Acute Exercise and Anxiety Reduction: Does the Environment Matter?

Edward McAuley, Shannon L. Mihalko, and Susan M. Bane
University of Illinois at Urbana-Champaign

This study was designed to examine whether the exercise environment affected individuals' anxiety responses. Participants either sat quietly (control) or exercised in either a laboratory or a setting of their own choosing. State anxiety measures were assessed at baseline, during activity, and following 15 minutes of rest after activity. Analyses indicated that the exercising conditions significantly reduced anxiety, whereas the control condition did not. Additional analyses indicated that anxiety increased from baseline during exercise and then was reduced upon exercise cessation. The implications of these findings for the examination of acute exercise effects on psychological function are discussed.

Key words: state anxiety, psychological outcomes, physical activity

The exercise and psychological health literature has largely been dominated by studies examining the effects of acute and chronic activity on the reduction of negative symptomology (McAuley, 1994). Several comprehensive reviews have documented the efficacy of exercise in both depression (e.g., Morgan, 1993; North, McCullagh, & Tran, 1990) and anxiety (e.g., Landers & Petruzzello, 1994; Petruzzello, Landers, Hatfield, Kubitz, & Salazar, 1991) reduction. With respect to the latter, the consensus is that both acute and chronic exercise lead to reductions in state anxiety, although this relationship appears to be moderated by a number of variables (Landers & Petruzzello, 1994). However, several aspects of the exercise–anxiety reduction relationship make it a contentious topic.

For example, it has been argued that the time course of anxiety reduction during and following exercise is such that anxiety increases from baseline during activity and then drops significantly below baseline following activity (Morgan, Horstman, Cymerman, & Stokes, 1980). Recent studies both refute and support this position. Rejeski, Hardy, and Shaw (1991) examined anxiety responses in 30 males engaging in treadmill exercise and noted that no differences existed be-

Edward McAuley, Shannon L. Mihalko, and Susan M. Bane are with the Department of Kinesiology at the University of Illinois at Urbana-Champaign, 215 Freer Hall, Urbana, IL 61801.
between baseline and in-task responses, although anxiety did indeed drop significantly at 10 minutes postexercise. Rejeski et al. (1991) further argued that this postexercise reduction was a function of reduced arousal states that were unrelated to anxiety but that nonetheless constituted items on the state anxiety measure employed. Moreover, Rejeski et al. were highly critical of the internal consistency of the 8-item short form of the Spielberger State Anxiety Inventory (SAI; Spielberger et al., 1979), reporting the reliability to be inferior under exercising conditions. In contrast, Tate and Petruzzello (1995) report acceptable internal consistency for a 10-item short form of the SAI (Spielberger, Gorsuch, Luschene, Vagg, & Jacobs, 1983). More importantly, however, they document time course differences for anxiety responses that mirror the contentions of Morgan et al. (1980) in that anxiety increased from baseline to activity and then was significantly attenuated following activity. This pattern was reproduced at exercise intensities of 55% and 70% of VO$_{\text{max}}$.

A further issue of debate concerns Bahrke and Morgan’s (1978) argument that the effects of exercise on anxiety are no more potent than those of resting quietly for a commensurate period of time. In essence, they suggest that exercise may serve no greater purpose than that of a distraction. Once again, Tate and Petruzzello (1995) ably refute this stance by demonstrating a differential pattern of anxiety responses over time for participants engaged in exercise, whereas the responses of participants in a quiet rest control condition remained essentially unchanged.

Inextricably tied to the anxiolytic effects of exercise is the question of what moderates these effects. That is, does the anxiolytic effect generalize across exercise modalities and conditions, or is the nature of the reduction driven simply by the cessation of physical activity in laboratory environments initially perceived as threatening by the participant? The argument suggested here, of course, is that the exercise-equivalent effect on anxiety is one that parallels the “white-coat effect” attributed to the increases in blood pressure experienced by patients in the context of visits to a physician. Petruzzello (1995) recently attempted to address this possible confound by adopting a modification of a paradigm presented by Farha and Sher (1989), whereby baseline self-report and physiological assessments of anxiety were recorded under two conditions in the same session. In the first condition, participants were simply told they were taking part in a study of coping strategies, and in the immediately following condition, they were told they were to participate in a bout of treadmill running (sham condition). Petruzzello (1995) was unable to effectively demonstrate significant differences in anxiety under the two conditions. In a second experiment, he reported that of three measurements of anxiety prior to exercise, the lowest exhibited was immediately prior to exercise. Petruzzello (1995) argues that such findings are at odds with the position that preexercise anxiety levels do not necessarily reflect normal resting levels.

Although such findings appear heartening from the perspective that the anxiety reduction seen in laboratory studies appears to be a function of exercise, there is a further consideration that needs to be addressed in attempting to tease out the validity of the relationship. We are concerned here with the effects that exercising in contrasting environments might have on anxiety responses. For example, Boutcher and Trenske (1990) demonstrated that under varying workload conditions (i.e., exercising under control, sensory deprivation, or music conditions) differentially influenced affective responses. Specifically, under light exercise conditions, par-
Participants reported similar affective responses across conditions. However, in the moderate and heavy exercise conditions, affect was less positive in the control and deprivation conditions than in the exercising with music condition. Similarly, exercising under conditions in which attentional focus is on the self rather than on the external environment has been demonstrated to result in more negative psychological responses (Pennebaker, 1982). However, for the most part these tests of environmental conditions have been limited to laboratory studies. Whether initial preexercise anxiety values, and the corresponding reduction over time that have been reported in laboratory settings, parallel those of the same participants when they exercise in their preferred or natural environment, is not known. Several benefits might result from such a comparison. First, demonstration of a similar reduction over time for both laboratory- and natural environment-based exercise when compared to a control condition would indicate some generalizable effect relative to exercise location. Thus, the laboratory context would receive support as an effective environment in which to test other exercise–anxiety hypotheses. Second, if the laboratory condition was unable to demonstrably influence anxiety when compared to the natural environment condition, then the wisdom of the laboratory as a venue for such research would be questionable. That is, in spite of obvious advantages to internal validity, the laboratory condition may under- or overestimate the effects of exercise on anxiety. Finally, if both exercise conditions resulted in reductions in anxiety, but there was a significant and differential impact of the laboratory environment on baseline levels of anxiety, useful knowledge would be garnered relative to either reducing such differences a priori or statistically controlling for them in subsequent tests of study hypotheses (Gauvin & Brawley, 1993).

Thus, the objective of the present study was to test the hypothesis that the exercise environment may play a role in the degree to which exercise reduces anxiety. In so doing, we were further interested in the examination of the time course of anxiety responses across two exercise conditions (laboratory and natural environment) and a nonactive control condition of quiet rest. If the laboratory environment is perceived as more threatening than either a control condition or exercising in one’s natural habitat, then we should certainly see these differences manifest in anxiety prior to exercise participation. If this is the case, whether these differences are maintained or eradicated with onset and culmination of activity needs to be determined.

**Method**

**Participants and Design**

Undergraduate students (N = 34; 16 males and 18 females) participated in this study in partial fulfillment of course requirements. As the study design was a within-subjects design, all participants were required to attend three counterbalanced sessions. Prior to these sessions, the participants engaged in a submaximal graded exercise test to determine aerobic power and had their body composition assessed. In the three subsequent sessions, participants were required to (a) report to the laboratory and participate in a moderately vigorous exercise session (laboratory condition), (b) sit quietly for a similar amount of time (control condition), or (c) exercise in an exercise setting of their choosing (natural environment condition).
Procedures, Conditions, and Measures

Physiological Assessments. Although not central to study hypotheses, fitness levels and details of body composition were assessed for all participants. A submaximal graded exercise test employing a modified Åstrand-Ryhming protocol (Siconolfi, Cullinane, Carleton, & Thompson, 1982) was employed to determine predicted aerobic power (estimated VO\textsubscript{2max}). Body weight and percent body fat were assessed as measures of body composition, with the latter being calculated using the three-site technique and generalized equation developed by Pollock, Schmidt, and Jackson (1980) and the four-site technique and equation developed by Durnin and Wormersley (1974). Because the Pollock et al. (1980) technique tends to underestimate body fat and the Durnin and Wormersley (1974) approach tends to overestimate it, the mean of the two measures was employed in the present study. Body weight was assessed using a Howe-Richardson Magna scale, with the mean of two independent measures being used as a representative value.

Following these assessments, participants were oriented to walking/jogging on a treadmill, as this was the mode of activity that was to constitute the laboratory exercise condition. In this orientation, Borg’s (1985) 15-item Ratings of Perceived Exertion (RPE) scale was explained to the participants. The participants were then informed that they would be exercising at an intensity level between 14 and 16 (hard) RPE during the exercise conditions. Although meta-analytic reviews of the exercise-anxiety reduction literature (e.g., Landers & Petruzzello, 1993) have suggested that anxiety is reduced regardless of exercise intensity, recent evidence suggests that more vigorous bouts comparable to 70% VO\textsubscript{2max} elicit anxiety reduction, whereas less intense bouts do not (Tate & Petruzzello, 1995). To further orient them to this dose, participants were then asked to walk/jog on the treadmill while the speed was increased to the point that they were exercising at a RPE of 14–16. Participants then exercised for approximately 5 min at this intensity.

Control Condition. For the control condition, participants reported to our laboratory and were seated in a comfortable chair in an area of the laboratory reserved for the completion of questionnaires, health histories, and so forth. This was a relatively distraction-free area, separated from the exercise and physiological assessment areas by room dividers. Participants were asked to make themselves comfortable and to sit quietly for the 40 minutes. At the beginning of the session and at 15, 25, and 40 min, they completed state anxiety measures. State anxiety was assessed using the short form (10-item) version of the Spielberger et al. (1979) State-Trait Anxiety Inventory. This measure is highly correlated with the original 20-item measure, and is especially useful when research protocols demand multiple administrations of the measure (Spielberger et al., 1983).

Laboratory Condition. In this condition, participants reported to the laboratory where they were met by a research associate. Participants were shown to a room in the laboratory where they changed, if necessary, into their exercise clothes. Participants were then informed that they would walk or jog on the treadmill (Quinton 55XT, Series 90) for 5 min as a warm-up, and then the speed of the treadmill would be increased until they were exercising at an intensity of 14–16 on the RPE (Borg, 1985) scale, whereupon they would exercise at this intensity for 20 min. Following, a brief cool-down at the end of the exercise bout, participants were taken to a rest area and sat comfortably for another 15 min. These partici-
pants completed the 10-item short-form SAI prior to exercise, at 10 min into the aerobic portion of the exercise session, immediately at the end of the session (20 min), and finally at 15 min after cool-down. The SAI was administered orally during activity, with participants responding to each item and the research associate recording their responses. RPE data were collected every 4 min.

**Natural Environment Condition.** In this condition, participants a priori informed a research associate of their usual choice of venue for aerobic exercise in the natural environment. The most popular choice of activity was walking/jogging (44.1%), followed by stationary cycling (26.4%), stair stepping (17.6%), and other aerobic activity (e.g., aerobic dance, 11.9%). The research associate then met the participant at the venue of his or her choice wherein the participant began a 5-min warm-up, followed by 20 min of moderate intensity exercise at RPE of 14–16. At the end of the aerobic portion, participants spent 5 min in a cool-down phase, then rested quietly for 15 min. Participants completed the 10-item short-form SAI prior to exercise, at 10 min into the aerobic portion of the exercise session, immediately at the end of the session (20 min), and finally at 15 min after cool-down. The SAI was administered orally during activity, with participants responding to each item and the research associate recording their responses. In cases where the participant was exercising in an external environment (e.g., jogging outside), the research associate cycled unobtrusively behind the participant and at the appropriate time period had the participant exercise “on the spot” (e.g., run in place) briefly while anxiety data were collected from oral responses. RPE data were collected every 4 min using mini-RPE charts that were held up for the participants while they continued to exercise. These values were then documented by the research associate.

**Results**

**Descriptive Statistics and Preliminary Analyses**

A series of preliminary analyses were conducted to determine whether responses differed by sex of participant. These analyses were nonsignificant and subsequent analyses were conducted on data collapsed across males and females. Table 1 gives details of the biometric characteristics of the sample. Participants were moderately active, reporting exercising on average for 2.76 (SD = 1.23) days per week for approximately 40 min per session (M = 39.91, SD = 25.56) at a moderately hard intensity (M = 4.82 ± 1.06 on a scale of 1–7, very light to very hard). In order to determine whether participants were exercising at a consistent workload across conditions, RPE data were averaged across time points (preexercise, 10 and 20 min of exercise, and 15 min postexercise) for the laboratory and natural environment condition and these mean values compared with a paired t test. There was no difference between the two subjective intensities, with both the laboratory (M = 14.97 ± 0.53) and the natural condition (14.80 ± 0.61) exercising within the prescribed intensity range.

**Internal Consistency of SAI**

As noted earlier, previous research (Rejeski et al., 1993) has called into question the reliability of the SAI from an internal consistency perspective. We calculated coefficient alpha (Cronbach, 1951) for the SAI under each condition at the four administration time points. As can be seen in Table 2, the internal consistency,
Table 1  Subject Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Males</th>
<th></th>
<th>Females</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Age</td>
<td>22.50</td>
<td>3.01</td>
<td>21.17</td>
<td>1.62</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>70.70</td>
<td>3.08</td>
<td>65.17</td>
<td>9.93</td>
</tr>
<tr>
<td>Body mass index</td>
<td>24.98</td>
<td>2.93</td>
<td>23.86</td>
<td>3.14</td>
</tr>
<tr>
<td>Percent body fat</td>
<td>16.04</td>
<td>6.30</td>
<td>25.92</td>
<td>5.85</td>
</tr>
<tr>
<td>Estimated VO$_{2\text{max}}$</td>
<td>40.03</td>
<td>12.70</td>
<td>37.67</td>
<td>9.22</td>
</tr>
<tr>
<td>RPE during exercise (natural)</td>
<td>14.97</td>
<td>0.52</td>
<td>14.68</td>
<td>0.66</td>
</tr>
<tr>
<td>RPE during exercise (lab)</td>
<td>15.09</td>
<td>0.53</td>
<td>14.89</td>
<td>0.58</td>
</tr>
</tbody>
</table>

Table 2  Internal Consistency of the 10-Item SAI Across Time and Condition

<table>
<thead>
<tr>
<th></th>
<th>Preexercise</th>
<th>10 min exercise</th>
<th>20 min exercise</th>
<th>15 min postexercise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>.92</td>
<td>.92</td>
<td>.93</td>
<td>.87</td>
</tr>
<tr>
<td>Laboratory</td>
<td>.88</td>
<td>.84</td>
<td>.81</td>
<td>.76</td>
</tr>
<tr>
<td>Natural environment</td>
<td>.88</td>
<td>.89</td>
<td>.91</td>
<td>.78</td>
</tr>
</tbody>
</table>

although variable across time points, in general ranges from acceptable ($\alpha = .76$) to excellent ($\alpha = .93$). The mean internal consistency was .87. It should be noted that Rejeski et al. (1991) used an 8-item short form of the SAI rather than the more often used 10-item short form. The alpha values reported herein are also similar to those reported by Tate and Petruzzello (1995).

Effects of Exercise Condition on Anxiety Responses

In order to determine whether the environment influenced anxiety responses to exercise, we conducted a $3 \times 4$ (Condition $\times$ Time) within-subjects repeated measures multivariate analysis of variance (MANOVA; see Schutz & Gessaroli, 1987). This analysis revealed a significant Condition $\times$ Time interaction, $F(192, 6) = 7.02$, $p < .0001$, and a significant main effect for time, $F(96, 3) = 11.86$, $p < .001$. The condition main effect was nonsignificant, $F(64, 2) = 1.94$, $p < .10$. Decomposition of the multivariate interaction effect was carried out by conducting separate MANOVAs to test the condition effects at each time point. In the event that this was significant, paired t-tests, with Bonferonni correction to guard against Type I error inflation ($p < .016$), compared anxiety responses between conditions.
Table 3 Mean Values for SAI Across Conditions and Time

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Preexercise</th>
<th>10 min exercise</th>
<th>20 min exercise</th>
<th>15 min postexercise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M  SD</td>
<td>M  SD</td>
<td>M  SD</td>
<td>M  SD</td>
</tr>
<tr>
<td>Control^</td>
<td>15.93 6.02</td>
<td>14.69 5.59</td>
<td>15.26 5.87</td>
<td>15.03 4.52</td>
</tr>
<tr>
<td>Laboratory</td>
<td>16.68 5.23</td>
<td>18.23 5.27</td>
<td>17.76 4.18</td>
<td>13.35 2.92</td>
</tr>
<tr>
<td>Natural environment</td>
<td>15.03 4.26</td>
<td>16.30 4.93</td>
<td>16.05 5.00</td>
<td>12.85 2.81</td>
</tr>
</tbody>
</table>

^Assessments of anxiety in the control group were conducted at baseline, 15, 25, and 40 min.

Effect sizes were also calculated: $(M_1 - M_2)/SD_{pooled}$. In Table 3, we document the mean values for anxiety at each time point for each of the conditions.

The MANOVA examining preexercise levels of state anxiety did not significantly differ by condition, $F(2, 66) = 1.13, p > .10$. Examination of the means for each condition does, however, show the natural environment condition to have the lowest reported value ($M = 14.97, SD = 4.21$), followed by the control condition ($M = 15.88, SD = 5.93$), and finally, the laboratory condition ($M = 16.67, SD = 5.23$).

At 10 min into the aerobic exercise component, the multivariate effect for condition was significant, $F(2, 64) = 5.14, p = .009$. The primary source of this difference was the laboratory condition, ($t = 2.81, p < .008, ES = .64$) in which participants had considerably higher anxiety ($M = 18.23, SD = 5.26$) than the control condition ($M = 14.76, SD = 5.51$). No significant differences in state anxiety levels were evident for comparisons of the natural condition with either the laboratory or control conditions, although the laboratory condition was higher than the natural condition.

The multivariate effect for condition at the end of 20 minutes of exercise approached significance after Bonferroni correction (.01), $F(2, 66) = 3.91, p = .02$. In this case, the major difference in condition was between the laboratory condition ($M = 17.76, SD = 4.18$) and the control condition ($M = 15.26, SD = 5.87$; $t = 2.56, p = .015; ES = .50$). Interestingly, at this point, the control anxiety level has risen, albeit modestly, whereas the laboratory value has begun to decline. The final multivariate analysis examining postexercise anxiety differences across conditions was significant, $F(2, 66) = 5.47, p = .006$. Follow-up analyses suggested that the primary contribution to this multivariate effect was the difference ($t = -3.13, p = .004; ES = -.60$) between anxiety in the natural environment condition ($M = 12.85, SD = 2.80$) and the control condition ($M = 15.03, SD = 4.52$).

The multivariate main effect for time was further examined by conducting separate MANOVAs for each condition to examine the patterns of anxiety over time within those conditions. Similar follow-up analyses and effect sizes as described above were conducted for these analyses with the Bonferroni correction set at $p = .008$. The overall multivariate effect for anxiety over time in the control condition was nonsignificant, $F(3, 99) = 1.67, p > .10$. Although there were some minor fluctuations in anxiety, these values were basically uniform. There was a significant multivariate effect for anxiety over time in the laboratory condition,
Follow-up analyses indicated that there was a significant decrease in anxiety from pre- to 15-min postexercise ($t = 4.75, p < .0001; ES = -.82$), as well as significant reductions from 10 min to 15 min postexercise ($t = 5.56, p < .0001; ES = -1.20$) and from 20 min of exercise to postexercise ($t = 6.70, p < .0001; ES = -1.26$).

There was also a significant multivariate effect for time within the natural environment condition, $F(3, 99) = 8.56, p < .0001$. The pattern of simple effects was also similar to the laboratory outcomes, with exercise reduced significantly from pre- to 15-min postexercise ($t = 3.46, p < .001; ES = -.60$), and from 10 ($t = 5.49, p < .0001; ES = -.87$) and 20 min (end) into exercise ($t = 4.70, p < .0001; ES = -.84$) to 15 min postexercise. Thus, the time course of anxiety reduction in the present study suggest that sitting quietly has no effect on state anxiety, whereas anxiety is reduced following exercise when compared to preexisting and in-task levels.

**Discussion**

The present study had several objectives designed to better understand the acute exercise–anxiety reduction relationship. Specifically, we were concerned with determining whether exercising under different environmental conditions evoked similar responses in state anxiety when compared to a quiet, resting control condition. Additionally, we were interested in the time course of anxiety responses under exercising conditions, in particular whether anxiety was increased from baseline during exercise and then was significantly reduced from baseline postexercise.

Our data suggest that exercising in laboratory and natural environments have a significant impact on anxiety responses when compared to a resting control condition. In the latter condition, SAI responses showed little variation over time, suggesting that resting quietly is not as effective as acute exercise in the reduction of state anxiety. One potential concern with examining the effects of exercise on anxiety in laboratory situations is that the testing environment may be perceived as threatening and thereby give rise to anticipatory anxiety and thus result in an inflated effect of exercise on anxiety. The present data did not demonstrate any significant differences between the natural environment and the laboratory condition in terms of preexercise anxiety. However, the laboratory responses were higher than the natural condition to begin with and remained so throughout the four assessment periods. The Condition $\times$ Time interaction was largely explained by the laboratory condition being higher in anxiety during exercise than the control group at the same time point and the natural environment condition being substantially lower than the control group at the final measurement period (15 min postexercise termination for the exercising groups).

What are we to make of these findings? Initially, it would appear that in a statistical sense there is little difference in anxiety responses over time between the laboratory and field settings. Two considerations are of importance here. First, as noted in the Method section, we provided all participants with an orientation to the exercise modality to be used in the laboratory condition, a motorized treadmill, prior to testing. This, in effect, may have served to dampen somewhat, but not entirely, any threatening impact of the laboratory. If this is indeed the case, then we encourage investigators of acute exercise–psychological responses relationships to provide such an orientation prior to experimentation. This may be particularly
crucial for those participants unfamiliar with the equipment or who are to undergo graded exercise testing in which expired gases may be collected. Moreover, it may be useful to employ a "no orientation" condition as a further comparison group in subsequent research efforts. Second, as some, albeit marginal, differences did remain following our orientation attempts, we further encourage efforts to attenuate such differences in any way possible (Gauvin & Brawley, 1993). For example, the close proximity of the investigators to the participant and the apparent sterility of most laboratories may serve to increase the evaluation potential of the situation, which may prove anxiety provoking. This may be especially true in those participants who may be out of shape, overweight, or simply concerned about their appearance.

With respect to the time course issue, our results show support for those of Morgan et al. (1980) and Tate and Petruzzello (1995) in that the exercise stimuli resulted in increased anxiety responses during activity and then significant reductions postexercise. Several issues are worth discussing here. First, although the levels of anxiety are uniformly low across all conditions at baseline, we still see significant reductions at 15 min postexercise termination whereas the resting control condition basically shows little change in anxiety over time. This suggests that the effect is not simply an epiphenomenon or by-product of being distracted from anxiety or stress-provoking stimuli. However, the elevation of anxiety during activity and the subsequent drop postactivity leads to the question of whether what we are witnessing here are truly changes in anxiety or some other related construct. Rejeski et al. (1991) have argued that the SAI as a measure of state anxiety fails to hold together sufficiently well in a psychometric sense to be able to accurately tap anxiety per se. They were unable to demonstrate acceptable internal consistency for the SAI during exercise to have faith in the reliability of the instrument.

Both the present results and those of Tate and Petruzzello (1995), however, suggest that the SAI items do hold together quite well. The measure employed by Rejeski et al. (1991) employed an 8-item version that differs somewhat in item content, from the more frequently used and recommended 10-item version (see Spielberger et al., 1983, for a discussion of problems with using shorter measures of the SAI). Thus, item content may be a concern here. Although not a central issue in this study, it may be useful to briefly discuss the pattern of responses at baseline and during exercise of representative items from the SAI.

Rejeski et al. (1991) suggest that certain SAI items are representative of arousal, as opposed to anxiety. In Table 4, we show mean responses at baseline, at 10 and 20 min into the exercise bout, and postexercise for two SAI items that could be argued to reflect arousal (calm and relaxed) and two items that reflect anxiety (nervous and anxious). The pattern of results is strikingly similar for both exercise groups. The items reflecting anxiety demonstrate a linear reduction over time, whereas the arousal items show a curvilinear pattern with increases from baseline occurring during exercise, then decreasing dramatically following exercise. That is, participants became more aroused during activity and calmer and more relaxed following activity. Such findings lend support to Rejeski et al.'s critique of the stance that anxiety increases during activity and then drops below baseline following activity. Also, like the Rejeski et al. data, our participants were moderately active. Whether the anxiety reduction effect of the exercise stimulus has a similar effect on participants with low levels of activity or fitness remains to be seen.
Table 4 Anxiety and ARousal-Related Item Responses Across Time in the Exercise Conditions

<table>
<thead>
<tr>
<th>Item</th>
<th>Nervous</th>
<th>Anxious</th>
<th>Calm</th>
<th>Relaxed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laboratory condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Preexercise</td>
<td>1.41</td>
<td>1.56</td>
<td>1.85</td>
<td>2.06</td>
</tr>
<tr>
<td>10 min exercise</td>
<td>1.35</td>
<td>1.38</td>
<td>2.21</td>
<td>2.50</td>
</tr>
<tr>
<td>20 min exercise</td>
<td>1.18</td>
<td>1.47</td>
<td>2.15</td>
<td>2.35</td>
</tr>
<tr>
<td>Postexercise</td>
<td>1.09</td>
<td>1.26</td>
<td>1.26</td>
<td>1.56</td>
</tr>
</tbody>
</table>

Certainly, data from Boutcher and Landers (1988) have suggested that postexercise reductions in state anxiety were only manifest in trained participants. Thus, these results call into question the employment of SAI items that reflect arousal rather than the construct of interest, anxiety. Such a contention veers beyond the issue of whether a measure of multidimensional anxiety may or may not be the more appropriate measure to employ in such studies. Rather, the concern is with the basic psychometric content of the SAI. Future studies of the phenomena of interest should consider carefully the item content of anxiety measures.

We believe that the results of the present study are valuable from several perspectives. First, they offer further insight into the exercise–anxiety reduction relationship by virtue of the fact that there appears to be little substantive difference in examining this relationship in either field or laboratory settings. Whether subsequent studies employing similar methodologies are able to replicate these findings or whether with larger sample sizes differences in responses across conditions become more pronounced remains to be determined. With respect to the time course of anxiety elevation and reduction, our results support those of Morgan et al. (1980) and Tate and Petruzzello (1995) in that they suggest anxiety during exercise is elevated above baseline levels and then is significantly reduced beyond baseline and in-task levels. Unfortunately, the nature of these responses is obfuscated by the apparent representation of both anxiety and physiological arousal items embedded in the measure of state anxiety. Subsequent research must continue to tease out the constitution of this relationship and more carefully consider the extent to which selected measures adequately represent the construct of interest.

In closing, we are conscious of the limitations of the present study. We employed a small number of healthy and relatively active college students as participants, and thus, the extent to which our findings are generalizable is limited. Nonetheless, the within-subjects nature of the design served to provide sufficient statis-
cational power for our purposes. Whether the effects would be more pronounced or attenuated on low fit older adults or clinical populations remains to be seen. At any rate, we suggest that the present methodology and further extensions of it may be usefully employed to determine the time course and nature of acute exercise influences on other psychological variables hypothesized to be influenced by physical activity.

References


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Acknowledgment

We would like to thank Jason Jones and Geof Gentry for their assistance with data collection. This research was supported in part by grant AG12113 from the National Institute on Aging.

Manuscript submitted: March 4, 1996
Revision received: July 22, 1996