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The Effects of Active Breaks on Primary School Students' Attentional Processes and Motivational Regulation

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A Mexican man in pre-Hispanic Aztec costume eludes the ball during a traditional "Juego de Pelota" (in Spanish), called by the Maya "pok-ta-pok" and by the Aztecs "tlachtli". Xcaret eco-park, Mexico June 5, 2009
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Abstract

Introduction/objective: Engaging in physical activity (PA) is considered a very cost-effective way of improving neurocognitive function. Both moderate-intensity and short-duration vigorous PA have positive effects on brain function, cognition, and academic performance during childhood. The aim of the present study was to analyse the effect of active breaks (AB) on students' attention and motivation, as well as to examine possible sex and grade differences. *Method:* 215 students (119 girls) from grade 2 to 6 of primary school, aged 7-13 years (M = 9.18; SD = 1.55), distributed between an experimental group (n = 108; 62 girls) and a control groupl (n = 107; 57 girls) participated. A quasi-experimental design with pre-post measurements and quantitative methodology was used. The experimental group underwent an AB programme (20-30/week; 2-5 minutes per active break). Se utilizó el Test de caras-R y el PLOC adaptado. *Results:* The results for attention showed significant differences between groups only in 3rd grade, where the programme was based on vigorous intensity AB starring the students. The experimental group reported high levels of self-determined motivation. Younger grades were more self-determined. *Conclusions:* Vigorous AB can have positive effects on students' attention and self-determined motivation.

Keywords: active breaks, executive functions, physical activity, self-determined motivation.

Introduction

Physical inactivity and sedentary behaviour have become a global challenge with adverse effects on both the physical health of young people and the cognition and brain health of children (Chaput et al., 2020; Guthold et al., 2020). Engaging in physical activity (PA) is considered a very cost-effective way of improving neurocognitive function and thus increasing the likelihood of educational success (Pontifex et al., 2019). Recently, the World Health Organization (WHO, 2020) concluded that both moderate-intensity and short-duration vigorous PA have positive effects on brain function, cognition, and academic performance during childhood (Bull et al., 2020). The positive relationship between PA and cognition in children is well substantiated: PA triggers an increase in blood flow, brain-derived neurotrophic factor and plasma catecholamines (Chang et al., 2012). Chronic PA has been shown to alter brain structure and function through synaptogenesis, neurogenesis, and angiogenesis (Hillman et al., 2008).

Despite this evidence, most educational systems rely on essentially sedentary classes, which results in schoolchildren adopting the sedentary position on a mandatory and prolonged basis for around 7-8 hours a day or more (Bedard et al., 2019). However, the educational context is considered a unique opportunity for providing sufficient PA to all schoolchildren for extended periods of time (Donnelly and Lambourne, 2011). Active breaks (AB) (*brain/active breaks*) consist of independent PA programmes designed as 1-10 min breaks to activate the brain, either during academic classes or during transition periods. The study by Daly-Smith et al. (2018) concluded that AB interventions increased PA and time-on-task, but, unlike previous reviews (e.g., Donnelly et al., 2016), did not provide evidence for improved cognition or academic performance. In the same vein, the systematic review and meta-analysis of the study by Masini et al. (2020) also found a significant effect on increasing PA levels in primary school children (both in AFMV and step count), and a significant increase in time on task. However, the effects on cognitive functions (attention components, working memory, executive functions) and academic achievement (mathematics, reading) were inconclusive. As the previous review by De Greeff et al. (2016) had identified acute PA programmes' positive effect on attention and executive functions, Masini et al. (2020) pointed to two possible explanations for these contradictory results: a) the variability of the measurements used in the studies, and b) the different typology (with or without cognitive compromise) and duration of the AB interventions. In another meta-analysis, Chang et al. (2012) had specified the activity threshold of ≥ 20 min of MVPA for an improvement in cognition; however, almost no intervention in the review by Masini et al. (2020) reached or exceeded 20 min. On the other hand, Schmidt et al. (2015) argued that cognitively engaging PA is more beneficial for cognitive functions than purely aerobic PA. In relation to academic performance results, Masini et al. (2020) concluded that ABs have limited or no impact, which contradicts the findings of Watson et al. (2017) and Mavilidi et al. (2020). These contrasting results may be due to the different AB interventions included in the reviews.

Some studies have focused on learner satisfaction in AB interventions. Howie et al. (2014) showed that children who received a Brain BITES programme enjoyed the intervention more than doing sedentary activities. However, little is known about the type of motivational regulation that triggers AB among students. The study by Hajar et al. (2019) found that ABs were successful in maintaining motivation for PA in the experimental group, while the control group showed a decrease in motivation for PA among Malaysian primary school students. One of the most relevant theoretical frameworks to explain motivational processes in the school setting is the self-determination theory (SDT) (Deci & Ryan, 1985). SDT postulates that motivation can be defined on a continuum of self-determination ranging from intrinsic motivation to demotivation, including at least three forms of extrinsic motivation: identified, introjected and external regulation. Research has connected more self-determined motivation (intrinsic motivation and identified regulation) with positive emotions (fun and satisfaction at school), executive functions (e.g., attention, memory) and academic performance (Di Domenico & Ryan, 2017; Muñoz-Parreño et al., 2021; Watson et al., 2017). To date, no study has connected AB and participants' motivational regulation from a SDT perspective.

Against this background, a study was designed in Spain with three objectives: a) to analyse the effect that AB can have on the visuoperceptual and attentional skills (correct answers, errors, net correct answers, impulsivity control index) of primary school students, b) to study the type of motivational regulation that these resources provoke, and c) to examine possible differences in terms of gender and grade level. Compared to the strategy used in other studies (Suárez-Manzano et al., 2018), in the present study the AB were supported exclusively by audiovisual material

generated by the teachers themselves (not commercialised) and the breaks took place during the classroom sessions (not during breaks or between classes). It was hypothesised that the application of breaks during classroom sessions in the most academically demanding subjects could contribute to distension, relaxation and, consequently, improve students' attention levels. A high level of the most self-determined motivation (intrinsic motivation and identified regulation) is expected to be found, which should be higher in lower grades. No sex differences were predicted for any of the variables under study.

Methodology

Research design

A quasi-experimental design with a pre- and post- repeated measurements design was used, randomly assigning control groups (5 groups, one per course) and experimental groups (5 groups, one per course). Quantitative methodology was used.

Participants

The study was carried out in a public school in a city in northern Spain, selected for its receptiveness and co-operation in the research.

Schoolchildren. The study population was 220 children in grades 2-6 of primary school from 10 ethnic groups and of intermediate socio-economic status. The inclusion criterion was that participants had attended 90% of the classes and had all their records duly completed, both in the pre-test and post-test. As a result of this filtering, five children were excluded from the analyses. A sample of 215 participants (96 boys and 119 girls) took part in the study, aged between 7 and 13 years (M = 9.18; SD = 1.55). The control group consisted of 107 participants (50 boys and 57 girls) and the intervention group consisted of 108 participants (46 boys and 62 girls). As for the calculation of the *a priori*sample size using the statistical package G*Power 3.1.9.7: for an effect size = .1, the sample size = 592; for an effect size = .2, the sample size = 150, and for an effect size = .4, the sample size = 40.

Teachers. There were ten teachers (six female and four male, three and two respectively for the control and experimental groups). They ranged in age from 28 to 52 years, had an average teaching experience of 7 years, and had no experience in using AB.

Resources

Perceptual and attentional aspects. Thurstone & Yela's (2012) R-Faces Test or Test of Differences-Revised, a test of perception of differences that assesses perceptual and attentional aspects, was used. The test has been proposed as a tool for assessing sustained and selective attention and the control of impulsive responses in schoolchildren (Monteoliva et al., 2014). It consists of 60 graphic illustrations, each consisting of three schematic drawings of faces, two of which are the same and one of which is different. Participants must determine which face is different and cross it out. The results are interpreted by considering the number of correct answers (A), the number of errors (E), the number of net correct answers (correct answers minus errors, A-E), which measures the efficiency of the subjects' responses, and the impulsivity control index [(A-E/A+E) x 100]. In terms of reliability by primary grade, the original study obtained Cronbach's alpha levels (α) ranging from .82 to .92. In the present study, the free software Jamovi 2.3.16.0 was used to calculate the McDonald Omega coefficient for the whole sample: ω = .90 in the pretest and ω = .89 in the postest.

Motivational regulation during the AB. Motivational regulation during the AB was assessed by adapting the Perceived Locus of Causality (PLOC; Goudas et al., 1994) scale translated into Spanish and validated in the context of PE by Moreno et al. (2009). This scale measures the different types of motivation set out in the SDT. In order to contextualise the instruments and adjust them to the scope of the study, the statement "I participate in PE classes" was replaced by "I participate in active breaks..." before each item of the five factors (18 items), and the wording of minor aspects was modified. Examples of items for each scale are: intrinsic motivation (e.g., "...because they are fun"), identified regulation (e.g., "...because I want to learn how to do moves, jumps, turns..", introjected regulation (e.g., "...because I want peers to think I'm doing well"), external regulation (e.g., "...because I'll get in trouble if I don't") and demotivation (e.g., "...well, I don't really know why"). A 5-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree) was used. The study by Moreno et al. (2009) obtained the following Cronbach's alpha values (α): .80 for intrinsic motivation, .80 for identified regulation, .67 for introjected regulation, .70 for external regulation and .74 for demotivation. In the present study McDonald's

omega values (ω) were: .72 for intrinsic motivation, .84 for identified regulation, .67 for introjected regulation, .75 for external regulation and .86 for demotivation. Although the reliability levels of introjected regulation were low, it was decided that the analyses with this variable should be maintained because of the interest of the study, the age of the students and its possible impact on future studies.

Procedure

During the 2018-2019 school year, an innovation and research project was carried out in two phases:

1. Video editing for the AB. A working group (18 teachers and a coordinator) was set up with the aim of generating audiovisual resources *ad hoc* to promote PA in class. The training of the teachers who implemented the AB in their respective subjects was carried out by the group coordinator and lasted 10 hours. The teachers were able to choose the type of material they considered most suitable for this purpose (e.g. based on choreographies from the internet or based on pupils' own choreographies, musical themes, etc.). The 3rd grade teacher involved the students in taking photographs, designing and filming choreographies, and composing rhythms and melodies.

2. Research. Informed consent forms for families and pre-intervention data collection were administered during March and April 2019. The investigation took place during April and May of that year. The study was carried out over two weeks. The pretest was carried out during the first one. In the second week, the experimental group was tested with the AB programme and the second wave of administration of the attention test took place. The intervention was carried out during a single week due to organisational issues at the centre. Additionally, the motivational questionnaire was only administered to the experimental group after the intervention. The experimental group completed the tests under the same general conditions as the control group, after an active break. The AB took place during regular classes in the subjects with the greatest curricular weight (languages, mathematics, natural, social, *science* and foreign languages). In line with Chang et al. (2012) with at least 20 min of PA to obtain benefits, teachers were told that they should include at least four AB each day during the week, but that they could distribute them as they saw fit. This meant a total of 20-30 breaks during the week. The duration of each video ranged from 2-5 minutes. The AB consisted in the reproduction (by the students) of the movements and gestures proposed to the rhythm of the music during the language, mathematics, natural, social and *science* classes. The activities varied in intensity: light and moderate for Grades 2, 4 and 6; vigorous for Grade 3. They consisted of segmental movements on the spot and on the move: jogging, jumping and twisting, varying in pace and intensity. The school management, parents and guardians, as well as the school council gave their informed consent. Support was also provided by the university of the corresponding autonomous community. The voluntary participation of both families and teachers was respected at all times. The tests were administered by a researcher and an expert teacher. The regular teachers were responsible for the implementation of the AB in the experimental group classes. The procedures complied with the standards of the Declaration of Helsinki. Consent was obtained from the Ethical Committee of the University of Oviedo (ID 2019.165). A researcher was present during data collection.

Data analysis

Analysis of visuoperceptual and attentional abilities

The data from the Faces-R test at pre-test and post-test were selected, and the variables under study (correct answers, errors, net correct answers and the impulsivity control index) were calculated and analysed with the SPSS programme for Windows (24.0). To assess the effects of AB on attention levels, 2 x 2 repeated measures ANOVAs were used with time (pre-test-post-test) as the intrasubject factor and group (experimental, control) as the intersubject factor. To investigate differences between boys and girls, sex was included as a second inter-subject factor (time x group x sex). The statistical significance level was set at $p < .05$. The effect size was also calculated(η_p^2). Cohen (1988) classifies the effect size as small ($\eta_p^2 = .20$), medium ($\eta_p^2 = .50$) or large ($\eta_p^2 = .80$).

In addition, the same analyses were carried out on a course-by-course basis.

Analysis of motivational regulation

Homogeneity of variances was analysed using Levene's test. To verify the normality of the data distribution, skewness and kurtosis were examined. The Shapiro Wilk test was also requested (< 50 participants per group). In order to assess whether there were significant differences in motivation for breaks according to gender and grade, Student's *t* t-test and one-factor ANOVAs were carried out, taking each of the forms of motivational regulation as dependent variables and gender and group as factors, respectively. As the assumptions of equal variances were not met, the Games-Howell *post hoc* test was requested in the ANOVAs in relation to the group.

Following Gravetter & Wallnau (2014), a variable was found to follow a normal distribution when the absolute values of skewness and kurtosis were less than 2, which was true in all cases.

Results

Visuoperceptual and attentional skills

Mauchly's test of sphericity indicated that the assumption of sphericity was not met for the condition effect ($p < .05$); therefore, the degrees of freedom were corrected with the Greenhouse-Geisser estimate of sphericity.

Table 1 shows the means and standard deviations for each of the dependent variables in the total sample and by sex.

Table 2 shows the tests for intrasubject effects on the variables under study. No significant main effects were found over time between the experimental and control groups on any of the variables under study, although a significant effect was found on the variables correct answers and net correct answers over time. In both groups, the values of both variables increased significantly, but not due to the effect of treatment.

Table 1
Descriptive statistics for attentional variables to be studied (sample total, boys y girls, in pre-test y post-test).

Variables		Pre-test			Post-test		
		Sample total *M (SD)*	Boys *M (SD)*	Girls *M (SD)*	Sample total *M (SD)*	Boys *M (SD)*	Girls *M (SD)*
Correct Answers	Control	36.72 (10.38)	37.62 (10.18)	35.93 (10.58)	44.08*** (12.29)	43.80 (12.71)	44.33 (12.01)
	Experimental group	34.66 (12.12)	32.26 (11.48)	36.44 (12.37)	42.52*** (11.21)	39.17 (11.34)	45.00 (10.53)
Errors	Control	1.66 (1.94)	1.52 (2.02)	1.79 (1.87)	1.90 (2.27)	1.26 (1.35)	2.46 (2.73)
	Experimental group	1.21 (1.53)	1.20 (1.68)	1.23 (1.43)	1.15 (1.80)	.83 (1.37)	1.39 (2.04)
Net Correct Answers	Control	35.06 (10.41)	36.10 (9.96)	34.14 (10.79)	42.19*** (12.47)	42.54 (12.72)	41.88 (12.34)
	Experimental group	33.44 (12.14)	31.07 (11.14)	35.21 (12.63)	41.37*** (11.44)	38.35 (11.84)	43.61 (10.69)
Impulsivity Control Index	Control	91.29 (10.01)	92.57 (9.72)	90.16 (10.22)	91.64 (9.69)	94.24 (7.03)	89.36 (11.09)
	Experimental group	92.57 (10.05)	92.55 (11.20)	92.59 (9.20)	94.39 (9.66)	94.80 (11.55)	94.09 (8.07)

Note: (*) $p < .001$.

Table 2
Tests for intrasubject effects on the variables under study in the total sample (Greenhouse-Geisser sphericity estimate)

	gl	*F*	*Sig.*	η_p^2	Power[a]
Correct Answers/T	1	143.092	.000	.404	1.000
T * G	1	0.127	.722	.001	.064
T * S	1	2.378	.125	.011	.336
T * G * S	1	0.052	.820	.000	.056
Error (Correct Answers)	211				
Errors/T	1	0.107	.743	.001	.062
T * G	1	1.032	.311	.005	.173
T * S	1	5.797	.017	.027	.669
T * G * S	1	0.427	.514	.002	.100
Error (Errors)	211				
Net Correct Answers / TIME	1	139.335	.000	.398	1.000
T * G	1	0.356	.552	.002	.091
T * S	1	0.913	.340	.004	.158
T * G * S	1	0.005	.945	.000	.051
Error (Net Correct Answers)	211				
Impulsivity control index / T	1	2.812	.095	.013	.386
T * G	1	1.096	.296	.005	.181
T * S	1	1.374	.242	.006	.215
T * G * S	1	0.390	.533	.002	.095
Error (ICI)	211				

Note: [a] Calculated using alpha = .05; TIME = T; GROUP = G; SEX = S

Tabla 3
Descriptive statistics for attentional variables to be studied for 3rd grade primary.

Variables		Pre-test			Post-test		
		Sample total *M (SD)*	Boys *M (SD)*	Girls *M (SD)*	Sample total *M (SD)*	Boys *M (SD)*	Girls *M (SD)*
Correct Answers	Control (*n* = 25)	38.36 (9.70)	37.13 (7.94)	40.20 (12.11)	34.00 (9.15)	32.53 (6.01)	36.20 (12.56)
	Experimental (*n* = 25)	31.72 (7.73)	29.55 (8.57)	33.43 (6.84)	41.52*** (9.82)	37.73 (9.68)	44.50 (9.19)
Errors	Control	1.32 (1.60)	0.87 (1.36)	2.00 (1.76)	1.44 (1.58)	0.87 (1.06)	2.30 (1.90)
	Experimental group	1.00 (0.95)	0.82 (0.75)	1.14 (1.10)	.84 (1.106)	0.73 (0.79)	0.93 (1.39)
Net Correct Answers	Control	37.04 (9.55)	36.27 (8.13)	38.20 (11.74)	32.56 (9.38)	31.67 (6.15)	33.90 (13.13)
	Experimental group	30.72 (7.67)	28.73 (8.56)	32.29 (6.81)	40.68*** (10.09)	37.00 (10.13)	43.57 (9.40)
Impulsivity Control Index	Control	93.65 (7.89)	95.45 (6.87)	90.95 (8.89)	91.53 (10.26)	94.83 (6.48)	86.58 (13.04)
	Experimental group	93.76 (6.13)	93.99 (6.16)	93.58 (6.34)	95.68* (5.49)	95.40 (5.18)	95.91 (5.90)

*Note: * p < .05; *** p <.001.*

Table 4
Tests for intrasubject effects on the variables under study in 3rd grade primary (Greenhouse-Geisser sphericity estimate).

	gl	*F*	*Sig.*	η_p^2	Power[a]
Correct answers/TIME	1	10.004	.003	.179	.872
TIME * GROUP	1	68.385	.000	.598	1.000
TIME * SEX	1	1.073	.306	.023	.174
TIME * GROUP * SEX	1	0.462	.500	.010	.102
Error (Correct Answers)	46				
Errors/TIME	1	0.023	.995	.000	.050
TIME * GROUP	1	0.573	.453	.012	.115
TIME * SEX	1	0.049	.826	.001	.055
TIME * GROUP * SEX	1	0.280	.599	.006	.081
Error (Errors)	46				
Net Correct Answers / TIME	1	8.762	.005	.160	.826
TIME * GROUP	1	62.466	.000	.576	1.000
TIME * SEX	1	0.847	.362	.018	.147
TIME * GROUP * SEX	1	0.568	.455	.012	.114
Error (Net Correct Answers)	46				
Impulsivity Control Index / TIME	1	0.089	.766	.002	.060
TIME * GROUP	1	4.326	.043	.086	.531
TIME * SEX	1	0.457	.502	.010	.102
TIME * GROUP * SEX	1	1.238	.272	.026	.193
Error (ICI)	46				

Note: [a] Calculated using alpha = .05

In relation to the grade-by-grade analyses, significant main effects were found over time between the experimental and control groups in 3rd grade primary school on the variables correct answers, net correct answers and impulsivity control index. The AB programme in 3rd grade was based on videos of high-intensity choreography featuring the students themselves. Table 3 shows the means and standard deviations for each of the dependent variables for the 3rd grade group and by sex.

Table 4 shows the tests of intrasubject effects on the attentional variables in that group (Greenhouse-Geisser sphericity estimate).

Table 5
Descriptive statistics of motivational regulation in the experimental group according to sex and grade.

	Sample total (*N* = 80)		Boys (*N* = 33)		Girls (*N* = 47)		2º		3º		4º		6º	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
IM	4.21	0.83	4.33	0.76	4.12	0.88	4.59^{a}	0.58	4.43^{a}	0.36	3.97^{ab}	0.87	3.52^{b}	1.18
IdR	3.38	1.18	3.56	1.04	3.26	1.26	4.23^{a}	0.65	3.40^{b}	0.96	2.63^{b}	1.33	2.91^{b}	1.20
IR	2.72	1.06	3.00	.98	2.52	1.07	3.61^{a}	0.83	2.57^{b}	0.62	1.94^{b}	1.04	2.47^{b}	1.08
ER	2.89	1.16	2.95	1.07	2.85	1.22	3.49^{a}	1.04	2.82^{a}	0.67	1.60^{b}	0.84	3.57^{a}	1.06
D	2.39	1.17	2.58	1.02	2.26	1.25	2.99^{a}	1.14	2.12^{b}	0.71	1.31^{c}	0.61	3.15^{a}	1.27

Unequal superscripts in the same row indicate significant differences between groups at the p < .05 level.
Note: IM = Intrinsic motivation; IdR = Identified regulation; IR = Introjected regulation; ER = External regulation; D = Demotivation.

Motivational regulation during the AB

Table 5 shows the descriptive statistics of motivational regulation in the experimental group according to sex and grade (post-test measure). Overall, the most self-determined motivation (intrinsic motivation and identified regulation) was high. In all grades, intrinsic motivation was the most highly rated regulation, except in grade 6. Significant differences between grades were observed in intrinsic motivation [F (3, 75) = 6.548, p = .001], identified regulation [F (3, 75) = 9.705, p < .001], introjected regulation [F (3, 75) = 11.901, p < .001], external regulation [F (3, 75) = 16.379, p < .001], and demotivationn [F (3, 75) = 13.697, p < .001]. The *post hoc* tests showed differences in intrinsic motivation between the 2nd and 6th grades (p = .20), and 3rd and 6th grades (p = .45); identified regulation between the 2nd and 3rd grades (p = .005), 2nd and 5th grades (p = .001), and 2nd and 6th grades º (p = .005); introjected regulation, between grades 2 and 3 (p < .001), grades 2 and 5 (p < .001), and grades 2 and 6 (p = .010); external regulation, between grades 2 and 5 (p < .001), grades 3 and 5 (p < .001), and grades 5 and 6 (p < .001), and demotivation, between grades 2 and 3 (p = .017), 2 and 5 (p < .001), 3 and 5 (p = .002), 3 and 6 (p = .042), and 5 and 6 (p < .001). No differences between the sexes were found.

Discussion

The aims of the study were threefold: a) to analyse the effect that AB can have on the visuoperceptual and attentional skills of primary school students, b) to study the type of motivational regulation that these resources provoke, and c) to examine possible differences in terms of sex and grade level. The results partially supported the first hypothesis (expected improvement in student attention levels). Significant differences were only found between the experimental and control groups in the attentional variables in the 3.rd grade of primary school. Overall, these mixed results are consistent with research evidence reporting inconclusive results regarding the effect of ABs on cognition and executive functions. While several investigations (De Greeff et al., 2016; Donnelly et al., 2016) have reported small effects of classroom interventions on cognition improvement, the specific reviews on AB by Daly-Smith et al. (2018) and Masini et al. (2020) did not support this view. Masini et al. (2020) pointed to two possible explanations for the contradictory results: a) the variability of the measurements used in the studies, and b) the different typology (with or without cognitive compromise) and duration of the AB interventions.

Since in the present study only pure AB (PA programmes with no connection to subject content) were applied, the results introduce a new element to the discussion, namely concerning the intervention in 3rd grade. Participants in this experimental group obtained significant improvements in number of correct answers, net correct answers, and impulsivity control compared to the control group. The programme of this course was based on videos of choreographies of vigorous intensity starring the students themselves. These results are in line with previous studies linking PA and attention in children and adolescents (Guiney & Machado, 2013; Jiménez-Parra et al., 2022; Pastor-Vicedo et al., 2021). It is argued that the students in this intervention benefited psychologically from the relaxing and recuperative effect of the short-term programme, which allowed them to improve their levels of accuracy, net accuracy and impulsivity control. It is possible that the students' own participation in the production of the videos may have had a positive effect on their motivational state and accelerated the effects on immediate attention compared to the other groups.

The results shed light on the mode, frequency, duration and intensity of PA in AB programmes that aim to produce positive short-term effects on attention. In terms of the mode/typology of resources, the study shows the effects of videos produced by teachers in collaboration with pupils where pupils reproduce choreographies with which they feel identified. This kind of involvement can motivate learners to

use it. In terms of duration and frequency, the results promote at least 15-20 minutes of PA daily that can be spread over several breaks during the school day (Fairclough et al. 2021; Muñoz-Parreño et al., 2020). And with regard to intensity, the results seem to support the idea that vigorous intensity PA programmes may accentuate the effect on attentional processes. Future work with longer interventions could examine these assumptions.

Regarding the second and third objective (high levels of self-determined motivation are expected, higher in the lower grades, with no sex differences), the results draw a self-determined motivational profile in the participants of the experimental group during the AB. Specifically, students reported high levels of intrinsic motivation and identified regulation and low levels of external regulation and demotivation, which is consistent with the hypothesis formulated. These findings are of particular interest considering the positive effects on outcome variables that SDT anticipates for these motivational forms. More self-determined forms of motivation produce more adaptive outcomes, such as persistence or greater enjoyment in PA, while less self-determined forms of motivation predict less adaptive outcomes, such as boredom or dropout (Méndez-Giménez et al., 2016).

No sex differences were found in the different motivational regulation during the AB. However, these types of motivation varied from year to year, being higher in younger students. The decline of more self-determined motivation with age (intrinsic motivation) has been described in previous research both in the context of PE and in general education (Cecchini et al., 2012). In Grade 6, external regulation levels were higher than intrinsic motivation and demotivation scores were intermediate, suggesting that the programme should be reviewed at pre-pubertal age.

Compared to other school-based programmes, ABs offer the advantage that they can be implemented by all classroom teachers, not only PE specialists (see review by Masini et al., 2020). It simply requires conviction to integrate them into the classroom (increased PA, improved classroom behaviour, more time on task, better attention and academic performance), and the necessary resources.

Depending on the mental fatigue observed in students, teachers could adapt their lessons, choosing the most appropriate time to introduce their AB. Future research could provide further evidence to help teachers systematise their use.

The present study was not without limitations. Firstly, it should be noted that despite the significant increase in daily PA time achieved during the programme, the duration of the intervention was reduced. Although planned to be more extensive, the video editing phase was delayed, resulting in the implementation taking place at the end of the school year. As a result, the effect of ABs may have been compromised. Secondly, the study did not control for variables such as PA performed outside the classroom context, body mass index or students' social status, which may have led to unintended effects in the design. Thirdly, the most important limitation of the study is the intervention time (one week), the control of intervening variables and the sampling technique used. In the case of motivational regulation, only one measurement was obtained at the end of the intervention (post-test). The PA intensity of the AB was not measured with any instrument (e.g. accelerometers). It would have been desirable to test the fidelity of implementation to understand the intensity of ABs and to follow up with observational analysis to see if they were developing well (as indicated in the review by Watson et al., 2017). Finally, an experimental study, with randomised participants (rather than natural groups) would allow for a more complete picture of cause-effect relationships. This is a huge challenge in the educational context when combined with a large number of classes and groups, as was the case here.

In conclusion, vigorous intensity AB programmes can increase the attention span of primary school children. The more self-determined motivation to perform AB decreases with age, while the less self-determined motivation to perform AB increases. Involving students in making videos with PA choreographies in which they themselves are the protagonists can increase students' more self-determined motivation.

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