Original Article

Psychomotor development and sports practice in primary school: application of the APCM test for preventive purposes

PALUMBO CARMEN,¹

¹Department of Human, Philosophical and Educational Sciences, University of Salerno, Fisciano Salerno
ITALY

Published online: July 31, 2020

(Accepted for publication: July 22, 2020)

DOI:10.7752/jpes.2020.s3288

Abstract

All the most modern currents of studies that deal with the well-being and growth of young people today recognize the need for exercise and movement as a basis for psycho-physical development and as a maintenance of good body and mental health (Slutzky and Simpkins, 2009). Movement is the active tool that allows you to acquire awareness of yourself through the body and self-care through the achievement of the well-being of the body itself. It plays an irreplaceable role necessary to reach, implicitly, but often explicitly, a state of good health, keeping vigilant and efficient all those gears that collaborate in the functioning of a healthy body and serve to maintain a living, thinking and active being for a long time (Strong, 2005). The importance of the role of the movement must be promoted by the School because it is the fabric in which the new and more in-depth skills of teachers and the additional necessary means can be made available alongside physical education. It was conducted a field research through the APCM-2 protocol (Sabbadini, 2018) on a sample of 281 children. The survey, carried out on a sample of primary school pupils, aimed to evaluate the psychomotor development and cognitive-adaptive functions in relation to sport activity. The results highlight the strong relationship between sport practice and psychomotor and cognitive development. Low levels of cognitive-adaptive functions are sometimes predictors of possible learning disorders and/or school learning problem, if identified early, can be compensated for and monitored with appropriate educational interventions.

Keywords: school, childhood, psycho-physical well-being.

Introduction

Knowledge of the world starts from feeling and exploring through your body. From the first years of life the child manifests the primary need to know everything around him. Learning takes shape through perception and movement: the child touches, grasps and brings the various objects to his mouth; crawls and crawls exploring the space around him. Experience stimulates thought, symbolic forms of representation are built through direct action on things and with things (Piaget, 1967; Bruner, 1987). Movement especially in childhood is a fundamental element for the growth of the child. Scientific evidence confirms the efficacy of motor activity from a healthy point of view, emphasizing the enormous benefits especially for cognitive development, strongly conditioned and interconnected with the psycho-motor one. The expansion of exploration and movement will significantly affect the perceptual-motor stimuli and therefore will be decisive in the construction of that motor baggage with which the child can be “master” of the world.

To understand how the child becomes progressively “protagonist” of his development, it is possible to observe his motor skills in the first years of life and his way of relating to parents, and later with peers (Vecchiato, 2017). Corporeity is the tangible means that allows us to be present to others, to express our intentions and to represent the communication and connection that we want to establish with others. The same learning, as Rogers wrote in 1969, is not a mere transfer of knowledge but a detailed process that involves the whole person. It starts at the moment of birth through movement and continues through movement that is carried out by the child as an *«active exploration that allows us to implement knowledge of the world and to develop physical, psychic, cognitive, affective and emotional relationships with it and with other individuals»* (Meraviglia, 2012).

Beyond this moment of exploration (which in fact never has a real end), we arrive at the moment of meeting with others, people different in skill, age, mentality, education, etc. through not only movement, but also sport. Sport promotes the discovery of the other and the comparison with it and is able to increase the level of self-esteem of any person, even disabled or in a difficult social situation, thus contributing to the maturation of the human being. The school must promote the global motor development of the child, understood as integrated development of *human capital*, not limited to physical development only, but oriented to the use of movement and exploratory action through the body so that it can become physical, emotional, intellectual growth, social and productive of the person in life contexts (Bailey et al., 2013; Gomez Paloma, 2013).

The teacher must therefore encourage progressive control of psychomotor behavior in every young pupil. Modern scholars indicate motor skills and psychomotor skills as the starting point for starting the child's study, getting to know him and promoting his education. Motor education therefore has a central focus in the school. The studies agree in stating that practicing daily exercise produces many benefits, especially in the developmental age, which promote healthy and balanced development, with long-term effects. Unfortunately, in recent years there has been an evident tendency to increase sedentary age in school age and a reduction in the time that children use to practice motor and sports activities with significant negative consequences on educational growth (Stodden, 2007).

In fact, motor and sports activities, as widely recognized in the literature, not only guarantee health and physical efficiency, positively influencing physiological conditions and adaptations that act on the various systems and systems, but are heavily involved in cognitive processes (WHO, 2016). Numerous studies have shown that regular physical activity involves improvements in attention, concentration and memory levels (Tomprowski P.D. et al., 2011), which indirectly affect personal factors (self-esteem, self-efficacy, etc.) (Whitehead, 1997).

All the psychomotor and psychosocial relationships that are fundamental for the global growth of the child begin to be structured already from the first years of kindergarten. The first forms of motor skills, language, non-verbal communication and free play will be the substrate for further and more complex learning. It is in this first phase of growth, kindergarten and the beginning of primary school that it is crucial to stimulate action and aimed movement because it is in this age group that we learn and acquire the gross and fine motor skills, those basic movement patterns for adequate perceptual-motor functionality, fundamental for global development.

The educational potential of movement activities should therefore be "incorporated" within school contexts. Exercise has gone from being considered a simple "performance" to a higher, inclusive and integrative level. At the same time, it is an educational medium, a means of knowledge, a creative medium, a means of recreational and social integration. (Talachir L. G., et al 2019)

Recent studies have highlighted the considerable importance of the development of space-time skills, crucial in understanding mathematical and grammatical logic, which must be stimulated through bodily experiences, bodily games and exploration and ideation of form through the body (Kim et al., 2018). Literature reviews show that physical activity, mainly in early childhood, positively affects both structure and brain functions (Donnelly et al., 2016; Carso et al., 2016). Neurophysiologist Hannaford (2005) has provided evidence of a complex interaction between muscles, thinking and emotions. The human brain is actually activated during physical activity and, as Blakemore (2003) points out, this activity reinvigorates existing brain cells, and this could be the reason why movement improves learning outcomes.

Confirming this, a 2016 study showed that gross and fine motor skills are positively correlated with school results and cognitive functions (Geertsens et al., 2016). A 2014 study showed that some indicators that show delay or speech disorder, persistent weakness in motor skills and executive functions, are real "alarm bells" not to be underestimated in the early identification of any specific disorders of the learning (Gooch et al., 2014). Numerous researches highlight a relationship between motor problems and specific learning disorders; It has been found that at least 50% of children with DSA have a comorbidity with motor coordination disorder (DCD) (Lyytinen & Ahonen, 1989; Silva et al., 1982) and vice versa (Haslum & Miles, 2007).

It seems that poor participation in motor and sports activities also corresponds to a lower level of motor coordination and that in general, children with motor difficulties are less motivated to practice sports. A Canadian study investigated the relationship between children's motor skills and their choices and participation in sports activities by highlighting that children with DCD not only participate to a lesser extent in activities but tend to choose quieter and socially more isolated activities than average of children (Jarus et al., 2011). Several studies confirm this evidence by indicating a lower frequency of participation in free and organized play by children with motor coordination disorder, especially in school age (Carney et al., 2005; Fong et al., 2011).

Scientific evidence only confirms the importance of identifying any delays in psychomotor development early, delays that if recognized in time can be compensated by preventing that further variables related to lack of safety, a sense of physical self-efficacy and low self-esteem can negatively influence participation to motor activities. To confirm this hypothesis, some studies have been published that have demonstrated the effectiveness of targeted interventions in the early years of primary school. In particular, the Carney study (2005) has experimented with an 8-week protocol of specific activity on gross motor skills and general dynamic coordination in children with DCD recording notable improvements. It has also been found that slight delays in psychomotor development can be adequately recovered after appropriate investigations with batteries of motor assessment tests sampled in schools (Vayer, 1992) or in other similar educational contexts. It has been shown that this type of evaluation allows to facilitate and facilitate the diagnosis of a possible delay in the evolution of the individual and to establish what level it is (Meinel, 1984). In the light of this synthetic frame of reference, this study has a twofold objective: to verify if there is a relationship between motor-sport practice and psychomotor development levels; experiment with the application of the assessment test of praxic skills and motor coordination (APCM-2) in the school context for preventive purposes. Low levels of cognitive-adaptive functions are sometimes predictors of possible learning disabilities and / or difficulties in school learning which, if identified early, can be compensated and monitored with appropriate teaching interventions.

Material and methods

Participants

The survey involved a sample of convenience made up of four primary school classes (n. 2 first classes and n. 2 second classes) for a total of 281 children aged between 6 and 8 years.

All the parents of the participants signed the informed consent to the research, which briefly illustrated the objectives of the study.

Instruments

Based on the objectives of the investigation, the following tools have been identified:

- Evaluation test of praxic skills and motor coordination (APCM-2) (Sabbadini, 2015);
- Information questionnaire (addressed to the parents of the children involved);

APCM-2

It is a tool for evaluating motor praxis at the service of the clinician who evaluates the motor skills of children from 3 to 8 years of age, and who uses an observation methodology that has its foundations in the theory of *Embodied Cognition*.

The protocol was created with the aim of being able to define a specific profile of the development of the child from 3 to 8 years of age which is based on a neuropsychological observation. The evaluation underlies the definition of an individualized therapy project, which aims to act by enhancing the quality of coordination starting from the results of the tests obtained through the use of the protocol which aim to indicate the specific value of the degree of coordination. It is essential to pay attention to sensory receptivity, respiratory coordination and posture.

In particular, the attention is paid to the sensorineural aspects, since the perception changes from individual to individual, even breathing and posture therefore play a very important role in the chorus of the observation process, in fact, it helps to outline the image body that the subject has of himself and also of his own emotional perception.

The aforementioned protocol, for example, is able to rework the difficulties encountered in maintaining an adequate posture, and by means of a subsequent intervention, it will be possible to offer the patient under treatment the possibility of improving motor difficulties, since by a good level of safety and consequently from a good motor control, movements arise that will ensure a successful outcome of the motor task in charge.

The correlation between sensory receptivity and postural anomalies is undeniable and quite appreciable: tactile hypersensitivity problems could manifest themselves in refusing direct contact of the foot with the floor, and visual and oculomotion dysfunctions affect the quality of movement, including motor acts such as writing and ancillary movements such as bending the head or sticking out the tongue during the course of the action, and these movements can be indicative of dyspraxia of the look.

The specialists, but also the parents, must be able to recognize in the child those compensatory dynamics, that is, those support movements put in place with respect to the corresponding difficulties; the movements of daily praxies, such as dressing, undressing and washing, to those of natural oral like chewing and swallowing deserve a lot of attention, and this is why the existence of questionnaires to be addressed to parents as well, since such behaviors are naturally observable at home, as it is also in the daily actions and considered trivially "automatic" that the degrees of attention and self-control are detected.

The APCM protocol is divided into two sections: *movement patterns* and *adaptive cognitive functions*. The movement patterns concern: balance, whether static or dynamic, (focus on the observation of breathing); eye movements and visuo-spatial skills, (focus on posture and muscle tension); hand movements, such as the ability to *diakokinesis*, i.e. the rapid and successive movements of pronation and supination of the hands and forearm, any lack of these movements would lead to a condition of *adiadocokinesia*, a disorder affecting the cerebellum and a typical sign of ataxic cerebellar diseases; the movements of opposition thumb-forefinger and thumb-little finger (fine coordination ability that appears at the age of about 4 years) and opposition of the thumb to the other fingers both upper and lower, also by alternating the index, ring, middle and little fingers; with regard to the hands, it is also possible to evaluate an additional ability, what in French is called *pianotage* which is about to "strum on the piano", which translates into placing the child's fingers on a piano, providing the sound of the keys in a casual and paying attention to his ability to detach one finger from the other during the gesture, an act not to be underestimated since it also implies fine-coordinative skills.

The ability to coordinate hand movements is closely linked to verbal expressiveness, and in case of dyspraxia it is important to consider their correlation during the evaluation process and subsequently on the intervention process. Particular importance is assigned to the sequential aspects that are mainly expressed through the motor-gestural but also visual channel, from whose observation derives the recognition of the knowledge of one's own body and of the spatial representation.

In summary, the attention is especially addressed on three main aspects:

- *the ocular motility;*
- *the sequential movements of the fingers;*
- *the system of crossing the limbs.*

The latter concerns making movements through cross patterns, movements that presuppose the simultaneous activation of both cerebral hemispheres, an aspect that affects multiple daily activities.

Cognitive and adaptive functions

The observation, referring to these specific aspects, focuses on dynamic coordination related to usual actions in the child such as walking, running, jumping, jumping obstacles, going up and down stairs.

Attention is also directed to manual skills, the graphic-motor skills, during which it is good to observe manual dominance, breathing, posture related to the involved limb, the handle of the pen, the position of the head and the possible accessory movements related to it or to the non-dominant limb, the quality of the tracing and the pressure exerted on the sheet. The fine coordination of the fingers and the eye-hand coordination are specific skills detectable in activities such as cutting along a line, grasping a ball, cutting the contours of a shape, but also constructive skills such as reconstructing figures cut into 3 or 4 pieces, the construction of figures using materials such as sticks, matches, rulers.

The Protocol also tries to evaluate the symbolic gestural skills on imitation, body and spatial representation, but also distal independence, such as moving the fingers selectively.

The protocol also provides for a series of very specific items to be submitted to children relating to the aforementioned sections. The APCM Test is a validated tool that according to the neuropsychological approach, considers the different skills separately by dividing them into basic functions, *movement patterns and adaptive cognitive functions*. Through a series of structured tests, the test allows you to perform a detailed analysis of some determining factors for the early detection of *motor-praxic coordination problems*. *The test provides a global picture not only of motor coordination, but also of the level of skills acquired by the child in praxies*, through a targeted assessment of sequencing, identified by the authors as a motor-gestural factor strongly correlated to expressive-verbal skills (Sabbadini, 2005).

Survey

The self-administered questionnaire collected general personal information on pupils, respiratory coordination and posture and a second part containing detailed information on sports practice, which responded to the need to obtain qualitative information regarding the actual or non-sports practice of children.

Procedures

In the first phase of the research, information was acquired from the parents through the information questionnaire, which made it possible to quantify the levels of adherence to the practice of sports among the children of the chosen sample.

Not all parents returned the questionnaire; of the 281 subjects in the sample, only 172 questionnaires were acquired and therefore it was possible to derive the following 3 categories:

- Children practicing sports (n = 81);
- Children not practicing sports (n = 91);
- Children who did not submit the questionnaire (n = 109).

The second phase of the research was carried out in the field through the administration of the APCM-2 test, which took place within the same school buildings, in previously prepared environments. The administration of the tests was structured according to the times and spaces offered by the school managers of the school institutions in which the survey was carried out. The sample of students examined in the different classes was divided into three subgroups of equal numbers and each subgroup was entrusted to the supervision of an examiner.

For an optimization of data collection and evaluation times during administrations, evaluation grids have been drawn up. Specifically, each child was assigned a code shown inside the grids on each page. Each class examined had the file of 11 grids, filled in by hand during the administrations.

For each test, following the test protocol, scores were awarded according to the following criteria:

- the score of 0 if the test has not been performed or if it has been performed incorrectly;
- the score of 1 if the test has been partially performed;
- the score of 2 if the test was carried out correctly.

Data analysis

The collected data were computerized in an Excel environment. For each group the means, variance and standard deviation were calculated. The data were represented in descriptive tables (tables n.I / n.III), which synthetically highlight the average, the variance and the standard deviation for each group of pupils as previously divided. Thanks to the questionnaires, it was possible to have further data concerning the subjects who practice sports, distinguishing them from those who do not practice it, marginalizing the data concerning children whose sports data are unknown.

Tab. I Children who play sports

SAMPLE	AVERAGE	STANDARD	SD
FIRST School 1	92,94	96,16	9,80
FIRST School 2	93,11	115,51	10,74
SECOND School 1	101,17	73,15	8,55
SECOND School 2	102,33	65,03	8,06
TOT. FIRSTclasses	93,02	102,63	10,13
TOT. SECOND classes	101,72	68,01	9,56
TOT. Sportychildren	97,75	101,76	10,08

Tab. II Children who don't play sports

SAMPLE	AVARAGE	STANDARD	SD
FIRST School 1	88,97	133,02	11,53
FIRST School 2	83,45	130,47	11,42
SECOND School 1	98,48	55,87	7,47
SECOND School 2	89	498,57	22,32
TOT. FIRST classes	87,89	135,04	11,62
TOT. SECOND classes	96,31	161,69	12,71
TOT. Children who don't play sports	91,13	160,58	12,67

Tab. III Children who didn't return the questionnaire

SAMPLE	AVARAGE	STANDARD	SD
FIRST School 1	87,10	146,35	12,09
FIRST School 2	100,71	75,57	8,95
SECOND School 1	95,95	344,75	13,04
SECOND School 2	87,66	1668,26	40,84
TOT. FIRST classes	88,61	155,72	12,47
TOT. SECONDClasses	94,86	340,87	18,46
TOT. Children who didn't return the questionnaire	91,25	241,04	15,52

Results and Discussion

The APCM test results were, instead, graphically represented (Figure n. 1 and n. 2), in order to synthetically highlight the overall trend.

The analysis of the data clearly highlights a strong relationship between sports practice and the development of the motor pattern; the latter is qualitatively better in those who play sports, with consequent positive implications for the person as a whole.

The comparison between the averages of the 3 investigation groups allows a synthetic picture that allows you to perform a more detailed analysis to draw the correct meaning.

From the averages obtained, it can be deduced that the subgroup of children who play sports is the one that has scored the highest average score; the subgroup of children, who did not return the questionnaire, scored a higher average score than those who certainly did not practice sports. It is spontaneous, from a logical point of view, to think that there are more children playing sports inside it, but unfortunately, we cannot confirm due to the missing values (information questionnaire not delivered).

From the observation of all three groups, there has been a marked improvement in psychomotor development between the first and second year of primary school, so it is around 7 years that psychomotor development is strengthened.

Figure 1 Gaussian Curve - Children who play sports

Figure 2 Gaussian curve - Children who do not play sports

The two graphs (fig.1 and fig.2) referring to the APCM test, highlight the differences between the two groups. Graph 1 shows a wide and symmetrical curve, which corresponds to the aforementioned homogeneity already found in the data. It occurs vertically and continuously and indicates values fairly close to the average of the values found, even if there is some discontinuity in the descending phase. If we associate the result observed in the graph with the low variance index of the subgroup of children who play sports, it turns out that they have a tendency towards homogeneous psychomotor development as a whole. With regard to the discontinuities found in the downward phase of the curve, the deduction that is obtained is that sporting activity exerts more sensitive benefits on children who have psychomotor deficits, rather than on those who are sufficiently developed. In the Gaussian representation of the subgroup of children who do not practice sport, it is interesting to note that in the ascending part of the curve there are several discontinuities.

Conclusions

In early childhood and throughout the development period involving primary school, the child constructs his logical beliefs on the basis of sensorimotor experience. Before thinking about the physical laws that govern the world around him, he experiences it through the senses and understands them with the body. Therefore the movement and quality of bodily experience cannot be considered subordinate to intellectual development but an integral part of it. All teaching seems to want to ignore the role of movement in learning processes and the importance of harmonious sensorial integration of the person during his development.

The study proved particularly useful mainly because it allowed us to draw a detailed picture of the psychomotor development of children, aspects that are rarely investigated in the school context. The application of a specific assessment test in the first and second classes of primary school allowed to observe with a sort of “magnifying glass” movement patterns and adaptive cognitive functions, evaluating not only the global motor skills, but making any eventual emergence problems in motor-praxic coordination and by testing qualitative aspects of specific skills closely related to sequencing, memory, attention, etc.

Only through a deep knowledge of the problems and the levels of psychomotor development, can it allow to plan, in the following phase, targeted and personalized didactic interventions for the different subjects, adapting the proposals according to any expressive, communicative and / or coordinative difficulties (Perrone R. et al., 2020). The possibility of evaluating through a specific and wide-ranging test, in fact, is certainly a strength of this descriptive research. A scientific study (Stella et al., 2011) identified some typical behaviors and difficulties in children that can be interpreted as predictive elements of Specific Learning Disorders. Specifically, the detected behaviors are six: sequence anomalies, difficulty of space-time orientation, motor coordination, play habits, relationships with others, organization of work. All aspects that have corporeity as the common denominator and that can have a series of repercussions with the other learning domains (Pastena, 2015).

It is therefore clear how important it is to use these observation and evaluation tools, especially in the first years of primary school, to have a 360 ° picture of the child; early detection of any difficulties will allow effective intervention through customized designs. The lack of some data relating to participation in sport or not (about half of the sample did not deliver the information questionnaire) did not allow us to correlate the two variables (sports practice and psychomotor development) on the entire sample and therefore emerges as a critical point of the study together with the sample that only investigates an age group.

It would be interesting, as a future research perspective, to foresee an experimental study by subjecting a group of pupils to a period of psychomotor training, in which to apply a specific methodological protocol. The pre and post intervention evaluation and the comparison with a control group, could allow to evaluate the effectiveness of the application of a specific methodology implemented early in the first years of primary school for preventive and compensatory purposes, avoiding that possible and minor ailments could have serious repercussions on the quality of life in children of developmental age.

Conflicts of interest

The authors declare that there are no conflicts of interest.

Author Contributions

Palumbo C., Associate professor of Methods and Didactics of Motor Activities (SSD M-EDF / 01), at the Department of Human Sciences, Philosophy and Education of the University of Salerno.

References

- Bailey R., Hillman C., Arent S., Petipas A. (2013). Physical activity: an underestimated investment in human capital? *Journal of Physical Activity and Health*, 10, 289-308.
- Berthoz A. (2012). *Simplexity: simplifying principles for a complex world*, Yale University Press.
- Blakemore C. (2003). *Movement is essential to learning*. *Journal of Physical education, Recreation & Dance*, 74(9), 22-41.
- Bruner, J. S., Haste, H. (1987). *Making sense: The child's construction of the world*. New York: Methuen. Tr. It. MakingSense. La costruzione del mondo nel bambino, Roma, Anicia, 2005. Doi: [10.1016/j.ypmed.2011.01.028](https://doi.org/10.1016/j.ypmed.2011.01.028)
- Cairney, J., Hay, J.A., Faght, B.E., Wade, T.J., Corna, L. and Flours, A. (2005a) 'Developmental coordination disorder, generalized self-efficacy toward physical activity, and participation in organized and free play activities', *The journal of paediatrics*, 147(4), 515-520,
- Cecilian A. (2018). Integrated quali-quantitative teaching, in motor-sports education, and well-being in developmental age. *Training & Teaching XVI - 1 - 2018 ISSN 1973-4778 print - 2279-7505*.
- Donnelly JE, Hillman CH, Castelli D, Etner JL, Lee S, Tomporowski P, Lambourne K, Szabo-Reed AN. Physical Activity, Fitness, Cognitive Function, and Academic Achievement in Children: A Systematic Review. *Med Sci Sports Exerc*. 2016 Jun;48(6):1197-222. Review
- Fong, S.S.M., Lee, V.Y.L., Chan, N.N.C., Chan, R.S.H., Chak, W. and Pang, M.Y.C. (2011) 'Motor ability and weight status are determinants of out-of-school activity participation for children with developmental coordination disorder', *Research in developmental disabilities*, 32(6)
- Geertsens SS, Thomas R, Larsen MN, Dahn IM, Andersen JN, Krause-Jensen M, Korup V, Nielsen CM, Wienecke J, Ritz C, Krusturup P, Lundbye-Jensen J. Motor Skills and Exercise Capacity Are Associated with Objective Measures of Cognitive Functions and Academic Performance in Preadolescent Children. *PLoS One*. 2016 Aug 25;11(8).
- Gomez F.P. (2004). *Corporeality and emotions. A psychomotor teaching for the construction of knowing ... being*, Naples: GuidaEditore.
- Gomez F.P. (2013). *Embodied Cognitive Science: embodied acts of teaching*. Rome: New Culture Editions.
- Gooch D, Hulme C, Nash MH, Snowling MJ. Comorbidities in preschool children at family risk of dyslexia. *J Child Psychol Psychiatry* 2014;55(3),237-246.
- Hannaford C. (2005). *Smart Moves: Why Learning is not all in your head*. Marshall, NC: Great Ocean Publishers.
- Haslum MN, Miles TR. Motor performance and dyslexia in a national cohort of 10-year-old children. *Dyslexia* 2007 Nov;13(4):257-75.
- Jarus, T., Lourie-Gelberg, Y., Engel-Yeger, B. and Bart, O. (2011) 'Participation patterns in school-aged children with and without DCD', *Research in developmental disabilities*, 32(4), 1323-1331,
- Kim H, Duran CAK, Cameron CE, Grissmer D. Developmental Relations Among Motor and Cognitive Processes and Mathematics Skills. *Child Dev*. 2018 Mar;89(2):476-494.
- Lyytinen H, Ahonen T. Motor precursors of learning disabilities. In D. J. Bakker & H. Vlugt (Eds.), *Learning Disabilities: Neuro-psychological correlates* (pp. 35-43). Amsterdam: Swets&Zeitlinger 1989.
- Meinel, K. (1984). *Theory of movement*. Rome: Sports Press Company.
- Meraviglia M.V. (2012). *Motor Systems: New learning and communication paradigms*. Italy: Springer-Verlag.
- Pastena N., Damiani P. and Gomez Paloma F. (2015). Specific Learning Disorders and Embodied Cognitive Science. From Bio-genesis to Education. In school and social integration. Vol. 14, n. 3, 2015, 48-63
- Piaget J. E Inhelder B. (1969), *The psychology of the child*, New York, Basic Book. Trad. It., *La psicologia del bambino*, Torino: Einaudi, 1970.
- Perrone R., Pallonetto L., Palumbo c., (2020), The use of the APCM-2 protocol for a preventive assessment of the motor coordination disorder. *Journal of Human Sport and Exercise*, 15(2proc), S232-S243. doi:<https://doi.org/10.14198/jhse.2020.15.Proc2.14>.
- Rogers C. (1969). *Freedom to learn, A view of what education might become*, Columbus, Ohio Merrill, tr. it. *Libertà nell'apprendimento*, Firenze, Giunti Barbera, 1973.
- Sabbadini L., Tsafirir Y., Iurato E. (2005). Protocol for the evaluation of Praxic skills and Motor Coordination APCM, *Rehabilitation Methodologies InLogopedia* vol. 13, Milan: Springer, pp.1-21.
- Silva PA, McGee R, Williams S. The predictive significance of slow walking and slow talking: a report from the Dunedin Multidisciplinary Child Development Study. *Br J Disord Commun*. 1982 Dec;17(3):133-9.

- Slutzky C. B., Simpkins S. D., (2009). *The link between children's sport participation and self-esteem: Exploring the mediating role of sport self-concept*. Medicine and Science in Sport and Exercise, 10, 381-189
- Stella G., Savelli E., Gallo D. and Mancino M. (2011). Developmental dyslexia in pediatrics. Guide to early identification, Trento: Erickson.
- Stodden DF, Langendorfer SJ, Robertson MA, Kelbley L. (2007). Association between motor skill competence and health-related physical fitness. *J Sport Exerc Psychol*. 29:S45.
- TalaghirLaurentiu Gabriel, Berdilă Anamaria, Iconomescu Teodora Mihaela (2019), Study regarding psychomotor aspects approached by Romanian authors Journal of Physical Education and Sport (JPES), Vol 19 (Supplement issue 6), Art 347 pp 2297 – 2304, 2019 online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 – 8051.
- Tomporowski P.D., Lambourne K., Okumura M.S. (2011). *Physical activity interventions and children's mental function: An introduction and overview*. Prev Med. 2011 Jun 1; 52(Suppl 1): S3–S9.
- Vayer, P. (1992). Psychomotor education in school age. Rome: Armando Editore
- Vecchiato M. (2017). Relational psychomotor skills: Emotional-behavioral maps from childhood. Rome: Armando Editore.
- W.B. Strong, R.M. Malina, J.R. Cameron, C.J. Blimkie, S.R. Daniels, R.K. Dishman , B. Gutin, A.C. Hergenroeder , A. Must, P.A. Nixon J.M. Pivarnik, T. Roland, S. Trost, F.Trudeau, (2005), *Evidence based physical activity for school-age youth*, in «J. Pediatr», 146, pp. 732–737.
- Whitehead, J. R., & Corbin, C. B. (1997). Self-esteem in children and youth: The role of sport and physical education. In K. R. Fox (Ed.), *The physical self: From motivation to well-being* (p. 175–203). Human Kinetics.
- WHO(2016), Physical activity strategy for the WHO European Region 2016-2025. World Health Organization. Regional Office for Europe.