positive effects for adults, including reduced mental and emotional stress (Jin 1992) and improved mood (Jin 1989). Although stress hormone levels were not assayed in this study, the adolescents were perceived by their teachers as being less anxious, emotional, and hyperactive following Tai Chi. The adult literature has reported reduced stress hormones (cortisol) with Tai Chi (Jin 1992).

Tai Chi research on adults has identified changes in cardiovascular, respiratory, electroencephalographic, and biochemical levels (e.g., lower cortisol stress hormone levels) (Brown et al 1989, Jin 1989). Reduced sympathetic activity, or enhanced parasympathetic activity, has been considered a potential underlying mechanism (Hsu, Wang & Kappagoda 1985). This mechanism might also account for the marked behavioral changes observed in the adolescents in this study and in our earlier ADHD massage study (Field et al 1998). The lower stress hormone (cortisol) observed following at least the massage therapy in our other studies (Field, Seligman et al 1996, Ironson et al 1996) is consistent with a mechanism of enhanced parasympathetic activity.

Future studies might compare Tai Chi and massage therapy effects on the reduction of stress hormones (e.g., salivary cortisol or urinary catecholamines) in ADHD adolescents. The comorbidity of ADHD with other psychiatric disorders, such as depression and anxiety, and the potential side effects of a multidrug therapy, make Tai Chi and massage therapy attractive alternative treatments. In addition to little or no side effects, especially appealing are the documented effects of Tai Chi and massage therapy on reducing anxiety and hyperactivity, the major and most difficult symptoms in ADHD children.

ALERTNESS

Study 4: Massage therapy reduces anxiety and enhances EEG pattern of alertness and math computation performance

Despite the increasing popularity of stress-management programs (Ivancevitch et al 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 et al 1996). Long-term (1 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 et al 1992). Thus, massage is noted to decrease anxiety and depression based on self-report, negative behavior based on 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 EEG and by speed and 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 et al 1988). The EEG alpha was expected to similarly 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 (1992) study on disturbed adolescents and the Ironson et al (1996) study on HIV-positive men.

Method

Sample The subjects were 50 medical faculty and staff members (80% females, mean age = 26). The subjects were well-educated (62% college graduate, 12% graduate school, 27% graduate degree). Income was less than $20 000 for 58%, $20–30 000 for 35%, and greater than $30 000 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%). Fifty percent of the sample had tried relaxation techniques, and 62% had rarely 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) yielded no group differences (see Table 3.4).

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

Table 3.4 Means for demographic variables for massage therapy and relaxation control group measures (Study 4)

Measures	Massage	Control	*p*
Age	26.4	26.2	NS
Gender (% female)	79.5	80.2	NS
Graduate degree (%)	26.8	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 (%)	64.1	60.9	NS

clothed in a special massage chair (Fig. 3.1), and they were given a moderate pressure massage that was focused on the kneading of muscles.

1. *Back*:
   (a) compression to the back parallel to the spine from the shoulders to the base of the spine
   (b) compression to the entire back, adding some rocking
   (c) trapezius squeeze
   (d) finger pressure around scapula and shoulder
   (e) finger pressure along the length of the spine and back
   (f) circular strokes to the hips below the iliac crest

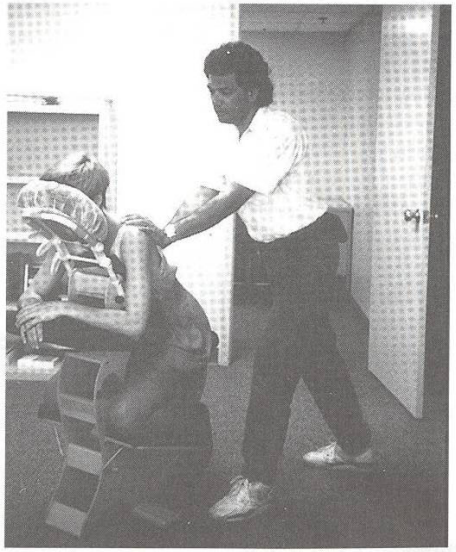

Figure 3.1 Special massage chair.

2. *arms*:
   (a) dropping arms to the side; kneading arms from shoulders to lower arms
   (b) pressing down points on upper and lower arms
3. *hands*:
   (a) massaging entire hands; traction to the fingers
   (b) pressing the fleshy part of the palm between the thumb and index finger for 15 to 20 seconds
   (c) traction of the arms both in lateral and superior directions (arm in line with the body)
4. *neck*:
   (a) kneading cervical vertebrae
   (b) finger pressure along base of skull and along side of neck; pressing 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 for movement artifact in the EEG measure).

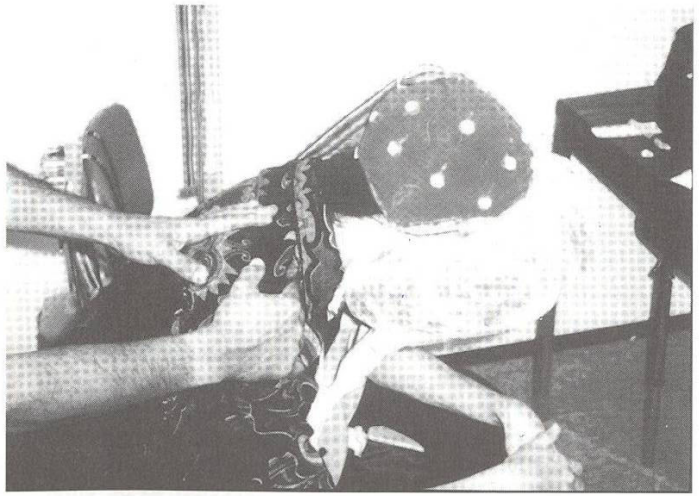

Figure 3.2 Subject wearing EEG cap while receiving massage.

Assessment procedures On the first and last day of the study the procedure was conducted in the following order for each subject.

1. The EEG cap was positioned on the subject's head (Fig. 3.2).
2. A saliva sample was taken for cortisol.
3. The subject completed the three long-term measures: the Life Events, Job Stress, and Chronic POMS Depression Scales.
4. The subject completed the session baseline measures: the POMS Depression, State Anxiety, and a math computation problem.
5. Immediately after the 15-minute massage/cortisol sessions the subject completed another math computation, the POMS Depression and State Anxiety Scale, and about 20 minutes after the end of the massage 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.

- *The Profile of Mood States* (POMS) (McNair, Lorr & Droppleman 1971). This scale was used because positive mood state would be expected to affect alertness and performance on math computations and because massage therapy has been noted to improve mood state in stressed adolescents (Field et al 1992).
- *The STAI* (Spielberger, Gorsuch & Lushene 1970). This measure was included because state anxiety is known to negatively affect alertness and performance on cognitive tasks and because state anxiety typically decreases following massage therapy (Field et al 1992, Ironson et al 1996).
- *Salivary cortisol* (Appendix 2A). 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 1996). The samples were collected at the beginning of the therapy sessions and 20 minutes after the end of the sessions on the assessment days.
- *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 answers were recorded. This measure was used to determine the immediate effects of massage on a task that might be expected to be enhanced by alertness.

- *EEG procedure* (Appendix 3B). 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.

First-day/last-day measures. These longer-term measures were as follows.

- *Life Events Questionnaire.* (Appendix 3C). The Life Events Questionnaire is comprised of 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 4 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.
- *Job Stress Yesterday Questionnaire* (Appendix 3D). 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 4-point scale how much it bothers him/her. This questionnaire was included as a self-report measure on job stress.

Results

Self-report data The analyses revealed the following (see Table 3.5).

1. The massage and relaxation control groups had significantly lower POMS depressed mood state scores following the first and last day sessions.
2. The massage therapy group had significantly lower state anxiety scores after the first and the last day sessions than the 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. A decrease in job stress was noted only for the massage group.
5. Both groups showed a decrease in chronic depressed mood state.
6. A *decrease* in salivary cortisol levels occurred on the first day for the massage group and an *increase* on the last day for the relaxation control group.
7. Massage also facilitated performance on math computation tasks (see Table 3.5). 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 control group
8. On the EEG data, delta, theta and alpha waves changed in the direction of heightened alertness for the massage therapy group (see Table 3.6).

Table 3.5 Means for massage therapy and relaxation control group measures (SDs in parentheses) (Study 4)

	Massage				Control				
	Day 1		Day 10		Day 1		Day 10		
Measures	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Effects[1]
POMS depression	1.5_a (0.4)	0.6_b*** (0.2)	1.4_a (0.4)	0.5_b*** (0.3)	2.1_a (0.6)	0.9_b*** (0.3)	1.7_a (0.5)	0.8_b** (0.3)	S
State anxiety	37.0_a (11.3)	30.0_b**** (9.6)	38.5_a (12.7)	31.3_b**** (10.5)	38.0_a (13.2)	37.0_a (12.9)	37.0_a (13.9)	5.2_a (11.4)	SxG
Computation accuracy	69.2_a (20.9)	89.2_b** (28.3)	83.1_b (29.7)	96.2_c** (31.0)	60.0_a (24.0)	68.2_a (20.7)	70.8_a (26.3)	72.3_a (25.9)	SxG
Computation time	250.0_a (85.1)	234.0_b** (72.3)	232.5_b (75.9)	210.9_c* (64.0)	249.0_a (82.6)	241.0_a (71.8)	231.1_b (65.0)	226.2_b (62.3)	SxG
Salivary cortisol (ng)	2.1_a (0.5)	1.6_b** (0.5)	1.8_a (0.4)	2.0_a (0.5)	2.2_a (0.7)	2.0_a (0.6)	1.6_b (0.4)	2.1_a*** (0.6)	SxG
	Day 1		Day 10		Day 1		Day 10		Effects
Life events	8.0_a		7.4_a		9.5_a		8.9_a		
Job stress[2]	38.7_a		44.0_b*		47.0_b		46.0_b		PxG
Chronic POMs depression	4.5_a		3.8_b*		5.1_a		3.6_b*		P

[1] G = group (massage/control); S = session (pre-session/post-session); P= phase (pre-treatment/post-treatment).
[2] Higher score is optimal.
* $p < 0.05$; ** $p < 0.01$; *** $p < 0.005$; **** $p < 0.001$.

Table 3.6 Means of natural log of raw power for EEG delta, theta, alpha, and beta (SDs in parentheses) (Study 4)

delta (1–4 Hz)

Massage			Control		
Pre	During	Post	Pre	During	Post
4.29 (0.93)	4.55 (1.14)	4.16 (0.81)	3.93 (0.96)	4.66 (1.34)	3.99 (1.22)
Pre vs Dur vs Post: Trial $F = 6.32$ $p = 0.004$			Pre vs Dur: Trial $F = 8.07$ $p = 0.009$		

theta (5–7 Hz)

Massage			Control		
Pre	During	Post	Pre	During	Post
3.02 (1.38)	2.71 (1.20)	3.02 (1.32)	2.92 (1.58)	3.25 (1.26)	3.00 (1.45)

alpha (8–12 Hz)

Massage			Control		
Pre	During	Post	Pre	During	Post
5.50 (1.58)	4.64 (1.30)	5.20 (1.67)	4.99 (1.01)	4.87 (1.41)	5.61 (1.32)
Pre vs Dur vs Post: Trial $F = 6.51$ $p = 0.003$ Pre vs Dur: Trial $F = 6.86$ $p = 0.02$			Group by Trial $F = 3.40$ $p = 0.04$ Pre vs Post: Group by Trial $F = 6.36$ $p = 0.02$		

beta (13–30 Hz)

Massage			Control		
Pre	During	Post	Pre	During	Post
1.71 (1.81)	1.45 (2.14)	1.41 (1.95)	2.03 (1.50)	3.04 (1.44)	2.84 (1.49)
Pre vs Dur vs Post: Trial $F = 8.23$ $p = 0.001$ Pre vs Dur: Trial $F = 7.32$ $p = 0.01$ Pre vs Post: Trial $F = 13.68$ $p = 0.001$			Group by Trial $F = 12.37$ $p = 0.000$ Group by Trial $F = 21.29$ $p = 0.000$ Group by Trial $F = 5.20$ $p = 0.03$		

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 1996). And both the massage therapy and relaxation therapy groups showed increased delta activity, suggesting that they had both 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 1996) and other relaxation studies (Platania-Solazzo et al 1992).

The sessions in our study involved deep pressure in the head, neck, shoulders, and back regions. Surprisingly, instead of becoming sleepier after their midday massage, the participants reported experiencing heightened alertness, much like a runner's high. EEG recordings before, during and after the massage sessions confirmed the subjects' impressions. As compared with a group of relaxation therapy subjects, their levels of alpha wave activity significantly decreased during massage (in contrast to alpha levels typically increasing during sleep). This decrease, combined with increased delta and decreased beta waves, suggested a pattern of heightened alertness. We then added a math computation task to determine whether this EEG pattern of heightened alertness translated into performance. Following the massage sessions, computation time was significantly reduced and computation accuracy increased, showing that 15-minute massages during the lunch hour not only enhanced alertness, but also improved cognitive performance.

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 et al 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 post 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 noted to be 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 to further understand the underlying mechanism for the relationship between massage therapy and enhanced alertness.

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.

Study 5: Aromatherapy positively affects mood, EEG patterns of alertness, and math computations

Aromas have been used throughout history for their medicinal and mood-altering properties. Aroma molecules have direct effects on human behavior and physiology ranging from activation of memories to changes in mood or emotional states. Although much of what we know about these effects comes from anecdotal rather than empirical evidence (Buchbauer et al 1993, Tisserand 1989), these effects may be explained by the close association between the olfactory and limbic systems (Bear, Connors & Paradiso 1996).

Aromatherapy has been rapidly gaining popularity. The essential oils involved in aromatherapy are highly concentrated essences extracted from plants through the process of distillation. Each oil is said to produce a predictable and reproducible effect on the user when its fragrance is inhaled (Sanderson & Ruddle 1992, Tisserand 1989). For example in one study certain essential oils (lavender, spiced apple, and eucalyptus) modified EEG activity, including increasing relaxation as suggested by increases in alpha power (Lorig and Schwartz 1987). In another study Lorig and colleagues found that frontal beta EEG activity increased during lavender and decreased during spiced apple presentation (Lorig et al 1990). Parasuraman and his colleagues (1992) found that subjects exposed to a peppermint aroma were better able to sustain attention as assessed by an increase in skin conductance levels and sustained event-related potential across the attention task. Other studies have supported these EEG findings. For example Badia and colleagues recorded high-frequency bursts in the EEG of subjects who were presented with a peppermint aroma during sleep (Badia et al 1990). Aromatherapy research has also shown behavioral changes including improved mood following presentation of chamomile oil (Roberts & Williams 1992), positive affect while