Exercise Enhances Cognitive Function in Children

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Introduction

The United States' childhood population is becoming increasingly sedentary.[1] This statistic is thought to be a direct cause to the current academic decline in standardized test scores among children. Currently, US children rank 25th in math and 17th in science out of 33 surveyed countries around the globe. There is an important link between exercise and cognitive function that is often overlooked by entities such as the World Health Organization when publishing childhood exercise guidelines. This link may be the key, not only for general physical and mental wellbeing, but also for increasing academic performance among children.

What is Cognition?

Prefrontal Cortex

Executive Function

- Selection
- Planning
- Initiating appropriate actions
- Inhibiting inappropriate actions

Cognition

- Learning information
- Judgement
- Organization
- Interactions

Defining Exercise

Acute Bout any physical activity performed only once for any duration and intensity.

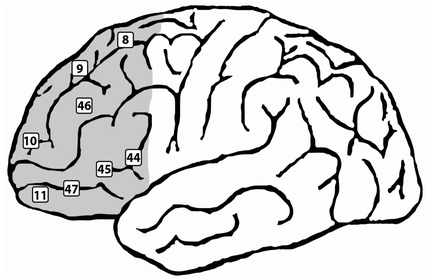
Acute exercise activity that was carried out more than once, for any period of time less than one month and for any duration or intensity.

Chronic exercise activity repeated or engaged in at least three times per week, with no maximum days per week of participation, for more than one month.

Exercise Intensity	Mild	Moderate	Vigorous	Above Vigorous
Heart Rate & VO2max (% maximum)	≤ 59%	60-74%	75-91%	>91%

Hypofrontality Hypothesis

fMRI studies have shown that similar areas of the brain active during physical and cognitive demands.[6,7] Resources required by these areas are in constant competition. If only cognitive tasks are being utilized, the portions of the brain responsible for those functions will consume more resources and deprive the rest of brain of excess resources. The same is true for any task which utilizes the brain.



The Link: Cognitive processes are required for meaningful directed movement through tasks such as motor planning and decision-making. Therefore, the prefrontal cortex must also draw resources and blood supply when motor tasks are performed. It is hypothesized that through this metabolic connection and practice of the cognitive functions required to perform physical activities, the prefrontal cortex benefits from exercise.[8]

Other brain regions that are linked to exercise:

- Hippocampus
- Perirhinal cortex
- Temporal lobe

These areas are responsible for emotions, memory and item retrieval from memory.[5,7,9]

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The Research

- Chang et al.[12] – in *general*, a child's fitness level is directly proportional to academic success.
- Hillman et al.[13] – children that exercised at moderate intensity had better reading comprehension and reaction times (P=0.016).
- Pesce et al.[14] – Moderate to vigorous exercise improved memory recall of word lists. Children could remember and recall faster, better stronger!
- Davis et al.[7] – High or low-dose exercise increases planning (p=.03) and math scores (p=.045).
- Budde et al.[15] – Any form of exercise can be beneficial to academic performance. Children who performed coordinative exercises showed greater increases in cognitive function over "normal exercise" (p<0.05).
- Dishman et al.[16] – Social support and exercise encourages the following in females: Self-efficacy, increased perceived social support reduced perceived barriers to physical activity.

Conclusions:

- Chronic Exercise is better than acute, but acute is still beneficial.
- Greater fitness = less fatigue, in both exercise and cognitive performance.
- 30-60 minutes of exercise, with at least 15 minutes of moderate or moderate-to-vigorous intensity.

The Future

Video games dubbed "Exergames" – video games that incorporate interpersonal interactions, movement, or exercise. Requires Coordinative activity, physical activity thinking, planning, and Interpersonal Interactions.[17]

Treatment for congenital diseases such as Fragile X, Down syndrome, Autism spectrum disorders.

- Sowa M.[18] – Motor function and social difficulties improve with exercise. (DS, ASD)
- Hessl D et al.[19] – Sympathetic regulation of high cortisol levels in FXS.
- Peuschel M et al.[20] – Treadmill walking accelerates walking milestone in 30 infants (typically 1 year late)
- Llorens-Martin M.[21] – Exercise induced neurogenesis of new hippocampal cells DS model mice

Treatment for Alzheimer's and other neurodegenerative disease.[22]

- Portions of the brain that are active during physical activity do not necessarily differ with age. Regional fMRI…[23] In other words child studies may be applicable to adults and vise versa.

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