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Original Article

Indoor and outdoor education: the role of body representations on sport practice.

TERESA IONA[1], SIMONA RAIMO[2], DANIELE MASALA[3], MARIA CROPANO[4], MARIACHIARA GAITA[5], FRANCESCO TORNELLO[6], ANTONIO AMMENDOLIA[7], LIANA PALERMO[8].
[1,6] Department of Experimental and Clinical Medicine, University of Catanzaro, Catanzaro, ITALY
[3,,5,7,8] Department of Medical and Surgical Sciences, University of Catanzaro, Catanzaro, ITALY
[2,4,]Department of Psychology, University of Campania, Caserta, ITALY

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Abstract
Background: Body representation is a complex process determined by the interaction of information coming from many different stimuli inside and outside the body and is a fundamental construct that reflects our knowledge of self. However, the way in which we perceive our bodies and how the body is represented in the brain during development, particularly during outdoor or indoor physical activity, is not yet fully understood. The aim of this study was to examine the development of different body representations (i.e., body semantics, body structural representation, and body schema) in school-aged children who practice indoor or outdoor sports. The role of motor coordination was considered as well. *Methods:*One hundred twelve school aged-children (age range: 8-10 years) completed a computerized battery that included three tasks, the Hand Laterality Task (HLT), Object-Body-Part Association (OBP), and Frontal Body Evocation task(FBE)involving body representation processing as well as control tasks. These control tasks included the Object Laterality Task (OLT), the Christmas Tree Task (CTT), and the Object-Room Association Task (ORT).Theparticipants also performed a foot-tapping performance test *(FTap)*. *Results:* The effect of indoor or outdoor physical activity on body representations and the associations between age,performance on body representation tasks, and performance on the FTap were all analyzed.When we compared the performance of the two groups on the different body representation and control tasks, we found significant differences only on the FBE, whereas the outdoor physical activity group showed a better performance than the indoor physical activity group. Among the outdoor athletes, significant correlations were foundbetween age and errors made in the FTap, but there were no significant associations between the FTap and the body representation measures. Instead, in the indoor physical activity group, we found significant correlations between the FTap measures and body representation tasks. *Discussion*: Participants engaging in outdoor physical activities (i.e., soccer, baseball, tennis, cross-country) had better performance on the task assessing the body structural representation (FBE), suggesting that in addition to a significant improvement of physical and mental wellbeing, outdoor physical activity significantly improves the visuo-spatial body map during development.*Conclusion:*In conclusion,for the first time, we have demonstrated that in school-aged children outdoor physical activity as compared toindoor physical activity improves the structural body representation. These findings are discussed for a better understanding of body representation development and physical activity in indoor and outdoor environments.Also, considering the possible impact of body processing on cognition, this data is discussed in the light of the role of the practice of sportin the educational context.
Keywords: structural body representation; physical education, full body perception; school-agedathletes; outdoor environment.

Introduction

Body representation is a complex process determined by the interaction of information coming from many different stimuli inside and outside the body. Indeed, the integration of interoceptive, proprioceptive, vestibular and visual information with that coming from motor systems is crucial for building the mental representations of one's body, for acting in relation to the environment and for developing our sense of self (Berlucchi & Aglioti, 2010; Gallagher, 2005;Medina & Coslett, 2016; Palermo et al., 2014).

Although body representation is a fundamental construct that reflects our self-knowledge, the way in which we perceive our bodies and the way the body is represented in the brain is not yet fully understood (Di Vita et al., 2016; Srismith et al., 2020). A fair amount of data, including neuropsychological studies on patients with brain damage (Boccia et al., 2020), neuroimaging studies on healthy individuals (DiVita et al., 2016) and developmental studies on healthy children (Raimo et al., 2019; Slaughter et al., 2012), however, suggests that there is no single representation of the body in the cortex.Indeed, individuals know their own bodies from within through interoception, but can also objectively reflect on their own bodies, regarding their shape, size, location,

Corresponding Author: TERESA IONA, E-mail: iona@unicz.it

and aesthetics, from an external perspective (Longo, 2016). Following the triadic taxonomy (Schwoebel &Coslett, 2005), there are at least three different representations of the body: the *body schema*, that is a dynamic representation of the body parts derived from multiple motor and sensory inputs, and which interacts with motorial systems in the genesis of actions (Schwoebel et al., 2002; Raiola, 2013); then there isthe *body structural representation* (or visuo-spatial body map) that is a topographic representation of the body mainly derived from the visual information of the body parts and that includes information about body part boundaries and spatial proximity relations; and lastly, *body semantics*, which is a lexical–semantic representation of the body including body part names, functions, and association with objects (Coslett et al., 2002).Although these differentbody representationshave been shown to have distinct underpinning neural networks, we know very little about the mechanisms responsible for their development.

A large body of empirical research now indicates that exposure to natural environments (e.g., wild forests, coastal areas, and greenspaces) is associated with wide-ranging positive outcomes (Hartig et al., 2014; Frumkin et al., 2017; Kondo et al., 2018). Recently, this body of research has been extended to show that exposure to nature is also associated with positive outcomes in terms of *body image*, a multifaceted construct that includes one's thoughts, feelings, beliefs, and behaviourin relation to the body (Cash &Smolak, 2011). In other words, the body image includes all the body representations that are not action-oriented (Di Vita et al., 2016) and, according to the triadic taxonomy of body representation, can be subdivided into body structural representation and body semantics.Several studies have investigated the body image but not the body schema in relation to physical activity in childhood and pre-adolescence (Mancilla et al., 2012).

Given the association of body representations with the practice of sports,the presentstudy considers this factor to be a possible moderating variable of body representation.Specifically, the aim is to examine the development of different body representations (i.e., body semantics, body structural representation, and body schema) in school-aged children who practice indoor or outdoor sports. The role of motor coordination was considered as well. Indeed, a higherlevel of body representationis unlikely to emerge from abstract cognition alone (Srismith et al., 2020) since body representations are developed through theinterplay of multiple sources of information inside and outside the body (Berlucchi & Aglioti, 2010; Palermo et al., 2014) and also through the interplay of distinct body representations (Pitron et al., 2018). For this reason, body representation and motor coordination were evaluated in a sample of school aged-children by means of a battery used in previous studies on the development of body representations in clinical and non-clinical populations (Raimo et al., 2019; Di Vita et al., 2020).The Foot Tapping Task was also implemented, using an accurate automatic detection system (i.e.,OptoJump Next, Microgate) (Musalek, 2013).

Material & Methods

Participants.

A total of 112 typically developing 8-to10-year-old (age 8.09±1.3 y; school grade 3.2±1.3) children were recruited from state primary schools in the urban and rural areas of Calabria (Southern Italy). They were subdivided into two groups: 60 (72%) participants who performed indoor physical activities and 52 (28%) engaging in outdoor physical activity (Table 1). These two groups were matched for age (outdoor activity group: age= 8.12±1.29 y; indoor activity group: age = 8.07±1.3 y;t (1,110)= -.198, p= .843).

Participants were recruited only in: (1) schools that had a similar number of children in a given age category, (2) schools with no specific specialization (e.g., technical, arts, sports or linguistics), (3) and classes without children with special needs. The 8-10 years category was selected because at this age children's motor skills are harmoniously developed with stable coordination patterns and this age isreferred to as the golden age of motor skill development (Sgro et al., 2017).

All participants showed normal reasoning abilities according to the Italian norms of the Colored Progressive Matrices (Basso etal.,1987; Belacchi et al.,2008); none of them had developmental or learning difficulties, had been diagnosed with a neurological condition or had ever exhibited any emotional or behavioral conditions. All had normal hearing and normal or corrected-to-normal vision based on parental and/or teacher reports. This research was approved by the Regional Ethics Committee and performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. Written parental consent was obtained for all participants, and the children gave their assent before testing.

Variable	***Mean***	***SD***
Age	*8.09*	*1.3*
Grade (1st-5 th)	*3.21*	*1.3*
Years of sport	*2.01*	*1.5*
	Frequency (n)	***Percentage***
Indoor activity	*60*	*53.6%*
Outdoor activity	*52*	*46.4%*

Table 1. *Demographic characteristics of theparticipants (N=112)*

Experimental apparatus, stimuli and procedure

All participants were given a computerized battery (Raimo et al., 2019) that included the Hand Laterality Task, the Object-Body Part Association Task,and the Frontal Body Evocation Task for testing the three different body representations, namely body schema, body structural representation and body semantics, respectively.There were also three corresponding control tasks which consisted in the Object Laterality Task, the Christmas Tree Task, and the Object-Room Association Task. The control tasks were similar to those that probed representations of the body for characteristics such as presentation and response modalities, but they did not include body stimuli and did not involve body processing. Indeed, they have been used to differentiate the development of body representation from the development of general cognitive abilities (e.g.,, visual processing, mental imagery, visuo-spatial attention, decision making) necessary to perform the body representation tasks. The tasks are briefly described below.

Hand Laterality Task (HLT) (adapted and simplified from Parsons, 1987; see also Fontes et al., 2014) evaluated the body schema: participants were asked to make a decision on the laterality of a single hand (20 stimuli, 10 left and 10 right), presented at varying degrees of angular rotation (0, 45, 90, 270, 315 degrees) on a computer screen. To answer, the participant had to press on the drawing of a left or right hand shown on the touchscreen below the target hand. The accuracy was computed for each participant as the sum of correct answers. Individual scores range from 0 to 20 with higher scores indicate better performance.

Object Laterality Task (OLT) is a control task that includes a mental rotation of no body stimuli: participants were asked to make a decision on the laterality of a flower with a leaf positioned at the right or at the left base of the stem (20 stimuli, 10 left and 10 right) that could be presented at varying degrees of angular rotation (0, 45, 90, 270, 315 degrees) on the computer screen. In particular, a rotated flower (target) was shown in the middle of the screen with two response items (i.e. a flower with a leaf positioned at the left of the stem and another with a leaf positioned at the right of the stem) which were visible in the bottom left- and right-hand corners of the screen. Participants had to decide whether the target flower corresponded to the one with the leaf positioned at the left or the one with the leaf positioned at the right, by mentally rotating it and tapping one of the two response items. Similarly to the HLT, accuracy was computed for each participant as the sum of correct answers. Individual scores range from 0 to 20, with higher scores indicating better performance.

The Body Structural Representation was assessed with the computerized version of the *FrontalBody Evocation subtest (FBE)* of the Body Representation test (Daurat-Hmeljiak et al., 1978). Participants were shown an image of a child for 10 seconds and then were asked to reposition a specific body part on a touch screenwhere only the child's head was shown as a reference. Each participant was asked to reposition nine different body parts (left and right legs, left and right arms, left and right hands, left and right parts of the chest, and the neck). The FBE score is the result of the deviation from the exact position of the body parts measured in millimeters.

The *Christmas Tree Task* (*CTT;* Raimo et al., 2019)was also administeredas a control task. It involved the visual-spatial processing of stimuli not related to the body. Participants were shown an image of a Christmas tree for 10 seconds and then asked to reposition a specific part of the tree on a touch-screen where only the star's top hat was shownas a reference. Then a specific part of the tree was shown and the participant had to drag it to the correct position in the box. Each participant was asked to reposition nine different parts of the Christmas tree (left and right lower branches, left and right middle branches, left and right lower branches with trunks, left and right parts of jar, and the top). The CTT score is the result of the deviation from the exact position of the tree parts measured in millimeters.

The*Object-Body Part Association (OBpa)* (adapted from Fontes et al., 2014) evaluated body semantics. In this task,the participants had to correctly associate an object (e.g., hat) with the correct part of the body, selecting between two options (e.g., head and foot). To answer, the participantshad to press on the drawing of a body partshown on the left or right sidesof the touchscreen below the object. The tasks included 20 stimuli. Individual accuracy corresponded to the sum of the correct answers; individual scores ranged from 0 to 20, and higher scores indicateda better performance.

The*Object-Room Association Task* (*ORpa;* Raimo et al., 2019), a control task, involved the semantic processing of non-body related stimuli. Participants were asked to correctly associate an object (e.g., armchair) with a room, choosing between two options (e.g., living room and bathroom). In particular, an object was shown in the center of the screen (target) and two different rooms (response items) were shown on the left and right sides of the screen, respectively. The participant had to choose the room that he deemed best associated with the target object by tapping on one of the two response items. The control task included 20 stimuli. Individual accuracy corresponded to the sum of correct responses; individual scores ranged from 0 to 20, with higher scores indicating a better performance.

All tasks were presented on a laptop with a touch screen monitor (13.3" display) and the accuracy was recorded. The order of presentation of the task (i.e., body/non-body) was counterbalanced among the participants. During the testing, the children were instructed to remain in the same position. All the children were sitting in front of the laptop, placed on a desk, and had to answer as quickly as possible.

Skilled foot performance tests

*Foot tapping (FTap)***.**For this task, the participant had to stand next to a desk, with the preferred leg closest to the desk. The aim of each participant was to tap his foot in a standing position for 30 seconds in the sagittal plane. The participant had to touch the ground in front of him/her with the heel and behind him/her with the toe, and the range of motion had to be the length of one of the participant's feet. The task was completed withboth the "preferred", "non- preferred" feet, and the "twice foot" in both the left and right directions.The number of taps the child could make in 30 seconds was recorded (Musálek, 2013).An automatic foot-touch detection approach (i.e., OptoJump Next, Microgate) was used to assess the parameters of the tapping test which included Contact time (ms); and Flight time (ms).TheStep length calculation was measured in step length (cm), foot length (cm), number of taps and errors.

Outdoor/Indoor Sports Practice

The practice of the physical or sporting activity was evaluated in terms of sports organized in outdoor or indoor areas, based on the required commitment and assiduity (Isorna et al., 2014). Organized sport is that which is institutionalized, recognized and practiced following specific rules and regulations, and which is developed on the basis of training and official competitions (Blanco et al., 2006). This variable was measured dichotomously (yes/no). The following sports were considered: soccer, basketball, ice hockey, baseball/softball, indoor track, outdoor track, cross-country, tennis, swimming, and diving.

Statistical analysis

Personal correlations among age, body/control tasks, and physical performancewere carried out for the whole sample and the indoor and outdoor physical activity groups were evaluated separately.

Moreover, t-tests were computedin order to verify the presence of differences between the indoor and outdoor physical activity groups in the body representation and control tasks. SPSS (version 25.0, IBM Corporation, Armonk, NY, USA) was used to perform statistical analyses.

Results

Results on age and body representations.

Considering the whole sample, we found that significant correlations existed betweenthe task probing the body schema (HLT) andage (r= .228; p=.016) and that probing the body structural representation and age (FBE; r= -.364; p<.001), while the task probing body semantics was not significantly correlated with age (OBpa; r= -.059; p=.542). Concerning the correlations among the three body representation tasks, we found a significant correlation only between the body structural representation (FBE) and body semantics (OBpa) (r= -.205; p=.034).

Correlation analyses done on the indoor physical activity group showed that there was a significant correlation between age and FBE (r= -.361; p=.005) as well as the respective control task (CTT) (r= -.296; p= .040) but not with the performance results on the tasks probing the other body representations (i.e., body schema and body semantics) and their respective control tasks.Correlational analyses in the outdoor physical activity group evidenced a significant correlation between age andFBE (r= -.401; p=.004) and between age and HLT (r= .325; p=.019), but not with the OBpa or the control tasks.

When we compared the performance of the two groups on the different body representation and control tasks, we found significant differences only on the FBE (t(1,107)= -2.082; p= .040). In other words, the outdoor physical activity group (FBE average deviation from correct location= 82.177±34.538 mm) performed better than the indoor physical activity group (FBE average deviation from correct location= 99.779±50.591 mm) in the task probing the body structural representation.Worthy of note is the fact that this effect was specific for this body representation since there were no significant differences between the two groups regarding the control task (CTT).

Results on physical performance and body representations.

Concerning the *FTap*, across the whole sample, the analysis on the "preferred" foot tapping showed no significant correlation but in the "non-preferred" task there was a significant negative correlation between age and errors on the left (r=-0.231, p=.024). In the "non-preferred" task, the performance onthe body structural representation task (FBE) was significantly correlated with flight time performance (r=.341, p=.001); body semantics was correlated with flight time (r= -0.933, p<.001) and number of taps (r= 3.13, p=.002); one control task (i.e., CTT) was correlated with foot length (.338, p= .007). In the "twice foot" tapping task, the age was correlated with errors on the right (r= -0.214 , p= .033), and OBpa and CTT with number of taps (r= -0.247, p=.014; r= -0.224, p= .024).

In the indoor physical activity group, the task probing the body semantics (OBpa) showed a significant correlation with flight time ("no-preferred" foot: r = .959, p < .000), contact time ("preferred" foot; r = -.452, p < .001) and number of taps ("non-preferred" foot: r = .408, p < .001; "twice foot": r = -.323, p = .002); while the body schema (HLT) was correlated with contact time ("non-preferred"; r = -.365, p = .001). There were also significant correlations between control tasks (ORpa and CCT) and some *FTap* parameters (see Table 2 for details).

Variables	indoor																													
	preferred										*no-preferred*										*twice*									
	contact time		*flight time*		*numbers tapp*		*area*		*errors*		*contact time*		*flight time*		*numbers tapp*		*area*		*errors*		*contact time*		*flight time*		*numbers tapp*		*area*		*errors*	
	OR	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*
age	0,03	_	-0,10	_	-0,20	_	0,06	_	,304*	0,03	-0,08	_	-0,13	_	-0,01	_	-0,29	_	-0,14	_	-0,07	_	0,02	_	0,02	_	0,05	_	-0,11	_
sport age	0,06	_	-0,15	_	0,00	_	0,14	_	-0,09	_	-0,03	_	-0,07	_	0,15	_	0,12	_	-0,09	_	-0,21	_	0,16	_	-0,05	_	0,07	_	0,01	_
body semantics																														
Object-Body Part Association (Obpa)	-,452**	0,00	-0,16	_	0,12	_	0,01	_	0,10	_	-0,01	_	-,959**	0,00	,408**	0,00	0,11	_	0,00	_	-0,03	_	0,10	_	-,323*	0,02	0,08	_	0,13	_
Object-Room Part Association (ORpa)	-,295*	0,03	-0,06	_	-0,23	_	-0,18	_	0,16	_	-0,02	_	0,06	_	-0,02	_	-,466**	0,01	0,10	_	-0,19	_	0,03	_	0,02	_	-0,27	_	0,19	_
representation																														
Frontal Body Evocation subtest (FBE)	0,10	_	0,20	_	-0,17	_	-0,18	_	-0,04	_	0,02	_	,392**	0,00	-0,20	_	0,23	_	0,05	_	-0,03	_	0,14	_	-0,02	_	-0,06	_	-0,03	_
Christmas Tree Task (CTT)	-0,02	_	-0,26	_	-0,01	_	-0,21	_	-0,11	_	-0,01	_	0,11	_	-0,08	_	0,32	_	-0,04	_	-0,05	_	-0,17	_	-,326*	0,02	0,22	_	-0,17	_
body schema																														
Hand Laterality Task (HLT)	-0,07	_	-0,23	_	-0,05	_	0,12	_	-0,19	_	-,365**	0,01	-0,16	_	0,13	_	-0,12	_	-0,10	_	-0,08	_	-0,13	_	0,02	_	0,04	_	-0,01	_
Object Laterality Task (OLT)	0,07	_	-0,04	_	-0,21	_	0,20	_	-0,23	_	0,14	_	-0,19	_	0,05	_	-0,12	_	-0,01	_	0,12	_	0,10	_	-0,13	_	0,14	_	0,20	_

Table 2 Correlations among body and control tasks and performance on preferred, non-preferred and twice foot tapping task (*FTap*) in the indoor physical activity group.

In the outdoor physical activity group, results showed significant correlations between age and errors in the preferred and non-preferred tasks of the *FTap* ("preferred" foot: r = -0.362, p =.015; "no-preferred" foot: r = -0.321, p = .03);

the control task for the body structural representation (CTT) was correlated with the area ("no-preferred" foot: r = .345, p = .05) while the control task for the Hand Laterality Task (OLT) was correlated with numbers taps ("preferred" foot: r = -.300, p = .005), flight time ("no-preferred" foot: r = -.481, p = .001) and contact time ("no-preferred" foot: r = -.460, p = .001); while the body structural representation (FBE) was correlated with contact time ("preferred"; r = .324, p = .003; "twice foot": r = -.367, p = .01). No significant associations were found between body semantic and body scheme tasks (OBpa, HLT) and parameters of the foot tapping task (see Table 3).

Variables	OUTDOOR																													
	preferred										*no-preferred*										*twice*									
	contact time		*flight time*		*numbers tapp*		*area*		*errors*		*contact time*		*flight time*		*number s tapp*		*area*		*errors*		*contact time*		*flight time*		*number s tapp*		*area*		*errors Dx/Sx*	
	OR	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*	*OR*	*p*
age	-0,11	_	0,06	_	0,01	_	-0,11	_	-,362*	0,01	0,06		-0,12		-0,05		-0,03		-,321*	0,03	-0,01		0,17		-0,10		-0,07		-,329*	0,03
sport age	0,06	_	0,01	_	-0,27	_	-0,15	_	0,02	_	-0,04		0,08		-0,08		-0,10		-0,07		-0,08		0,05		-0,09		0,07		-0,14	
body semantics																														
Object-Body Part Association (Obpa)	0,02	_	-0,18	_	0,05	_	0,02	_	0,08	_	-0,17		0,03		0,09		-0,09		0,08		-0,21		0,18		-0,15		-0,20		-0,01	
Object-Room Part Association (ORpa)	0,05	_	-0,07	_	0,17	_	0,01	_	-0,18	_	-0,05		-0,17		0,00		0,21		-0,17		-0,02		-0,06		0,02		0,15		-0,11	
body structural representation																														
Frontal Body Evocation subtest (FBE)	0,324 *	0,03	0,13		-0,21		-0,11		0,05		0,00		0,09		-0,06		0,21		0,16		,367*	0,01	0,05		-0,11		0,13		0,17	
Christmas Tree Task (CTT)	0,21		0,07		-0,07		-0,08		0,12		0,08		-0,02		0,12		,345*	0,05	0,23		0,20		-0,10		0,14		0,12		0,20	
body schema																														
Hand Laterality Task (HLT)	0,06		-0,08		0,25		0,08		-0,10		0,07		-0,22		0,07		0,19		-0,05		-0,05		-0,09		-0,13		0,00		0,06	
Object Laterality Task (OLT)	-0,25		0,06		,300*	0,05	-0,10		-0,01		-0,14		-,481**	0,00	-0,04		-0,02		-0,01		-,460**	0,00	0,06		0,14		-0,16		-0,02	

Table 3 Correlations among body and control tasks and performance on preferred, non-preferred and twice foot tapping task (*FTap)* in the outdoor physical activity group.

Discussion

The aim of this studywas to examine the development of different body representations (i.e. body semantics, body structural representation and body schema) in school-aged children who practice indoor or outdoor sports, using a new psychophysical method. Compared to most of the previous studies, the three body representations were evaluated in the same sample of participants by means of specific tasks involving both bodily stimuli (body tasks) and non-bodily stimuli (control tasks).This means itwas possible to exclude the effect of the development of cognitive processes in addition to those strictly related to body representation.

Moreover, we assessed the motor coordination of the lower limbs by means of a more accurate automatic detection system (i.e.OptoJump Next, Microgate) for the *FTap* (Musalek, 2013).

Concerning age-related changes in body representations, we found there was an effect of age on both body schema and body structural representation. This is consistent with previous data on body schema, assessed by means of the Hand Laterality task, suggesting that it is not fully developed in school-aged children (6–10 years). This is evident becausethe children's performances were significantly scarcerthan those of the young adults (Raimo et al., 2019). Current results also indicate a significant interaction between different body representations, particularly between the structural body representation and the body semantics in school-aged children, suggesting that these body representations partially overlap during childhood. This pattern of results fits well with the co-construction model of body representations (Pitron et al., 2018) which suggests that although the different body representations are functionally distinct, their construction is partly based on their interaction.

A number of specifics in the current results are also worth pointing out.

Considering the distinction between outdoor and indoor physical activity groups, we foundthat participants engaging in outdoor physical activities (i.e.,soccer, baseball, tennis, cross-country) had better performance on a task assessing the body structural representation (i.e., FBE). This finding suggests that,in addition to a significant improvement in physical and mental wellbeing (for more details, see systematic review of Thompson-Coon et al., 2011),outdoor physical activity as compared to indoor physical activity also significantlyimprovesthe visuo-spatial body map during development. Moreover, the relevance of outdoor physical activities for body representation development was also confirmedthrough correlation analyses,demonstrating thatonly in participants playing outdoor physical activities did accuracy on a hand motor imagery task (body schema) significantly improve with age.

Concerning the relation with the motor coordination of the lower limbs, only in the indoor physical activities group were the performances on a task assessing the dynamic sensory-motor representation of the body (i.e., the body schema)significantly correlated with coordination ability (i.e., contact time).This may suggest that a superior ability to execute a lower limb movement in a more closed space may be associated with greater activation of the body schema in participants who practice indoor physical activities. This data is in line with recent literature onthe motorial and postural control of one's own body,besides that on the vividness of movement imagery in indoor athletes (Dave & Nandhinee, 2019).

The lack of correlation between body representation tasks and the measures of motor coordination (FTap) in the outdoor physical activity group deserves comment as well. This finding is striking since this group outperformed the indoor physical activities group on a measure of body representation processing (the FBE). However, correlations depend crucially on variability, and thus, no correlation will be seen when performance in the group is homogenous. Thus, we hypothesize that the homogeneous performance of this group on tasks probing body representations, possibly due to the practice of outdoor sports, could explain the lack of significant correlation with a measure of motor coordination.

Conclusions

Based on the current results, there is a significant difference between participants practicingindoor and outdoor sports activities. We have shown for the first time that outdoor physical activity improves the development of body representations in school-aged children, as compared to indoor physical activity.

These results are particularly relevant for the understanding of body representation development and physical activity in indoor and outdoor environments. Also, this data could prove to be valuable in educational settings to improve learning. Indeed, considering the embodied cognition theories which suggest that cognitive processes also depend upon the kinds of experience that come from having a body and that modal simulations, bodily states, and situated action underlie cognition (Barsalou, 2008), and considering the impact of the body representations on high-order cognition (Dijkerman & Lenggenhager, 2018), the current findings could provide the field of education with valuable insights for formulating guidelines for the effective integration of body-related activities and sports in learning environments.

Moreover, an efficient body representation can be particularly relevant for the performance of athletes. Indeed, considering the fact that athletes often create mental images as if they were externally completing the action, and that this is important to help themtomentally visualize the activity as it improves their ability to do it in a real context, specific training that targets the ability to represent the body representation processing can be particularly relevant.

Limits of the present study include the use of tasks that did not probe self body processing as well as the fact that attaining the body schema and the motor coordination data did not involve the whole body but was limited tothe hands and feet. Thus, future studies should investigate the development of the body representations and their interaction, using tasks that actually involve one's whole body, extending the age range of the sample beyond that of 10 years (i.e., adolescence), and taking into account the role of variables such as kinds of sport and dance (see for example Palmiero et al., 2019).

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