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Neuromotricity and body schema. Bases for the use of body percussion in the sciences of physical education and sport

Neuromotricidad y esquema corporal. Bases para el uso de la percusión corporal en las ciencias de la educación física y el deporte

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Abstract. The aim of this article is to propose a theoretical and practical justification on the work for the internalization of the body schema in relation to neuromotricity. For this purpose, a bibliographical review is established on the perceptual-motor variables related to the elaboration of the body schema, such as attitude, postural control, spatial structuring, temporal structuring, balance and coordination with practical exercises of body percussion for its application in the physical education sciences. In this way, applying practical resources focused on the work of cognitive and executive functions, we offer an innovative psycho-pedagogical method in the field of human motor skills.
Keywords: Body schema, neuromotricity, body percussion, BAPNE, physical education, executive functions

Resumen: El objetivo de este artículo es proponer una justificación teórica y práctica sobre el trabajo para la interiorización del esquema corporal en relación a la neuromotricidad. Para ello se establece una revisión bibliográfica sobre las variables perceptivo-motrices relacionadas con la elaboración del esquema corporal, como son la actitud, control postural, estructuración espacial, estructuración temporal, equilibrio y coordinación con ejercicios prácticos de percusión corporal para su aplicación en las ciencias de la educación física. de este modo, aplicando recursos prácticos focalizados en el trabajo de las funciones cognitivas y ejecutivas, ofrecemos un método psicopedagógico innovador en el ámbito de la motricidad humana.
Palabras clave: esquema corporal, neuromotricidad, percusión corporal, BAPNE, Educación Física, funciones ejecutivas

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Introduction

In the Sciences of Physical Activity and Sport, human motricity is the object of study, not only regarding the quantitative aspects of the growth and performance of our systems, but also in the qualitative aspects of the maturation processes (Castro-Lemus, 2016). In addition to the analysis of parameters arising from the use of basic physical qualities, our field of knowledge focuses on variables related to the concept of the body, highlighting the brain and cognitive functions related to the quality of movement. As the essence of motor development, underlying the concept of corporeality and the wide possibilities of reflex and voluntary movement, highlighting for its importance, a structure: the body schema (Aguilar-Anisa et al., 2015).

Regarding the use of body percussion, we observe that it has a clear link with the knowledge of the body schema (Andreu-Cabrera & Romero-Naranjo, 2021; Arnau-Mollá & Romero-Naranjo, 2022; Alonso-Marco & Romero-Naranjo, 2022). The act of hitting different parts of the body, as well as moving in space and working laterality (Romero-Naranjo, 2012, 2013, 2014, 2018a, 2018b; Trigueros-Cervantes et al., 2022; Martínez-Heredia et al., 2021) require knowledge of our body both statically and in movement.

The correct use of the body schema allows us to work in parallel with cognitive functions by unifying language, the attentional network, spatial orientation, praxias and memory, as well as executive functions (Romero-Naranjo, 2022).

By learning a rhythmic structure in which both the upper and lower limbs must be used and where the activities are constantly changing without the student being able to intuit what the next movement is, possibly both cognitive functions are being stimulated (Arnau-Mollá & Romero-Naranjo, 2020; Jiménez-Molina et al., 2017; Moral-Bofill et al., 2020; Piqueres-Juan et al., 2019; Ros-Silla et al., 2019) and executive functions (Álvarez-Morales & Romero-Naranjo, 2019; Castelló-Juan et al., 2019; Cozzutti et al., 2017; Fernández et al., 2019; González et al., 2019; Latre-Nava et al., 2019; Torró-Biosca et al., 2019). This is the reason why neuromotor skills acquire a higher status, because when cognitive aspects are added to a physical activity, several areas of the brain are possibly worked (Burbano et al., 2021; González, 2022; Luis-de Cos et al., 2019; Mezcua-Hidalgo et al., 2020; Muñoz-Arroyave et al., 2020; Villa et al., 2019).

The correct use of the body schema in Physical Activity and Sport Sciences brings wide benefits not only at a physical or cognitive level, but also at a socioemotional level (Aguilar et al., 2021; Carretero-Martínez et al., 2014; Carretero-Martínez & Romero-Naranjo, 2015; Martínez et al., 2021; Pacheco et al., 2022; Padial-Ruz et al., 2022; Palma et al., 2021; Pérez et al., 2022; Romero et al., 2021; Rosa al., 2021; Zambrano et al., 2022).

After an extensive review of the specific narrative, there seems to be some theoretical discussion about terms such as motricity and psychomotricity, with a new discipline appearing in recent decades called neuromotricity. In this new approach to motor action, cognitive functions, and especially executive functions, are part of its essence. Therefore, neuromotor skills, as a discipline independent of psychomotor skills, proposes a completely different set of activities in which the dual task is always present. The

methodology of applied neuromotor skills could promote the generation of neural networks through stimulation protocols of increasing complexity, which in turn improve brain functions. This work aims to relate the internalization of the image of one's own body with neuromotor activities as a method for the knowledge of all body systems, as well as the possibilities of movement that the human being has. This is where neuromotor skills emerge as a means of getting to know oneself, knowing our limits, internalizing the image of our body and becoming aware of the possibilities and functions of our organism as a motor structure.

Motor action allows the exploration of the environment and the acquisition of relevant information for the formation of thought, so we can conclude that psychomotor development is linked to the acquisition of knowledge. There seems to be a consensus that early and rich stimulation in the sensitive stages of human evolution will facilitate motor and cognitive maturation.

Method

A qualitative methodology was used, proceeding to the reading and handling of documents that offered us data related to motor development and learning, specifically concerning the body schema. An investigation focused on the perceptual-motor variables for the development of the mental image of our body, as well as its functions and limitations. At the same time, this research focused on the methodologies that could facilitate the process of internalization and development of the body schema, highlighting the BAPNE method as the most effective within the field of neuromotor skills. The information collected was the object of reflection and discussion, and searches were carried out mainly in the Scopus, Pubmed and Web of Science databases.

The body schema

The first psychomotricians defined it as the result and at the same time the requirement of an adjusted relationship between the individual and his environment (Gallego, 2009; Prieto, 1983; Wallon, 1959). Subsequently, its definition was transformed giving it a much more complete meaning by defining it as the global intuition or immediate knowledge of our body (Castro-Lemus, 2016), whether in a state of rest or in movement, depending on the interrelation of its parts and, above all, its relationship with the space and objects around us (Le Boulch, 1966; Mamani et al., 2019). This notion is the core of the sensation of availability of our body and is also the center of our experience of universe-subject relationship. It is important to note that there is a review article (Rodríguez-Camacho & Alvis-Gómez, 2015) that provides us with a global overview on this subject with the latest contributions, but without including body percussion or neuromotor skills, central aspects of this article. The image of our body is fundamental for action in general, as it helps the child to organize the motor schemes that give rise to the most usual acts.

Perceptual-motor abilities are variables derived from the neurological structure and depend on the central nervous system. It is important to note that balance and the various types of coordination depend on sensory differentiation and proprioceptive analysis of recognition of one's own body or somatognosia (Martínez, 1999). In parallel, according to this author, knowledge of the outside world or exterognosia is also influenced by orthostatic postural tonic activity, which facilitates interaction with objects and others within spatiotemporal coordinates (Castañer & Camerino, 1991).

In any type of activity or movement, the notion of body, muscle tone, breathing, laterality, balance, etc., is present. All these variables present in any type of activity or movement favor the construction of the idea of the body, which allows us to create it in the mind as a structure with a series of functions. According to different authors (Rodríguez-Camacho & Alvis-Gómez, 2015), the perceptual-motor skills involved in the elaboration of the body schema are the following: attitude-postural control, spatio-temporal structuring, balance and coordination.

From body percussion we can work the body schema, so in Figure 1 we provide the following basic activity from the BAPNE BASIC program (Romero-Naranjo, 2018a) in which a first stage that allows working the upper and lower extremity is proposed.

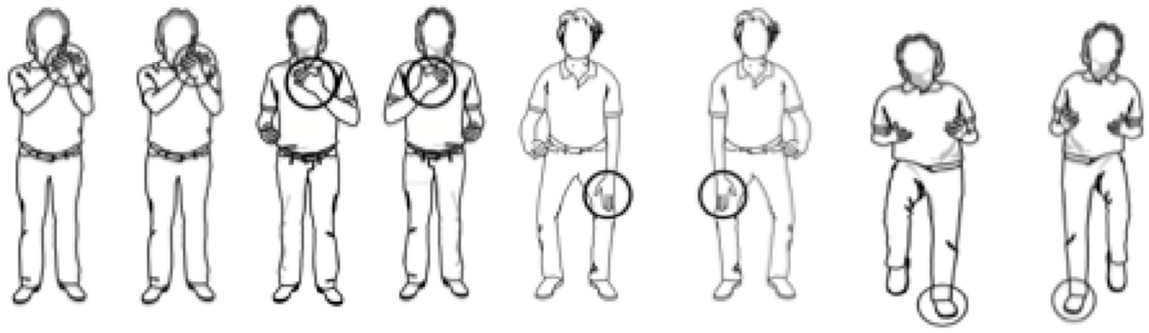

Figure 1. Basic coordination of upper and lower extremities

As an aid it can be taught by unifying the body stroke with the words Clap - Clap - Tox - Tox - Mus - Mus - Mus - Pie - Pie. Once the sequence has been learned, there are many activities that can be executed. From a neuromotor point of view, students are invited to perform the following activities while performing the sequence:

- Tell a story while performing this rhythmic sequence repeatedly.
- Repeating words or onomatopoeias while performing the rhythmic sequence.
- Moving in space in the foot part by jumping or stepping.

Attitude/postural control

Attitude education consists of moving from the adoption of a global attitude to the conquest of a habitual attitude, comfortable and capable of being maintained with a minimum of fatigue and without danger of causing osteoarticular imbalances (Chacón-Borrego et al., 2018; Le Boulch, 1966). The exercise of the adjustment function that expresses the greater or lesser plasticity of the central nervous system, allows the child, to respond to situations/problems he/she encounters when facing the environment. These adapted responses represent true praxis which are stabilized by repetition. Muscle tone is the key to postural adjustment and balance. The postural tone of the motor action is regulated by the cerebellum, which performs unconscious postural automatisms based on lived experiences. These postures are adapted at each moment to the development of the action through constant rebalancing and readjustment. This process depends on a series of information: visual, tactile, muscular, articular, etc. In general dynamic coordination, postural regulations and balance (perceptual-motor training inherent and inseparable from any motor behavior) are permanently involved. For Da Fonseca (1998), tonicity is conceived as the function of alertness and vigilance that requires the mobilization of a certain energy essential to the activation of selective connection systems without which no mental activity can be processed, maintained or organized. He also defines it as the active tension in which muscles are found when innervation and vascularization are intact, processing the activation of intra-, inter- and suprasegmental reflexes that ensure adapted postural accommodations. It is the basic structure that prepares and guides osteomotor activity, controlling joint modulation and ensuring plastic and integral adjustment of range of motion.

Figure 2 shows an example from the BAPNE FIT program (Romero-Naranjo, 2020a, 2020b) using a Step, ankle and wrist weights and elastic bands.

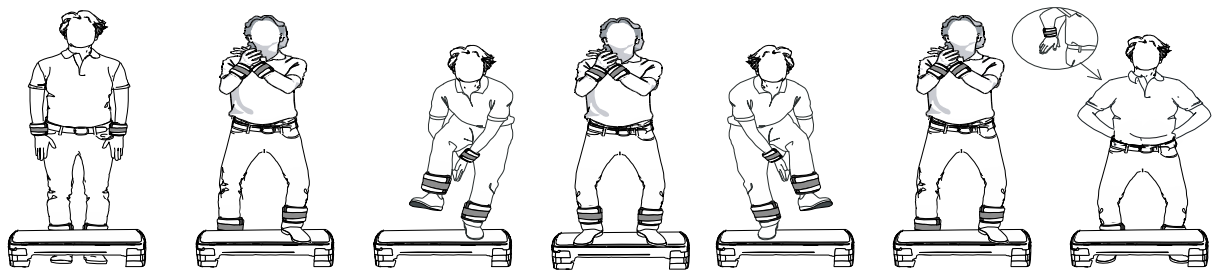

Figure 2. Activity with Step and other elements for coordination

Spatial structuring

Space is not the object of a mental representation but of a perception as a function of action. This concept is explained by Le Boulch (1966), indicating that the domain of "lived" space implies: the appreciation of directions, the appreciation of distances (aiming), the localization of a moving object (trajectory and speed) and orientation in space (Abellán, 2021). At the neurological level, according to Luria, cited by Da Fonseca (1998), the spatio-temporal structuring occupies the primary, secondary and tertiary areas of the visual and auditory analyzers respectively projected in the occipital lobes and temporal lobes. Da Fonseca argues that spatial structuring has functions of reception, processing and spatial storage that require a perceptual-visual structuring that contains the visual areas of the occipital cortex. Similarly, temporal structuring

involves brain functions such as reception and rhythmic processing and storage, naturally dependent on the integration of the auditory nuclear areas of the temporal cortex.

Other authors define spatial orientation as the ability to maintain constant the location of one's own body both in terms of the position of objects in space and to position those objects in terms of one's own position (Castañer & Camerino, 1991). Here, we must highlight the concept of laterality also studied by the same author, which defines it as the internal feeling of directionality or body tropism in relation to the surrounding space. This concept is developed together with the verbal conceptualization of the spatial components: up-down, right-left, front-back, etc. Cortical lateralization would be the specificity of one of the two hemispheres in the processing of sensory information and in the control of actions. The right hemisphere becomes a basic instrument of spatial thinking and visuoperceptual orientation.

For Da Fonseca (1998) laterality involves interhemispheric organization in terms of predominance: telereceptor (ocular and auditory), proprioceptor (manual and pedal) and developmental (innate and acquired). The identification of selective pre-predominance of one side of the body reflects the quality of sensory integration, both intracorporeal (vestibular and tactile-kinesthetic) and extracorporeal (visual and auditory), hence its importance in the functional organization of psychomotor and higher mental activity. Lateral predominance may vary in the visual, auditory or limb use channels. Lateral hemidominance presents the following cases: integral, in which there is predominance of one side in all its aspects; and non-integral, which in turn can be crossed (laterality does not occur uniformly on the same side), inverted (when the innate laterality of the individual has been counteracted by environmental stimuli) or ambidextrous (the execution of motor actions can occur with both parts of the body). The right cerebral hemisphere is the one that influences left lateralization, while the functioning of the left hemisphere has an impact on right lateral predominance. It is essential for human beings to know the position of their body within the environment, as well as to know how to measure distances, recognize them and apply movement from different perspectives.

From neuromotor skills we can provide very clear resources that allow the work of laterality unifying movement with and without speech. Figure 3 shows an example of such work.

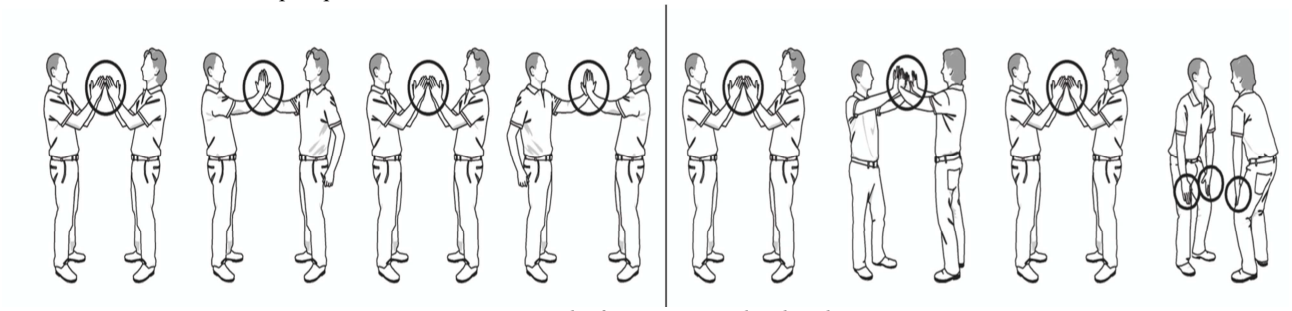

Figure 3. Example of an activity to work on laterality

Temporal structuring

According to Castañer & Camerino (1991), temporal structuring can be distinguished between the qualitative aspect of the time factor (perception of organization and order) and the quantitative aspect (perception of intervals of duration). The term rhythm is applied as a synonym for cadence, tempo, periodicity, accentuation or speed. Rhythm plays a fundamental role in the improvement of the automatic mechanisms of basic motor execution, located at the subcortical level. According to these authors, there are a series of systems involved in this capacity. Rhythmic induction, originated by an immediate perception reaction. That is, there is an effective synchronization between the stimulus and the response, the result of a reaction and anticipation to a melody or specific rhythm. Cognitive discrimination would be the assimilation, distinction and comprehension of rhythmic structures. Motor performance would be the last level of rhythmic training which, depending on learning and experience, provokes the intervention of higher brain processes generating complex and voluntary behaviors.

Finally, rhythm is based on two fundamental notions that allow a wide range and variety of rhythmic structures: the notion of regularity in the more or less rapid succession of rhythmic beats and the notion of alternation between two or more elements. Temporal structuring improves the coordination of movements. There are two basic components: order and duration. Order is the successive and irreversible distribution of events and situations that happen to us, while duration is defined as the representation of the measured physical time (seconds, minutes, hours…) that separates two temporal reference points. The human body is a set of articulated segments that moves discontinuously and by means of a series of supports (steps, strides, jumps) that constitute a rhythm, an order and a specific duration depending on the speed of locomotion.

From a practical point of view, the notion of structure and regularity is very well perceived through the activity called Clap Change from the BAPNE BASIC program (Romero-Naranjo, 2018a). Figure 4 shows this activity in which the students move their feet to make a square and clap their hands according to the numbers of the feet previously indicated by the teacher.

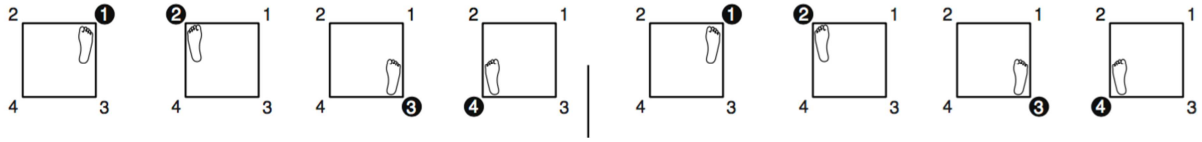

Figure 4. Activity carried out with the square to work on the temporal structure

Equilibrium

In the Sciences of Physical Activity and Sport, postural balance is defined as the process in which the subject tries to maintain an upright posture thanks to straightening reflexes, labyrinthine, optical, tactile, attitude reflexes or positive support reflexes (Álvarez, 1983). It has also been defined as the ability to control one's own body, to maintain it in space in an upright position thanks to compensatory movements involving global motor and fine motor skills. If the individual is still, we speak of static balance and if he/she is moving, of dynamic balance. In the latter, mastery and body control are the basis of the previous balance in rhythmic exercises, dance and in general in sports. In relation to body percussion, not only the upper limbs are used, but also the lower limbs in a profuse manner. Figure 5 shows an activity in pairs from the BAPNE BASIC program (Romero-Naranjo, 2018a) where balancing is the main objective.

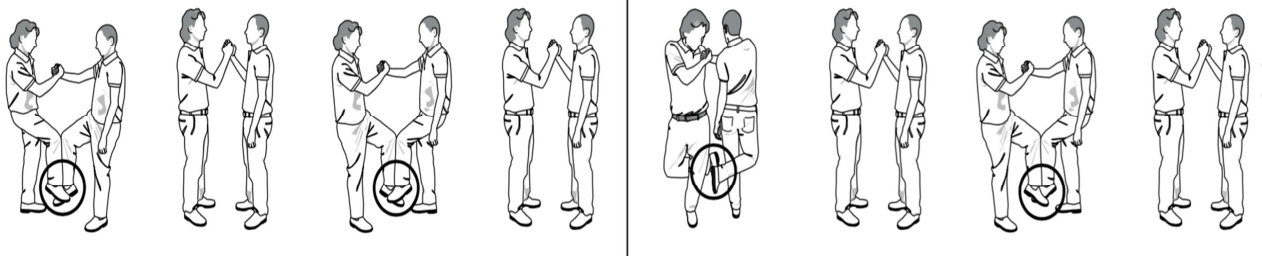

Figure 5. Balance work through neuromotor skills

Figure 6. Example of coordination with the title Handsball Change

Coordination

The work of coordination is not only limited to the mastery or synchronization of a movement or technical gesture, but in addition to the synchronization of movements, the precise adjustment of muscle tone and the speed with which the agonist muscles must intervene in interrelation with the antagonist muscles is also necessary (Álvarez, 1983). Therefore, coordination also means naturalness, adaptation and assimilation of the gesture, in such a way that it is spontaneous and devoid of synkinesis (atypical, unthought-of movements). From another point of view, Castañer & Camerino (1991) define coordination as the capacity to precisely regulate the intervention of one's own body in the execution of the right and necessary action according to the prefixed motor idea. There are two types: segmental and general dynamic.

The segmental coordination integrates the afferences of the various sensory modalities with a certain segmental-bodily zone located in the distal limbs (hand, foot) of the upper and lower segments. The hand-eye coordination is the one in which the relation of the object with the upper limb is positively effected and is the specific characteristic in the learning of a skill exercise. Exercises of this type establish the relationship between the target and the body, in order to lead the movements directly to a target. As the individual improves the skill, exercises of this type are less necessary, being able to execute them with closed eyes. Oculo-pedic coordination is the one in which the lower body is related to the fixed or moving object. Oculus-testa coordination, or eye-head coordination, is the coordination used to control an object with the head. Finally, Le Bouch (1966) defines general dynamic coordination as

those movements that require reciprocal adjustment of all parts of the body and, in most cases, involve locomotion. It is defined as that which groups movements that require a joint action of all parts of the body, movements where a large number of body segments and their muscles are involved.

In this respect, from neuromotor skills we can work extensively on coordination not only with body percussion but also with objects, as in this case with balls, as shown in Figure 6.

Neuromotricity and Body Schema

Dual-tasking is the ability to perform two completely independent tasks at the same time. Researchers have initially classified dual-tasking into 3 classical paradigms:

1. Motor-motor paradigm
2. Cognitive-motor paradigm
3. Cognitive-cognitive paradigm

The literature linking movement working with various parts of the body is growing ((Beauchet, Dubost, Hermann, & Kressig, 2005; Dubost et al., 2008; Ijmker, & Lamoth 2021; Jacobs, 2021; Mirelman et al., 2014; Park, & Brünken, 2014; Park, & Kim, 2021; Thornberg, Josephsson, & Lindquist, 2014; Yogev et al., 2005). For this reason, literature justification that supports the work of Neuromotricity and body schema is of vital importance. Neuromotricity is a discipline that involves rhythmic motor activities focused on cognitive and executive functions on a dual-task basis. The literature with people with cognitive impairment is extensive (Kim, Cho, & Yoo, 2017a, 2017b; Teixeira, Gobbi, Pereira, Pereira, Ueno, et al., 2013; Teixeira, Gobbi, Pereira, Vital, et al., 2013).

The literature describing the positive effects of movement on dual-tasking is growing. (Bååth, Tjøstheim, & Lingonblad, 2016; Chen, & Pei, 2018; Fritz, Cheek, Nichols-Larsen, 2015; Malcolm, Massie, & Thaut, 2009; Perrochon, Kemoun, Watelain, Dugué, & Berthoz, 2015; Plummer-D'Amato, Altmann, & Reilly, 2011; Silsupadol, Siu, Shumway-Cook, & Woollacott, 2006).

In 2017 Korean researchers bring a new paradigm after an intervention article calling it: Rhythmic-Motor (Kim et al., 2017, 2022; Loehrer et al., 2016; Montero-Odasso, Muir, & Speechley, 2014; Oh, 2016; Patel, Lamar, & Bhatt, 2014; Schrodt, Mercer, Giuliani, & Hartman, 2004).

Through the body schema work and following the literature reviewed there are four paradigms linked to the dual task in which the BAPNE method contributes to a possible fifth paradigm which is summarised below:

1. Motor-motor paradigm (walking while bouncing a ball with both hands)
2. Cognitive-motor paradigm (walking and talking; walking and arithmetic operations).
3. Cognitive-cognitive paradigm (writing an alphabet and answering arithmetic tests verbally).
4. Rhythmic-motor paradigm (walking and tapping two cylindrical objects with both hands).
5. Rhythmic-motor-cognitive paradigm (walking forward or freely in space while tapping the Cuban clef and responding verbally to arithmetic tests, questions about capital cities and countries, translation of objects into another language, etc.).

The following tables classify the possible benefits of body schema work through the BAPNE method (Alonso-Marco & Romero-Naranjo, 2022).

Table 1.
Benefits and contents attached to body percussion BAPNE method I

Kinesthetic / Anatomical	Psychological	Neurological / Cognitive	Etnomusicologic
• Body Scheme: Postural Control / Attitude Spatial Structuring Temporal Structuring Balance Coordination • Learning by biomechanical plane • Learning by biomechanical axes • Manual and pedal coordination (audio/visual/motor) • Motor dissociation • Development of the proprioceptive system • Development of the vestibular system • Strength work • Resistance work • Power work • Work on laterality • Knowledge of joints and bone structures in relation to neuromotor skills. • Learning of different types of timbres and sounds with the body. • Learning of clapping games and their modification to bring them to the classroom. • Movement technique / Motor coordination technique.	• Emotions CASA • Emotions TRAM • (Roberto Aguado) • Rooting: gaze, hands, feet (Lowen). • Increased motivation • Improvement of self-concept • Improvement of self-esteem • Acceptance of error as a vital learning process • Bonding work • Frustration management • Management of socioemotional aspects • Stimulation of play in learning • Sense of belonging to the group (tribe) • Learning theories and models • Forms of learning in BAPNE: • Imitation • Reverse reaction • Variable Circular Coordination • Real-time signalin • Learning in values • Evolutionary stages of neuromotor learning.	• Cognitive functions work: Memory Language Praxis Gnosias Spatial orientation Visuospatial ability Attentional network Social cognition Executive functions • Executive functions work: Processing speed Working memory Inhibition Verbal fluency Dual Task Cognitive flexibility Planning Branching Decision Making • Frontal lobe • Parietal lobe • Temporal lobe • Occipital lobe • Hormones in Neuromotricity (Serotonin, Cortisol, Oxytocin…) • Possible stimulation of the cerebellum • Amygdala	• Learning of work songs and their relationship with movement and body percussion. • Knowledge of chroniclers, travelers and explorers. • Introduction to the learning of the TALA of India. • Learning of the dances percussed by geographical zones: Verbunk Schuhplattler Esku dantza Haka Gumboots Kecak Stepping Balls dels Moretons Flamenco, etc. • Types of clapping by geographical zones: Gnawa Somalí Deaf Bright Cameroon, etc. • Learning urban rhythms

- BAPNE FIT program.
- BAPNE BODY EXPRESSION Program.
- Motor learning
- Motor control
- Motor programming
- BDNF
- Attentional network (Sohlberg and Matter, 1989).
- Work of the various types of memory (procedural, etc).
- Learning African rhythms
- Learning Latin rhythms
- Learning Asian and Oceanian rhythms

Table 2.
Benefits and contents attached to body percussion BAPNE method II

Musical	Visual Arts	Creativity	Evaluation	Research
Pulse	Commercial Spots	Gesture	Assessment of the learning sequence	Introduction to research
Rhythm	study	Movement theatricality		Scientific-academic search engines
Musical figures	Analysis of the	Logical thinking	Assessment of accountability for a job well done	Search strategies
Metric division and subdivision	product and its relationship with the	Systemic thinking		Bibliographic managers
Beats and Offbeats	movement	Creative thinking	Evaluation of the management of the "You are the Teacher" activity.	Case studies
Timbre	Analysis and relationship with painting and design	Body language		Quantitative-qualitative research
Agogic		Bases of Creativity		Evaluation instruments (validated tests and questionnaires)
Improvisation		Creation of activities based on the Cognitive Functions	Evaluation of the management of values in learning.	
Composition	Creation of practical	Creation of activities based on	Evaluation of error management	Presentation of projects to the research ethics committee.
COGNITIVE SOLFEG PROGRAM	resources linked to technologies	Executive Functions	Evaluation of body language	Selection of centers (control and experimental groups).
	Relationship between space, architecture and movement	Creation of activities based on ethnographic aspects	Evaluation of socioemotional management	Types of articles: rationale, research design, bibliometric, review, systematic review…
		Analysis of relevant works such as Corporel, Clapping music, Libertadores, etc.	Evaluation of the kinesthetic aspects and their technique	Data analysis (SPSS).
			Evaluation of musical aspects	Publication process in congresses and journals.
		Creation of activities for corporal expression	Evaluation of activities related to Cognitive and Executive Functions.	Scientific-academic writing: introduction, method, participants, instruments, procedure, results, discussion, conclusion, references.
		Neuromotor skills and mathematics in infants.		Citation and references according to standards (APA).
		Neuromotor skills and learning a foreign language.		
		BAPNE PROGRAM OF CREATIVITY AND RESEARCH		

Results

The neuroscience specialty in charge of the study of the neural network that organizes and controls human movement is neuromotor. Lapierre (1974) states that, between the psyche and the mechanics of a muscle, there is a whole neurological structure of transmission and regulation, which the author calls the psychoneuromotor system. Based on these principles, the same author explains in detail the essential neurophysiological bases that preside over the elaboration and execution of voluntary, automatic and reflex movements. On the other hand, Hernando and Useros (2007), define neuromotor as the nervous response performed in the cortical and subcortical nerve centers to produce a motor response. In turn, Díaz-Jara (2015), defines neuromotor as the analysis of the neurological aspects involved in the development of a movement, its programming, its control and the acquisition of the models of execution of the movement. It is a subject that is spreading, leaving behind motor reeducation or motor therapy. The knowledge of the brain in the 21st century has an unequivocal impact on new procedures that promote the stimulation of the cortex, perception, movement programming, motor control and decision-making in the field of motor skills.

The term "neuromotricity" is cited in research related to motor development and learning, as well as in studies on neuromotor and cognitive aspects, especially in developmental disabilities or disorders. Neuromotricity as a science is defined as a part of Neuroscience that studies the neurological processes that influence the generation and mastery of human motor skills, and that plan, organize, evaluate and control movement, to achieve motor milestones in adaptation to the environment and depending on environmental stimulation. As a system or procedure, we understand neuromotor skills as the educational and neurorehabilitative methodology within the motor field, which affects cognitive and socioemotional stimulation through the specific work of the executive functions of the brain in relation to learning and motor skills (Andreu-Cabrera & Romero-Naranjo, 2021).

Neuromotricity and the BAPNE method: a proposal for the Physical Activity and Sport Sciences

The BAPNE method has several programs with very specific activities according to the discipline of work. In the first instance, we work initially with the BAPNE BASIC program (Romero-Naranjo, 2018a) with the objective of acquiring basic skills. Once internalized, we move on to the BAPNE FIT program (Romero-Naranjo, 2020a, 2020b) which provides much more specific resources for Physical Activity and Sports Sciences.

The novelty is not only in offering aerobic exercises with the aim of improving motor coordination, lung capacity, muscle tone and reduction of subcutaneous fat, but also focuses on cognitive work focused on the executive functions presented below.

Processing speed: reflects the amount of information

that can be processed per unit of time or even the speed at which a series of cognitive operations can be performed, but also the time that elapses from the appearance of the stimulus to the execution of a response.

Working memory: also called working memory, it is the ability to record, encode, maintain and manipulate information during a very specific interval of time to maintain a sense of unity of cognitive activity.

Verbal fluency: related to the processes that carry out the appropriate strategies for the search of information and its appropriate response in the shortest possible time. It is worked through the ability to improvise verbally within certain structures provided by the teacher.

Dual task: the ability to perform two completely different tasks simultaneously and paying equal attention to both of them constantly. It involves working in parallel on a visual and a visuospatial task.

Inhibition or interference control: the ability to inhibit or control impulsive responses, interferences or distracters while performing a task. It can be worked on at the motor, attentional and behavioral levels.

Cognitive flexibility: is the ability to make changes in what was previously planned and thus adapt to the circumstances of our environment.

Planning: is the ability to generate objectives, develop action plans to achieve them and choose the most appropriate one based on the anticipation of consequences.

Decision making: is the process of making a choice between several possible choices based on needs, assessing the results and consequences of each one of them.

Branching: is the ability to organize and perform three tasks optimally simultaneously, interleaving them and knowing where each of them is at any given moment.

The possibilities of neuromotor skills are very broad, since both the motor and cognitive dimensions are closely related. From the kinesthetic point of view, the activities can be performed both in a seated and bipedal position, as well as moving in square, triangle or other spatial shapes. Possible stimulation of executive functions is activated by parallel use of language and solving different challenges of increasing complexity.

Figure 7 presents a global activity model showing the potentials in the area of motor development and learning. This example is applicable for the development of the body schema and is subsequently performed with Step, elastic bands and weights on the ankles and hands.

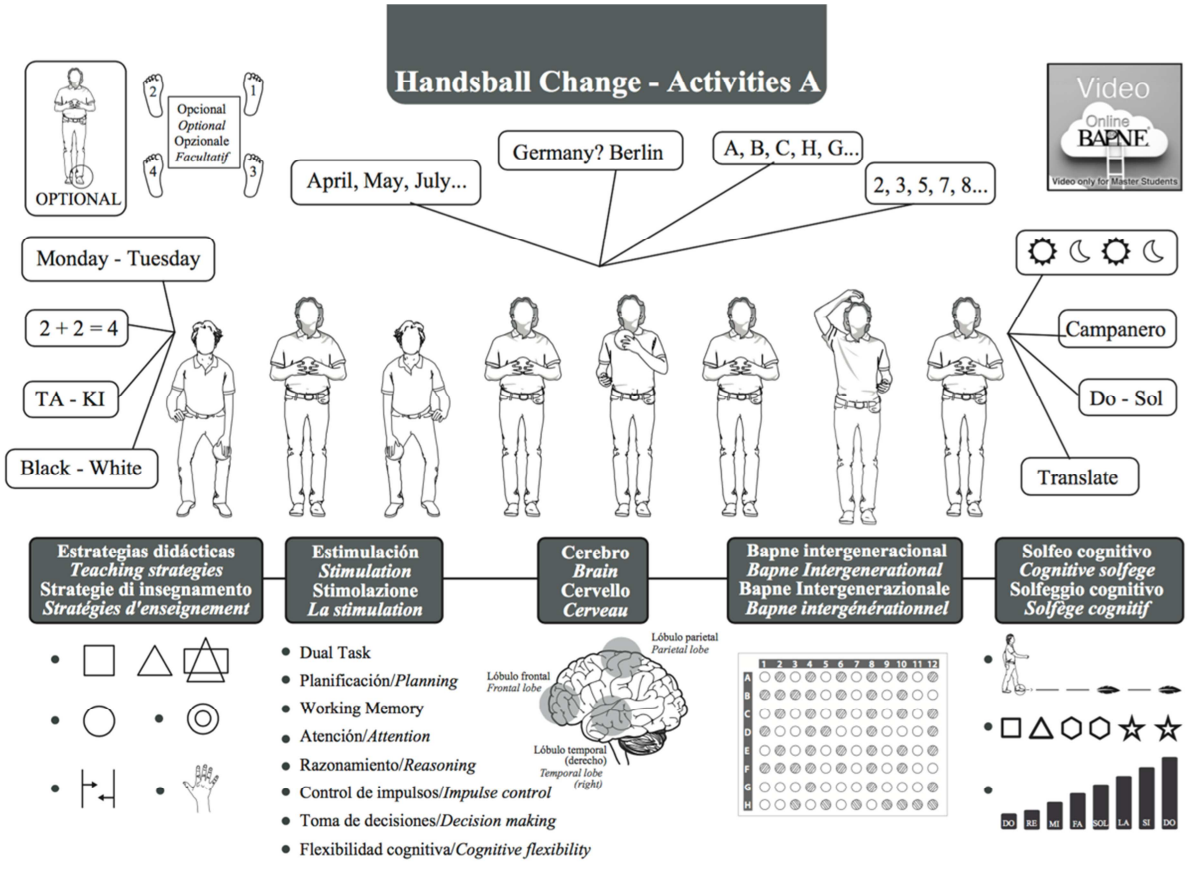

Figure 7. Activity model of the BAPNE method

The BAPNE method is a didactic approach for working on neuromotor skills through a protocol that could help structure the concept of the body. This method offers activities in which, among others, the perceptual-coordinative capacities for the development of the body schema are worked on. These activities are designed in a progression of psychomotor difficulty, and involve motor variables such as muscle tone, postural attitude, laterality, spatial concepts (front, back, up, down...), balance, all types of coordination and temporal concepts (rhythm,

order, duration, etc.).

Conclusions

Methodologies inspired in the 19th century, taught by 20th century teachers, for 21st century students deserve a revision of the educational paradigm. We cannot think of neuromotor skills by performing the same classical activities coming from psychomotor skills. Based on this theoretical justification, we provide examples that imply an increase in complexity in execution. The correct execution of such activities would allow the optimization of brain work, through multitasking. Applied to the process of elaboration of the body schema, the BAPNE method could facilitate the internalization of the notion of body. Thus, a novel methodology is presented, which aims to replace or complement the psychomotor approaches that have existed in infant school for decades. Advances in research on the brain force us, as teachers, to innovate in terms of the activities to be carried out in the classroom.

Once analyzed the different meanings of the terms motor, psychomotor and neuromotor, we are in favor of evolving towards practices that enhance the executive functions, while cognitive, of our gray mass. In recent years, knowledge and research on the brain has provided new channels of development, with neuromotor skills taking on special relevance.

With regard to motor development and learning, it is essential to know at the neuropsychological level, the principles of motor coordination linked to cognitive functions and executive functions. In the case of the body schema, a notion so important for the motor evolution of the individual from the earliest ages, we consider it essential that the educator has a broad base of knowledge about the brain, since all his educational action has a direct effect on this organ. Neuropsychological and neuroscientific knowledge will facilitate the development process of a student and will improve the methodologies of psychopedagogical intervention in the area of Physical Education.

By way of conclusion, we want to advocate that neuromotor skills, as a science and as a method, becomes in the XXI century a common core between Neuroscience and the Sciences of Physical Activity and Sport with a transversal vision to other disciplines. In addition to the above, the BAPNE method is presented as a general methodology for the Sciences of Physical Activity and Sport as well as specifically as a procedure to help in the elaboration and internalization of the body schema or mental image of our body and its possibilities of action.

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