

# Correlation of primary students' physical activity and progress in regulatory functions

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## Abstract

**Objective of the study** was to analyze correlations between regulatory functions and physical activity in primary school groups.

**Methods and structure of the study.** We sampled for the study the 8 year-old 2-grade students (n=103, 47 boys and 56 girls) at Moscow schools and split them up into unsporting Group 1 (n=49) and sporting Group 2 (n=54) of individuals trained at least twice a week for 45+min in 1+ sport groups on an off-class basis for at least one year. The sample was tested on an individual basis, with the test data processed by SPSS 21.0 software written in R-language (version 4.0.3). We used NEPSY-II Neuropsychological Test System (designed to test mental functions in the 3-16-year-olds) to rate the self-regulation elements in the sample. Visual operational memory was rated by a Design Memory subtest; restraining control by an Inhibition subtest run in two series with different triggers/ stimuli; cognitive flexibility by a Sorting Animals subtest using cards with animals; and the short-term auditory memory was rated by the A.R. Luria's Ten Words test.

**Results and conclusion.** Our tests and analyses rated the habitually sporting children meaningfully higher on the self-regulation and short-term auditory memory scales than their unsporting peers, with the highest progress and inter-group differences in the cognitive flexibility tests. This finding gives us the reasons to recommend reasonably high physical activity among the most efficient cognitive progress facilitation methods.

**Keywords:** *regulatory functions, self-regulation, operational memory, physical activity, sport, primary schoolchildren.*

**Background.** Regulatory function is referred herein as the array of cognitive functions responsible for non-standard (non-stereotyped) responses to new/ challenging situations in need of special concentration. As provided by Miyake et al., the self-regulation functions are headed by visual and auditory operational memory, restraining control (to inhibit a standard response and find the right one) and cognitive flexibility (that facilitates transition from one rule/ viewpoint to another) [7]. It should be noted that the self-regulation skills are often more important for social success than the intellectual abilities [8], and this is the reason for the modern child development programs to give a growing priority to the self-regulation encouragement methods.

Physical activity is commonly ranked among the most accessible methods to facilitate progress in the self-regulation domain since mental functionality is known to fall with sags in the physical fitness [2]. Thus children with sedentary lifestyles are always tested with low restraining control [4], whilst habitual team sports and active games are known to improve cognitive flexibility [10] and develop operational memory in sporting underage groups [3]. Some authors believe, however, that physical activity is beneficial for self-regulation only in case of high-intensity trainings [6]; whilst the others find no meaningful progress in regulatory functions with habitual physical activity [9]. Therefore, benefits of physical activity for progress in self-regulation functions are still arguable in the research community.



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**Methods and structure of the study.** We sampled for the study the 8 year-old 2-grade students (n=103, 47 boys and 56 girls) at Moscow schools and split them up into unsporting Group 1 (n=49) and sporting Group 2 (n=54) of individuals trained at least twice a week for 45+min in 1+ sport groups on an off-class basis for at least one year. The sample was tested on an individual basis, with the test data processed by SPSS 21.0 software written in R-language (version 4.0.3). We used NEPSY-II Neuropsychological Test System (designed to test mental functions in the 3-16-year-olds) to rate the self-regulation elements in the sample [9]. Visual operational memory was rated by a Design Memory subtest; restraining control by an Inhibition subtest run in two series with different triggers/ stimuli; cognitive flexibility by a Sorting Animals subtest using cards with animals; and the short-term auditory memory was rated by the A.R. Luria's Ten Words test [10].

**Results and discussion.** We first rated and analyzed correlations between the sporting lifestyle and self-regulation function elements (see Table 1); and found the highest correlation for cognitive flexibility. This finding gives us the reasons to believe that physical activity facilitates progress in cognitive flexibility critical for decision-finding and problem solving capacity.

**Table 1.** Correlations between the sporting lifestyle and self-regulation function elements (\* $p < 0.05$ ; \*\* $p < 0.01$ )

Tests	Sporting lifestyle
Visual operational memory	,28**
Naming time	-,2*
Inhibition time	-,31*
Attention switch, missed errors	-,2*
Switch time	-,3**
Cognitive flexibility, number of right groups	,43**
Short-term auditory memory, reps needed to memorize	-,22*

Then we analyzed the subtest data of the unспортing Group 1 versus sporting Group 2: see Table 2.

Sporting Group 2 was on average tested higher than the unспортing on the Visual Operational Memory Image and Visual Operational Memory Total Score scales; and faster in the Inhibition test, although the group error rates were virtually the same. It is not unlikely that the sporting lifestyle develops the fast decision-making abilities encouraged by the sport-specific instructions and goals, with a top priority to fast completion; and this is the reason why the sporting children get used to concentrate on this aspect as required by their sporting experiences. Furthermore, sporting Group 2 was tested meaningfully better than Group 1 (56% correct namings versus 36%, respectively) in the Sorting

**Table 2.** Group 1 and Group 2 test data averages and differences, (M – average, p – meaning ratio)

Subtests	Group 1	Group 2	t / U test	p
<i>Visual operational memory</i>				
Design memory: image	48,92	52,43	t = -3,317	0,001
Design memory: location	26,63	27,69	U = 957,0	0,013
Design memory: total score	107,4	118,9	t = -2,876	0,005
<i>Restraining control</i>				
Naming: missed errors	0,24	0,15	U = 1241,0	0,411
Naming: corrected errors	0,65	0,37	U = 1110,0	0,085
Naming: time	60,16	56,2	t = 2,128	0,036
Inhibition: missed errors	1,29	1,24	U = 1290,	0,816
Inhibition: corrected errors	2,38	2,26	U = 1212,5	0,458
Inhibition: time	88,88	79,8	t = 2,542	0,013
Attention switch: missed errors	5,08	2,79	U = 1021,5	0,043
Switch: corrected errors	4,67	3,66	U = 1137,5	0,217
Switch: time	126,6	111,8	t = 3,108	0,002
<i>Cognitive flexibility</i>				
Sorting animals	4,37	6,76	t = -4,87	0,000
<i>Short-term auditory memory</i>				
Ten Words: reps needed to memorize	4,51	3,93	U = 989,5	0,024



Animals test – that may be interpreted as indicative of the higher cognitive flexibility. And the short-term auditory memory tests also rated sporting Group 2 significantly higher than Group 1 – that may be due to the fact that sporting children naturally develop due attention to verbal instructions on tactics and goals in the sports groups, with their short-term memorizing abilities facilitated by the training and competitive settings more efficiently.

**Conclusion.** Our tests and analyses rated the habitually sporting children significantly higher on the self-regulation and short-term auditory memory scales than their unsporting peers, with the highest progress in the cognitive flexibility tests. Therefore, sporting lifestyles were tested to facilitate self-regulation skills critical for success in the learning and socializing domains. We recommend further studies to analyze correlations of the regulatory functions with the sport-specific physical activity to find the sport disciplines most beneficial for the children's development agendas.

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