

The Anxiolytic Effects of Exercise are Sustained after an Emotional Challenge



Background Information

Exercise and Anxiety

- Acute exercise has been widely reported in the literature to reduce anxiety.

The **State Trait Anxiety Inventory (STAI)** measures trait and state anxiety.

- State anxiety refers to feelings of anxiety 'right now at this moment'. Trait anxiety is more generalized, or the propensity to experience state anxiety.
- After exercise, scores on the STAI should decrease.

Event Related Potentials (ERPs) measure the time course of cortical neural events by averaging Electroencephalographic (EEG) waveforms time-locked to the onset of stimuli.

- EEG records measurements of electrical activity from the brain (post-synaptic potentials) through the scalp.
- Previous studies indicate the late portion of ERPs, known as Late Positive Potentials (LPP) change with respect to affective cues (Codispoti et al 2007).

While exercise is known to improve subjective mood, the effect of exercise on neural responses to affective cues and whether exercise buffers against the effects of emotional stress in humans is unknown.

Methods

Participants: 36 healthy college students (21 men, 15 women)

Forms: informed consent form, a health history form, Beck Depression Inventory (BDI), and the State-Trait Anxiety Inventory (Spielberger et al., 1983).

Time: conducted over two separate days; one day involving an exercise condition and the other day a seated rest control condition, completed in a counterbalanced order.

Condition: *Exercise day:* 3-minute warm up, thirty minutes of "somewhat hard" exercise--a rating of 13 on the Borg (1998) scale--3 minute cool down on a stationary bike. Ratings on Borg were taken every 5 minutes.

Rest day: Participant rested on bike for 36 minutes.

Post Condition: Completed STAI form again (15 minutes after condition).

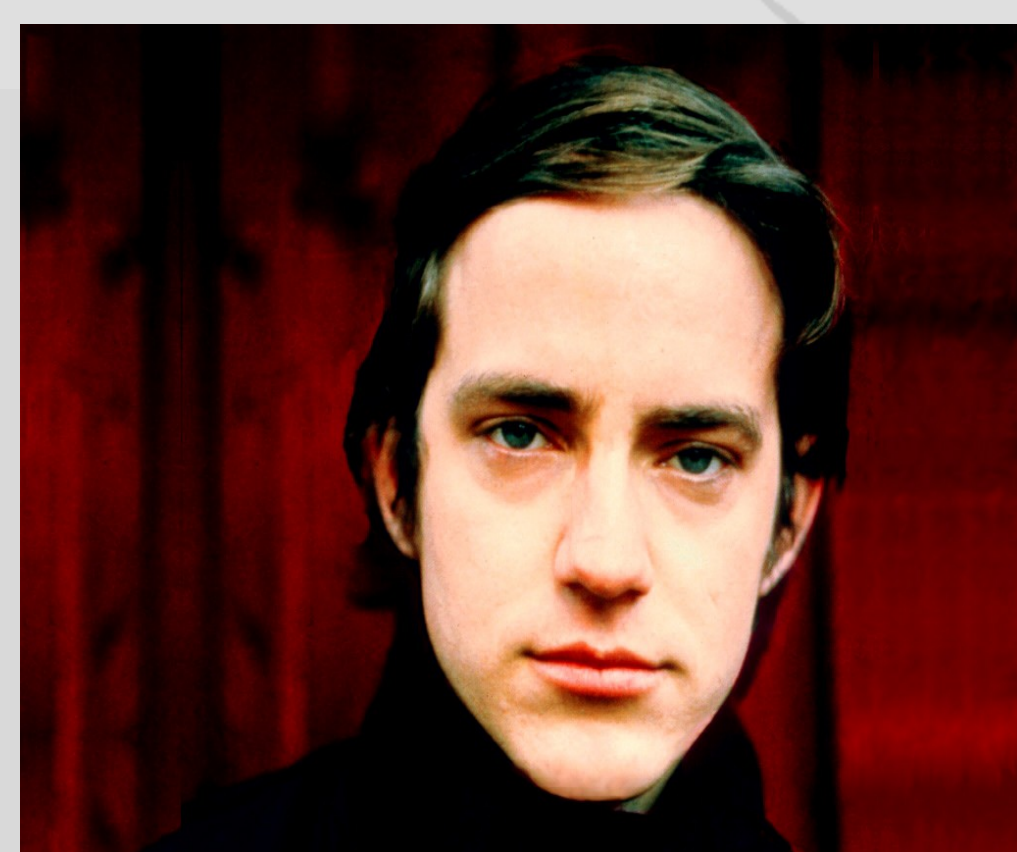
Emotional Challenge: Participants wore EEG nets. Each participant viewed a 90-image slide show that varied in emotional content (pleasant, neutral and unpleasant). Participants rated this emotional content on a 1-3 scale. Each picture was shown for 4 seconds followed by a 12 seconds black screen with a central fixation cross.

Post Emotional Challenge: Completed STAI form again (about 50 minutes after each exercise or rest condition).

Pleasant



Neutral



Unpleasant



Taken together, these data suggest the anxiolytic effects of exercise are related to a change in emotional reactivity, specifically toward unpleasant events.

Figure 1. Example images from each emotional category. Participants viewed 30 of each type of image counterbalanced in two different orders.

Results

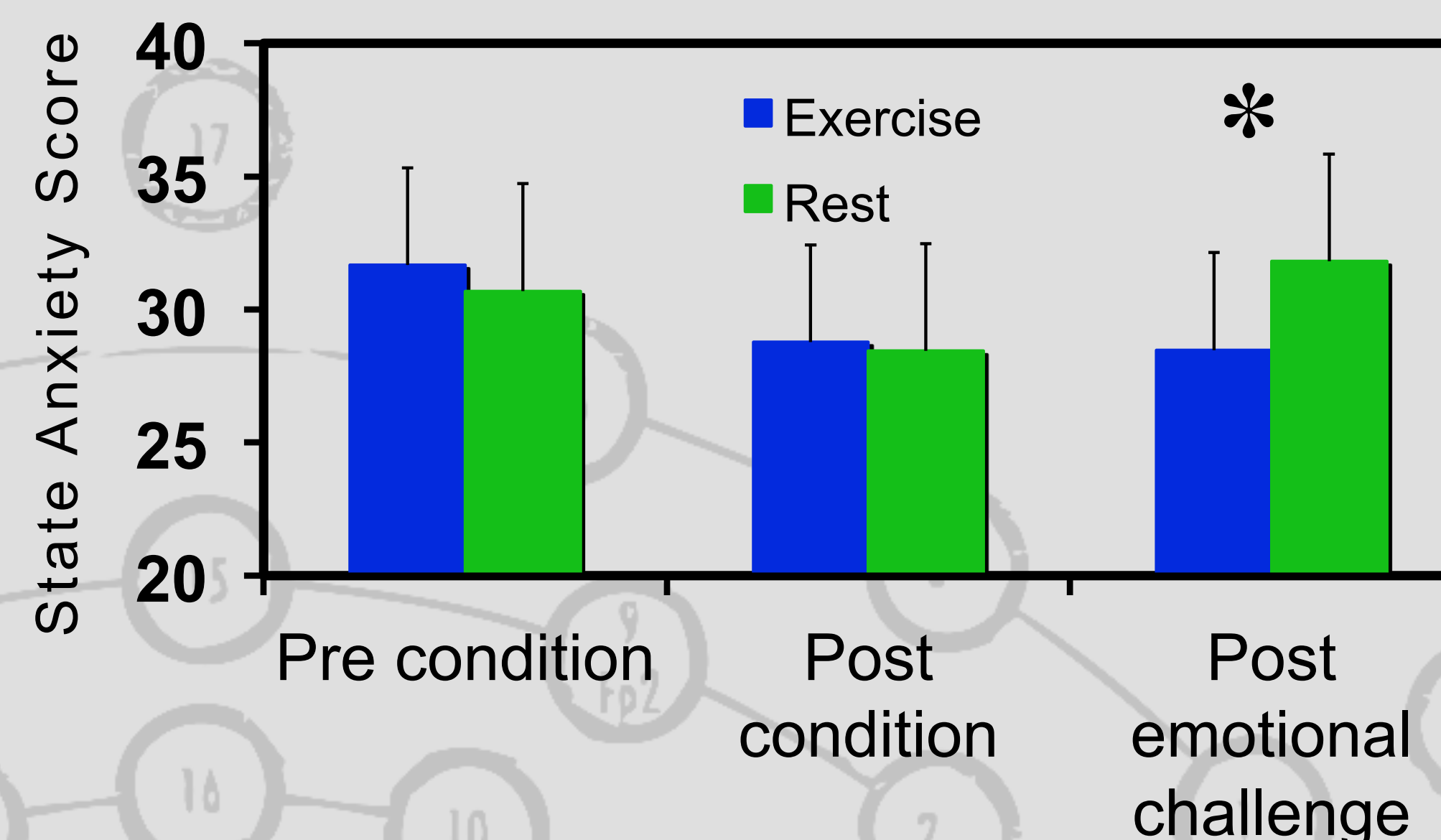
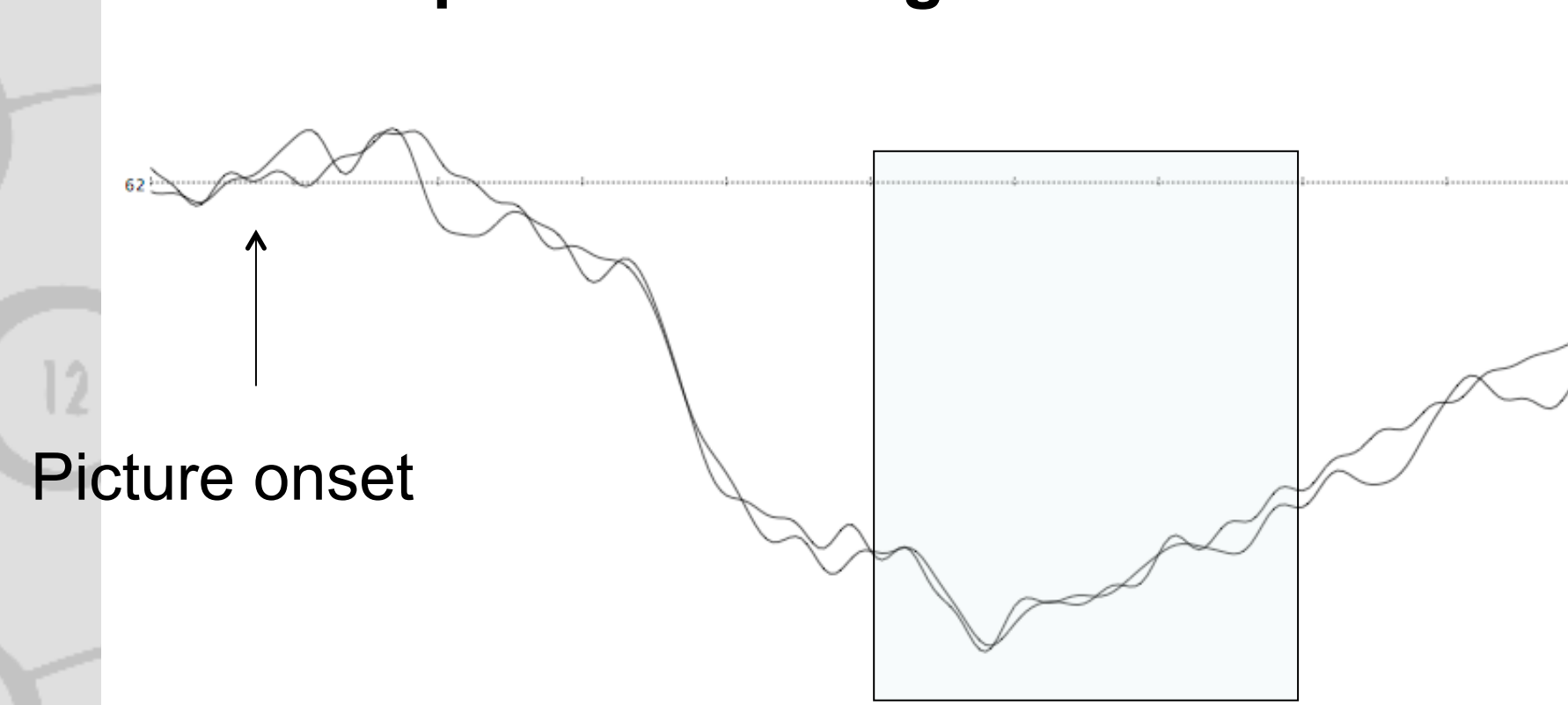
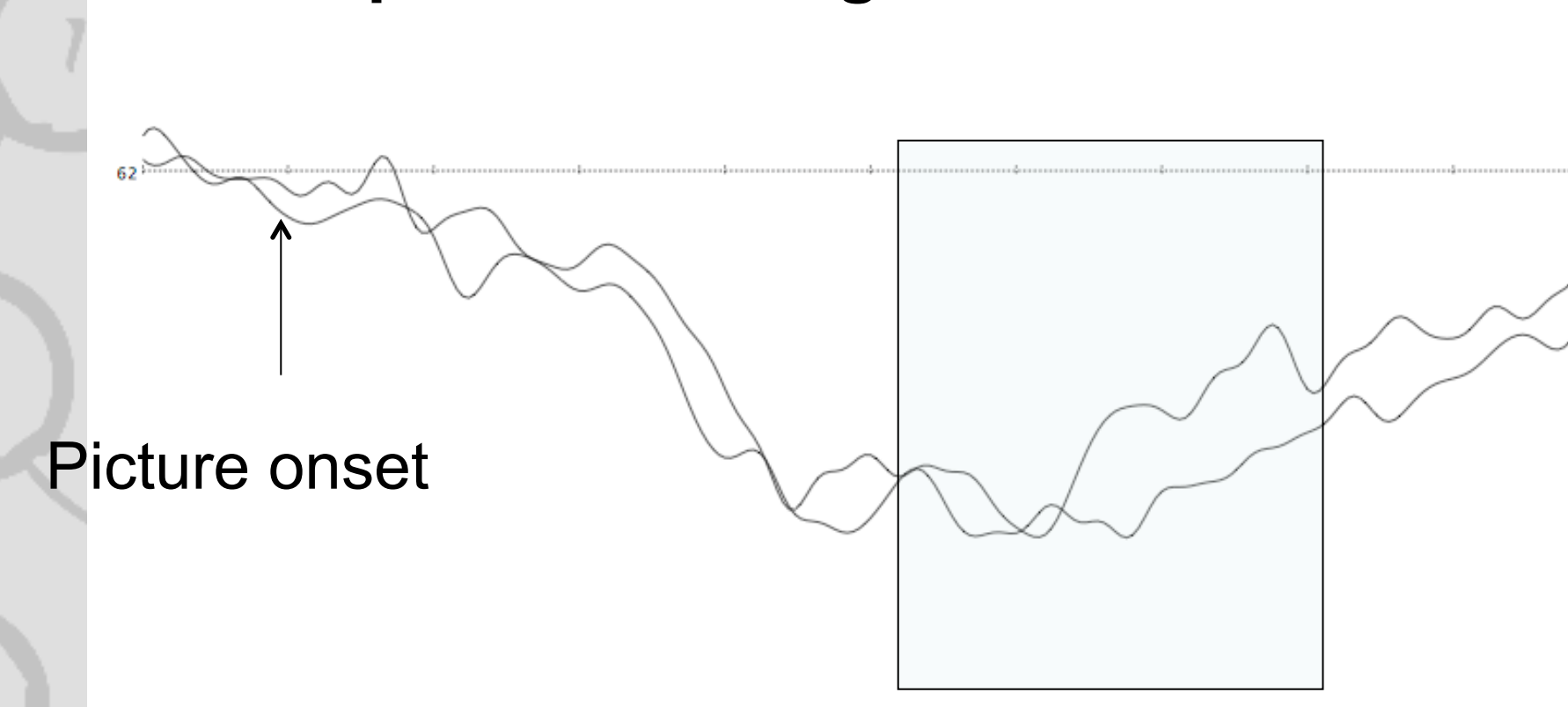


Figure 2. Mean state anxiety scores decreased after both exercise and rest ($p = .003$). After the emotional challenge, state anxiety remained decreased when preceded by the exercise condition, but increased to baseline levels for the rest condition ($p < .05$).

Pleasant picture viewing



Neutral picture viewing



Unpleasant picture viewing

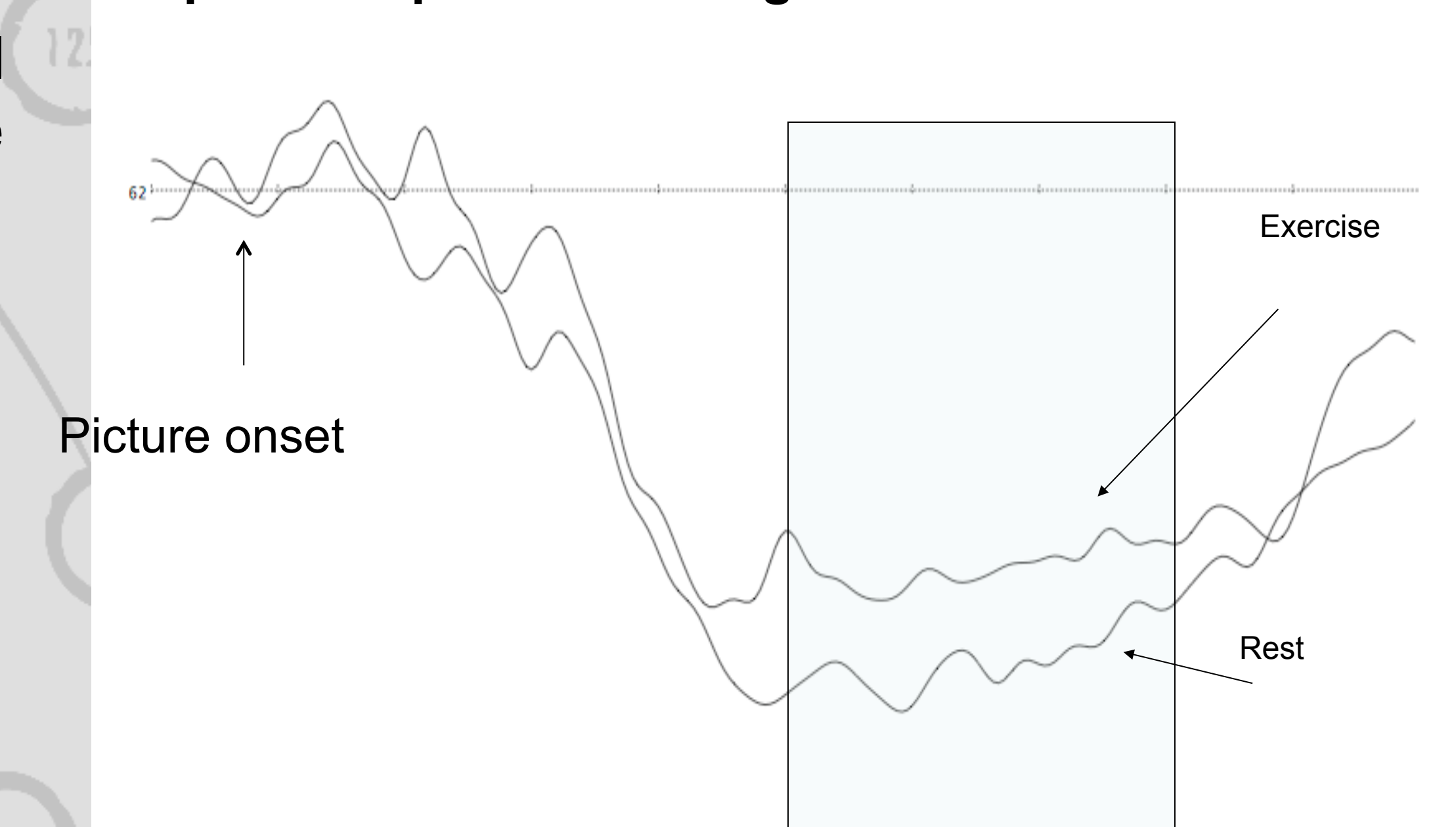


Figure 4. (above) Component ERP for the Unpleasant image condition. Exercise and rest conditions show significant reduction in the positive direction in the LLP. Note: Positive is down.

Figure 3. (left) Component ERPs for Pleasant (top) and Neutral (bottom) image conditions. The boxed sections highlight the LPP. These show no significant differences after exercise compared to rest conditions.

Conclusion

Cycling exercise at a perceptual rating of 'somewhat hard', as well as quiet seated rest, may lead to reduced state anxiety. However, prior exercise may buffer against the effects of a subsequent emotional challenge and lead to sustained anxiety reduction up to 50-minutes after exercise (see Figure 2). This result is consistent with previous findings that reductions in state anxiety can be attributed to moderate intensity exercise up to 60 minutes after a session of moderate intensity exercise (Petruzzello et al., 1991).

During the viewing of unpleasant images, the LPP was reduced on the day of the exercise condition (See Figure 4). The pleasant and neutral conditions showed no significant change.

References

1. Borg, G. (1998). *Borg's perceived exertion and pain scales*. Stockholm: Human Kinetics.
2. Codispoti, M., Ferrari, V., Bradley, M.M. Reptition and Event-related Potentials: Distinguishing Early and Late Processes in Affective Picture Perception. *Journal of Cognitive Neuroscience*, 19:4, 577-586.
3. Petruzzello, S.J., Landers, D.M., Hatfield, B.D., Kubitz, K.A., & Salazar, W. (1991). A meta-analysis on the anxiety-reducing effects of acute and chronic exercise: Outcomes and mechanisms. *Sports Med*, 11, 143-82.
4. Spielberger, C.D., Gorsuch, R.L., Lushene, P.R., Vagg, P.R., & Jacobs, G.A (1983). *Manual for the State-Trait Anxiety Inventory*. Consulting Psychologists Press, Inc., Palo Alto, CA.