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Original Article

Physical activity and academic performance in primary school: an essential relation

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Abstract:
The aim of the study is to investigate the relation between body, physical activity and learning during the age of development. Overcoming the superficial factor often attributed to physical activity and considered secondary to intellectual activity even from the educational institution, it has been highlighted and analyzed the benefit that physical activity brings to the state of health of the individual, as well as the relation to the positive outcomes it has on academic performance in primary school. The course of the study starts from the analysis of the main contributions on the theories of learning originating from behaviorism, cognitivism and constructivism, following up with an overview of the studies in the neuro-bio-physiological field which has provided significant explanations about the relation between physical activity and cognitive and emotional techniques. The analysis of the selected ten scientific studies, enabled to observe the outcomes on the academic performance of primary school children after the integration of a few extra hours of physical activity in the classroom lessons.
Key words: body, physical activity, cognition, age of development, learning, academic performance.

Introduction

The physical education, especially during the developmental age, represents an essential element, as it is a delicate period for the acquisition of healthy and correct life habits (Gaetano, 2012, 2016), inasmuch it is right in this phase that the child fully develops his psychic and somatic characteristics. The body results being, indeed, a didactical and learning medium thanks to the active experience, experienced, it keeps off a rigid didactics – which is simply the core of the transmission of knowledge -, highlighting the *acted*. So it is necessary that in the schools there would be expert professionals in the physical education's fieldand, especially, that there would be the right environmental conditions to stimulate the movement with appropriate hours (Raiola, 2011, 2013, 2017). The educational-formative process should allow the interaction between mind, corporeity and emotionality. Many of the difficulties that students, nowadays, come upon in "absorbing the knowledge" (Valentini et al., 2018ab) are due to an unchangeable environment, which doesn't "fulfil" to the expressive necessities of the students, but "force". It is right from the motivation of learning that we should start or better arrive: the body allows this optic change. Currently, the children are the first *not protagonists* of a hard decrease of the levels of physical-motorial activity sufficient to prevent several diseases, indeed doing movement lead to: benefits to the locomotor apparatus, control of the body weight, in addition to positive effects upon the mental health and upon the development of cognitive processes (Pisapia, D'Isanto, 2018, D'Isanto 2016).

The connection between body and psychic mechanisms: the theories of learning.

Many researches have been carried out in the didactic and psychic field – educational which have contributed to rewrite, discuss and reflect about the methodologies of learning and teaching (D'elia et al., 2018, Raiola et al., 2018). It is agreed in recognizing the cognitive value of the motorial activity applicable in support of the didactic for its closed relationships with the psycho-pedagogical researches which, from the first decades of the last century, have spotlighted the usage of a didactic methodology that wouldn't recognize only the verbal communication, but would allow the process of a teaching-learning based on the valorisation of the motorial field, valorising it as a preparatory function to the development of the thought. The motorial activities play a central role in the formation of the mental representations and they influence the learning process which "has to occur (…) through not exclusively intellectual activities, but also of manipulation, respecting in that wat, the global nature of the child, who never tends to separate knowledge and action, intellectual activity and practical activity" (Cambi, 2005). One of the first scholars who enhanced the relationship between body and psychic mechanisms was H. Wallon who considered the movement as "the only expression and the first tool of psychism"(D'Isanto, 2016, Sibilio, 2002) and he states that it is through the experience that the abstract thought

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is developed. Another contribute comes from the psychologistGuido Petter who stated that they are the same mechanisms that to develop the motorial and cognitive development, that is why the importance of motorial education is valorised. Since the methodology of the contemporary didactic is the outcome of the psychological studies developed during the beginning of 1900, it is essential examining the main theories of learning, which have fulfilled a prosper research on the baby(just think about Freud, Piaget, Vygotskij, ecc.)and on learning (Piaget, Wertheimer, Koehler). Starting from the discussion about the behavioural approach, based on the consideration that the behaviour is the only notion of reference for the analysis of the human psyche, we shift to the study of cognitivism, whose psychology analyses the interior mental processes that influence the learning and goes beyond the concept ofbehaviourism, which considered the subject as a passive one rather than stimulus-environment, in favour of a learning process as an active one, interactive and constructive, with a continuous interaction of the subjects with the environment. In particular, Piaget and Vygotskij have valorised the cognitive dimension of the movement and of the body, being the development of the organs of the body linked to the capacity of thinking and to the expressive and communicative potentialities. The intelligence is a form of environmental adaptation and Piaget himself affirms that "the intelligent behaviour can be defined as an adaptation form of the organs to the physical and social environment" (Petter, 1990), that occurs according to a double and synergetic assimilation movement and of accommodation. According to his theory, the exchanges with the environment allow to create well-organised cognitive schemes. If to Piaget the environment is physical, to Vygotskij it is instead social, being the cognitive development basically a social process, as the superior intellective functions, in other words the reasoning, the comprehension, the planning, ecc. Emerge from the social experiences. The child, indeed, fulfil an active role in the development of his knowledge, which are the results of the interaction with other people. Another fundamental contribute results being that one of Howard Gardner, who proposed in the essay "Formae mentis" nine different intelligences, among which that corporeal-kinaesthetic. Examining his theory and applying it in the motorial field, the importance of the body and of the movement are individualised as intelligent dimensions, since thanks to this knowledge is transferred with educative-formative value. Gardner states, indeed, that "the abilities involved from an intelligence can be used as a tool to acquire information. The individuals can learn using linguistic codes, kinaesthetic presentations, spatial or interpersonal relationship." (Gardner, 2002). the didactic of the movement becomes therefore an essential cognitive approach, an efficient modality, alternative or complemental, to use personal systems of coding and decoding, using the plurality of the intellective forms, in order to resolve problematic situations (Sibilio, 2002).

The contribution of neuroscience

Neuroscientific researches on the brain has led to a reevaluation of the role and importance of the body and of the skills belonging to it, demonstrating the influence of perceptive and motor systems on the formation of the structures from which the global functions derive, all those activities that lead to the development of the memory and categorization. The last contributions of the neurosciences in the didactic field have begun to consider the body as fundamental part of the learning moment since, as Antonio Damasio writes, "...the mind must not only move from a non-physical cogito to the realm of the biologic tissues, but must also be related to an entire organism, in possession of a brain and an integrated body and in full interaction with a physic and social environment" (Damasio, 1995). The cognitive functions, which constitute the scaffolding of the mind, are none other than that which derives from the continuous interactions between the pre-constituted structures at the genetic level and the environment, existing in the body a continuous activity of exchange, elaboration and collection of information (Mandolesi, 2012). Thanks to its plasticity, the brain, if stimulated adequately, is enhanced by increasing and consolidating synaptic connections. The experiences are, therefore, an important factor to stimulate the phenomena of neuronal plasticity and the mechanisms of mnesic consolidation, because "to determine our behavior, in fact, not only are the genetic factors, but also the environment that surrounds us, and even as we move in it. The interaction between genetics and environment therefore translates into phenomena of neuro-plasticity "(Mandolesi, 2012). The importance of an "enriched" environment has been supported by important scientists and biologists, among whom we remember Donald Olding Hebb and Gerald H. Edelman in particular. The researches of the latter has allowed the understanding of the biological base that, in addition to belonging to the memory and learning, it is also the anatomical changes on the brain resulting from the processes of learning. To investigate the relationship between movement and learning it is essential to examine the cerebral structures involved: the prefrontal cortex and the cerebellum. The prefrontal cortex is essential for the most complex cognitive abilities, while the cerebellum, specifically the neocerebellum, is for motor skills (Diamond, 2000). The two brain regions are closely interconnected, in fact when cognitive development is disturbed, as in a neurodevelopmental disorder, motor development is often negatively affected. The cerebellum is therefore important not only for motor functions, but also for cognitive functions, such as the prefrontal cortex, which, instead, plays an important role in cognitive functioning, as in motor performance, since there are strong neuronal connections between these two cerebral areas (Diamond, 2000). As emerges from the study by Berquin and collaborators (1998), it was found that children with ADHD, compared to others, tend to have motor problems associated with a dysfunction of the cerebellum, the latter being smaller than normal. A fundamental role in learning strategies is played by the hippocampus, the hub of a network that involves prefrontal and parietal regions that supports effective learning strategies and supports flexible cognition, which

includes critical thinking and problem solving, creative thinking and social behavior (Senatore, D'Elia, 2018, Voss et al., 2010). The development of effective learning strategies and the flexible cognition is particularly important for school-age children, as these processes lay the groundwork for future school success. The hippocampus is particularly sensitive to the effects of various health factors, in particular related to physical activity and nutrition, which bring about changes in its volume (Voss et al, 2010). The influence of these factors on the hippocampus engraves the performance of memory and therefore, for children, whose educational success is based on the hippocampal dependent memory, explains why these types of health problems can have a substantial impact. These diseases lead to a reduction in hippocampal neurogenesis and synaptic plasticity, increasing the risk of neuroinflammation that leads to a decrease of the functional capacity of the hippocampus (Hassevoort et al, 2016). Physical activity and appropriate nutritional interventions, therefore, entail to an increase in hippocampal neurogenesis rates, with a consequent increase in neurotrophic factors within the hippocampus (Hassevoort et al, 2016). The interventions that aim to promote health behaviors, have positive effects on the function of the hippocampus, especially in school age, being still developing, and this is one of the few structures in the brain that is able to undergo neurogenesis throughout life (Hassevoort et al., 2016). Physical exercise therefore influences the cognitive processes of learning and memory, leading to improved performance in the study. This is reason why it is important to reduce the sedentary lifestyle that is spreading widely, a no-style which one must lose the habit of. "There can not be cognition, without movement, without planning of action and prediction of the results of this" (Mandolesi, 2012).

Analysis of the protocols

In support of the indispensable theoretical foundations, it is wanted to reflect on some experimental studies that, starting from the worrying assumption that the school is drastically decreasing the hours dedicated to physical education, focusing on the teaching of reading, writing and counting, have confirmed how much the motor skills are of relevance for the scholastic performance.Starting from the assumption that participation in physical activity is positively correlated to neurocognition in childhood, after a scrupulous and careful bibliographic research, 10 research protocols were selected and analyzed in the following databases: PsycInfo, PubMed and SportDiscus.The objective has been to observe and evaluate the results concerning the influence of physical activity on motor skills, scholastic performance and executive functions, following an experimental program of integration of a few extra hours of physical activity in an intervention group compared to a control group that maintained, instead, the pre-established program of physical education.The inclusion criteria for the selection of the protocols were: research of studies concerning the scholastic field, specifically primary school; published between 2010 and 2016; studies conducted in the United States, Sweden, the Netherlands, Ireland, Denmark, Australia.All the researches reported have examined the benefits of physical activity: in children attending primary school, in normal weight and overweight, with the development of motor skills, with fun and with cognitive development (concentration, attention and scholastic performance).In addition to specific tests and accelerometers to measure pupils' physical form and their learning, several tests have been proposed (Tower of London, Standard Flanker, etc.) to evaluate the executive functions. Longitudinal studies and randomized controlled trials were examined, being the subjects randomly assigned to the control or intervention group. The followingtablesummarizes the 10 selectedstudies.

Tabel 1. Own Source

TITLE AUTHORS JOURNAL	YEAR	COUNTRY	NUMBER OF PARTICIPANTS	AGE	SETTING	ACTIVITY	RESULTS
"Motor skills and school performance in children with daily physical education in school - a 9 year intervention study" I. Ericsson M.K.Karlsson Scandinavian Journal of Medicine & Science in Sports	2012	Sweden	220 (119 M-101 F)	Between 7 and 9 years	Primary School	9-year intervention study, with the aim of assessing whether daily PEH (Physical Education and Health) in the school curriculum could improve motor skills and the percentage of pupils qualifying for upper secondary school. The motor skills were evaluated using the MUGI	Daily physical education and the adapted training of motor skills during the years of compulsory schooling lead not only to the improvement of motor skills, but also to the academic performance and the percentage of pupils who qualify for upper secondary school. The results suggest that physical activity is associated with cognitive results.

						observation list.	
"The impact of a Physical Activity intervention program on Academic achievement in a Swedish elementary school setting" Lina B. Käll M. Nilsson T. Lindén Journal of School Health	2014	Sweden	1.965 (408 of the intervention school and 1557 of the reference school).	10 years	Primary School	The purpose of this study is to determine the impact of a physical activity intervention protocol at school (" School in Motion ') on the academic performance of children. The intervention program involved a local sports club and selected elementary schools. The students of the intervention school were involved in physical activities, twice a week, of "play and movement" led by the instructors of the sports clubs.	The data show that before the start of the intervention program there were no differences between the intervention school and the reference schools in the proportion of students who had achieved "the objectives to be achieved" in none of the three subjects (mathematics, Swedish and English); but after the start of the intervention program, a higher percentage of students in the intervention school achieved national targets in all three subjects, compared to the schools of reference. Increased physical activity at school may have improved student concentration and classroom behavior, which may have contributed positively to their academic success.
"The relationship between motor skills and cognitive skills in 4-16 year old typically developing children: a systematic review" Irene M.J. Van der Fels, Sanne C.M. TeWierike, Esther Hartman, Marije T. Elferink-Gemser, Joanne Smith, Chris Visscher Journal of Science and Medicine in Sport	2014	Netherlands	Notspecified	Children from 4 to 16 years	Notspecified	The present review, based on Piaget's theory and neurological explanations, aims to provide an overview of the studies providing evidence of a relationship between motor and cognitive skills in children with typical development, highlighting the relationship between the motor and cognitive abilities that typically develop in children aged 4 to 16 years. 21 articles were analyzed, searched in the following databases:	A stronger relationship between motor and cognitive abilities was found, especially in pre-pubertal children compared to pubertal children (over 13 years of age), as both skills have an accelerated development between 5 and 10 years. The researchers sustein that complex motor skills, as well as fine motor skills, coordination of movement in rhythm, and sequential movements should be included in motor intervention programs to improve higher-level cognitive abilities or vice versa.

						PubMed, Web of Science and PsycINFO.	
"Outcomes and process evaluation of a programme integrating physical activity into the primary school mathematics curriculum: The EASY Minds pilot randomised controlled trial" Nicholas Riley, David R.Lubans, Philip J. Morgan, Myles Young Journal of Science and Medicine in Sport	2014	Australia	54 children (28 males and 26 females). Of these, 27 were part of the intervention group, while the remaining 27 of the control group.	10 years (grade 3 of the Australian elementary school education system).	Primary School	The study aims to reduce the time of sedentary lesson at school that lead children to assume an increasingly sedentary attitude, with negative consequences. The movement was used both to teach explicitly and to reinforce mathematical concepts. Motion-based learning experiences have been incorporated into maths lessons on three occasions a week over a six-week period. Levels and duration of physical activity were measured using accelerometers.	The EASY Minds program has determined to a significant increase in the MVPA (Moderate to Vigorous Physical Activity) throughout the school day, as well as a reduction in sedentary time during math lessons and throughout the school day, with a consequent increase in concentrated behavior. As part of a multi-level intervention, a small 6-min increase in MVPA during the class time could have important clinical meaningfulness. The EASY Minds program has shown significant improvement in concentrated behavior, thus demonstrating that movement-based learning can potentially lead to increased concentrated time, which is time spent engaging in scholastic learning.
"Moving and Academic Learning are not antagonists: acute effects on executive function and enjoyment" SpyridoulaVazou, Ann Smiley-Oyen Journal of Sport & Exercise Psychology	2014	Iowa (USA)	35 children (16 boys and 19 girls)	Between 9 and 11 years	Primary School	The study examined the effects of integrated physical activity with the mathematical practice on the executive function, with respect to sitting mathematical practice, taking into account the influence of body mass (BMI). The tasks of the Standard Flanker, the Reverse Flanker, and the Mixed Flanker were used to evaluate inhibition, working memory, change and selective attention.	The present study offers a test, albeit preliminary, which indicates that after 10 minutes of aerobic physical activity integrated with math practice, a positive effect on inhibitory control, an important component of the executive function, can be caused. Above all for overweight children, physical activity prevents the decline of the executive function that occurs after a sedentary period. Compared to normal-weight children, overweight children showed less accuracy after sitting rather than after physical activity. The performance of

							children on multiplication oprations was not negatively affected during physical activity, but at the same time no improvements were found.
"Associations between daily physical activity and executive functioning in primary school-aged children" Anneke G. Van der Niet, Joanne Smith, Erik J.A. Scherder, Jaap Oosterlaan, Esther Hartman, Chris Visscher Journal of Science and Medicine in Sport	2014	Netherlands	80 children (36 males and 44 females)	Between 8 and 12 years	Primary School	The aim of this study was to examine the relationship between objectively measured daily physical activity and the fundamental aspects of executive functioning in primary school children, namely inhibition, working memory, cognitive flexibility and planning skills, measured with specific tests.	It has been found that the more the child is active, the better is his performance in solving the problems of the Tower of London. A negative relationship was found between sedentary behavior and inhibition, as measured with the Stroop test, indicating that the longer the children pass into sedentary behavior, the worse their performance in this inhibition task. The study shows that sedentary behavior is negatively linked to performance on executive functioning tasks.
"Acute Effects of Classroom Exercise Breaks on Executive Function and Math Performance: A Dose–Response Study" K. Howie, Jeffrey Schatz, Russell R. Pate Research Quarterly for Exercise and Sport	2015	South Carolina (USA)	96 children	Between 9 and 12 years	Primary School	The purpose of this study was to determine the acute dose-response relationship between classroom exercise breaks with executive function and mathematics performance in children 5 minutes, 10 minutes, or 20 minutes of exercise breaks were compared in class with 10 minutes of sedentary class activity. Students completed the Trail-Making Test, an Operational Digit Recall test and a mathematical fluency test immediately before and after each condition.	Classroom breaks of 10 and 20 minutes moderately improved math scores in students compared to a sedentary lesson in classroom. This relationship was not found following exercise breaks of less than 10 minutes. Participants with lower IQ, with higher aerobic fitness, or with less schooling commitment have had improve math scores with classroom breaks.
"Improving academic performance of School-Age	2015	Netherlands	228 children (122 males and 106 females)	8 years	Primary School	In the F & V (Fit and Academically Proficient at	The intervention program was successfully implemented and

children by physical activity in the classroom: 1-year program evaluation" Marijke J. Mullender-Wijnsma, Esther Hartman, Johannes W. De Greff, Roel J. Bosker, Simone Doollaard, Chris Visscher Journal of School Health						School) intervention program, 63 physically active academic lessons were developed in the classroom. During each F & V lesson, 10 to 15 minutes were spent solving math problems followed by 10 to 15 minutes to solve the language problems. The main objective was the repetition and memorization of enhanced concepts that the children had previously learned. The physical exercises were moderate to vigorous, but relatively easy to perform.	the physically active lessons contributed positively to the scholastic results of third year children, unlike those of the second year. Probably the third-year children who participated in this study had the ability to focus their attention more on scholastic content while second-year children focused on both tasks (physical activity and scholastic content) equally. The observations in class showed that the concentrated behavior of the children during the lessons was more than 70%.
"Preliminary findings of Active Classrooms: an intervention to increase physical activity levels of primary school children during class time" Rosemarie Martin, Elaine M.Murtagh Teaching and Teacher Education	2015	Ireland	28 students (14 boys and 14 girls)	Notspecified	Primary School	The aim of the "Active Classes" pilot study was to evaluate the levels of moderate to vigorous physical activity (MVPA) of the participants during the lessons of the intervention. The comparisons were made between the levels of MVPA generated during the intervention classes (English and mathematics) and the normal lesson in the classroom. The research team created 20 English and 20 math lesson plans that integrated physical activity into the curriculum content.	The results of the "Active Classes" study show that intervention classes not only improve students' levels of physical activity, but also reduce the time spent in sedentary behavior when compared to regular classroom lessons. In fact, they have shown that the teaching of physically active school classes is able to improve the levels of physical activity of the students, but also their involvement and interest in tackling the school lessons. Pleasure was the dominant theme of the study, and was found in all participating students. Changing the teacher's behavior towards the use of physically active teaching methods is a promising way to increase the levels of physical activity of children.

"Rationale and design of a randomized controlled trial examining the effect of classroom-based physical activity on math achievement" Mona Have, Jacob Have Nielsen, Anne KaerGejl, Martin Thomsen Ernst, KjeldFredens, Jan ToftegaardStøckel, Niels Wedderkopp, Sidsel Louise Domazet, Claire Gudex, Anders Grøntved, Peter Lund Kristensen BMC Public Health	2016	Denmark	505 children	7 years	Primary School	This article describes the research project and the methodology of an intervention study that examines the effect of PA (Physical Activity) in the classroom on mathematical achievement, creativity, executive function, body mass index and aerobic capacity. The intervention consisted of a nine-month classroom physical activity program that involved the integration of physical activity into the mathematics lessons provided by the school's mathematics teachers. Students received an average of 6 math lessons of 45 minutes per week with physically active teaching.	The study offers in detail the methods and tools to be used to verify the influence of physical activity in primary school on mathematics performance. The limitation of this study is, however, the lack of collection of qualitative data that can support the veracity and effectiveness of the described intervention.

These studies, in order to provide an analysis as accurate as possible, were divided into three groups: a) studies concerning motor skills and academic performance, b) studies concerning motor activity and executive functions, c) study on moving teaching.

Studies concerning motor skills and academic performance

First of all, it is important to underline how an active lifestyle and higher levels of aerobic capacity are associated with better academic performance and better cognitive abilities, having a direct influence on the structure and functioning of the brain (Chaddock et al, 2011).The movement affects the volumetric variations of gray matter, which are reputed to play an important role both in improvements and in the decline of cognitive abilities related to age (Gogtay et al, 2010). In physically active children, the thickness of gray matter in the upper frontal cortex, in the upper temporal areas and in the lateral occipital cortex, is more subtle, leading to better academic results, especially in mathematics (Chaddock et al, 2015).Physical activity is also closely related to the hippocampus, a brain structure that plays a decisive role in supporting relational memory and especially in effective learning strategies (Hassevoort et al, 2016). The hippocampus is particularly sensitive to the effects of various factors of health, especially related to physical activity and nutrition, which make changes in its volume and affect memory performance, as their inadequacy leads to a reduction of both volume and functional capabilities of the hippocampus and synaptic plasticity (Voss et al, 2010). The first study selected was "Motor skills and school with a 9 year intervention study", by I. Ericsson and M. K. Karlsson, published in 2012 in Scandinavian Journal of Medicine & Science in Sports. This study was conducted in a Swedish school for 9 years and included 251 children between 7 and 9 years of age, divided into a control group and an intervention group. The control group followed the two weekly classes of motor education provided, for a total of 90 minutes, while the school day of the intervention group was extended with 45 minutes per day of motor activity (225 minutes per week in total), using the MUGI method for the extra training of motor skills and aimed at the automation of basic motor skills. The results showed that daily physical education and adapted training of motor

skills in primary school are essential to improve not only the motor skills, but also the grades in school subjects, encouraging the increase in the percentage of students who qualify for higher studies. This article has brought to light the great relevance of the relationship between motor skills and school performance in primary school children, providing long-term results. Based on previous studies and thanks to observations, it has been found that motor skills seem to be of great importance for academic performance.Another important factor that has been emphasized is that children with impaired motor skills may have problems with school results. Therefore, it seems important to identify the students with reduced motor skills already at the beginning of the school to be able to intervene promptly, with the aim of improving not only the development of motor skills, but also the future school objectives. The results of this research support the point of view according to which a program of intervention with a greater space dedicated to physical activity, would lead to the improvement of school results. A further study examined is "The impact of a Physical Activity intervention program" by Lina B. Käll, Michael Nilsson and Thomas Lindén, published in the Journal of School Health, Vol. 84, 2014.The aim is to determine the impact of a physical activity intervention protocol at school, called "School in motion", on the academic performance. This program began in 2004 in the city of Mölndal, Sweden, and involved a local sports club and selected elementary schools. A control group (1557 students) and one intervention group (408 students) were set up, where physical activity sessions were increased through two weekly lessons conducted by a local sports club, in addition to the two hours of physical curricular activity.

These included, twice a week for 45 minutes, gaming and movement activities, designed to be engaging, entertaining and non-competitive.The results of the intervention were assessed by analyzing the academic performance of children in Swedish, mathematics and English, during the period between the first four years and five years after the start of the "School in Motion" intervention. It is essential to underline that before the start of the intervention program there were no differences in the proportion of students who had achieved the learning objectives in the three subjects (Swedish, mathematics and English) between the intervention school and those of reference.The examination of the results showed that the percentage of students who achieved the national objectives in all three subjects, after the start of the intervention program, was higher in the intervention group where the chances of achieving the learning objectives have increased twice. The school environment, being more motivating, may have encouraged students to engage more in school work and may have been, therefore, a factor of mediation that has contributed to the observed results.However, all of these effects may also have been the result of the intervention, which had a direct or indirect impact on children's academic performance. It is likely that biological effects, such as increased cerebral blood flow and angiogenesis, may have contributed to improvements in the prerequisites for learning (Käll et al., 2014).The third study, entitled "The relationship between motor skills and cognitive skills in 4-16 year old typically developing children: a systematic review", was published in the Journal of Science and Medicine in Sport in 2014 by Irene M.J. Van der Fels, Sanne C.M. TeWierike, Esther Hartman, Marije T. Elferink-Gemser, Joanne Smith, Chris Visscher. It represents a systematic review that aims to provide an overview and evidence of a relationship between motor and cognitive skills in children aged 4 to 16 with typical development.The analysis involved 21 total studies, searched in PubMed, Web of Science and PsycInfo, evaluating certain categories: purpose of the study, background of the literature, study design, samples, intervention results, conclusions and clinical implications. The results have shown that the benefits in the motor skills are better, those in cognitive abilities are better and this ratio is stronger especially in pre-pubertal children (before 13 years), as both skills have a development accelerated between 5 and 10 years. These studies suggest how much a physical activity intervention based on the school curriculum is effective for improving students' academic performance, and of course, their health. Following the reduction of sedentary behaviors, the motor skills that are relevant for the academic performance improve.

Studies concerning physical activity and executive functions

Participation in physical activity not only correlates positively with neurocognition in childhood; but it can also make changes in the brain of children during development (Chaddock et al, 2012). It is necessary to examine the aspect concerning the development of executive functions, that is, those cognitive operations that are important for learning, the activities of daily life and even for the scholastic performance of pupils.In the brain, executive control involves the prefrontal, parietal, striatal, and hippocampal regions (Chaddock et al, 2012). Numerous researches, such as that conducted by Rohde & Thompson (Rohde & Thompson, 2007), have shown a relationship between academic performance and different cognitive processes, such as processing speed and cognitive control. Of particular interest is the positive link between aerobics and cognitive control that has been studied by many neuroscientists.These have focused their studies, specifically, on attention, memory and functions "that can be considered a sort of 'orchestra director' of the mind, ie the executive functions" (Pesce et al, 2015). The term "executive functions" contains within it a multiplicity of functions of the mind, but the most important for the purposes of the treatment are, without a doubt, inhibition, working memory and cognitive flexibility. All three are crucial for the ability to effectively manage their attention, which will affect the improvement of learning and academic performance. The two functions most involved in the relationship with motor activity are inhibition and working memory, which are implicated in mathematics and reading results (Thompson & Gathercole, 2006). In fact, children with higher levels of aerobic capacity demonstrate a more extensive dorsal striatum, together with an increased inhibitory control during the administration of specific

tasks, compared to those with less physical fitness (Chaddock et al, 2010). Low levels of physical and aerobic activity also reflect a reduced ability to inhibit extraneous neuronal operations and delays in processing and classification of information.Recent studies have suggested that P3, a neuroelectric biomarker, is found to have greater amplitude in physically active children, reflecting increased capacity for inhibition and working memory. The study "Moving and Academic Learning Are Not Antagonists" published in 2014 in the Journal of Sport & Exercise Psychology by SpyridoulaVazou and Ann Smiley-Oyen examined the acute effect of a 10-minute period of aerobic physical activity integrated with the mathematical practice, comparing it with the seated mathematical practice, the executive function and the fun among 24 normal and 11 overweight children.The tasks of the Standard Flanker, the Reverse Flanker and the Mixed Flanker were used to evaluate inhibition, working memory and selective attention.

The fun was, instead, evaluated with the 16 item version of the Physical Activity Enjoyment Scale. The children completed a session of physical activity integrated with mathematics and a session of mathematical exercise seated, as a condition of control, in counterbalanced order.The results showed that, after the integrated physical activity with the math, the response time in the Standard Flanker has improved compared to the sedentary condition and that therefore 10 minutes of aerobic physical activity integrated with the math can have a positive effect on the inhibitory control. Among overweight children physical activity benefited from performance in the Standard Flanker, preventing the decline of the executive function that occurs after a sedentary period. The study "Acute Effects of Classroom Exercise Breaks on Executive Performance and Math Performance: A Dose Response Study", published in 2015 in the Research Quarterly for Exercise and Sport, was conducted by K. Howie, Jeffrey Schatz and Russell R. Pate in South Carolina with 96 students.The aim was to determine the acute dose-response relationship of classroom interruptions with the executive function and mathematics performance in children between 9 and 12 years, comparing 5 minutes, 10 minutes, or 20 minutes of breaks in exercise in the classroom with 10 minutes of sedentary class activity. They were randomized to receive each of the four treatments: 5 minutes, 10 minutes or 20 minutes of exercise breaks, or 10 minutes of a sedentary lesson, led by research staff.Students completed the Trail-Making Test, an Operational Digit Recall test and a mathematical fluency test immediately before and after each condition. The results showed that a 10-minute and 20-minute classroom exercise break moderately improves students' mathematical performance compared to a seated classroom lesson. In conclusion, from these studies it emerges that the more the child is active in MVPA, the faster and better is his performance in the inhibition tasks. The effects of physical activity on overweight children were also investigated, showing an improvement in their performance in tasks related to executive functions, such as the Standard Flanker for inhibition and the Tower of London Test for planning. The greatest positive effects on cognitive function were visible after 10 and 20 minutes of aerobic physical activity, but not after 5.

A study about the didactic in movement

As IvanoGamelli says in his seminar 'Teaching for skills. A possible challenge in the motor field ', held in Milan on 18 April 2013, "Living the school with the body is to think of it as a place of dynamic and affective relationships, with a teaching able to give body to knowledge, to meet the natural readiness to learn of the boy at the level of his most authentic sensitivity. In fact, the school is not attended but is 'inhabited'. To live means to feel good, in a place where one is seen, welcomed in a global way.And the first and indispensable measure of recognition and acceptance for the student (and the teacher) is, in fact, the body. "Teaching, using motor and recreational activities, implies a greater and more multi-sensory involvement, allowing to combine the transmission of repetitive information with stimuli able to integrate the various contents mnemonically, always respecting the identity of the subject and the importance of the relational experiences. The educational process should be able to avoid being both an intellectual and an instinctive fact, but mediating the two polarities, allowing the interaction between mind, emotionality and corporeality (Gamelli, seminar April 2013).The study examined "Preliminary findings of Active Classrooms" was conducted by Rosemarie Martin and Elaine M. Murtagh and published in 2015 in Teaching and Teaching Education, 52. L 'article illustrates the pilot study "Active Classroom" that was conducted with 28 students during school hours, for 5 consecutive days, in the first week of October 2014. The aim was to evaluate the levels of moderate to vigorous physical activity (MVPA) of the participants during the lessons of the intervention, trying above all to allow teachers to change their behavior towards the use of teaching methods physically active in the lessons of English and mathematics. The research team produced 20 English and 20 mathematics lessons that integrated the movement into the curriculum content.Lesson plans were linked to elements and units of elements of the English and mathematics curriculum covering a range of topics in both subjects (number teaching, operations, spatial awareness, models, sequences, fractions, time and problem solving using physically active methods). As well as improving the teaching and learning of specific content areas, the lessons also aimed to increase the levels of student MVPA during class hours. Physical activity was monitored during school hours using ActiGraph accelerometers to collect data.To the teacher was asked to propose to the students a physically active lesson in mathematics and one of English every day and record the times and duration of each active lesson taught. All the remaining class time was considered to be regular teaching time. The "Active Classes" project represented an example of teaching in movement that, in addition to changing the classroom environment, activities and tasks proposed, and reducing the sedentary lifestyle, a negative habit that is always more widespread among children and in school, has

promoted another ingredient of fundamental importance for the improvement of learning and a central component of intrinsic motivation: entertainment. The results supported the thesis that, contrary to the beliefs of many teachers, the integration of physical activity into school contents does not lead to a reduction in the performance of students.

Conclusions

Examining the selected studies, positive results emerged, which confirmed that the integration of physical activity in the normal lessons, not only does not affect the concentration and the scholastic results of the students in the different disciplines, but globally only positive effects were found. Most of the research starts from the worrying assumption that the school is drastically decreasing the hours dedicated to the movement, as it tends to focus the attention mainly on academic teaching.The decline of the hours devoted to physical activity, instead of bringing positive results, turns out to be counterproductive, since this decrease seems to negatively affect the ability of learning in children. The results of the protocols support this last affirmation, as it has been observed that the motor skills are of great relevance for the academic performance and that often students who have deficits in motor skills, can manifest problems in the academic results and vice versa.It is therefore of fundamental importance, therefore, to promote timely interventions from the beginning of the school to make improvements not only for the development of motor skills, but also for future school results, as better are the performances in motor skills, the better are those in cognitive abilities. The studies compared the outcomes of the control and intervention groups where extra physical activity was integrated and, the highest percentages of students who achieved better results in mathematics and in general in other disciplines, were also higher in intervention groups compared to control groups.In addition to this, it should be noted that increased physical activity improves concentration, classroom behavior, self-efficacy, mental health and decreases stress, thanks to the serene climate and the increased motivation that the school environment offers.

From the analysis of the illustrated studies, some fundamental conclusions emerge:

1) The school should promote to all students health education programs aimed at promoting physical activity and reducing a sedentary lifestyle.
2) An active lifestyle in the developmental age positively affects the academic performance.
3) The plasticity of development in the brain and cognition are related to aerobic capacity.
4) The physical structure of the brain changes and grows on the basis of the life experiences that the individual experiences.
5) The researches invite to re-evaluate the role and importance of the body and its influence on the formation of the structures from which the "global functions" derive.
6) Teaching through play and movement fosters the acquisition of skills and enhances interest.

With this work of bibliographic research we wanted to further reflect and rethink the didactic action, where the body becomes the protagonist of the teaching-learning process because, in the construction of the personality of each subject, particularly in the evolutionary age, it is fundamental to turn to the physical-motor area, a positive meeting between verbal and analogical language.The educational praxis, taking into account the centrality of the body, comes out so valued, adopting methodological choices of teaching that give space to the movement, which provide strong and positive stimuli to reach all the knowledge but above all to reach, to center, in the mind and in the heart of the pupil.

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