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Slowed Reaction Time During Exercise: What is the Mechanism?

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Exercise has been shown to have beneficial effects to human health (3). In this issue of *Exercise and Sport Sciences Reviews*, however, Ando (1) outlines a series of experiments which demonstrate that reaction time slows down at higher intensity levels of exercise. The author interprets a slower reaction time to suggest that peripheral visual perception is reduced, and proposes a mechanism based on decreased cerebral oxygenation. If visual perception is negatively affected during intense exercise as Ando suggests, this finding would have implications for rehabilitation specialists and their patients, as well as for athletes during training and performance.

Although the findings by Ando are interesting and suggest a slowing of information processing with high intensity exercise, we wonder if alternative mechanisms for the slower reaction time could be involved. In their paradigm, Ando and colleagues (2) have studied reaction time of the right hand in response to a visual cue. The reaction time was studied at rest, and during exercise on a cycle ergometer at 40% peak VO_2 max and 75% peak VO_2 max. The visual cue was provided at different eccentricity angles from the midpoint of the eyes. During exercise, the premotor reaction time was increased at 75% VO_2 max compared with rest. Premotor reaction time was slower at the wide angle compared with the midpoint suggesting that reaction time is slower for peripheral vision. Nonetheless, the interaction between eccentricity angle and exercise intensity was not significant. This raises the possibility that visual perception may not be the only mechanism to consider. Below we briefly describe some neuroimaging studies, which indicate that different mechanisms can potentially influence the findings by Ando.

Even a simple task that requires the use of visual information to produce force on a button as in the task studied by Ando can require a network of brain activity well beyond visual cortex. For example, studies using blood oxygenation-level dependent (BOLD) functional magnetic resonance imaging have shown that increased activity exists across visual cortex, parietal cortex, motor cortex, premotor cortex, prefrontal cortex, insular cortex, basal ganglia, cerebellum, and thalamus (4). It is reasonable to hypothesize that any of these brain regions could be affected by exercise to alter reaction time. In a series of experiments by Williamson and colleagues (5,6,7), the authors measured regional cerebral blood flow using single-photon emission-computed tomography immediately following exercise. The group studied active and passive cycling and found that the insular cortex and leg area of motor cortex had increased regional cerebral blood flow compared with rest (7). Furthermore, in a

study of static hand grip exercise (5), it was observed that the sensorimotor cortex, anterior cingulate cortex, thalamus, and anterior and posterior insular cortex had increased regional cerebral blood flow compared with rest. Since an intense bout of exercise seems to influence a subset of the brain regions needed during a simple reaction time task, it is possible that mechanisms in addition to visual perception are at play, and are worth considering in future studies. Such studies, for example, could examine the effects of high intensity exercise on reaction time when the cue is auditory, somatosensory, and visual. The physiological explanation proposed by Ando would be supported if exercise only slows reaction time with visual stimuli.

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