

ORIGINAL ARTICLE

State anxiety responses to 60 minutes of cross training

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Objectives: Significant reductions in state anxiety following bouts of aerobic exercise have been consistently noted, whereas changes are generally absent after acute resistance training. However, the influence of a single exercise session involving both modes on state anxiety has not been examined.

Methods: To address this, state anxiety responses to 60 minutes of cross training were examined in 16 collegiate athletes (12 women, four men). Each subject completed two cross training exercise sessions (30 minutes of resistance training, 30 minutes of bicycle ergometry) in which the order of the exercises was reversed, with a minimum of one week between sessions. Each exercise mode was completed at about 70% of maximum. State anxiety (SAI-Y1) was assessed five minutes before, and 0, 10, and 60 minutes after exercise.

Results: Repeated measures analysis of variance showed a significant ($p < 0.05$) main effect for time. However, the main effect for order and the order by time interaction were not significant. Post hoc analysis showed that state anxiety was reduced ($p < 0.05$) from baseline (mean (SD) = 34.8 (7.9)) at 10 minutes (32.1 (7.5)) and 60 minutes (30.4 (5.9)) after exercise, but not at 0 minutes (33.8 (6.9)).

Conclusions: The results indicate that combined sessions of aerobic and resistance exercise are associated with reductions in state anxiety, and that the order in which the exercise is completed does not influence this response.

Research indicates that physical exercise is associated with improvements in aspects of mental health.¹ In the case of acute bouts of aerobic exercise completed at intensities prescribed for cardiovascular enhancement, state anxiety reductions last for two to four hours after the cessation of activity.^{2,3} These anxiety reductions have also been shown to be greater than control or placebo interventions.³ Compared with the large body of research on acute aerobic exercise, relatively few studies have involved resistance training. The findings of this work indicate that acute bouts of resistance training either do not result in reduced state anxiety,^{4,5} or result in reductions that are delayed for anywhere from 30 minutes⁶ up to 120 minutes after the cessation of exercise.^{7–9} Hale and Raglin¹⁰ observed reductions in state anxiety after resistance training in persons with average or above average baseline values of state anxiety, but not in persons with baseline values that fell one standard deviation below the published norms.¹¹ Hence, with some exceptions, it appears that acute aerobic exercise is more effective in reducing state anxiety than resistance training.

Research has been conducted to investigate the influence of exercise sessions that combine aerobic and resistance activity—that is, cross training—on physiological variables such as $\text{VO}_{2\text{MAX}}$, insulin resistance, and blood hormone levels,^{12–14} but the psychological influences of this form of exercise have not been investigated. Given the apparent differences in the state anxiety responses to aerobic and resistance exercise, it would be worth examining the psychological responses to single exercise sessions that incorporate both modes, a form of exercise commonly referred to as cross training. This is particularly relevant because it is increasingly common in fitness programming to incorporate both modes of exercise such as cross conditioning or sport training into single exercise sessions to enhance overall fitness or for injury rehabilitation.¹⁵ In addition, on the basis of previous studies that have investigated the anxiolytic effect of a single mode of exercise, the order of exercise completion was investigated to determine if the resistance training mitigates or prevents a state anxiety reduction from being observed.

Hence, the purpose of this investigation was to examine the consequences of a cross training session of moderately vigor-

ous resistance training and aerobic exercise sessions on anxiety. Measurements were conducted to determine if state anxiety responses were altered during the course of participation in combined sessions of exercise. In addition, the potential impact of order of the completion of exercise modes was assessed.

MATERIALS AND METHODS

Participants

Potential participants were solicited from intercollegiate athletic teams currently engaged in off season conditioning at Indiana University. This group was targeted because of their experience with both exercise modes. A total of 16 collegiate athletes (12 women, four men) took part in and completed all phases of the study (mean (SD) age 22.2 (4.5) years, range 18–23). Before the start of the investigation, the general requirements of the study were described. Participants were told that the purpose of the study was to assess feeling states before and after exercise, but they were not informed about the findings of previous exercise research to minimise demand characteristics. All procedures used in this study had received approval from the Indiana University human subjects committee.

Instrument

State anxiety was assessed by the 20 item state portion of the State Trait Anxiety Inventory (STAI-Y1) of Spielberger *et al.*¹¹ The state portion (SAI) of the inventory consists of 20 item Likert format statements. The STAI has been extensively validated and is the most widely used measure of anxiety in exercise research.¹¹ The state anxiety of the participants was assessed five minutes before a 60 minute cross training session and immediately, 10, and 60 minutes after the completion of the exercise session.

Exercise prescription

Participants completed two 60 minute sessions of cross training, with a minimum of one week between sessions. The exercise order (aerobic-resistance, resistance-aerobic) was randomly assigned for the first session and reversed for the

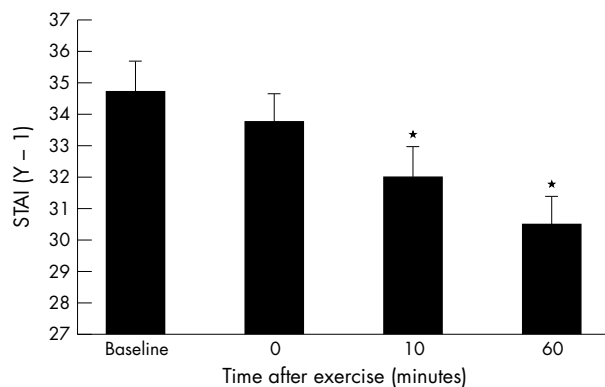


Figure 1 State anxiety responses, measured by the State Trait Anxiety Inventory (STAI-Y1), over time after cross training sessions. * $p < 0.05$ compared with baseline.

second session. In the aerobic exercise session, participants completed a 30 minute session of bicycle ergometry at about 70% of minimal heart rate reserve based on their own age predicted maximum exercise heart rate. For the resistance exercise session, participants completed 30 minutes of resistance exercise at 70% of one repetition maximum for each individual exercise. All participants had previously been tested to establish their one repetition maximum for the exercises they would perform during the sessions. Exercises included bench and shoulder press, bicep curls, triceps extensions, leg curls, and extensions. The participants completed 8–10 repetitions of each activity followed by a one minute rest period, completing 6–8 exercises during each exercise session.

Analysis

Data were analysed using three way session by order by time repeated measures ($2 \times 2 \times 4$) analysis of variance. Analysis for main effects was performed in cases where no significant three way or two way interactions were noted. Post hoc analyses by the Newman-Keuls method were conducted in cases in which the main effects were significant. Additional analysis was performed to calculate the magnitude of the state anxiety responses for the entire sample by the partial ETA squared effect size equation.

RESULTS

The repeated measures analysis of variance failed to show significant main effects for order ($F_{1,14} = 1.40$) and session ($F_{1,14} = 1.01$); however, a significant ($p < 0.05$) main effect for time ($F_{3,42} = 3.18$) was observed. The absence of a main effect for session indicates that the state anxiety responses to the first and second exercise session did not differ significantly. The lack of a main effect for order indicates that the order in which the exercise modes were completed—that is, aerobic-resistance or resistance-aerobic—did not significantly influence state anxiety responses. The SAI scores at baseline for each order were 33.5 (7.9) and 36.05 (8.0), and the scores immediately after the exercise session based on order were 33.5 (6.7) and 34.0 (7.1) for resistance-aerobic and aerobic-resistance respectively. At 10 minutes after exercise, the values were 32.1 (9.0) for resistance-aerobic and 32.0 (6.0) for aerobic-resistance. At 60 minutes after exercise, the SAI values were 30.2 (6.1) and 30.7 (5.9) for resistance-aerobic and aerobic-resistance respectively.

Because of the lack of a main effect for order, a Newman-Keuls post hoc test was conducted on the pooled results to determine at which assessments state anxiety differed from baseline. This analysis showed a significant ($p < 0.05$) reduction 10 and 60 minutes after the cessation of cross training exercise from baseline anxiety scores (fig 1).

Take home message

Combined sessions of aerobic and resistance training are associated with decreases in state anxiety, indicating that improvements in state measures of mental health can be obtained by cross training exercise.

Partial ETA squared effect sizes were calculated for all three conditions. The values for the magnitude of these changes was 0.19 for time, 0.09 for condition, and 0.07 for session. The power values for these conditions was 0.69 for time, 0.19 for condition, and 0.16 for session.

DISCUSSION

In this study, significant state anxiety reductions were observed by 10 minutes after a 60 minute session of exercise consisting of equal length segments of aerobic exercise and resistance training. The assessment of state anxiety immediately after exercise was 1 unit below baseline, but this decrement did not achieve significance. However, the values at both 10 and 60 minutes after exercise were both significantly reduced below baseline. This trend is consistent with other work showing that state anxiety reductions can be delayed for several minutes after the cessation of activity.^{5,16} These results indicate that psychological improvements can occur after a session of cross training with experienced exercisers.

Significant reductions in state anxiety occurred regardless of the exercise order (aerobic-resistance or resistance-aerobic). Because previous research generally indicates that resistance exercise sessions are not associated with reduced state anxiety,^{4,5} it could be expected that the aerobic-resistance session would not result in a significant state anxiety decrement or that reductions would be delayed after exercise for a longer period of time when the resistance component was completed last. However, these results indicate that combining equal length periods of aerobic and resistance exercise into a single workout results in anxiety reduction that is unaffected by the order of the exercise mode.

The magnitude of the anxiety reduction was about one half of a standard deviation, and this decrement is comparable to that observed in research involving sessions of acute aerobic exercise.¹⁷ Replication with novice exercisers and with participants who have elevated baseline state anxiety will be necessary to determine if the results generalise to samples with different psychological characteristics, such as the clinically anxious. This study did not examine potential physiological or psychological mechanisms that are responsible for the reduced state anxiety after cross training exercise. It is possible that the anxiolytic effect of the aerobic portion of the cross training was strong enough to result in a reduction in state anxiety, despite potentially neutral or counteracting effects of the resistance training. The factor or factors responsible for psychological improvements after a session of cross training may differ from an exercise session consisting of a single activity, and research will be needed to examine putative underlying mechanisms.

In summary, these results suggest that the combination of 30 minutes of aerobic and resistance exercise in a single session is associated with state anxiety reductions that are comparable in time course and magnitude to previous findings involving only aerobic exercise. Moreover, the state anxiety reduction was not affected by the order of exercise mode. If replicated, the results would indicate that cross training can be effective for those who choose to exercise for mental health benefits.

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REFERENCES

- 1 **Morgan WP**. *Physical activity & mental health*. Washington DC: Taylor and Francis, 1997.
- 2 **Morgan WP**. Affective beneficence of vigorous physical activity. *Med Sci Sports Exerc* 1985;**17**:94-101.
- 3 **Raglin JS**. Anxiolytic effects of physical activity. In: Morgan WP, ed. *Physical activity and mental health*. Washington DC: Taylor & Francis, 1997:107-26.
- 4 **Koltyn KF**, Shake CL, Morgan WP. Interaction of exercise, water temperature and protective apparel on body awareness and anxiety *Int J Sport Psychol* 1993;**24**:297-305.
- 5 **Raglin JS**, Turner PE, Eksten F. State anxiety and blood pressure following 30 min of leg ergometry or weight training. *Med Sci Sport Exerc* 1993;**25**:1044-8.
- 6 **Bartholomew JB**, Linder DE. State anxiety following resistance exercise: the role of gender and intensity. *J Behav Med* 1998;**21**:205-18.
- 7 **Breus MJ**, O'Connor PJ. Exercise-induced anxiolysis: a test of the "time-out" hypothesis in high anxious females. *Med Sci Sports Exerc* 1998;**30**:1107-12.
- 8 **Focht BC**, Koltyn KF. Influence of resistance exercise of different intensities on state anxiety and blood pressure. *Med Sci Sports Exerc* 1999;**31**:456-63.
- 9 **O'Connor PJ**, Bryant CX, Veltri JP, et al. State anxiety and ambulatory blood pressure following resistance exercise in females. *Med Sci Sports Exerc* 1993;**25**:516-21.
- 10 **Hale BS**, Raglin JS. State anxiety responses to resistance training and step aerobic exercise across 8-weeks of training. *J Sports Med Phys Fitness* 2002;**42**: (in press).
- 11 **Spielberger CD**, Gorsuch RL, Lushene R, et al. *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press, 1983.
- 12 **Mutton DL**, Loy SF, Rogers DM, et al. Effect of run vs combined cycle/run training on $\dot{V}O_{2\max}$ and running performance. *Med Sci Sports Exerc* 1993;**25**:1393-7.
- 13 **Wallace MB**, Mills BD, Browning CL. Effects of cross-training on markers of insulin resistance/hyperinsulinemia. *Med Sci Sports Exerc* 1997;**29**:1170-5.
- 14 **Flynn MG**, Pizza FX, Brolinson PG. Hormonal responses to excessive training: influence of cross training. *Int J Sports Med* 1997;**18**:191-6.
- 15 **Godfrey RJ**. Cross-training. *Sports Exercise and Injury* 1998;**4**:50-5.
- 16 **Garvin AW**, Koltyn KF, Morgan WP. Influence of acute physical activity and relaxation on state anxiety and blood lactate in untrained college males. *Int J Sports Med* 1997;**18**:470-6.
- 17 **Petruzzello SJ**, Landers DM, Hatfield BD, et al. A meta-analysis on the anxiety reducing effects of acute and chronic exercise. *Sports Med* 1991;**11**:143-82.

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The final submission date for completed abstracts is 15 June 2002.