Boost your brain, while having a break!

How cognitively engaging physical activity breaks affect school children's executive functions and academic achievement

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Introduction

There is a growing body of research supporting a positive relationship between physical activity (PA), cognitive functions and academic achievement[1]. Cognitive functions, particularly executive functions, are acknowledged as a predictor for academic achievement[2]. Recently, intervention studies are revealing that not all forms of PA benefit cognition equally. To date, the *cognitive engagement* inherent in many forms of PA is one of the qualitative aspects most widely discussed. This cognitive demand is thought to induce cognitive engagement, which is defined as the degree to which cognitive effort is needed to master difficult skills[3]. Previous studies, compared experimental conditions to an in-active control condition, e.g. sedentary academic or regular lessons. Therefore, it is not surprising that children's cognitive functions benefit from all varieties of PA interventions when they were compared to either no treatment or purely academic content. Interventions comparing cognitively challenging vs. cognitively non-challenging PA, found the enhancement to be significantly more pronounced in response to cognitively engaging activities[4,5]. The "cognitive stimulation hypothesis"[6] provides a possible explanation for the cognitive improvement. The assumption is that cognitively demanding exercises activate similar brain regions that are used to control higher-order cognitive processes[7].

The aim of this study was to compare systematically different PA modalities with different amounts of physical exertion and cognitive engagement in a long-term PA intervention.

Method

Participants

N = 142 (54.9% ♀), 2nd grade children: *M* = 7.91 years (*SD* = 0.40)

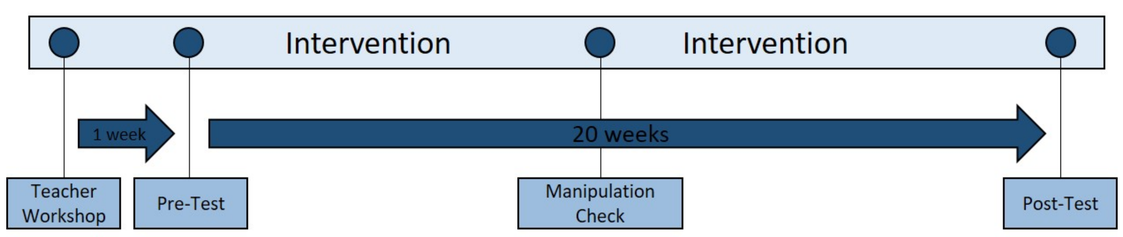
Conditions:

- Combo group: specifically designed physical activity breaks integrating cardiovascular-stimulating tasks with executive demands; *n* = 47.
- Aerobic group: specifically designed physical activity breaks integrating cardiovascular-stimulating tasks; *n* = 49.
- Cognition group: specifically designed physical activity breaks integrating executive demands; *n* = 46.

Sample Characteristics	Combo		Aerobic		Cognition	
	M	*SD*	*M*	*SD*	*M*	*SD*
Age	7.94	0.40	7.96	0.36	7.82	0.41
Gender (m/f)	21/26		21/28		22/24	
SES	6.83	1.70	6.67	1.42	7.10	1.55
BMI (kg · m²)	16.21	2.22	16.51	2.91	16.21	2.36
Motor skills	103.28	15.41	106.25	15.94	105. 81	14.64
Aerobic fitness	273.79	146.74	313.09	117.19	263.63	128.69

Table 1.
Means and standard deviations of the background variables for the three groups.

Design



Tasks

Assessment of executive functions and academic achievement by five standardized tests[8-12].

Results

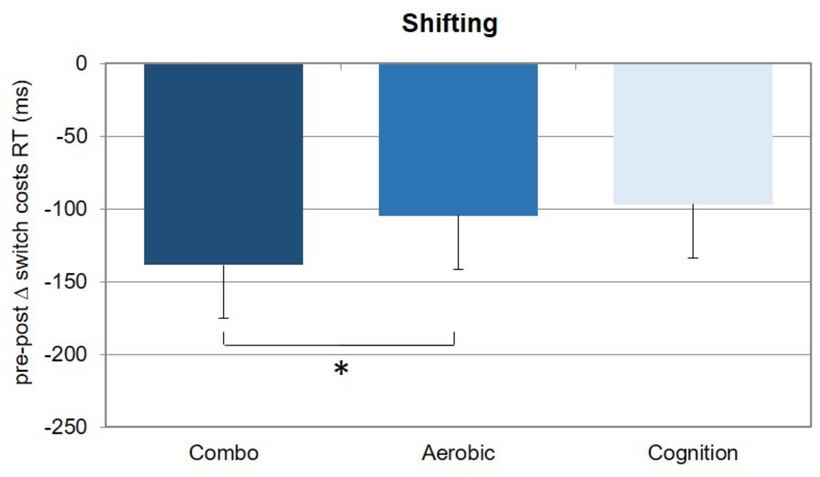


Figure 1.
Means and error bars of shifting performance for the three groups.

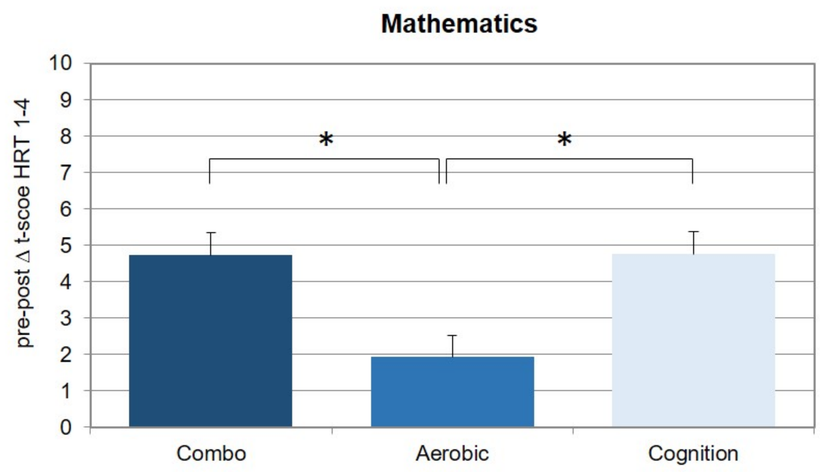


Figure 2.
Means and error bars of mathematics performance for the three groups.

In summary, the results showed (1) that only the combo group intervention (high cognitive engagement and high physical exertion) fostered significant increases in children's shifting performance, whereas updating and inhibition remained unaffected and (2) that the two cognitively challenging interventions enhanced children's mathematic performance significantly more than the aerobic group intervention. However, spelling and reading performance could not be improved through any of the three interventions.

	F(3, 138)	*p*	η^2_p
Updating	0.16	.856	.002
Inhibition	0.68	.507	.010
Shifting*	4.68	.011	.064
Mathematics*	7.34	.001	.096
Reading	1.64	.236	.021
Spelling	1.26	.287	.018

Table 2.
Test statistics for the six dependent variables

Note. *$p < .05$

Discussion

The current results are in line with previous research showing a higher improvement on cognitive performance for those interventions with higher amounts of cognitively engaging PA.

Besides physical education, classroom-based PA breaks are a further opportunity, not only to enhance daily PA time, but also to improve children's cognitive outcomes. High-qualitative PA breaks, such as a combination of both PA and cognitive engagement, seems to be the most effective if the adjustment of quantitative characteristics (duration and intensity) is considered as well.

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