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Tai Chi/ Yoga Effects on Anxiety, Heartrate, EEG and Math Computations

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Abstract

Objective—To determine the immediate effects of a combined form of tai chi/yoga.

Design—38 adults participated in a 20-minute tai chi/yoga class. The session was comprised of standing tai chi movements, balancing poses and a short tai chi form and 10 minutes of standing, sitting and lying down yoga poses.

Main outcome measures—The pre- and post- tai chi/ yoga effects were assessed using the State Anxiety Inventory (STAI), EKG, EEG and math computations.

Results—Heartrate increased during the session, as would be expected for this moderate intensity exercise. Changes from pre to post session assessments suggested increased relaxation including decreased anxiety and a trend for increased EEG theta activity.

Conclusions—The increased relaxation may have contributed to the increased speed and accuracy noted on math computations following the tai chi/yoga class.

1. Introduction

Yoga has been noted to increase frontal EEG alpha wave activity, suggesting increased relaxation. [1] Similar results have been reported for tai chi in at least one study involving women who were either novices or skilled at tai chi, brain waves changed in the direction of alertness and relaxation for both groups. [2] In that study, higher alpha power was noted along with higher beta power on EEGs, which is a pattern that typically occurs during relaxation and attentiveness.

Yoga has also been associated with improved cardiorespiratory performance, highlighting the aerobic nature of yoga. [3] Similarly, an increase in peak oxygen uptake was seen in at least one tai chi study, suggestive of the aerobic nature of tai chi. [4] In another heartrate study, oxygen consumption was 55% of the oxygen consumption peak, and heartrate was 58% of the heartrate range noted during a practice session. [5] These results demonstrate that both yoga and tai chi are moderate-intensity exercises and aerobic in nature. In a meta-analysis on tai chi studies, aerobic capacity was significantly greater for the practitioners in at least seven studies. [6] Similar effects have been noted across different age groups and in both genders. [7]

These changes in physiology may relate to the decrease in self-reported symptoms of anxiety following yoga [8] and following tai chi. [9] Yoga has also decreased stress and negative affect, [10] and similar changes have been noted after tai chi. [11-12]

Limitations of the existing literature include: 1) the lack of generalization inasmuch as many samples have included only experienced practitioners of yoga and tai chi [13-14]; 2) several studies have included the breathing and meditative components of yoga along with the poses, thus confounding the effects of yoga postures (asanas), [15] and 3) results are based on atypically and impractically long sessions. [16]

The purpose of the present study was to determine the effects of shorter sessions of tai chi and yoga exercises combined. Sessions would need to be shorter to be widely adopted and more frequently practiced. Combining the two forms of exercise might further reduce stress and enhance performance. Short massage therapy sessions have been used for those reasons and have effectively reduced anxiety, altered EEG activity in the direction of heightened alertness and enhanced performance on math computations (increased speed and accuracy). [17] We have also assessed the effects of aromatherapy on EEG and math computations. In one study, the presentation of a lavender aroma led to greater relative left frontal EEG activation (a positive shift).[18] In two other studies, lavender aromatherapy resulted in improved math computations including both speed and accuracy. [19-20] Using these massage and aromatherapy studies as a model, we conducted short sessions of tai chi/ yoga and measured self-reported changes in anxiety as well as the immediate effects of one session on EEG, heartrate and performance on math computations.

2. Materials and methods

Following internal review board approval of this study and informed consent, medical faculty, clinicians and staff (95% female) participated in the study (N= 38). The participants averaged 41.0 years of age (R= 21-59), were middle socioeconomic status (M = 2.7 on the Hollingshead Socioeconomic Index) and were distributed 57% Caucasian, 14 % Hispanic, 14% Asian, 5% Black, and 10% other. 72% of the sample had never participated in yoga or tai chi sessions.

Procedures

Following informed consent, the participants were assessed before and after a 20-minute tai chi/ yoga session to determine the immediate effects of this brief session. The pre-session measures were given in the following order: 1) the State Anxiety Inventory (STAI); 2) EKG and EEG; and 3) math computations. The post-session assessments were in the following order: 1) EKG and EEG; 2) math computations; and 3) the STAI.

Assessments

State Anxiety Inventory (STAI) [21]—This scale was administered to determine anxiety. The STAI is comprised of 20 items and assesses how the subject feels at that moment in terms of severity from (0) ‘not at all’ to (4) ‘very much so’. Typical items include ‘I feel nervous’ and ‘I feel calm’. The STAI scores range from 20 to 80, and they increase in response to stress and decrease under relaxing conditions.

EEG

EEG was recorded for a 3-minute period prior to and a 3-minute period after the tai chi/yoga sessions, with the participants' eyes closed. The EEG was recorded using a lycra stretchable cap (Electro-Cap, Inc.) positioned on the participant's head using the standard 10-20 system. Electrode gel was inserted into the midfrontal (F3 & F4), central (C3 & C4), anterior temporal (T3 & T4), and parietal (P3 & P4) sites and referenced to the vertex (Cz) during recording.

Impedances are brought below 5K ohms. The EEG signals are amplified using Biopac EEG100B amplifiers. The output from the amplifiers is directed to a Dell Inspiron 7000 laptop computer fitted with the Biopac MP100 Acquisition System. The signal is sampled at a rate of 512 samples per second, streamed onto the computer screen, and then saved to a hard drive.

EEG is then computed off-line to derive a computer-averaged site reference, and then it is edited for artifact using software designed by James Long, Inc. The artifact-free data are spectrally analyzed using a discrete Fourier transform with a Hanning window with 50% overlap to yield power values (in uV^2) for the following frequency bands: 1-4 Hz (Delta); 5-7 Hz (Theta); 8-12 Hz (Alpha); 13-20 Hz (Low Beta) and 21-30 Hz (High Beta). These values are then transformed to normalize the data.

EKG

EKG was obtained for three minutes pre, during and post the tai chi/yoga session by placing 3 EKG electrodes in a standard configuration along the participant's inner arms. The EKG signals are amplified using a Biopac EKG100B amplifier. The output from the amplifiers is directed to a Dell Inspiron 7000 laptop computer fitted with the Biopac MP100 Acquisition System. The signal is sampled at a rate of 512 samples per second and streamed onto the computer screen and then saved to a hard drive. EKG data are then edited for artifact, and beats-per-minute (BPM) are computed off-line using AcqKnowledge software.

Math Computations

Before the massage sessions, a series of 7 single digit 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 because our previous studies on other therapies including massage therapy [17] and aromatherapy [19-20] documented enhanced alertness and improved performance on math computations following one session of the therapies.

Tai Chi/ Yoga sessions

The tai chi/yoga sessions were 20 minutes long and were comprised of: 1) 10 minutes of standing tai chi movements (4 exercises), balancing poses (2 exercises) and a short-form (see appendix 1); and 2) 10 minutes of standing (7 exercises), sitting (7) and lying down (7) yoga postures (asanas) done in a dance style of continuous movement rather than sustaining the postures (see appendix 2).

3. Results

As can be seen in table 1, paired t tests for pre to post changes revealed the following: 1) a statistically nonsignificant trend for an increase in frontal EEG theta activity (p= .10); 2) an increase in heart rate (EKG) from prior to during the session; 3) a decrease in self-reported anxiety (on the STAI); and 4) improved performance on math computations as reflected in both reduced time taken to perform them and increased accuracy.

4. Discussion

The trend for theta activity to increase and the decrease in self-reported anxiety highlight the relaxation effects of tai chi and yoga. Others have reported decreased anxiety following yoga [8] and tai chi [9] and decreased stress following yoga [10] and tai chi. [11-12] These measures provide convergent validity for the relaxation effects of tai chi and yoga. Enhanced performance on math computations, both speed and accuracy, may relate to this relaxation response. Being more relaxed following massage therapy [17] and following aromatherapy [19-20] has similarly

led to better performance on math computations, although the EEG changes did not involve theta activity but alpha and beta wave changes in the direction of heightened alertness in these studies. These discrepancies in brain wave data are not readily interpretable, but they are consistent in suggesting relaxation effects of the therapies.

Increased heart rate during the session suggests that tai chi/yoga is also aerobic. Others have also reported aerobic features of yoga [3] and tai chi.[4] Rarely has a form of exercise been both aerobic and relaxing. And, that these brief 20 minute sessions had positive effects on physiological, psychological and performance variables highlights the cost-effectiveness of this tai chi/ yoga protocol, a routine that could be conveniently practiced on a daily basis.

The limitations of this study should be noted including that the effects of these two forms of exercise, yoga and tai chi, are confounded in this study. In addition, they need to be studied separately in larger samples using the same variables but adding biochemical measures such as cortisol assays to provide confirmatory data on the relaxation effects. Finally, the long-term effects of repeated sessions of this combined exercise form should be assessed. Nonetheless, these data suggest the value of this short routine of combined tai chi and yoga.

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Appendix 1

Tai Chi Exercises (each 10×)

- Deep knee bends and hands moving down and up.
- Each arm stretched and alternately arching above head to opposite side
- Airplane wings (arms spread horizontally and then “banking”) to right and left
- Karate kicks in slow motion to each side
- Balancing on one foot, diamond formed by hands in front of face
- Weight on back foot, playing guitar position, as if holding neck of the guitar with one hand and plucking strings with the other hand.

Short Form (repeated 3×)

- Form- left foot to left, deep knee bend, arms lowering and raising with bending knees.
- Left toe to right foot, right ball (right hand above left hand as if holding a basketball)
- Left arm (palm up) and left foot forward
- Left foot pigeon toeing back toward right foot, left ball (left hand above right hand as if holding a basketball)
- Right arm and right foot forward, hand on top
- Pull arms back into flexion and forward into extension, back and forward

- Left clouds- left forearm and hand moving to left in front of face extending to left, right arm following in front below waist
- Right cloud- right forearm and hand moving to right in front of face extending to right, left arm following in front below waist
- Repeat left cloud
- Repeat right cloud
- Beak- right arm extended out to right forming bird's beak with right hand, left hand moving to top of beak
- Form-left foot to left, deep knee bend, arms raising and lowering.

Appendix 2

Yoga Postures

Stretching sitting straight with legs crossed (straight back)

- Extending right arm around to right,- left hand on right knee, right hand on floor
- Repeat on opposite side
- Moving head to right knee, hands clasped high in back
- Repeating same to left knee and middle of crossed legs.

On Hands & Knees (Stretching Back)

- Table- on hands and knees with back flat
- Cat- undulating center of back down with face up (Friendly cat) and back up with face down (scared cat)
- Kneeling balance- right arm straight forward, left leg straight back- bend leg & grab ankle with right hand-opposite side
- Repeat on opposite side
- Child's pose- lying back on haunches, chest on upper legs, hands & arms forward on floor

Up on Knees (stretching Legs)

- Runners stretch- Stretching forward with right foot on floor, hands on knees.
- Repeat on opposite side
- Legs up (standing), hanging down and hands on floor
- Repeat opposite side.

Standing Up (Balancing)

- Tree- right foot in left crotch or on left knee, hands in prayer position
- Repeat on opposite side
- Standing balance- both arms forward, right leg back, grab right ankle with right hand.

Sunset Salutation

- Start in standing prayer position
- Swoop down to floor with prayer hands, back and up & over head, slightly back-bend, then hands down to floor.
- Right foot back on floor (downward dog or inverted V position)
- Left foot back on floor (downward dog or inverted V position)
- Right foot forward, then left
- Then slowly up over head with prayer hands
- Back to standing prayer position
- Repeat on opposite side

Warrior Poses

- Warrior One- Facing forward, right leg forward, & straight, left leg back and foot pointed to left, both arms raised parallel to floor with right hand forward, left to the back, body in straight line
- Warrior Two – Moving from warrior one into warrior two, bring both arms up to head to ears and lean forward, bending right leg
- Repeat warrior one and two on other side moving to other side by bending at middle and relaxing with hands on floor
- Triangle- Both legs straight in V position, right leg forward, right hand travels down leg to ankle, left arm raises above head and looking up to left hand
- Inverted triangle- Switch arms with left hand on floor next to right foot & right arm above head, looking up to hand

Seated on Floor

- Bending over legs, both hands grabbing toes
- Right foot in crotch, bending over to grab toes
- Repeat on left

Lying on Back

- Right knee to chest, head to knee
- Right leg straight up, head to knee, walking hands up leg
- Repeat on left side

Spinal Twist

- Right arm up above head, head faced up to right hand
- Right knee to chest
- Left hand pulls bent right knee across to left side
- Repeat on left side

Spinal Stretch

- Grasp hands above head and stretch hands as far away from feet as possible

Rolling

- Bring knees to chest and grasp with hands, roll to left, to right, to left & right
- Roll up and down, u p and down, and up again

Prayer Position

- Sit with legs crossed in prayer position with arms extended above head, bring prayer hands down and say Namesté (namastay)- peace go with you.

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Table 1

Means for measures pre and post yoga/tai chi sessions (Standard deviations in parentheses).

	Mean		t	p (1-tailed)
Measure	**Pre**	**Post**		
Frontal EEG				
Delta	8.35 (1.53)	8.46 (1.35)	NS	NS
Theta	7.07 (1.44)	7.63 (2.17)	-1.30	.10
Alpha	6.92 (1.41)	6.79 (1.60)	NS	NS
Beta	5.74 (1.71)	5.74 (1.81)	NS	NS
EKG (Pre/During)	74.02 (9.40)	91.47 (16.61)	-5.31	.000
Anxiety (STAI)	33.64 (7.01)	31.62 (7.99)	2.39	.02
Math Computations				
Time (Sec)	186.64(107.51)	159.41 (81.96)	54.0	.000
Accuracy	3.62 (1.44)	3.97 (1.37)	-1.74	.05