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Aerobic fitness and cognitive development: Event-related brain potential and task performance indices of executive control in preadolescent children.

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The relationship between aerobic fitness and executive control was assessed in 38 higher- and lower-fit children (M-sub(age) = 9.4 years), grouped according to their performance on a field test of aerobic capacity. Participants performed a flanker task requiring variable amounts of executive control while event-related brain potential responses and task performance were assessed. Results indicated that higher-fit children performed more accurately across conditions of the flanker task and following commission errors when compared to lower-fit children, whereas no group differences were observed for reaction time. Neuroelectric data indicated that P3 amplitude was larger for higher- compared to lower-fit children across conditions of the flanker task, and **higher-fit children exhibited reduced error-related negativity amplitude and increased error positivity amplitude compared to lower-fit children.** **The data suggest that fitness is associated with better cognitive performance on an executive control task through increased cognitive control, resulting in greater allocation of attentional resources during stimulus encoding and a subsequent reduction in conflict during response selection.** The findings differ from those observed in adult populations by indicating a general rather than a selective relationship between aerobic fitness and cognition.

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Cardiorespiratory fitness and acute aerobic exercise effects on neuroelectric and behavioral measures of action monitoring.

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Cardiorespiratory fitness and acute aerobic exercise effects on cognitive function were assessed for 28 higher- and lower-fit adults during a flanker task by comparing behavioral and neuroelectric indices of action monitoring. The error-related negativity, error positivity, and N2 components, as well as behavioral measures of response speed, accuracy, and post-error slowing were measured following a 30-minute acute bout of treadmill exercise or following 30-minutes of rest. A graded maximal exercise test was used to measure cardiorespiratory fitness by assessing maximal oxygen uptake. Results indicated that higher-fit adults exhibited reduced error-related negativity amplitude, increased error positivity amplitude, and increased post-error response slowing compared with lower-fit adults. However, acute exercise was not related to any of the dependent measures. **These findings suggest that cardiorespiratory fitness, but not acute aerobic exercise, may be beneficial to behavioral and neuroelectric indices of action monitoring following errors of commission by increasing top-down attentional control.**

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Cognition is a general term that reflects a number of underlying mental processes. [Colcombe and Kramer \(2003\)](#) conducted a theory-driven meta analysis of 18 studies designed to assess the impact of physical activity on older adults' cognitive performance. Tasks used in these studies were coded in terms of four specific types of mental processing: executive function, which involves scheduling, response inhibition, planning, and working memory; controlled processing, which requires the automatization of response sequences ([Chodzko-Zajko and Moore 1994](#)); visuospatial processing, which involves perceptual learning ([Stones and Kozma 1989](#)); and speeded processing, which places demands on simple reaction time ([Spirduso and Clifford 1978](#)). Their analysis revealed that aerobic exercise resulted in a moderately large effect on overall cognitive performance (Effect Size (ES)=0.47). Further, the strength of effect was related to the type of test employed. Greatest gains were found for tests of executive function (ES=0.68), followed by tests of controlled processing (ES=0.46), visuospatial processing

(ES=0.42), and speeded processing (ES=0.27). These results were interpreted as evidence for a causal link between fitness level and brain vitality and, further, they indicated that the link is particularly strong when the effects of exercise training are evaluated with cognitive tests that tap into executive function. Similar conclusions were drawn by [Hall et al. \(2001\)](#) review of research.

Strong support for the executive function hypothesis has been provided through research conducted with older adults. [Kramer et al. \(1999a, b\)](#) assessed the impact of aerobic exercise training on both executive and non-executive cognitive processes in older adults. Participants in this study were assigned to either a 6-month aerobic training program or a non-aerobic toning program. A battery of cognitive tests was administered to participants prior to and following interventions. Clear post-training differences were observed. **Individuals who participated in aerobic exercise training performed tests that required executive function (i.e., a category switching task, a flanker task, and a countermanding task) more rapidly and more efficiently than non-exercisers.** Importantly, treatments had negligible influence on older adults' performance of tasks that did not emphasize executive-type mental processes (e.g., pursuit rotor task, spatial attention task, digit-digit matching task). More recently, [Colcombe et al. \(2004a, b\)](#) used magnetic imaging techniques (fMRI) to assess the brain functions of 29 sedentary older men prior to and following a 6-month aerobic walking program. Physical activity modified brain function in the anterior cingulate cortex, a prefrontal cortical area implicated in the regulation and control of behavior. **Men who exercised were able to perform a complex decision task more rapidly than those who did not exercise.**