50%* had tried relaxation techniques, and 62% had received a massage prior to the study (62% rarely, 31% occasionally and 8% weekly). The subjects were recruited using advertising fliers at the medical school. They were randomly assigned to the massage and the relaxation control groups. Chi square analyses comparing the two groups on sex, education, income, and lifestyle questions (i.e., exercise and previous use of massage and relaxation) and a *t* test on age yielded no group differences (see Table 1).

TABLE 1
Means for Demographic Variables for Massage Therapy and Relaxation Control Group Measures

Measures	**Massage**	**Control**	**p**
Age	26.4	26.2	NS
Sex (% female)	79.5	80.2	NS
Graduate degree (%)	25.8	28.0	NS
[income> $30.000 (%)	7.8	9.1	NS
Regular exercise (%)	47.3	45.4	NS
Tried relaxation (%)	49.2	51.0	NS
Tried massage (%)	64.0	60.9	NS

Therapy Procedures

Massage therapy. The massage therapy was given by a professional massage therapist (different therapists each day) for 15 minutes a day, 2 days a week for 5 weeks, and the sessions were scheduled at noon each day. The subjects were seated fully clothed in a special massage chair, and a standard Swedish massage procedure (kneading of muscles) was used. The procedure consisted of long broad strokes with moderate pressure on the BACK: 1) compression to the back parallel to the spine from the shoulders to the base of the spine; 2) compression to the entire back adding some gentle rocking; 3) trapezius squeeze: 4) finger pressure around scapula and shoulder; 5) finger pressure along the length of the spine and back; and 6) circular strokes to the hips below the iliac crest. ARMS: 1) drop arms to the side. Knead arms from shoulder to lower arm; and 2) press down points of upper and lower arms. HANDS; 1) massage entire hands. Traction to the fingers; 2) press the fleshy part of the palm between the thumb and index finger for 15 to 20 seconds; and 3) traction of the arms both in lateral and superior directions (arm in line with the body). NECK: 1) kneading area of cervical vertebrae; 2) finger pressure along base of skull and along side of neck; 3) scalp massage; and 4) press down on trapezius, finger pressure and squeezing continuing down the arms.

Relaxation control group. The subjects were asked to relax by tightening and relaxing the same body parts as

those that were massaged for the massage therapy group (and in the same sequence). The subjects were briefly shown by a research assistant how to tighten and release their muscles which they were told would help them relax. This group was included as a control for focusing on the body and for standardizing activity level during the assessment sessions (controlling movement artifact in the EEG measure).

Assessment Procedures

On the first and last day of the study the procedure was conducted in the following order:
1) the EEG cap was positioned on the subject's head; 2) a saliva sample was taken for cortisol; 3) the subjects completed the 3 long-term measures including the Life Events, Job Stress and Chronic POMS Depression Scales; 4) the subjects completed the session base-line measures including the POMS Depression, State Anxiety and the math computations; and 5) immediately after the 15 minute massage/control sessions the subjects completed another math computation, the POMS Depression and State Anxiety Scale, and about 20 minutes after the end of the massage/control sessions they provided another saliva sample for cortisol.

Pre-post therapy session measures on first and last day. The following measures were used to assess the immediate effects of the massage on the first and last days of the study.

a) *The Profile of Mood States (POMS; McNair, Lorr & Droppleman, 1971).* The POMS Scale is a 5-point adjective Likert rating scale asking the subject to describe how well an adjective describes his/her current feelings. The 14 items that comprise the depression factor were used. The scale has adequate internal consistency *(r* = .95; McNair & Lorr, 1964) and is an adequate measure of intervention effectiveness (Pugtach, Haskell & McNair, 1969). A summary score is obtained by adding the weight of each item. This scale was used because positive mood state would be expected to affect alertness and performance on math computations and because massage therapy have been noted to improve mood state in stressed adolescents (Field *et al.,* 1992).
b) *The State* Anxiety *1nventory (STAI; Spielberger, Gorsuch & Lushene, 1970).* This is a 20 item scale which measures the transitory anxiety level in terms of severity (not at all to very much so). Characteristic items include "I feel tense," "I feel nervous" and 'I feel relaxed." The STAI has adequate concurrent validity (Spielberger, 1972) and internal consistency *(r* - .83; Spielberger *et al.,* 1970). In addition, the STAI state scores an increase in response to situational stress and a decline under relaxing conditions (Spielberger *et al.,* 1970). A summary score is obtained by adding the weight of each item. This measure was included because state anxiety is known to affect alertness and performance on cognitive tasks negatively and because state anxiety typically decreases following massage therapy (Field *et al,* 1992; Ironson et *al.,* 1995).
c) *Salivary cortisol.* Saliva samples were collected and assayed for cortisol as a measure of stress that might be expected to affect alertness and performance on math computations. In addition, salivary cortisol levels decreased in at least two previous massage therapy studies (Field *et al.,* 1992; Ironson *et al,* 1995). The samples were collected at the beginning of the therapy sessions and 20 minutes after the end of the sessions 0fl the assessment days. Due to the 20 minute lag in cortisol change, saliva samples reflect responses to events occurring 20 minutes prior to collection. Salivary cortisol samples were obtained by having subjects place a cotton dental swab dipped in sugar-free lemonade crystals along their gumline for 30 seconds. The swab was placed in a syringe, and the saliva was squeezed into a microcentrifuge tube.
d) *Math computations.* Before the massage sessions a series of 7 numbers was given and after the massage a different series was given, and the subject was asked to add them. The time to complete the series and the correct/incorrect answer were recorded. This measure was used to determine the immediate effects of massage 0fl a task that might be expected to be enhanced by alertness.
e) *EEG procedure.* EEG was considered the primary dependent variable in this study as the physiological measure of alertness. Although subjects have anecdotally reported heightened alertness in previous studies, no direct measures have been made of alertness. Although EEG alpha and beta were noted to decrease (suggesting heightened alertness) in a previous study (Jodo *et al.,* 1988), face massage was used and no self report or performance measures were included. EEG was recorded in the present study for 3 minute periods prior to, during and after the therapy sessions with the subjects' eyes closed. The EEG was recorded using a Lycra stretchable cap (manufactured by Electro-Cap, Inc.) that was positioned on the subject using the standard 1~20 system. Electrode gel was injected into the following sites: F3, F4, P3, P4 and Cz. Impedances were brought below 5 K ohms, and the impedances of adjacent sites were brought within 500

ohms of each other. The EEG signals were amplified using a Grass Model 12 Neurodata Acquisition System with amplifiers set as follows: Low frequency filter: 1 Hz; High frequency filter: 100 Hz; Amplification: 20,000. The line frequency filter was on for all channels. The output from the amplifiers was directed to a Dell 325D PC fitted with an Analog Devices RTI-815 A/D board. The signal was sampled at a rate of 512 Hz and streamed to hard disk using data acquisition software (Snapstream HEM Data Corp.). Additional electrodes were positioned on the external canthus and the supraorbital position of one eye to record the subject's EOG, which was used to facilitate artifact scoring.

The first step involved the elimination of data which were unusable due to artifact from eye movements, muscle activity or technical difficulty. The artifact-free data were spectrally analyzed using a discrete Fourier transform with a Hanning window to yield power data for the following frequency bands: 1-4 Hz (Delta), 5-7 Hz (Theta), 8-12 Hz (Alpha), 13-20 Hz (Beta-low), 21-30 Hz (Beta-high). The EEG data were analyzed using an EEG analysis software package developed by James Long Company.

First Day/Last Day Measures

a) *Life Events Questionnaire.* The Life Events Questionnaire comprises a list of 9 stressful events (e.g., death of mate or lover, major financial difficulties). The subject is asked to check which events have occurred in the last four weeks. The subject is then asked to rate how each event has affected his/her life from not at all to very stressful on a 4 point scale. This measure was included to ensure that the results of this study were not negatively affected by significant life events. The Cronbach's alpha (.71) for internal consistency was reasonable as was the test-retest reliability (.89).
b) *Job Stress Yesterday Questionnaire.* This questionnaire measures job stress experienced yesterday and consists of 31 words or phrases requiring two responses each. The first response is a word or phrase describing the job (e.g., hectic, hassled, comfortable, too little time to think or plan). Possible answers are YES, NO or ? (cannot decide). If the phrase does describe the job yesterday, the subject is then asked to rate on a four point scale how much it bothers him/her. This questionnaire was included as a self-report measure on job stress. Cronbach's alpha (.73) for internal consistency was reasonable as was the test-retest reliability (.87).

RESULTS

Self-Report Data

Analyses of baseline measures yielded no group differences except that the control group had less job stress at baseline higher scores are optimal). Data were subjected to repeated measures by group (massage/control) ANOVAS with session (presession/postsession) and phase (pretreatment/posttreatment) as the repeated measures. Post hoc Bonferroni corrected *t* tests were performed to assess the group by repeated measures interaction effects. A priori nonorthogonal contrasts were made because based on previous anecdotal reports by subjects and the facial massage EEG data (Jodo *et al.,* 1988) we expected that the analyses would reveal enhanced alertness and performance. We also expected reduced anxiety, depression and cortisol levels following massage therapy based on previous massage therapy studies (Field *et al.,* 1992; Ironson *et al., 1995).* The analyses revealed the following (see Table 2): 1) a repeated measures effect revealed that the massage and relaxation control groups had significantly lower POMS depressed mood state scores following the first and last day sessions; 2) a repeated measures by group interaction effect revealed that the massage therapy group had significantly lower state anxiety scores after the first and the last day sessions than the relaxation control group; 3) No group differences or time changes were noted for the Life Events Scale; 4) for the Job Stress Scale, a significant repeated measures by group interaction effect was noted, suggesting a decrease in job stress (higher scores are optimal) but only for the massage therapy group; and 5) a repeated measures effect suggested both groups showed a decrease in chronic depressed mood state.

Saliva Cortisol Data

A repeated measures by group interaction effect revealed a *decrease in* salivary cortisol levels on the first day

for the massage group and an *increase* on the last day for the relaxation control group.

Math Computations

Massage also facilitated performance on math computation tasks (see Table 2). Group by repeated measures interaction effects suggested that the massage therapy group performed better following the sessions on both the first and last days. The decreased time required to complete the math computation task was significantly greater for the massage therapy group, and the decrease in the number of errors was significantly greater for the massage therapy versus the relaxation control group.

EEG Data

Repeated measures ANOVAs with group as the between subjects factor and pre-, during and postsession values as the repeated measures were conducted on the frontal alpha, beta, delta and theta values recorded before, during and after the massage/control sessions. These group (massage/control) by trial (0efore, during, after massage/control session) repeated measures ANOVAS revealed the following (see Table 3 for repeated measures and repeated measures by group interaction effects and their *F* values): 1) a repeated measures effect revealed that delta increased for both groups from pre- to during the session, suggesting enhanced relaxation (see Table 3); 2) theta did not change for either group; 3) group by repeated measures interaction effects suggested that: a) alpha significantly decreased from pre- to during the massage and from pre- to postmassage while alpha significantly increased for the relaxation group from pre- to postmassage and; b) beta significantly decreased for the massage group from pre- to during and from pre- to postmassage, and the control group significantly increased from pre- to postmassage.

Relations between EEG and Math Computation Measures

Correlation analyses were performed for each of the groups to determine whether there was a relationship between the alpha and beta EEG measures and the math computation (speed and accuracy) variables. For the massage therapy group the number of problems correctly solved was correlated with the decrease in the natural log of alpha from the period pre to during the massage *(r,-,* .43,p <.05), and the amount of time required to complete the computations was inversely related to the decrease in the natural log of beta from pre- to postmassage *(r* = -.59, p < .001).

TABLE 2

Means for Massage Therapy and Relaxation Control Group Measures (S.D.s under means)

	Massage				Control				
	Day 1		Day 10		Day 1		Day 10		
Measures	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Effects *
POMS depression	1.55	$.6_b{}^3$	1.4_a	$.5_b{}^3$	2.11	$.9_b{}^3$	1.7_a	$.8_b{}^2$	S

	.4	.2	.4	.3	.6	.3	.5	.3	
State anxiety	37.0_a	30.0_b [4]	38.5_a	31.3_b [4]	38.0_a	37.0_a	37.0_a	5.2_a	SxG
	11.3	9.6	12.7	10.5	13.2	12.9	13.9	11.4	
Computation accuracy	69.2_a	39.2_b [2]	83.1_b	96.2_c [2]	600_a	68.2_a	70.8_a	72.3_a	SxG
	20.9	28.3	29.7	31.0	24.0	20.7	26.3	25.9	
Computation time	250.0_a	234.0_b 2	232.5_b	210.9_c [1]	249.0_a	241.0_a	231.1_b	226.2_b	SxG
	85.1	72.3	75.9	64.0	82.6	71.8	65.0	62.3	
Salivary cortisol (ng)	2.1_a	1.6_b [2]	1.8_a	2.0_a	2.2_a	2.0_a	1.6_b	2.1_a [3]	SxG
	.5	.5	.4	.5	.7	.6	.4	.6	
	Day 1	*Day 10*	*Day 1*	*Day 10*	*Effects*				
Life events	8.0_a	7.4_a [1]	9.5a	8.9a					
Job stress1	38.0	44.0_b	47.0b	46.0b	PxG				
Chronic POMS depression	4.5_a	3.8_b [1]	5.1a	3.6b1	p				
$^1p<.05$, $^2p<.01$, $^3p<.005$, $^4p<.001$									
*G = group (massage/control)									
S = session (pre-session/post-session)									
P = Phase (pre-treatment/post-treatment)									
**higher score is optimal									

TABLE 3

Natura1 Log of Raw Power for Delta, Theta, Alpha. and Beta

Delta (1~4 Hz)

	Massage			Control		
	Pre	Dur	Post	Pre	Dur	Post
Mean	4.29	4.55	4.16	3.93	4.66	3.99
SD	.93	1.14	.81	.96	1.34	1.22

Pre v. Dur v. Post: Tria1 $F = 6.32$ $p = .004$
Pre v. Dur: Trial $F = 8.07$ $p = .009$

Theta (5-7 Hz)

	Massage			*Control*		
	Pre		*Post*	*Pre*	*Dur*	*Post*
Mean	3.02	2.71	3.02	2.92	3.25	3.00
SD	1.38	1.20	1.32	158	1.26	1.45

Alpha (8-l2 Hz)

	Massage			Control		
	Pre	*Dur*	*Post*	*Pre*	*Dur*	*Post*
Mean	***5.50***	**4.64**	5.20	4.99	4.87	5.61
SD	158	1.30	1.67	1.01	1.41	1.32

Pre v. Dur: Trial $F = 6.51$ $p = .003$
Group by Trial $F = 3.40$ $p = .04$
Pre v. Dur: Trial $F = 6.86$ $p = .02$
Pre v. Post: Group by Trial $F = 6.36$ $p = .02$

Beta (1~30 ***Hz)***

	Massage			Control		
	Pre	*Dur*	*Post*	*Pre*	*Dur*	*Post*
Mean	1.71	1.45	1.41	2.03	3.04	2.84
SD	1.81	2.14	1.95	150	1.44	1.49

Pre v. Dur v. Post: TriaI $F = 8.23$ $p = .001$
Group by Trial $F = 12.37$ $p = .000$
Pre v. Dur: Trial $F = 7.32$ $p = .0l$
Group by Trial $F = 21.29$ $p = .000$
Pre v. Post: Trial $F = 13.68$ $p = .001$
Group by Trial $F = 5.20$ $p = .03$

DISCUSSION

These data, like those of other studies on massage therapy showed decreases in anxiety and stress hormones (cortisol) immediately after the sessions (Field *et al.,* 1992; Ironson *et al.,* 1995). And, both the massage therapy and relaxation therapy groups showed increased delta activity, suggesting that both therapies had a relaxation effect and temporary *and* more chronic shifts in mood State which may have related to their relaxation. The decrease in self-reported depression is consistent with other massage studies (Field *et al,* 1992; Ironson *et al.,* 1995) as well as other relaxation studies (Platania-Solazzo, Field, Blank, Seligman, Kuhn, Schanberg & Saab, 1992).

Heightened alertness and enhanced performance on math computations occurred in the massage therapy group. The massage sessions were characterized by an EEG pattern of alertness. Although delta increased for both groups of subjects, suggesting relaxation, the pattern of enhanced alertness (decreased alpha and decreased beta) occurred in the massage therapy group while a pattern of drowsiness (increased alpha and increased beta) occurred in the relaxation control group. The decreased alpha and decreased beta were not surprising since at least one other study documented EEG alpha decreases associated with facial massage (Jodo Yamada, Hatayama, Abe & Maruyama, 1988). The correlation analysis further suggested that the accuracy of the math computations and the decrease in pre- to during massage EEG alpha were related. Although the alpha decrease occurred during the massages it could have affected the state of alertness for enhancing accuracy after the massage. Further, the speed of performing the calculations and the decrease in EEG beta pre- to postmassage were related. This more contemporaneous relationship suggests that performance speed may have been related to decreased beta.

The superior performance of the massage therapy group might relate to the tactile and pressure stimulation. Tactile and pressure stimulation, in addition to enhancing the EEG patterns of alertness and math computations in this study, have been noted to enhance parasympathetic activity (elevated vagal tone) which is characteristic of a more relaxed, alert state during which cognitive performance improves (Field *et al.,* 1992). Future research might add other measures such as vagal activity and catecholamines further to understand the underlying mechanism for the massage therapy-enhanced alertness relationship.

In addition, a longer term follow-up would be important to assess the persistence of the effects. Presumably, like exercise, a steady dose of massage may be required. Larger doses may also be more effective and result in more clinically meaningful changes in mood state and cortisol than occurred in this study. Finally, the cost effectiveness of massage therapy would need to be documented for more widespread

acceptance and adoption of the treatment.

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