



Mood State Response to Massage and Subsequent Exercise Performance

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A within subjects experimental design ($N = 16$) was used where participants performed a 30-s Wingate anaerobic cycling test (WAnT) after 30-min rest and after 30-min back massage. Mood State was measured before and after each intervention and after the WAnTs. No significant change in mood was detected following rest or massage. However, WAnT performance was better following massage compared to rest. Mood disturbance increased following the WAnT in both the rest and massage conditions. The results suggest that preperformance massage had no effect on mood state yet seemed to facilitate enhanced WAnT performance. The relationship between massage and anaerobic performance remains unclear, however is almost certainly mediated by preperformance psychological factors other than mood state.

Massage has become an integral component of athletic training and is used extensively by athletes and coaches across a range of sport disciplines. Although research has produced inconsistent findings regarding the use of sports massage, there are no signs that such practises are likely to subside. The American Massage Therapy Association alone claims to represent 51,000 massage therapists in 27 countries, 49% of whom state they use sports massage and 92% state they use Swedish massage (a series of techniques used in sports therapy). At the 1983 Boston Marathon, the sports massage team comprised only 20 student massage therapists compared to 175 personnel in 2001, who performed more than 1200 massage treatments. Anecdotal evidence therefore seems to suggest that sports massage has substantially grown in popularity over the past 20 years and is continuing to grow. Given the prevalence of sports massage and the recent emphasis on “evidence based practice” in physical therapy, there is a need for continued empirical research in this area.

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The majority of published literature relating to sports massage has mainly focused on its physiological manifestations with relatively few articles covering its psychological effects. In a comprehensive review of massage by Callaghan (1993), there are 28 citations relating to the various physiological responses to massage yet only two citations pertaining to its psychological effects. In another review by Cafarelli and Flint (1992), there were 29 citations relating to massage physiology and only seven citations regarding massage psychology. In both of these reviews, the issue of preperformance massage was discussed; however, neither were able to provide any conclusive evidence that massage-induced physiological changes were in any way associated with subsequent improvements in exercise performance. Indeed, Callaghan (1993) summarized that “. . . although massage is widely used in the belief that it helps muscle recover from fatigue and can enhance performance, the studies to confirm this are few in number and contradictory. . . . It should be noted that these studies . . . may not reflect the effects of stress of competition and other psychological factors” (p. 32). The psychological effects of massage may therefore have an important influence upon subsequent exercise performance.

Previous research has demonstrated positive effects of massage on various aspects of psychological state. Tyurin (1986) reported reduced anxiety, increased self-feeling, and increased activeness following massage. Hemmings, Smith, Graydon, and Dyson (2000) demonstrated reduced perception of fatigue and increased perception of recovery following massage. Weinberg, Jackson, and Kolodny (1988) examined mood state changes that occurred after participating in a range of sports and mood state changes that occurred after receiving a massage. They measured the mood state of 183 university students, using the McNair, Lorr, and Droppleman (1971) Profile of Mood States (POMS) questionnaire, before and after 30 min of rest ($n = 56$), massage ($n = 40$), swimming ($n = 39$), jogging ($n = 47$), racquetball ($n = 52$), or tennis ($n = 45$). In the running and massage conditions, they detected positive changes in mood state that were characterized by an increase in vigor and a reduction in tension, depression, anger, fatigue, and confusion. While running and massage both seem to produce a similar positive mood state, massage has a lower energy cost. As a mode of preparation, massage may therefore be preferable to running, since participants may wish to limit the amount of physical exertion that they undergo immediately before an athletic event. In fact, Weinberg et al. reasoned that if the performance-enhancing benefits of massage could be demonstrated, then future research might examine the extent to which such effects were due to positive mood states.

In recent years, researchers have become increasingly interested in the relationship between emotional state and athletic performance, which was largely provoked by the work of William Morgan. Morgan (1980) proposed a Mental Health Model (MHM) that attempted to describe the relationship between an athlete's psychological condition and sports performance. Morgan's underlying rationale was that success in sport is associated with positive mental health. The MHM asserts that successful athletes possess positive mental health, defined as average or below average levels of neuroticism, trait anxiety, depression, confusion, and fatigue. With respect to mood state, Morgan described how successful athletes tended to exhibit an iceberg POMS that was characterized by elevated levels of vigor and reduced levels of tension, anger, depression, fatigue, and confusion. It is worth noting that the pattern of mood that Weinberg et al. (1988) detected following massage is synonymous with the iceberg POMS. Morgan initially reported that

the MHM had 70-80% success rate in predicting athletic success, however he was keen to emphasize that this was not sufficient for athlete selection purposes. Indeed Morgan (1985) suggested that a more appropriate use of the MHM would be as method of monitoring individual athlete's fluctuations in emotion, especially the dynamic aspects of psychological state like POMS. Rowley, Landers, Kylo, and Etnier (1995) also concluded that the most effective use of the MHM was in monitoring an individual athlete's psychological state since they were only able to show, through metaanalysis of 33 studies, that the iceberg POMS had a predictive value of less than 1% with respect to athletic success.

The MHM is of particular relevance to this study since it would seem that if massage can be used to induce a positive psychological state, as suggested in the Weinberg et al. study, then this might facilitate optimal or near optimal athletic performance by the massaged subject. Although Morgan (1985) specifically warned that there was no evidence to suggest that lowering anxiety or depression scores would enhance performance, there have since been considerable additions to the literature that have improved psychologists' understanding of mood-performance relationships and ought to be given extra consideration. We believe that the existing literature concerning the relationship between mood state and performance is sufficiently well described to justify an empirical examination of how preperformance mood states might be deliberately manipulated using massage for the purposes of optimizing athletic performance.

A key development in psychologists' understanding of psychological state and athletic performance has evolved around the dynamic components of the MHM. Raglin (2001) expressed concern that when mood disturbances are detected in elite athletes, they are misinterpreted as psychopathological rather than normal variations in psychological state. In fact, oscillating psychological states including mood have been found to be quite normal, even among elite athletic performers. For instance, Morgan, Brown, Raglin, O'Connor, and Ellickson (1987) reported elevated mood disturbances among endurance athletes that coincided with increases in training load. Athletes that usually exhibit positive mental health profiles may therefore experience fluctuations in mood state, particularly during periods of intensive training. Massage might be used to reverse a negative psychological state detected in an athlete, especially given the positive effect of massage on mood state reported by Weinberg et al. (1988). An intervention like massage might be particularly useful immediately before a competition at a time when fluctuations in an athlete's mood state might be expected and are likely to increase in amplitude.

The relationship between mood state and performance has been explored in several studies. Beedie, Terry, and Lane (2000) presented the results of two metaanalyses in which they demonstrated a significant relationship between POMS and performance outcome. They noted that the effect was more evident for short duration sports than it was for long duration sports. It would therefore seem that in order to investigate the effect of massage-induced mood states upon performance, a short duration exercise task should be used. Lane and Terry (2000) proposed a conceptual model of mood and performance with a focus on depression. They clearly describe how depressed mood acts as a catalyst in reducing vigor and increasing tension, confusion, anger, and fatigue. According to this model, suboptimal athletic performance is an expected consequence of a negative mood state. The model was partially supported in a study conducted by Lane, Terry, Beedie, Curry, and Clark (2001), who observed that children with elevated levels

of POMS depression tended to perform less well in a running task, compared to children who exhibited average or low levels of POMS depression. It would seem that individuals with positive mood state with low level of depression are more likely to perform an athletic event well. Massage may be an appropriate way of reversing elevated levels of depression since Weinberg et al. (1988) reported a significant reduction in depression following massage. Weinberg et al.'s idea that positive mood states might be associated with enhanced athletic performance does seem to have been supported in more recent literature. It also apparent from Lane et al.'s work with children, that mood-performance effects are not confined to elite athletes or competitive events. Where preperformance negative mood states are detected in participants, it would seem entirely sensible to try to reverse this effect. In these circumstances, massage might be a suitable intervention, as indicated by Weinberg et al.'s observed change in mood state following massage. Indeed, Weinberg et al. actually speculated that massage-induced positive mood changes might enhance athletic performance but acknowledged that a positive relationship between massage and performance needed to be explored first.

Research concerning the effects of massage on exercise performance is limited and has produced varied results. Drews et al. (1990) reported that massage did not significantly improve the performance of a 4-day stage race (161 km/day) among elite cyclists. Hemmings et al. (2000) reported no improvement in a 10-min boxing ergometer task following massage. These studies tend to show that massage fails to have any positive effect on the performance of medium and long duration exercise. Furthermore, the test-retest reliability of the performance tasks used in such studies has not been thoroughly established, a factor that may further reduce the chances of detecting massage-induced short term performance gains. In contrast, Ask, Oxelbeck, Lundeberg, and Tesch (1987) reported an increase of 11% in maximum power of knee extensions following massage. This study used an exercise mode of short duration in which a simple and reliable measure of performance was used. Although limited, previous research seems to indicate that preperformance massage is most likely to improve short duration, high intensity exercise tasks. It is important to note that massage (Ask et al., 1987) and positive mood (Beedie et al., 2000) have both been associated with enhanced performance of short duration exercise tasks.

Previous investigations have not studied the effects of massage on mood state and exercise performance together. The purpose of this experiment was to examine the effect of massage on mood state and subsequent anaerobic cycling performance. The findings could potentially support the use of massage as an applied psychological intervention for managing preperformance mood states. It was predicted that massage would produce a positive change in mood state and that anaerobic cycling performance would be better following massage compared to rest.

Method

Participants

Ten male and six female healthy participants (*M* age 22 years, *SD* 4.8, *M* height 174 cm, *SD* 7.7, and *M* body mass 68.5 kg, *SD* 10.2) were recruited from the University of Essex Department of Sport and Exercise Science (*N* = 16). Participants were all undergraduate university students who had participated in a minimum of 30 min

of moderate intensity physical activity (including recreational cycling) two to four times per week. None of the participants were elite standard cyclists or engaged in any high intensity training likely to impact upon their mood. Participants had a mean body mass index (BMI) of 22.6, SD 2.2 kg/m² indicating normal levels of physical condition. All participants satisfactorily completed a health screening questionnaire and gave voluntary consent to participate in the experimental procedures that were approved by the University of Essex ethical committee.

Profile of Mood State (POMS)

Mood state was measured using the McNair et al. (1971) Profile of Mood States questionnaire (POMS). The short form published by Educational and Industrial Testing Service (EdITS) San Diego CA was used to minimize the transition time between the experimental intervention (rest or massage) and commencement of the cycling task. The POMS short form comprised 30 items to which participants were required to indicate how they felt “right now.” There are six mood subscales in the POMS short form: tension, depression, anger, vigor, fatigue, and confusion. The short form subscales are identical to those used in the long form. The reliability of the POMS short form was established by McNair, Lorr, and Droppleman (1992). POMS short forms were marked using templates provided by EdITS and raw scores were converted into T-scores comparable with those used by Morgan (1980, 1985) to describe the iceberg mood state phenomenon. College student norm conversion tables were used that are published in McNair et al. (1992) since these were the most appropriate to the sample of undergraduate student participants that were used in our experiment.

Wingate Anaerobic Cycling Test (WAnT)

Cycling performance was measured using the 30-s Wingate anaerobic cycling test (WAnT) since it is a maximal effort short duration task. The WAnT uses highly reliable and valid quantitative measures of performance that are easily recorded and sensitive enough to detect small but significant changes in performance. The test-retest reliability of the WAnT ($r = .95 - .97$) was firmly established by Bar-Or, Dotan, and Inbar (1977) and is an ideal test to use in a repeated measures experimental design. Furthermore, the transition to the WAnT following massage can be achieved with minimal disruption to the participant and is therefore less likely to interfere with their existing mood state.

WAnT's were conducted using a Lode Excalibur Sport (Lode B.V., Netherlands) magnetically resisted cycle ergometer in conjunction with Wingate version 1.0.7 software© (Lode B.V., Netherlands). Saddle height remained constant in both conditions and was initially adjusted so that with the crank position at bottom dead center and the foot secured to the pedal with toe clips, the knee joint was almost in full extension (approximately 175-180°), and the sole of the foot was parallel to the ground.

The following WAnT variables were recorded: (a) total work, defined as the total work expended during the 30-s test period; (b) peak power, defined as the highest power output recorded during the 30-s test period; (c) minimum power, defined as the lowest power output recorded during the 30-s test period; (d) mean power, defined as the average power output during the 30-s test; (e) time to peak power, defined as the time peak power occurred; and (f) fatigue rate, defined as

the rate of decline in power output calculated as (peak power – minimum power) / (30 – time to peak power).

Massage

A 30-min back massage protocol was used incorporating a combination of effleurage and pétrissage Swedish massage techniques, which are presented in Table 1. Goats (1994) describes effleurage as "... slow rhythmic stroking hand movements, moulded to the shape of the skin... parallel to the long axis of the tissue" (p. 149) and pétrissage as "... a fold of skin, subcutaneous tissue and muscle is squeezed, lifted, and rolled against the underlying tissues in a continuous circular motion" (p. 150). Back massage was deliberately selected in order to avoid manipulating the muscle groups of the leg, which are recruited during the performance of a WAnT. The use of back massage thereby minimized the possibility that any observed changes in WAnT performance might be attributable to the physiological effects of leg massage rather than the psychological effects of massage.

Several additional precautionary measures were taken to improve the intrasubject reliability of the massage. First, the same qualified massage therapist was used to perform massages throughout the entire experiment, thus eliminating any possible variation in massage outcome that may have arisen had several different therapists been used. Second, each massage treatment was carefully timed and the therapist was discretely prompted when he was required to change massage technique in accordance with the protocol provided in Table 1. Finally, all rest and massage interventions were conducted within the same environment that was free of distractions or other potentially mood-altering influences. Participants were notified that they would not be spoken to during rest or massage. Using this method, all participants experienced the same standardized massage within a carefully controlled environment.

Procedure

A within subjects experimental design was used and all participants completed the rest and massage conditions. The order of the conditions was counterbalanced so that half of the participants performed the rest condition before the massage condition (RM) and the other half of the participants performed the massage condition before the rest condition (MR). Participants were randomly assigned to either RM or MR sequences. The requirements of each condition were only revealed to participants on the relevant day of attendance. Thus on the first attendance, RM participants were not aware that they would later receive massage, and MR participants were not aware that on their second attendance they would rest without massage.

Participants completed a POMS questionnaire to measure baseline mood state immediately before the rest and massage interventions (POMS trial 1). In the rest condition, participants remained in the supine position on a massage couch for 30 min in a quiet room. In the massage condition, participants received a 30-min back massage in accordance with the protocol presented in Table 1.

After the each 30-min intervention (rest or massage), participants completed a second POMS questionnaire to measure postintervention mood state (POMS trial 2). Participants then performed the manufacturers standard preinstalled WAnT on the Lode cycle ergometer. In order to countermeasure WAnT learning effects, only those participants who had previously performed a WAnT were used. All participants

Table 1 Back Massage Protocol

Back region	Stroke direction	Massage technique	Time (min)
Whole back	Distal to head	Bilateral palm effleurage	2
RHS			
Dorsal	Proximal to head	Palm effleurage	1
Dorsal	Proximal to head	Palm-heel effleurage	1
Lumbar	Transverse lateral	Palm-heel effleurage	1
Lumbar	Transverse medial	Protected fingertip effleurage (clawing)	1
Lumbar	Omnidirectional	Pétrissage	1
Thoracic	Proximal to head	Palm-heel effleurage	1
Scapular	Proximal to head	Ulna border effleurage	1
Thoracic	Omnidirectional	Pétrissage	1
Shoulder	Proximal to head	Palm effleurage	1
Shoulder	Proximal to head	Palm-heel effleurage	1
Shoulder	Omnidirectional	Pétrissage	1
Dorsal	Proximal to head	Palm effleurage	1
LHS			
Dorsal	Proximal to head	Palm effleurage	1
Dorsal	Proximal to head	Palm-heel effleurage	1
Lumbar	Transverse lateral	Palm-heel effleurage	1
Lumbar	Transverse medial	Protected fingertip effleurage (clawing)	1
Lumbar	Omnidirectional	Pétrissage	1
Thoracic	Proximal to head	Palm-heel effleurage	1
Scapular	Proximal to head	Ulna border effleurage	1
Thoracic	Omnidirectional	Pétrissage	1
Shoulder	Proximal to head	Palm effleurage	1
Shoulder	Proximal to head	Palm-heel effleurage	1
Shoulder	Omnidirectional	Pétrissage	1
Dorsal	Proximal to head	Palm effleurage	1
Erector spinae	Distal to head	Deep thumb effleurage	2
Whole back	Distal to head	Bilateral palm effleurage	2

Note. RHS = Right hand side; LHS = Left hand side; Dorsal refers to the whole length of back.

had performed at least one WAnT in the preceding two-month period and were fully familiar with the cycling task. This test comprised 5 min of warm-up cycling at 100W, during which participants were instructed to maintain a cadence of between 60-70 rpm. In the first 3 min of the warm-up, all participants performed two separate 3-s practice acceleration sprints. At the end of the 5-min warm-up, participants were given a 3-s countdown upon which the Lode automatically administered the

WAnT. Participants gripped the handlebars and remained seated in the saddle for the duration of the test. Participants were instructed to cycle as hard as they could right from the beginning of the test without attempting to conserve energy for later on. All participants were given the same amount of verbal encouragement. Immediately after the WAnT, participants completed a final POMS questionnaire to measure postWAnT mood state (POMS trial 3).

Results

Total Mood Disturbance (TMD)

TMD scores were calculated by subtracting POMS vigour subscale T-score from the sum of tension, anger, depression, fatigue, and confusion POMS T-score (McNair et al., 1992). A Bonferonni corrected alpha level of .0167 was used to indicate statistical significance in all of the statistical tests applied to TMD since there were three POMS trials. TMD scores were analyzed using a 2×3 (conditions $\times$ trials) ANOVA. There was no significant TMD condition-by-trial interaction, $F(2, 90) = 0.29, p > .0167$, partial $\eta^2 = .007$ or condition main effect, $F(1, 90) = 0.09, p > .0167$, partial $\eta^2 = .001$. A significant trial main effect was detected for TMD, $F(2, 90) = 9.9, p < 0.0005$, partial $\eta^2 = .18$, indicating a large effect size.

Post hoc comparisons were made using paired-sample t -tests. There was no change in TMD between the POMS trial 1 ($M = 150.9, SD = 19.0$) and POMS trial 2 ($M = 153.2, SD = 16.3$), $t(31) = -0.95, p > .0167, \eta^2 = .028$. A significant increase in TMD was measured between POMS trial 2 ($M = 153.2, SD = 16.3$) and POMS trial 3 ($M = 168.1, SD = 13.9$), $t(31) = -4.12, p < .0005, \eta^2 = .35$, indicating a large effect size. TMD trial main effects are presented in Figure 1. Mean TMD scores and standard deviations for each condition are presented in Table 2.

Profile of Mood States Subscales

A Bonferonni corrected alpha level of .0167 was used to indicate statistical significance in all the statistical tests applied to POMS subscale T-scores since there were three POMS trials. POMS subscale T-scores were analyzed using a 2×3 (conditions $\times$ trials) MANOVA. There was no significant condition-by-trial interaction of POMS T-scores, $F(12, 172) = 0.83, p > .0167$, partial $\eta^2 = .055$ or condition main effects for POMS T-scores, $F(6, 85) = 0.24, p > .0167$, partial $\eta^2 = .17$. Significant trial main effects in POMS T-scores was detected, $F(12, 172) = 9.15, p < .0005$, partial $\eta^2 = .452$.

Trial main effects were further investigated using a series of 2×3 (conditions $\times$ trials) ANOVAs for each POMS subscale. A significant trial main effect was detected within the fatigue subscale, $F(2, 90) = 40.77, p < .0005$, partial $\eta^2 = .475$. There were no significant trial main effects for tension, anger, depression, vigor, or confusion POMS subscales.

Post hoc comparisons were made using paired-sample t -tests, which showed no change in fatigue between the POMS trial 1 ($M = 39.8, SD = 6.4$) and POMS trial 2 ($M = 40.4, SD = 5.9$), $t(31) = -0.6, p > .0167, \eta^2 = .011$. A significant increase in fatigue was measured between POMS trial 2 ($M = 40.4, SD = 5.9$) and POMS trial 3 ($M = 52.0, SD = 5.8$), $t(31) = -7.5, p < .0005, \eta^2 = .64$, indicating a very large effect size. Trial main effects for fatigue are presented in Figure 2. Mean fatigue scores and standard deviations for each condition are presented in Table 2.

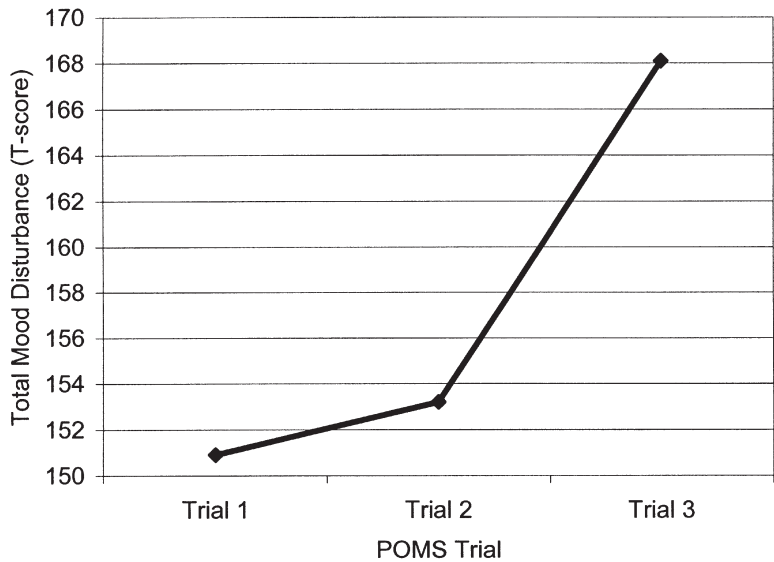


Figure 1 — Trial main effects for total mood disturbance.

Wingate Anaerobic Test Performance

MANOVA statistical procedures are unsuitable for analyzing WAnT performance scores, since there is a high degree of multicollinearity between total work, mean power, peak power, minimum power, and fatigue. Differences between the conditions in WAnT performance was therefore evaluated using separate paired-sample *t*-tests for each measure of WAnT performance. A conventional alpha level of .05 was used to indicate statistical significance for each of the WAnT measures since only one paired comparison was made between the control condition and the massage condition.

Paired-sample *t*-tests indicated that postmassage WAnT performance was significantly better than postrest WAnT performance with respect to total work, $t(15) = -2.12, p < .05, \eta^2 = .23$ and mean power, $t(15) = -2.12, p < .05, \eta^2 = .23$. The η^2 statistic indicated large effect sizes for total work and mean power. There were no significant differences between the conditions in peak power, minimum power, fatigue rate, or time to peak power. Means and standard deviations for WAnT scores in each condition are presented in Table 3.

POMS / WAnT Correlations

The relationship between WAnT performance and subsequent TMD and fatigue scores was further examined using a Pearson's product moment partial correlation. Partial correlations were calculated between all WAnT performance measures and all trial 3 POMS scores controlling for body mass (since the magnitude of WAnT measures is related to the participants body mass). The results indicated a significant

Table 2 Mean POMS Scores for Each Condition

POMS Scale	Rest Condition						Massage Condition					
	Trial 1			Trial 2			Trial 1			Trial 2		
	M			M			M			M		
	SD			SD			SD			SD		
TMD	153.1	18.4	153.7	16.1	166.9	16.1	148.8	20.0	152.6	17.0	169.2	13.5
Tension	35.2	3.6	36.2	5.2	36.3	2.4	36.6	5.1	33.3	2.9	37.0	3.0
Depression	38.3	2.5	38.2	2.4	37.9	1.6	38.4	2.4	38.5	2.9	37.9	1.9
Anger	38.6	2.1	37.6	1.8	38.0	1.9	38.4	2.7	37.4	1.8	37.6	3.4
Vigour	36.2	6.5	35.4	7.1	34.8	7.0	40.3	5.1	33.7	4.2	34.1	6.9
Fatigue	40.4	6.5	40.0	5.3	51.3	6.5	39.2	6.5	40.8	6.5	52.8	5.0
Confusion	36.8	4.2	37.2	3.9	38.3	2.9	36.4	4.3	36.3	5.1	38.0	4.8

Note. Trial 1 = pretreatment; Trial 2 = posttreatment / preWAnT; Trial 3 = postWAnT; TMD = total mood disturbance.

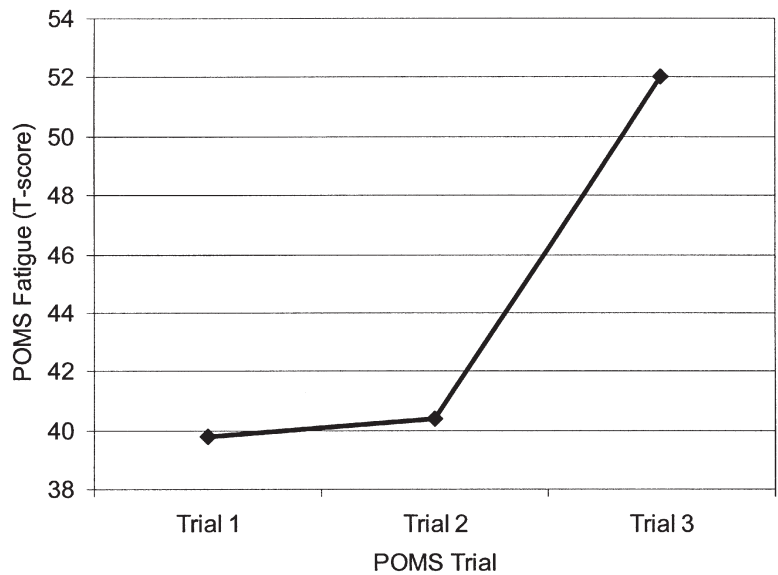


Figure 2 — Trial main effects for fatigue.

positive partial correlation between fatigue rate and TMD ($pr = .33, n = 32, p < .05$) and a significant positive partial correlation between fatigue rate and POMS fatigue ($pr = .34, n = 32, p < .05$). Inspection of the zero order correlations showed that as predicted, controlling for body mass did have an effect on the strength of the relationship between fatigue rate and total mood disturbance ($r = .19, n = 32, p > .05$) and between fatigue rate and POMS fatigue ($r = .23, n = 32, p > .05$). These results show that the amount of TMD and POMS fatigue experienced by participants was positively correlated with the actual physical rate of fatigue during the WAnT.

Discussion

The present study was intended to investigate the effect of massage on mood state and subsequent anaerobic performance. We hypothesized that there would be a positive change in mood state following massage and that compared to rest, anaerobic cycling performance would be better. Contrary to our hypothesis, the results indicated that massage did not have any positive effect on mood state. Nevertheless, WAnT performance was found to be better following massage compared to rest. In other words, massage seems to facilitate anaerobic exercise performance; however, this effect was probably due to factors other than a change in mood state. Since massage was confined to the back, which makes relatively no physiological contribution to performance of the WAnT, we reason that the observed improvements in performance following massage were most likely attributable to psychological rather than physiological factors. In fact,

Table 3 Mean WAnT Results After Each Recovery Condition

WAnT Parameter	Rest		Massage		<i>t</i> (<i>df</i> = 15)	Sig.	Effect size (η^2)
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Total Work (kJ)	16.8	3.2	17.2	3.3	-2.1	<i>p</i> < .05	.23
Mean Power (W)	560	109	574	109	-2.1	<i>p</i> < .05	.23
Peak Power (W)	859	211	887	206	-0.9	<i>ns</i>	.05
Minimum Power (W)	351	76	343	62	0.6	<i>ns</i>	.02
Fatigue Rate (W/s)	19.6	6.9	21.4	7.4	-1.2	<i>ns</i>	.09
Time to Peak Power (s)	4.1	0.9	4.4	0.8	-1.6	<i>ns</i>	.14

Mellalieu (2003) suggests that in addition to mood there are likely to be other more arresting aspects of preperformance psychological state, such as emotion and stress, which potentially influence athletic performance. Clearly, further research is needed to shed more light on the psychological mechanisms that seem to mediate the relationship between massage and anaerobic performance. In the broader context, the present investigation has demonstrated that the manipulation of preperformance psychological states remains a complex issue where a great deal of potential exists to inadvertently influence (positively or negatively) known or unknown psychological factors. In our experiment, massage seems to have had a positive effect on an unknown psychological factor, which resulted in better anaerobic exercise performance. The use of preperformance massage should be used cautiously because although it may yield positive effects on performance, at best, the psychological outcome is unpredictable. The possibility that massage, under certain circumstances, might evoke a counter productive psychological state with respect to exercise performance cannot be overruled. We recommend that preperformance massage is only used in competitive situations with those athletes who are known to respond to it in a positive way.

WAnT Performance

WAnT performance was significantly better in the massage condition than it was in the rest condition, which is consistent with our hypothesis. Since the WAnT procedure was carefully standardized and controlled for learning effects, it would seem that 30 min of back massage is a more effective mode of preparation for anaerobic cycling than 30 min of rest. Mean power was 2.5% higher following massage than it was following rest. According to Inbar, Bar-Or, and Skinner (1996), mean power is the principle measure of anaerobic capacity, which reflects an individual's ability to sustain high intensity exercise and is the principle measure of anaerobic capacity. The data provided in Figure 3 illustrates that massaged participants produced higher levels of power output for approximately 10-15 seconds after peak power. The onset of physical fatigue, as indicated by a drop in power, seemed to occur earlier in the rest condition. There was, however, no difference in power output beyond 17-s, regardless of whether the participant had received massage or not. Overall, participants performed an average of 2% more work following massage compared to rest. Upon closer examination of Figure 3, it is evident in the massage condition that participants were able to sustain peak power output for almost 2-s longer than in the rest condition. This transitory plateau of peak power had the effect of creating a significantly larger area under the curve, which was reflected in a greater amount of total work and a higher average power output. In the rest condition, there was no plateau in peak power, and a more traditional apex pattern was observed.

The WAnT performance effects that have been described have an applied significance. It is reasonable to expect that the positive effects massage had upon WAnT performance would also occur in other forms of anaerobic exercise. For instance, WAnT mean power has been correlated with a range of anaerobic athletic events including 500 m speed skating time (Thompson, Foster, Rogowski, & Kaplan, 1986), 300 m cycle time (Perez, Wygand, Kowalski, Smith, & Otto, 1986), 25 m swim time (Inbar & Bar-Or, 1977), and 300 m run time (Inbar & Bar-Or, 1977). We would therefore expect back massage to be beneficial to the performance of a range of other anaerobic exercise tasks. A summary of other anaerobic exercise tasks that

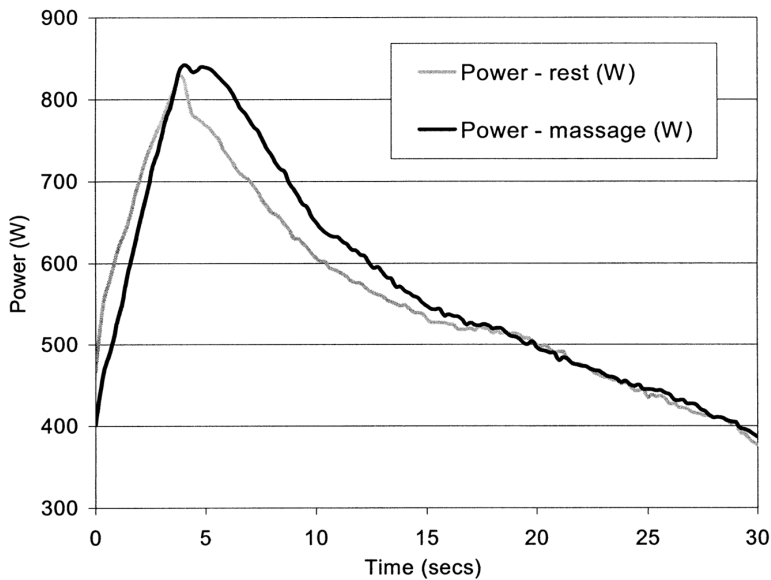


Figure 3 — WAnT power output curves for rest and massage conditions.

are significantly correlated with WAnT performance are provided in Inbar, Bar-Or, and Skinner (1996). A 2% improvement in average power and a 2.5% improvement in total work is a seemingly small performance difference. Nevertheless, a change of even this magnitude would actually constitute a significant improvement in events like 25 m swim or 100 m run, where winners and runners-up are often only differentiated by a fraction of a second. Our findings specifically show that massage has a positive effect on the performance of the WAnT, and therefore we predict that 30 min of back massage would significantly improve the performance of many other anaerobic sports and athletic events. The extent to which the relationship between massage and anaerobic performance is mediated by psychological factors will now be considered.

POMS Response to Massage

We wish to emphasize that although we did not detect any significant change in mood state following massage, under no circumstances do our findings compromise those reported by Weinberg et al. (1988). There are several important distinctions between our experiment and that of Weinberg et al. that help to explain why, under certain circumstances, massage provokes an inconsistent mood state response both between and within individuals. First, Weinberg et al. used Northern American college students over 15 years ago when massage was far less commonplace. In our experiment, we used British university undergraduates who may have been more accustomed to contemporary massage practices. It may be that an individual's mood response to massage is itself mediated by attitudes and beliefs that are socially and culturally embedded. We speculate that those who harbor a negative attitude

toward massage are those who are most likely to experience a negative shift in mood state following a massage treatment. We also acknowledge that in the absence of empirical support, this hypothesis remains conjecture, yet we would recommend asking prospective recipients about their attitude toward massage and consider screening out those who exhibit a strong anti-massage sentiment.

There were also substantial differences between the massage protocol we used and the massage protocol used by Weinberg et al., with the exception of its duration (30 min in both), Weinberg et al. (1988) used a standard 30-min full body Swedish massage compared with our 30-min massage that was confined to the back. Different sensations associated with various massage techniques may evoke different changes in mood state, since each technique varies in terms of the frequency, rate, and intensity of pressure applied to the tissues. For instance *tapôtéme*nt, which is a percussion massage technique involving rapid striking the skin with alternate hands, is likely to effect mood state in a different way compared to gentler massage techniques like *effleurage* and *pétrissage*. Any intention to use massage to control preperformance psychological states ought to consider the duration of the treatment and the specific combination of techniques employed. Future empirical work in this area must ensure that massage protocols are properly standardized and that massage procedures are described in sufficient detail.

In the present study, participants knew they were going to perform a WAnT immediately after the massage, which is comparable to a precompetitive situation. Nevertheless, the anticipation of performing a maximal cycling task may have had a dampening effect on the POMS response to massage. In the Weinberg et al. (1988) study, where there was no postmassage exercise task, a very positive mood state to massage was observed. It may be that any positive psychological responses to massage are offset by the negative effects of anticipating maximal exercise. Such an effect might have occurred in the present study and may be one reason why postmassage mood state appeared to be relatively unchanged. In fact, the complex interaction of various psychological states was recently considered by Mellalieu (2003), who remarked that mood state interacts with a range of other psychological factors to influence athletic performance. It is quite likely that the preperformance psychological state is not exclusively dominated by mood state but is potentially the product of a complex interaction with a range of other factors, including state anxiety, depression, attitudes, and certain personality traits. Given the apparent complexity of the preperformance psychological state, researchers may wish to consider a more eclectic approach to data collection rather than depending upon isolated measures of psychological state.

It is also worth pointing out that the preintervention mood states measured in this study were normal, and according to Morgan (1980), would qualify as a positive mental state. Further investigation is certainly needed to examine the effects of massage upon negative mood states, a situation that might arise before a sports event or competition among athletes.

Conclusions

Findings of the present study show that WAnT performance is better after massage compared to rest; however, such effects are not attributable to changes in mood state but may be related to other preperformance psychological factors. A carefully designed massage protocol might be used to prepare an athlete for anaerobic

exercise, providing the individual is already known to respond in a positive way. Practitioners should be mindful that massage may produce unpredictable psychological outcomes that could adversely affect exercise performance.

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