5 - Efetividade de uma aula de jogos de aeróbica na atenção seletiva em crianças em idade escolar durante o dia escolar

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Efetividade de uma aula de jogos de aeróbica na atenção seletiva em crianças em idade escolar durante o dia escolar

Resumo

O objetivo deste estudo foi avaliar a eficácia de uma aula de jogos de aeróbica na atenção seletiva em crianças em idade escolar durante o dia escolar. Participaram 160 estudantes (idade = 9,17 ± 0,96 anos), 77 meninas e 83 meninos. Os alunos foram divididos aleatoriamente no grupo experimental (GE, n = 82) ou no grupo controle (GC, n = 78). Usamos o teste D2 para medir a atenção. O GE realizou uma sessão de jogos aeróbicos com duração de 45 minutos, enquanto o GC não havia realizado aulas de educação física nesse dia escolar. Foram encontradas diferenças significativas entre os dois grupos: o GE apresentou melhor desempenho nas respostas totais (p = 0,024), sucessos totais (p <0,001) na concentração (p <0,001) e efetividade geral do teste (p = 0,017). Os resultados obtidos mostraram que a execução de exercício aeróbico moderado causa melhor atenção seletiva em crianças em idade escolar durante o dia escolar.

Palavras-chave: Desempenho cognitivo, Jogos aeróbicos, Atividade física aguda.

Effectiveness of an aerobics games class on selective attention in elementary school-aged children during the school day

Abstract

The purpose of this study was to evaluate the effectiveness of an aerobics games class on selective attention in elementary school-aged children during the school day. Participants were 160 students (age=9.17±0.96 years old), 77 girls and 83 boys. Students were randomly assigned to the experimental group (EG, *n*=82) or the control group (CG, *n*=78). We used the D2-test to measure attention. The EG performed an aerobic games session lasting 45 minutes, whilst the CG had not performed in a physical education class on this school day. Significant differences between both groups were found: the EG showed better performance in total responses (*p*=0.024), total successes (*p*<0.001) concentration (*p*<0.001) and overall effectiveness of the test (*p*=0.017). The results obtained showed that the execution of moderate aerobic exercise causes better selective attention in elementary school-aged children during the school day.

Keywords: Cognitive performance, Aerobic games, Acute physical activity.

Efficacité d'un cours de jeux d'aérobic sur l'attention sélective chez les enfants du primaire à l'école primaire

Résumé

Le but de cette étude était d'évaluer l'efficacité d'un cours d'aérobic sur l'attention sélective chez des enfants d'âge élémentaire pendant la journée scolaire. Les participants étaient 160 élèves (âge = 9,17 ± 0,96 ans), 77 filles et 83 garçons. Les élèves ont été assignés au hasard au groupe expérimental (EG, n = 82) ou au groupe témoin (CG, n = 78). Nous avons utilisé le test D2 pour mesurer l'attention. Le GE a effectué une session de jeux d'aérobic de 45 minutes, alors que le CG n'avait pas participé à un cours d'éducation physique ce jour-là. Des différences significatives ont été trouvées entre les deux groupes: l'EG a montré de meilleures performances dans les réponses totales (p = 0,024), les succès totaux (p <0,001), la concentration (p <0,001) et l'efficacité globale du test (p = 0,017). Les résultats obtenus ont montré que l'exercice aérobique modéré entraîne une meilleure attention sélective chez les enfants d'âge scolaire à l'école primaire.

Mots-clés: performance cognitive, Jeux d'aérobic, Activité physique aiguë.

Efectividad de una clase de juegos de aeróbicos en la atención selectiva en niños de primaria durante el día escolar

Resumen

El propósito de este estudio fue evaluar la efectividad de una clase de juegos de aeróbicos en atención selectiva en niños de primaria durante el día escolar. Los participantes fueron 160 estudiantes (edad = 9,17 ± 0,96 años), 77 niñas y 83 niños. Los estudiantes fueron asignados aleatoriamente al grupo experimental (EG, n = 82) o al grupo de control (CG, n = 78). Utilizamos la prueba D2 para medir la atención. El EG realizó una sesión de juegos aeróbicos que duró 45 minutos, mientras que el CG no se había presentado en una clase de educación física en este día escolar. Se encontraron diferencias significativas entre ambos grupos: el EG mostró un mejor desempeño en respuestas totales ($p = 0.024$), éxitos totales ($p < 0.001$) concentración ($p < 0.001$) y efectividad general de la prueba ($p = 0.017$). Los resultados obtenidos mostraron que la ejecución de ejercicio aeróbico moderado causa una mejor atención selectiva en niños de primaria durante el día escolar.

Palabras clave: rendimiento cognitivo, Juegos aeróbicos, Actividad física aguda

Introdução

The importance of physical activity for health is well known and research has noted both physical and psychological benefits when children participate in physical activity (AHN & FEDEWA, 2011; JANSSEN & LEBLANC, 2010). In the last years, a growing interest has arisen about the benefits of physical activity for academic and cognitive performance and executive function (EF) (BUDDE, VOELCKER-REHAGE, PIETRAßYK-KENDZIORRA, RIBEIRO, & TIDOW, 2008; ELLEMBERG & ST-LOUIS-DESCHÊNES, 2010; GALLOTTA ET AL., 2014; VERBURGH, KÖNIGS, SCHERDER, & OOSTERLAAN, 2014). Aerobic exercises have the potential to promote multiple facets of development through its direct impact on EF (BEST, 2010)**.** To date, few reports are available yet about that topic. Chang, Labban, Gapin, & Etnier, (2012) and Gallotta et al., (2014) showed that exercise duration, exercise intensity, participant fitness and specific type of physical exercises performed during physical activity interventions were significant moderators in the association between physical activity and cognitive performance. It is important to note that the individual's level of physical fitness is potentially involved in the interference of physical demand on EF (SOGA, SHISHIDO, & NAGATOMI, 2015). The children who are physically fit exhibited greater cortical activation and corresponding cognitive performance than less fit children (TOMPOROWSKI, DAVIS, MILLER, & NAGLIERI, 2008). Moreover, Chaddock, Pontifex, Hillman, & Kramer (2011) showed the importance of physical activity and aerobic fitness for maximizing brain health and cognitive function during development. Recently, Latorre Román, Pinillos, Pantoja Vallejo, & Berrios Aguayo, (2017) show an association between creativity and physical fitness in primary school children that may have important implications for academic achievement.

Some research studies have shown that acute and chronic exercise may facilitate EF (BEST, 2010; KVALØ, BRU, BRØNNICK, & DYRSTAD, 2017). Pesce, Crova, Cereatti, Casella, & Bellucci (2009) investigated the effects of physical exercise on memory performance in children through two sessions immediately followed physical education class (aerobic circuit training vs. team games) characterized by similar exercise intensities, but different cognitive and social engagement; the results indicated that an acute bout of aerobic exercise, as performed by students during physical education class, may facilitate memory storage. LIKEWISE, Pontifex, Hillman, Fernhall, Thompson, & Valentini (2009) concluded that an acute bout of aerobic exercise may facilitate cognitive performance, while Tomporowski (2003) reported that an aerobic exercise performed for periods up to 60 minutes facilitates specific aspects of information processing and cognitive performance in adults. The basis for this theory is the fact that aerobic exercise produces not only general but also specific physiological changes in the brain, besides causing an immediate neurochemical response that may enhance cognitive performance (BEST, 2010). Moreover, exercise has been shown to positively affect cognitive performance, due to the neuronal connection between the cerebellum and the frontal cortex (BUDDE et al., 2008). Aerobic exercise appears to enhance EF, and it may be that physical exercises requiring better cognitive engagement (which involve for example cooperation and opposition actions) have a greater effect on EF than simpler exercises, requiring limited cognitive engagement (BEST, 2010; LUDYGA, GERBER, KAMIJO, BRAND, & PÜHSE, 2018).

On the other hand, opportunities to be physically active at school are limited by pressure on scholastic performance (MAHAR et al., 2006). Therefore, little for physical activity time is incorporated into elementary school classrooms (KIBBE et al., 2011). Teachers complain about growing concentration deficits and reduced attention in children. Mahar et al. (2006) concluded that long periods of instructional time without a break might be counterproductive to academic performance. Some previous papers (JARRETT & MAXWELL, 1998; PELLEGRINI, HUBERTY, & JONES, 1995) pointed out that elementary school-aged children who undergo prolonged periods of academic instruction often become more fidgety or restless and experience reduced concentration and attention.

Accordingly, deficits in attention are associated with poorer academic performance (ARONEN, VUONTELA, STEENARI, SALMI, & CARLSON, 2005).

Taking into account the information above mentioned, the main purpose of this study was to evaluate the effectiveness of an aerobics games class on selective attention and concentration in elementary school-aged children during the school day. The authors hypothesize that attention and concentration improve by aerobic games therefore; these effects might be observed after an acute bout of this exercise. In addition, acute exercises induce increases in brain concentrations of catecholamines result in faster processing (MCMORRIS, SPROULE, TURNER, & HALE, 2011), therefore, since other authors (ZOUHAL, JACOB, DELAMARCHE, & GRATAS-DELAMARCHE, 2008) point out that in response to exercise, catecholamine are influenced by several factors such as exercise characteristics and sex, therefore, we have also hypothesized that sex could to influence on acute response of aerobic exercise and your effects on attention performance.

Métodos

Participants

Participants were 160 students (age=9.17±0.96 years old, age range = 8-11 years old), 77 girls and 83 boys, belonging to a school in primary education in southern Spain. Parental consent was obtained for participants. The students with intellectual or physical disabilities were not involved in this study (information obtained from the psychological school team). The study was conducted in adherence to the standards of the Declaration of Helsinki (2013 version) and following the European Community's guidelines for *Good Clinical Practice* (111/3976/88 of July 1990), as well as the Spanish legal framework for clinical research on humans (REAL DECRETO 561/1993 on clinical trials). In addition this study was approved by The Ethic Committee of University of Jaen. Students were randomly assigned to the experimental group (EG, n=82) or the control group (CG, n=78).

Design

We employed a quasi-experimental design only with posttest measure because attention is an unstable behavior; also, D2 test can produce self-learning, therefore, we do not consider convenient a pretest measure.

Instruments and testing

Neuropsychological performance of the students was assessed in the areas of selective attention and concentration using the d2-test (BRICKENKAMP, 2002). The d2-test determines the capacity to focus on one stimulus while suppressing awareness to competing distracters (BRICKENKAMP, 2002). The d2-test is a paper and pencil letter-cancellation test that consistsof 14 lines of 47 randomly mixed letters each (either d or p). Subjects are required to distinguish as quickly as possible, within 20 s for each line, only the letter “d” with two quotation marks (“) that can appear either above, below or separated, with one mark (“) appearing above and the other mark below. The letter ‘d’ with others attributes, and ‘p’ are the distractors. After 20 seconds, there is an acoustic signal, the participant to stop working on the current row and continue with the next. The test lasts 280 seconds. The reliability coefficients (internal consistency) reached values of around 0.90 (IZQUIERDO et al., 2007).

The variables analysed were: Total answers (TR): number of elements tried on the 14 lines; total successful answers (TS): number of correct guesses, total errors of commission (EC): number of irrelevant elements marked, total errors of omission (EO): number of relevant elements tried but not marked, total test effectiveness (TOT)= TR-(EO+EC) and concentration index (CON)=TS-EC. In addition, an average of the grades obtained in all the subjects studied by the students of the last two trimesters was made. Such scholastic ratings were evaluated on a scale from 0 to 4, from inadequate to outstanding.

Moreover, in order to obtain further information about the perceived exertion after the completion of the aerobic games session the rate of perceived exertion (RPE) was recorded on the 0 to 10 (low intensity to high intensity) Borg Scale (BORG, 1982).

Experimental procedure

Students responded to the d2-test on the last class of the school day, the EG having previously performed aerobic games lasting 45 minutes in physical education (PE) class (Twenty minutes after the end of the PE class, d2-test was performed in classroom), and the CG having not performed in a PE class on this school day and remained sitting in the classroom attending to other school subjects (e.g. mathematics, language). The intensity of aerobic games was monitored by the RPE. In this studio aerobics games such as those employed by Pesce et al., (2009) were used (games that involve chasing, team games, small-sided games) and which require cooperation with other children, strategic behaviour, coordination and adaptation to continually changing task demands. Aerobic games also require skilled and complex movement, which directly relies on the prefrontal neural circuitry supporting EF (BEST, 2010). Verbal encouragement ensured maximal effort throughout all games.

The aerobic games that were included in PE class were: 3 chasing games (lasting 5 minutes each) and 3 small sided games, such as passing and possession (soccer games) (lasting 8 minutes each). Small sided games are therefore, a high-intensity intermittent training method that allows the improvement of specific physical capacities of football, besides working with ball (BUJALANCE-MORENO, GARCÍA-PINILLOS, & LATORRE-ROMÁN, 2017). Between each game, the recovery was approximately 2-4 minutes, time necessary to organize the next game.

Statistical analysis

Descriptive statistics are represented as mean (SD) and percentage. Tests of normal distribution and homogeneity (Kolmogorov-Smirnov and Levene's respectively) were conducted on all data before analysis. An independent *t* and chi-squared test were used to compare demographic variables between groups. A multivariate analysis of variance (MANCOVA) was conducted between EG and CG and sex, with age and sex as a covariate. A Pearson's correlation between the D2 score and scholastic ratings was used. The level of significance was *p<.05*. The magnitudes of the differences between values were also interpreted using the *Cohen´s d* effect size (COHEN, 1988). Effect sizes of less than 0.4 represented a small magnitude of change while 0.41–0.7 and greater than 0.7 represented moderate and large magnitudes of change, respectively (THOMAS, SILVERMAN, & NELSON, 2015). Data analysis was performed using SPSS (version 21, SPSS Inc., Chicago, Ill.).

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Resultados:

No significant differences were found between the EG and CG, neither in age, scholastic's ratings or sex distribution (Table 1). In the EG, no significant differences (*p≥.05*) in the RPE among boys (RPE=5.29±2.77) and girls (RPE=5.65±2.97) were found. A significant correlation (*r=.363, p<.001*) was found between CON and scholastic ratings.

Table 1 - SOCIODEMOGRAPHIC VARIABLES

	CC n=78	EG n=82	p-value
Age (years) mean (SD)	9.21 (0.99)	9.13 (0.94)	.650
Scholastic's ratings (0-4) mean (SD)	2.78 (1.07)	2.55 (1.15)	.212
Sex (%)	52.9 M/47.1F	51.2M/48.8F	.834

Note: CC: control group. EG= Experimental Group. SD =standard deviation. M=male, F=female

Table 2 shows performance in the d2-test for both the EG and the CG. Considering the total sample, significant differences between both groups were found: the EG showed better performance in TR, TS, TOT and CON. According to sex, the boys in the EG showed better results than the CG in TR, TS TOT and CON. The girls of the EG showed better results in the TS and CON.

Table 2 - PERFORMANCE IN D2 TEST IN EC AND CG.

	CG Total Mean (SD) n=78	EG Total Mean (SD) n=82	p-value	Cohen´s d	CG Male Mean (SD) n=41	EG Male Mean (SD) n=42	p-value	Cohen´s d	CG Female Mean (SD) n=37	EG Female Mean (SD) n=40	p-value	Cohen´s d
TR	285.60 (49.68)	304.88 (60.50)	.024	-0,349	281.53 (47.40)	310.52 (61.39)	.031		290.19 (52.50)	298.95 (59.74)	.291	
TS	110.65 (19.85)	124.83 (30.15)	<.001	-0,556	109.78 (20.05)	128.31 (31.21)	.003		111.63 (19.89)	121.17 (28.94)	.046	
EC	3.15 (2.86)	4.79 (14.70)	.401	-0,154	3.03 (2.85)	5.10 (15.72)	.375		3.28 (2.91)	4.47 (13.72)	.757	
EO	4.62 (3.77)	3.40 (6.38)	.142	0,232	4.92 (4.31)	3.52 (6.10)	.308		4.28 (3.09)	3.28 (6.74)	.293	
TOT	277.84 (50.68)	296.68 (54.97)	.017	-0,358	273.58 (48.90)	301.90 (53.50)	.026		282.62 (52.10)	291.20 (56.64)	.240	
CON	107.50 (20.99)	120.04 (25.45)	<.001	-0,561	106.75 (21.01)	123.21 (22.64)	.003		108.34 (21.26)	116.70 (27.99)	.034	

Note: CG: control group. EG= Experimental Group. SD =standard deviation.TR= total responses. TS= total successes. EC=error commission. EO= error omission. TOT= overall effectiveness of the test. CON=concentration.

Discussão

The aim of this study was to analyse the effect of PE class based on aerobic games on selective attention and concentration of primary school children. According to the Borg Scale (BORG, 1982), the intensity of this PE session was strong. The obtained results confirm the initial hypothesis that after a session of moderate aerobic exercise with cognitive engagement, children from EG had a higher selective attention and concentration level than those from CG. Moreover, a comparative analysis according to sex showed that significant differences between EG and CG occurred in boys and girls. Likewise, Janssen, Toussaint, van Mechelen, & Verhagen (2014) found no evidence of sex influence on the acute effect of physical activity on attention.

This result may be explained by the fact that the aerobic games might produce an activation of parts of the brain which are also responsible for functions like attention (YANAGISAWA et al., 2010); (ISHIHARA, SUGASAWA, MATSUDA, & MIZUNO, 2017). Moreover, acute exercises induce increases in brain concentrations of catecholamines result in faster processing (MCMORRIS et al., 2011).

Although we focused on one specific cognitive measure, the methods of this study, sample (size and age), study design and measurement of attention, make it difficult to compare results with other research. In a similar previous study, Budde et al., (2008) found significant improvements in attention and concentration (using the d2-test) in teenagers after a PE class of coordinative exercise vs. a normal sport lesson.

In addition, others previous studies showed acute effects of physical exercise on various cognitive measures. Pirrie & Lodewyk (2012) analyzed the influence of moderate-to-vigorous physical activity on four cognitive processes: planning, attention, simultaneous processing and successive processing; the results indicate that performance on the planning test significantly improved after physical activity, although no improvement was observed for attention, simultaneous processing or successive processing. Moreover, Hillman, Buck, Themanson, Pontifex, & Castelli, (2009) showed that single bouts of moderately-intense aerobic exercise (i.e. walking) may improve the cognitive control of attention in preadolescent children. Pontifex et al., (2013) showed greater performance in the areas of reading and arithmetic following a single 20-minute bout of exercise in children between the ages of 8-10 years old.

The type of physical activity, intensity and activity length may have influence on the acute effect of a physical activity bout on attention (JANSSEN et al., 2014). Hence, the available information about the impact of physical activity on cognitive processes is highly controversial and that is why more research is needed. Different forms of physical activity need to be compared to test whether these have important effects on cognitive performance. There is weak evidence for the effect of acute bouts of physical activity on attention. More experimental studies with a comparable methodology, especially in the school setting, are needed to strengthen this evidence (JANSSEN et al., 2014).

Even though the current study has successfully demonstrated that a PE class based on aerobic games (totally feasible in the daily activity for teachers and students) improves selective attention and concentration, it has certain limitations. In this study, the previous physical fitness levels of the participants not were registered and because the previous fitness level may influence executive control during low- and moderate-intensity exercise (WANG, CHU, CHU, CHAN, & CHANG, 2013), it was a limitation of this study. Another limitation of the study is quasi-experimental design used, However, the strengths of this study are: this is a field-study carried out in a school context, away from laboratories where, to date, most of studies had been performed (HILLMAN et al., 2009; PONTIFEX et al., 2013). Additionally, the current study considers the sex influence, which is an influence factor not examined in previous studies (JANSSEN et al., 2014). Moreover, as indicated by (BEST, 2010), the repetitive aerobic exercises, likely require less cognitive engagement, particularly of EF, since there is little need to guide cognition to accomplish a challenging goal or coordinate the body to execute complex movements. These differences in EF demands may lead complex exercise, as aerobic games employed in this study, to have a stronger effect on EF than simpler exercise

Pontos fortes e limitações do estudo

Insira suas considerações sobre os pontos fortes e as limitações do estudo.

Conclusão

In conclusion, the results obtained showed that the execution of moderate aerobic exercise causes better selective attention in elementary school-aged children during the school day. The results indicate the importance of using physical activity as a means of regulating attention in the classroom among children. An additional curricular emphasis on PE may result in small absolute gains in grade point average and a relative increase in performance per unit of academic teaching time. In this regard, the literature suggests that academic achievement, physical fitness and health of children will not be improved by limiting the time allocated to PE and physical activity (TRUDEAU & SHEPHARD, 2008). Moreover, in this study, a significant correlation was found between CON and scholastic ratings. Therefore, increasing the amount of time devoted to PE can promote acute cognitive benefits such as improved attention and concentration, which have important implications for academic performance.

Declaração de conflito de interesses

Não nenhum conflito de interesses no presente estudo.

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