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PERFORMANCE IN A SUBSTITUTION TASK AND STATE ANXIETY FOLLOWING YOGA IN ARMY RECRUITS[1]

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Summary.—140 men (M age = 30.3 yr., SD = 5.7) from the Indian army in north India participated in the study. They were naïve to yoga and were assigned to yoga and breath awareness groups randomly, with 70 in each group. 20 healthy males of comparable age (M age = 33.7 yr., SD = 7.0) formed a comparison group. Their performance in a digit-letter substitution task and a state anxiety subscale was assessed immediately before and after two 45-min. sessions. The two groups of soldiers practiced either yoga or breath awareness. The comparison group listened to meditation music. Digit-letter substitution scores increased in both groups of army personnel and in the comparison group. State anxiety decreased after yoga and listening to meditation music, but not after breath awareness. This suggests that even in army personnel naïve to yoga, a yoga-based intervention or listening to meditation music could reduce anxiety while increasing performance on an attention task.

Soldiers participating in warfare as well as those deployed for peace missions are prone to anxiety (Gruszczyński, Florkowski, Gruszczyński, & Wysokiński, 2008). It is recognized that military personnel are vulnerable to developing serious health problems (Mather, Stein, & Sareen, 2010). In particular, military personnel with social anxiety disorder experience significant rates of role impairment in all domains. Being able to maintain an attentional focus is essential for personnel involved in active military duty (Jones, Perkins, Cook, & Ong, 2008).

In the general population, anxiety is associated with poor performance in specific tasks. For example, people with high trait anxiety took longer to color-name threatening words compared to neutral words, when assessed on a modified Stroop color-naming paradigm (Fox, 1993). Persons who had high trait anxiety were also distracted by color words which produced no distraction for those with low trait anxiety. This suggested that high trait anxiety is associated with a general inability to maintain an attentional focus, which is not specific to threatening stimuli. This has been differentiated for trait and state anxiety (Pacheco-Unguetti, Acosta, Callejas, & Lupiáñez, 2010). For a task which used emotionally neutral information, trait anxiety was associated with deficiencies in the executive control network. State anxiety was associated with hyper-functioning and altering of networks, which can be counter-productive, leading to reduced efficiency. Hence, an anxiety-reducing intervention would be use-

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ful in military personnel, as long as their attentional focus would improve or at least remain the same, even when they were more relaxed.

Yoga is an ancient Indian combination of techniques, which includes physical postures, regulated breathing, meditation, as well as certain philosophical principles (Taimini, 1986). Several studies have demonstrated that practicing yoga techniques reduces anxiety. For example, in a controlled prospective, non-randomized study, 24 females who perceived themselves as emotionally distressed (Michalsen, Grossman, Acil, Langhorst, Lüdtke, Esch, *et al*., 2005) engaged in twice weekly, 90-minute Iyengar yoga sessions for three months, consisting mainly of yoga postures. Participants showed a significant decrease in perceived stress and state and trait anxiety. Meditation also has been shown to alter anxiety. Transcendental meditation practice resulted in a reduction in anxiety symptoms and electromyography scores (Raskin, Bali, & Peeke, 1980). This was comparable to the decrease with electromyography-biofeedback and relaxation therapy. Mindfulness-based stress reduction was evaluated for anxiety reduction in a randomized controlled trial in patients with heterogeneous anxiety disorder (Vøllestad, Sivertsen, & Nielsen, 2011). Patients who completed eight weeks of mindfulness-based stress reduction showed reduced anxiety which was maintained six months later. The effect sizes were medium to large (Cohen's $d = 0.55$–0.97). Acute anxiety was fully mediated, while mindfulness partly mediated changes in worry and trait anxiety. Another yoga program which combined meditation and regulated breathing reduced state and trait anxiety, depression, and feelings of tension (Kozasa, Santos, Rueda, Benedito-Silva, De Ornellas, & Leite, 2008).

Yoga practice has also been shown to improve performance in tasks requiring attention. For example, the practice of a specific meditation which included yoga postures, called cyclic meditation, improved the performance in a P300 task (based on latency at Fz), with large effect sizes after cyclic meditation (Cohen's $d = 1.51$) and medium effect sizes after supine rest (Cohen's $d = 0.49$; Sarang & Telles, 2006). The P300 reflects the ability to sustain and shift attention while discriminating between stimuli which differ in a single aspect, e.g., frequency of tones (Polich, 1999). The P300 also assesses attentional and immediate memory processes. Similarly, cancellation tasks also require sustained attention, as well as visual scanning, and activation and inhibition of rapid responses along with motor speed. Yoga practice has been shown to improve performance in cancellation tasks, increasing total scores and decreasing errors [Sarang & Telles, 2007 (Cohen's d following cyclic meditation = 1.42 and following supine rest = 0.69); Telles, Raghuraj, Maharana, & Nagendra, 2007 (after right nostril yoga breathing, Cohen's $d = 0.35$ and after alternate nostril breathing, Cohen's $d = 0.62$); Kumar & Telles, 2009 (after meditative focusing, Cohen's $d = 0.55$)].

Another task which assesses attention as well as other abilities is the substitution task. This task assesses attention among other abilities such as visual scanning and motor speed (Orlowiejska-Gillert, Pajak, Szczudlik, Kawalec, & Pomykalska, 1998). The practice of cyclic meditation, mentioned above, improved the performance in a digit-letter substitution task, along with improved performance in two tasks for motor speed (Subramanya & Telles, 2009). Here, for the substitution task Cohen's *d* after cyclic meditation was 1.17, and after supine rest Cohen's *d* was small, i.e., 0.14.

In general yoga is associated with peace and tranquility (Taimini, 1986). Hence it is not usual to consider that individuals trained to be aggressive would benefit from learning and practicing yoga. The present study aimed to assess whether military personnel trained for active combat could retain their ability to be attentive and less anxious, after a single yoga session. This is apparently the first study examining attention and anxiety in military personnel, and the effect of an intervention on them. Their response to yoga was assessed based on performance in a substitution task and state anxiety. The hypothesis was that a single yoga session would help military personnel to perform better in an attention task while simultaneously showing reduced anxiety.

Method

Participants

The participants were 140 male soldiers from one regiment of the infantry of the Indian army. All participants were trained for active combat and were at an army base in the north of India. From the camp, they could be deputed for possible active combat to the northern border of India, as well as to the northeastern state of Assam, where there is ongoing conflict. The sample was selected from a total of 200 soldiers stationed at the army base. All of them were naïve to yoga, which was verified with a single question. Sixty individuals were excluded as they could not fit the yoga session into their regular schedule. The participants were all physically and mentally healthy based on the most recent examination by a physician for the armed forces. Their ages were between 20 and 48 years of age ($M = 30.3$ yr., $SD = 5.7$). They had all completed between 12 to 15 years of education and most of them had been in the army for three years or more prior to the study. The participants were asked if they had practiced yoga before (a single question, not a survey). Since the choice to include yoga as an intervention was made by the authorities, it was not possible to assess if the participants were individually interested or not. They were randomly divided into two groups of 70 men in each group. Participants did not know the hypothesis of the study.

The same assessments were also carried out on a comparison group ($n = 20$). They were not soldiers, but were healthy males of comparable age (i.e., range = 21 to 47 years; $M = 33.7$ years, $SD = 7.0$). This group listened

to meditation music for 45 minutes (a CD, *Aum: a Mediatation in Sound*, by Swami Rama; Himalayan Institute Hospital Trust, 2003). They did not chant themselves, but listened to the music.

Design

Participants were assessed in three types of sessions. There was no training period. One group (group A) practiced yoga postures (*asanas*, in Sanskrit) and voluntarily regulated breathing (*pranayama*, in Sanskrit). The other group (B) sat at ease with eyes closed and practiced breath awareness. This intervention was selected for comparison as breath awareness has also been shown to improve performance on an attention task (Telles, Raghuraj, Arankalle, & Naveen, 2008). The two groups had sessions on separate days but the duration of the sessions, as well as the time of day (06:00 hours to 06:45 hours), were the same for both groups. The comparison group, who were not soldiers ($n = 20$), were seated at ease listening to meditation music, but were not themselves chanting. In this study participants had a single session. For the yoga session, simple yoga postures were first demonstrated with verbal instructions after which participants tried the practice, remaining in a posture for 15 to 30 seconds. The postures were the lotus posture or half lotus posture (*padmasana* or *ardha-padmasana*), tree posture (*tadasana*), the child posture (*balasana*), and corpse posture (*shavasana*). Each posture was practiced with eyes closed and with normal breathing. The postures were all repeated five times each. This was also done for *pranayama*. For the breath awareness sessions, participants were asked to keep their eyes closed and to be aware of the movement of their breath as they inhaled through the nose. During meditation music, participants kept their eyes closed and listened to the chanting. The assessments (i.e., a digit letter substitution task and the State–Trait Anxiety Inventory) were given to the three groups at the beginning and end of each session, which was 45 minutes long. Also, each participant of the yoga group was asked to subjectively rate his quality of yoga practice on a 10 cm linear analog scale, with 0 representing the worst possible practice and 10 the best practice possible. All participants rated their practice of both yoga (Group A) and breath awareness (Group B) as more than 7.5 cm. This was a requirement for inclusion in the study. Participants took part in the study voluntarily and signed consent was obtained. The study had the approval of the institution's ethical committee.

Assessments

Digit Letter Substitution Task.—The Digit Letter Substitution Task consists of a worksheet on which digits from "0" to "9" are arranged randomly in 12 rows and eight columns (Natu & Agarwal, 1997). A code for the "letter-for-digit" substitution is provided at the top of the work sheet. There are nine such pairs of letters and digits. Participants were asked to

write down as many letter-for-digit substitutions as they could within a time limit of 90 seconds. They were told that the two strategies commonly used were (i) substituting all nine digits in the random order in which they occurred, or (ii) substituting one digit at a time. Participants were free to choose whichever strategy suited them the best. The total number of substitutions (TA) and wrong substitutions (WA) were scored, and the net scores (TA minus WA) were obtained by deducting wrong substitutions from the total substitutions attempted.

The substitution task was administered twice, at the beginning and at the end of the interventions which were 45 minutes long. To avoid practice effects, parallel worksheets were made by changing the digit-letter pairs provided at the top of the worksheet as a "key" and by randomly changing the sequence of digits in the working section. The reliability and validity of the test for an adult Indian population has been established (Agarwal, Kalra, Natu, Dadhich, & Deswal, 2002). Hence, both groups received separate worksheets before and after the 45-minute intervention, although the worksheets were the same for the two groups.

State-Trait Anxiety Inventory.—State anxiety was measured using a sub-scale of the State-Trait Anxiety Inventory which has 20 items to assess state anxiety or anxiety at the moment of testing (Gaudry & Spielberger, 1970). Participants selected the number that best described the intensity of their feelings at the moment of testing, on the scale 1: Not at all, 2: Somewhat, 3: Moderately, or 4: Very much so. State anxiety was assessed at the beginning and end of both sessions.

Visual Analog Scale (VAS).—A 10-cm linear visual analog scale was used to assess each participant's rating of their level of relaxation after both the practices. The Visual Analog Scale is a doubly anchored horizontal line where each end represents opposite ends of a continuum that extends from 0: Not at all relaxed at the left end of the scale to 10: Extremely relaxed at the right end of the scale. Participants were instructed to place a vertical mark on the line to indicate their experience of relaxation. Each participant's score was obtained by measuring the distance in centimeters from the left end of the line (score 0) up to the mark made by the subjects.

The linear analog scale has been used to assess anxiety before and after yoga practice in an entirely different population (i.e., survivors of a natural disaster). Using various measures of reliability and validity, the content validity and test-retest reliability were verified (Telles, Singh, Joshi, & Balkrishna, 2010). In that situation as in the present study, linear analog scales were used, as they were easier for the participants to understand, particularly since those with 12 years of education found more complex scales difficult to understand if the questions dealt with subtle aspects of relaxation. However, the fact that linear analog scales were used is a limitation of the study, as the validity has not been established.

Interventions

Yoga session.—The yoga session included voluntarily regulated yoga breathing (*pranayamas*, for 30 minutes) and yoga postures (*asanas*, for 15 minutes). For the yoga session, simple yoga postures were first demonstrated with verbal instructions after which participants tried the practice, remaining in a posture for 15 to 30 seconds. When approached by the officials of the army base, they were quite clear that they wanted yoga techniques to be taught which could be learned in a single session, as very often the soldiers do not remain at the base for more than a week (in some cases their stay is 3 to 4 days). It was explained to them that yoga has to be taught in several supervised sessions. However, in the present study, it was limited to a single session. The postures were the lotus posture or half lotus posture (*padmasana* or *ardha-padmasana*), tree posture (*tadasana*), the child posture (*balasana*), and corpse posture (*shavasana*). Each posture was practiced with eyes closed and with normal breathing. The postures were all repeated five times each. This was also done for yoga breathing techniques or *pranayama*. The yoga breathing techniques included high-frequency cleansing breathing (*kapalabhati*, at the rate of 1.0 Hz), breathing through both nostrils alternately (*anulom-vilom pranayamas*), exhalation with specific sounds (*bhramari* and *udgeeth pranayamas*) and breathing with a period of breath holding or with a voluntarily partially constricted glottis (*bahya* and *ujjayi pranayamas*, respectively).

Breath awareness.—Breath awareness was considered as an intervention for comparison for two reasons. The first is that breath awareness is a part of most yoga practices, particularly yoga breathing techniques (Telles, Joseph, Venkatesh, & Desiraju, 1992). The second reason is that in another study, breath awareness improved the performance in a letter-cancellation task which measures attention, though the improvement was less than that following the practice of yoga breathing (Telles, *et al*., 2008). During the breath awareness session, participants were instructed to adopt a comfortable sitting posture and be aware of the movement of air as they breathed through their nose.

Music session.—A comparison group of 20 volunteers who were not soldiers were assessed before and after they listened to meditation music. During the session they were seated on the ground and asked to keep their eyes closed. The chanting played was repetition of the Sanskrit syllable, *OM*. This was based on an audio CD (*Aum: a Meditation in Sound* by Swami Rama; Himalayan Institute Hospital Trust, 2003).

Data Analysis

Analyses of co-variance (ANCOVA) with pre-test values as the covariate for between-groups comparisons of the post-test values were done using SPSS Version 18.0.

TABLE 1

TOTAL ATTEMPTED, WRONGLY ATTEMPTED, AND NET SCORES IN A DIGIT LETTER SUBSTITUTION TASK AND STATE ANXIETY BEFORE AND AFTER SEPARATE SESSIONS OF YOGA, BREATH AWARENESS, AND MUSIC

Measure and State	Yoga Group ($n = 70$)		Breath Awareness Group ($n = 70$)		Music Group ($n = 20$)		Comparison Between Groups (ANCOVA, with Pre-test Values as Covariate)
	M	*SD*	*M*	*SD*	*M*	*SD*	
Total attempted							
Pre-test	45.89	13.22	44.79	19.18	38.45	11.96	
Post-test	55.19†	18.24	48.61*	18.20	43.50	13.00	
Comparison (Post–Pre *post hoc*)	$p < .001$		$p = .02$		$p = .11$		$F_{2,156} = 3.81$, $p = .02$
Wrongly attempted							
Pre-test	0.87	0.92	0.51	1.00	0.20	0.52	
Post-test	0.99	1.48	0.89*	1.11	0.25	0.44	
Comparison (Post–Pre *post hoc*)	$p = .50$		$p = .03$		$p = .88$		$F_{2,156} = 1.89$, $p = .15$
Net score							
Pre-test	45.94	13.33	44.93	19.14	38.20	12.23	
Post-test	53.71†	17.33	47.90	18.02	43.30	13.07	
Comparison (Post–Pre *post hoc*)	$p < .001$		$p = .10$		$p = .14$		$F_{2,156} = 2.77$, $p = .07$
State anxiety							
Pre-test	40.90	6.79	43.71	9.09	44.90	15.16	
Post-test	36.76†	8.60	44.21	8.50	41.25	15.11	
Comparison (Post–Pre *post hoc*)	$p < .001$		$p = .63$		$p = .06$		$F_{2,156} = 9.37$, $p < .001$

Note.—Comparisons were (i) Pre- and post-test session Means Within-groups and (ii) Between-groups post-test session values (controlled for pre-test session Scores). Between-groups comparison was ANCOVA, controlling for pre-session scores. †$p < .001$. *$p < .05$, RM ANOVA, with Bonferroni adjustment, pre- compared with post-session

The data obtained before and after yoga, breath awareness, and music sessions were compared using repeated measures analyses of variance (ANOVAs using SPSS Version 18.0). There were two within-subjects factors, i.e., Time, with two levels, pre- and post-, and Groups, with three levels, yoga, breath awareness, and music. *Post hoc* analyses with Bonferroni adjustment were done to detect significant differences between mean values. Separate analyses were carried out for the total substitutions attempted (TA), those wrongly attempted (WA), and the net attempted (TA minus WA).

Correlations were made between digit-letter substitution task scores (total substitutions attempted, wrongly attempted, and the net attempted) and state anxiety using the Pearson correlation test.

Results

Analyses of co-variance (with pre-test values as the covariate) for between-groups comparisons of the post-test values showed significant differences for total attempted and state anxiety scores. The *F*, *df*, and *p* values are given in Table 1.

TABLE 2

Details of the repeated measures analysis of variance

Measure and Source	*df*	*M* Square	*F*	*p*	η^2	*Post hoc* Comparisons (Post–Pre, Bonferroni adjusted)
Total attempted						
Group (A)	2	1,537.18	3.27	.04	0.04	Yoga group : $p < .001$
Time (B)	1	2,102.93	21.41	$< .001$	0.12	BA group: $p = .02$
A × B	2	271.98	2.77	.07	0.03	Music group: $p = .11$
Error	157	98.23				
Wrongly attempted						
Group (A)	2	7.91	5.77	.004	0.07	Yoga group : $p = .50$
Time (B)	1	1.83	1.82	.18	0.01	BA group: $p = .03$
A × B	2	0.74	0.74	.48	0.009	Music group: $p = .88$
Error	157	1.00				
Net scores						
Group (A)	2	1,358.92	3.11	.05	0.04	Yoga group : $p < .001$
Time (B)	1	1,597.25	13.80	$< .001$	0.08	BA group: $p = .10$
A × B	2	201.92	1.74	.18	0.02	Music group: $p = .14$
Error	157	115.75				
State anxiety						
Group (A)	2	972.45	6.98	.001	0.08	Yoga group : $p < .001$
Time (B)	1	338.46	9.14	.003	0.06	BA group: $p = .63$
A × B	2	203.25	5.49	.005	0.07	Music group: $p = .06$
Error	157	37.05				

Note.—BA group: Breath Awareness group.

The repeated measures ANOVA showed a significant difference between Time (pre-, post-) for total substitutions attempted, net substitutions and state anxiety scores. The *df*, mean square, *F* values and eta squared (η^2) are shown in Table 2.

Post-hoc tests for multiple comparisons were performed with Bonferroni adjustment and all comparisons were made between the pre-test and post-test states of the (i) yoga, (ii) breath awareness and (iii) music sessions, separately. The *p* values are given in Table 2.

The total attempted, wrongly attempted, and net scores were tested for correlations with state anxiety in all three groups. There was a positive correlation between state anxiety and wrongly attempted scores in the music group ($r = .93$). All *r* values are given in Table 3.

TABLE 3
CORRELATION OF TOTAL ATTEMPTED, WRONGLY ATTEMPTED, AND NET SCORES IN A DIGIT LETTER SUBSTITUTION TASK WITH STATE ANXIETY OF YOGA, BREATH AWARENESS, AND MUSIC SESSION

	State Anxiety Scores		
	Yoga Group ($n = 70$)	Breath Awareness Group ($n = 70$)	Music Group ($n = 20$)
Total attempted	−.06	−.13	.03
Wrongly attempted	−.06	.04	.93
Net scores	−.03	−.11	−.02

Note.—Values are Pearson correlation coefficient (*r*).

DISCUSSION

The present results suggest that in naïve-to-yoga military personnel, a 45-minute yoga session improved the net scores in a substitution task and reduced state anxiety. Similar results were seen when participants passively listened to rhythmic chanting. However, breath awareness did not have this effect, which could be because breath awareness may even increase anxiety (due to heightened attention) in people naïve to the practice. In a separate study, when the substitution test was repeated with no intervention in between, no changes were seen in the total attempts, number of wrong attempts, or in the net scores (Subramanya & Telles, 2009). This suggests that a practice effect may not be responsible for changes seen.

The digit-letter substitution task measures psychomotor performance (Gerrard, Wheeldon, & McDevitt, 1995). This task is based on substitution tasks developed earlier (e.g., the Digit Symbol Substitution Task) but uses over-learned signs (e.g., letters) instead of the symbols in other substitution tasks (Van Der Elst, van Boxtel, van Breukelen, & Jolles, 2006). The task assesses attention, speed of perception, and processing, as well as a repetitive motor response (Orlowiejska-Gillert, *et al*., 1998; de Groot, Horn-

stra, Roozendaal, & Jolles, 2003). These skills would definitely be useful to soldiers in combat even though the substitutions task cannot be considered an analogue to responses elicited during combat. The improvement in net scores following yoga could be attributed to an improvement in attention and speed of perception and processing, as these have been shown to improve following a combination of yoga postures and guided relaxation (Subramanya & Telles, 2009). However, the same study showed that the practices improved performance in tasks requiring repetitive motor activity. In the present study whether the improvement was related to better attention and perception or to better speed for repetitive motor activity was not determined.

A decrease in anxiety may have contributed to the improved performance in the substitution task though no statistically significant correlation was found, except for the wrong attempts in the music group, which correlated with reduced anxiety. Self reported cognitive impairment has been found to be strongly associated with fatigue, symptoms of anxiety and depression, and impaired quality of life (Vardy, 2009). Also, as mentioned in the introduction, high trait anxiety has been linked with poor performance in a modified Stroop color naming paradigm (Fox, 1993).

There have been several previous studies which demonstrated improved performance in an attention task (i.e., a cancellation task) following the practice of voluntarily regulated yoga breathing (Sarang & Telles, 2007; Telles, et al., 2007; Kumar & Telles, 2009). Thus, improved attention may have contributed to the improvement in the substitution-task performance following yoga. The improvement may also be related to better motor coordination and better performance in motor tasks, which has also been reported after yoga (Madan, Thombre, Bharathi, Nambinarayan, Thakur, Krishnamurthy, *et al*., 1992). Given the fact that yoga practice has effects on attention and on motor speed, the present findings make it difficult to understand whether the effects were due to an improvement in attention or in motor speed. The fact that this was not determined is a limiting factor in understanding how yoga may have helped.

The present study also demonstrated that yoga practice reduces state anxiety while breath awareness does not. The way in which the yoga session may be reducing state anxiety is not known but may be speculated upon. Slow and deep breathing are known to increase the parasympathetic tone and are associated with a calm mental state (Kaushik, Kaushik, Mahajan, & Rajesh, 2006). Breathing at high frequencies was found to be followed by slow frequencies, not in the breath, but in the electroencephalogram (EEG), along with subjectively rated calmness (Novak, Lepicovska, & Dostalek, 1992).

In the yoga session, 66.6% of the time was spent in yoga breathing,

which may have accounted for the benefits seen. The remaining time was spent in practicing yoga postures (*asanas*). Many of the benefits of these practices are ascribed to muscle stretching. For example, muscle stretching associated with yoga postures is believed to help in reducing pain (Garfinkel, Singhal, Katz, Allan, Reshetar, & Schumacher, 1998). Apart from these effects of yoga practice which are easy to understand, more complex effects of yoga *asanas* have been shown. Two unique studies demonstrated that γ-aminobutyric acid (GABA)-ergic activity increased after yoga practice. In one study, experienced yoga practitioners had a significant 27% increase in GABA levels using magnetic resonance spectroscopy (Streeter, Jensen, Perlmutter, Cabral, Tian, Terhune, *et al*., 2007). The increase in GABA levels was seen in experienced yoga practitioners after a 60–min. session of practicing yoga postures compared to no change in GABA levels in controls after they were asked to read for the same amount of time. This study resulted in the question as to whether the increase in GABA levels was specific to yoga or was due to an overall increase in physical activity. The same authors provided the answers for this in the subsequent study which compared GABA levels in a yoga and a walking group (Streeter, Whitfield, Owen, Rein, Karri, Yakhkind, *et al*., 2010). The 12-week yoga intervention group had greater improvements in mood and lower anxiety compared to a metabolically matched walking exercise group. This study was also the first to demonstrate that increased thalamic GABA levels are associated with improved mood and decreased anxiety. The implications of the study were that GABA may be mediating some, if not all, of the beneficial effects of yoga on mood and anxiety. In the present study some of the above mechanisms may have contributed to the decrease in state anxiety.

The improved net scores and lower state anxiety in the music group may be related to the fact that listening to "meditation music" was shown to reduce anxiety (Trappe, 2009). The study examined the effects of listening to music in a pre-operative session. Relaxing music such as classical music or meditation music were found to be useful alternatives to midazolam, whereas heavy metal music or techno sounds were found to be ineffective and even lead to stress and/or life threatening arrhythmias.

Apart from this, music as well as other measures, such as graded exercise, saunas, and manual massage, lowered morbidity, work losses, and promoted efficiency in flight personnel in a combat unit (Shakula & Varus, 1994). What was especially improved was functional efficiency of the pilot and the safety records in flights. These findings may explain the improved net scores and reduced state anxiety in the music group.

The results of the present study suggest that an active intervention, such as yoga or a passive relaxation, such as listening to meditation mu-

sic, may be useful in reducing anxiety while attention is improved. The participants were not given prior training, hence an intervention like this may help military personnel when facing challenging situations with minimal time for training. The challenge could be knowing that they are being deployed to a combat zone, as well as brief episodes of anxiety which are experienced by military personnel in isolated places. In some situations, there may not be an opportunity for long-term training. Hence, knowing that even a single session could be useful in such circumstances may help in planning programs for military personnel in these situations.

It is essential to keep in mind the chief limitations of the study. These were (i) the absence of a no-intervention control group, (ii) the fact that the music group was from the general population, not soldiers, (iii) the intervention was taught as a single session in persons naïve to yoga, (iv) relaxation was assessed using an analog scale, for which the reliability and validity were not known, and (v) no objective physiological variable for relaxation was assessed. The limitations suggest directions for future research, including a long-term follow-up, introducing a no-intervention control group, and assessing the effect of meditation music on military personnel.

REFERENCES

Agarwal, A. K., Kalra, R., Natu, M. V., Dadhich, A. P., & Deswal, R. S. (2002) Psychomotor performance of psychiatric inpatients under therapy: assessment by paper and pencil tests. *Human Psychopharmacology,* 17, 91-93.

De Groot, R. H., Hornstra, G., Roozendaal, N., & Jolles, J. (2003) Memory performance, but not information processing speed, may be reduced during early pregnancy. *Journal of Clinical and Experimental Neuropsychology,* 25, 482-488.

Fox, E. (1993) Attentional bias in anxiety: selective or not? *Behaviour Research and Therapy,* 31, 487-493.

Garfinkel, M. S., Singhal, A., Katz, W. A., Allan, D. A., Reshetar, R., & Schumacher, H. R., Jr. (1998) Yoga-based intervention for carpal tunnel syndrome: a randomized trial. *American Medical Association,* 280, 1601-1603.

Gaudry, E., & Spielberger, C. D. (1970) Anxiety and intelligence in paired-associate learning. *Journal of Education & Psychology,* 61, 386-391.

Gerrard, L., Wheeldon, N. M., & McDevitt, D. G. (1995) Effect of combined atenolol and nifedipine administration on psychomotor performance in normal subjects. *European Journal of Clinical Pharmacology,* 48, 229-233.

Gruszczyński, W., Florkowski, A., Gruszczyński, B., & Wysokiński, A. (2008) [Classification of mental disorders of soldiers participating in peace missions and warfare actions]. *Polski merkuriusz lekarski: organ Polskiego Towarzystwa Lekarskiego*, 25, 55-58. [in Polish]

Jones, D. E., Perkins, K., Cook, J. H., & Ong, A. L. (2008) Intensive coping skills training to reduce anxiety and depression for forward-deployed troops. *Military Medicine,* 173, 241-246.

Kaushik, R. M., Kaushik, R., Mahajan, S. K., & Rajesh, V. (2006) Effects of mental relaxation and slow breathing in essential hypertension. *Complementary Therapies in Medicine,* 14, 120-126.

Kozasa, E. H., Santos, R. F., Rueda, A. D., Benedito-Silva, A. A., De Ornellas, F. L., & Leite, J. R. (2008) Evaluation of Siddha Samadhi Yoga for anxiety and depression symptoms: a preliminary study. *Psychological Reports,* 103, 271-274.

Kumar, S., & Telles, S. (2009) Meditative states based on yoga texts and their effects on performance of a cancellation task. *Perceptual and Motor Skills,* 109, 679-689.

Madan, M., Thombre, D. P., Bharathi, B., Nambinarayan, T. K., Thakur, S., Krishnamurthy, N., & Chandrabose, A. (1992) Effect of yoga training on reaction time, respiratory endurance and muscle strength. *Indian Journal of Physiological Pharmacology* 36, 229-233.

Mather, A. A., Stein, M. B., & Sareen, J. (2010) Social anxiety disorder and social fears in the Canadian military: prevalence, comorbidity, impairment, and treatment-seeking. *Journal of Psychiatric Research*, 44, 887-893.

Michalsen, A., Grossman, P., Acil, A., Langhorst, J., Lüdtke, R., Esch, T., Stefano, G. B., & Dobos, G. J. (2005) Rapid stress reduction and anxiolysis among distressed women as a consequence of a three-month intensive yoga program. *Medical Science Monitor,* 11, 555-561.

Natu, M. V., & Agarwal, A. K. (1997) Testing of stimulant effects of coffee on the psychomotor performance: an exercise in clinical pharmacology. *Indian Journal of Pharmacology*, 29, 11-14.

Novak, P., Lepicovska, V., & Dostalek, C. (1992) Periodic amplitude modulation of EEG. *Neuroscience Letters,* 136, 213-215.

Orlowiejska-Gillert, M., Pajak, A., Szczudlik, A., Kawalec, E., & Pomykalska, E. (1998) [Cognitive impairment and cardiovascular disease risk factors. Project CASCADE KrakÓw. III. Assessment of cognitive function in elderly women and men (65–78 years old)]. *Przegląd Lekarski*, 55, 689-696. [in Polish]

Pacheco-Unguetti, A. P., Acosta, A., Callejas, A., & Lupiáñez, J. (2010) Attention and anxiety: different attentional functioning under state and trait anxiety. *Psychological Science,* 21, 298-304.

Polich, J. (1999) P300 in clinical applications. In E. Niedermeyer, F. Lopes da Silva, (Eds.), *Electroencephalography: basic principles, clinical applications and related fields*. Munich, Germany: Urban and Schwarzenberg.

Raskin, M., Bali, L. R., & Peeke, H. V. (1980) Muscle biofeedback and transcendental meditation: controlled evaluation of efficacy in the treatment of chronic anxiety. *Archives of General Psychiatry,* 37, 93-97.

Sarang, S. P., & Telles, S. (2006) Changes in P300 following two yoga-based relaxation techniques. *International Journal of Neuroscience,* 116, 1419-1430.

Sarang, S. P., & Telles, S. (2007) Immediate effect of two yoga-based relaxation techniques on performance in a letter cancellation task. *Perceptual and Motor Skills,* 105, 379-385.

Shakula, A. V., & Varus, V. I. (1994) [The efficacy of restoring the professional health of flight personnel in a combat unit]. *Lik Sprava,* 7-8, 149-152. [in Russian]

Streeter, C. C., Jensen, J. E., Perlmutter, R. M., Cabral, H. J., Tian, H., Terhune, D. B., Ciraulo, D. A., & Renshaw, P. F. (2007) Yoga Asana sessions increase brain GABA levels: a pilot study. *Journal of Alternative and Complementary Medicine,* 13, 419-426.

Streeter, C. C., Whitfield, T. H., Owen, L., Rein, T., Karri, S. K., Yakhkind, A., Perlmutter, R., Prescot, A., Renshaw, P. F., Ciraulo, D. A., & Jensen, J. E. (2010) Effect of yoga versus walking on mood, anxiety, and brain GABA levels: a randomized controlled MRS study. *Journal of Alternative and Complementary Medicine,* 16, 1145-1152.

Subramanya, P., & Telles, S. (2009) Performance on psychomotor tasks following two yoga-based relaxation techniques. *Perceptual and Motor Skills,* 109, 563-576.

Taimini, I. K. (1986) *The science of yoga*. Madras, India: The Theosophical Publishing House.

Telles, S., Joseph, C., Venkatesh, S., & Desiraju, T. (1992) Alteration of auditory middle latency evoked potentials during yogic consciously regulated breathing and attentive state of mind. *International Journal of Psychophysiology*, 14, 189-198.

Telles, S., Raghuraj, P., Arankalle, D., & Naveen, K. V. (2008) Immediate effect of high-frequency yoga breathing on attention. *Indian Journal of Medical Sciences,* 62, 20-22.

Telles, S., Raghuraj, P., Maharana, S., & Nagendra, H. R. (2007) Immediate effect of three yoga breathing techniques on performance on a letter-cancellation task. *Perceptual and Motor Skills,* 104, 1289-1296.

Telles, S., Singh, N., Joshi, M., & Balkrishna, A. (2010) Post traumatic stress symptoms and heart rate variability in Bihar flood survivors following yoga: a randomized controlled study. *Biomed Central Psychiatry*, 10, 18-27.

Trappe, H. J. (2009) [Music and health—what kind of music is helpful for whom? What music not?] *Deutsche Medizinische Wochenschrift*, 134, 2601-2606. [in German]

Van Der Elst, W., van Boxtel, M. P., van Breukelen, G. J., & Jolles, J. (2006) The Letter Digit Substitution Test: normative data for 1,858 healthy participants aged 24–81 from the Maastricht Aging Study (MAAS): influence of age, education, and sex. *Journal of Clinical and Experimental Neuropsychology*, 28, 998-1009.

Vardy, J. (2009) *Cognitive function in survivors of cancer.* New South Wales, Australia: Joy Curzio.

Vøllestad, J., Sivertsen, B., & Nielsen, G. H. (2011) Mindfulness-based stress reduction for patients with anxiety disorders: evaluation in a randomized controlled trial. *Behaviour Research and Therapy*, 49, 281-288.

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