Orientamenti di educazione permanente
Permanent education guidelines

Early roots of adult Mind
Le radici della mente adulta

Alberto Oliverio
University of Rome, Sapienza – alberto.oliverio@uniroma1.it

ABSTRACT
We are generally inclined to separate the various aspects of mental functions from each other as they were modules with their own autonomy. However, the mind, be it language as well as other cognitive and perceptive functions, has its own unity and is affected by a component, the motor one, which is the oldest from an evolutionary point of view and which depends on nervous structures – cortex, basal ganglia and cerebellum – that add in their motor, motivational and cognitive components.
Motor and cognitive processes are functionally related and share a similar evolutionary history. This is supported by clinical and neurophysiological data showing that some brain regions integrate both motor and cognitive functions. A large body of data supports the notion that motor processes can contribute to cognitive functions, as found by many rehabilitation and aerobic training programs.
From early childhood, muscular movements, the basis of complex procedural memories and automatisms, represent the building blocks on which a set of vast mental abilities are built. The infant gradually learns from the internal logic of movements and actions the principles of sequentiality and causality, essential to structure the language, to produce congruous phonatory movements, to sort words according to a logical progression.
During infancy, motor skills and activities typical of free play are closely associated with a series of cognitive consequences that are part of a remarkable brain plasticity. This plasticity continues to manifest itself in the life span and benefits from a cognitive reserve whose foundations were laid in the years of childhood and adolescence. Physical exercise, aerobic activity as well as intellectual stimulation continue to have a positive effect on brain plasticity even during old age.

Generalmente siamo inclini a separare l'uno dall'altro i vari aspetti delle funzioni mentali ritenendo che si tratti di moduli largamente autonomi. Tuttavia, la mente, che si consideri il linguaggio o altre funzioni cognitive e percettive, ha una sua unitarietà ed è influenzata da una componente, quella motoria, che è la più antica da un punto di vista evolutivo e che dipende da sistemi, corteccia, gangli basali e cervelletto, in cui sono evidenti componenti motorie, motivazionali e cognitive.
I processi motori e cognitivi sono funzionalmente correlati e condividono una simile storia evolutiva. Ciò è supportato da dati clinici e neurofisiologici che dimostrano, infatti, come alcune regioni cerebrali integrino funzioni motorie e cognitive. Numerosi studi nell'ambito della riabilitazione e dell'aero-

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bica indicano come i processi motori possano contribuire alla funzione cognitiva.
Sin dalla prima infanzia, i movimenti muscolari, alla base di complesse memorie procedurali e automatismi, rappresentano i mattoni su cui vengono edificate un insieme di vaste capacità mentali. Il lattante apprende gradualmente dalla logica interna dei movimenti e delle azioni i principi di sequenzialità e di causalità, essenziali per strutturare il linguaggio, per produrre movimenti fonatori congrui, per ordinare le parole secondo una progressione logica.
Nel corso dell'infanzia la motricità e i giochi di movimento sono strettamente associati a una serie di ricadute cognitive che fanno capo a una notevole plasticità cerebrale. Questa plasticità continua a manifestarsi nell'arco vitale e si avvantaggia di una riserva cognitiva le cui basi sono state gettate negli anni dell'infanzia e dell'adolescenza. La motricità, l'attività aerobica così come il tenere la mente in esercizio continuano a esercitare un effetto positivo sulla plasticità cerebrale anche nel corso della terza età.

KEYWORDS
Motricity, Plasticity, Aerobics, Cognitive reserve, Aging.
Motricità, Plasticità, Aerobica, Riserva cognitiva, Invecchiamento.

1. Motor and cognitive development

The mind of the child, as we know by observing its behaviour and as the studies of generations of psychologists have shown, is fundamentally different from that of an adult. An infant thinks and gets excited in a different way compared to an older child, a teenager, an adult. These differences are not so much quantitative, as if the mind of a child were still miniature, but qualitative. They reflect not only a distinctive number of experiences and adaptations but also profound differences in the maturation of the brain, of the senses, of motor and cognitive abilities. The visual world of a small child, for example, is a drastically diverse world than that of a 4–5-year-old, his eye movements are still uncertain and immature and not so much for muscular reasons but because his nervous system is not yet able to send the appropriate signals. From birth, senses, movements, thought, emotions gradually transform, passing through different stages, similar to the steps of a staircase – or successive waves – that lead to ever higher capacities. Do these stages respond to a strict genetic programme or are they affected by the environment in which development takes place?

To answer this question, it is necessary to trace a story that narrates in parallel biological and psychological events from their initial steps. The study of the behaviour of a foetus, newborn, infant or child indicates a strong synchronism between brain development and mind development and emphasizes the presence of a genetic program but also an extreme ability of the brain to adapt and modify its structural characteristics and functions to the needs of the moment. Our knowledge on the development of the mind is based on an alliance between developmental psychology and neuroscience, possible thanks to new tools for studying mind and brain. These tools – mostly brain imaging- have made it possible to accurately identify the developmental stages of various areas and nerve structures and therefore to relate a particular aspect of behaviour to a particular brain structure. Through these strategies it is possible to draw a new topographic map – dynamic and non-static – of the nervous system, starting from the very early stages of development.

To understand how a child's mind works it is therefore useful to go back in time, to follow step by step the stages of the growth of the nervous system, its path to maturity. This path can be compared to the weaving of a carpet that, initially, consists of a few knots that tell us little about what the final design will be. Gradually this design becomes more and more visible and, in principle, corresponds to the design to which it is inspired. Like any handcrafted artifact, a carpet may contain some errors, or variations on the theme: the same is true for the nervous system that is inspired by a genetic design, information contained in the genes, but deviates from the ideal project to become something extremely individual, the product of a complex and unrepeatable interaction between genes and the environment.

A fundamental aspect of cerebral maturational processes, and therefore of the maturation course of the child's mind, concerns motor development and the importance that motricity has in giving shape to a series of mental abilities, primarily language. During its evolutionary process, the brain especially needs to make tactile and motor experiences to develop those sensory-motor areas that represent the starting point for the maturation of the cortical areas responsible for executive procedures (such as attention, memory, decision making), for language and complex thinking. In its initial phase, the mind of a child is above all concrete, based on direct interaction, on a series of attempts, even unsuccessful, promoted by the child and not foreshadowed by a genetic program, on slow rather than fast times.

Somatic signals play an important role in the process of building our mind. The states of muscle tension, heart rhythm, changes related to the activation of the vegetative system are a series of signals that contribute to representing the outside world. The mind must take into account our body, its movements, their consequences, what we will do next. The body is an essential component of the mind and it is very difficult for symbolic functions to exist that do not require, depend on or are regulated by the exchange of information with the rest of the body. The so-called "interactive synchronicity" in infants is the first sign: children of a few weeks of life produce a series of micromovements in response to human voice, a kind of "dance" activated by the voice, by the rhythm of language (any language). The same "dance" does not appear when the child listens to other sounds, a fact that, on the one hand, argues in favour of an innate sensitivity to the human voice and on the other indicates that language is not a purely mental or abstract fact, but also involves the body. Even those who speak, accompany the language with micromovements (mimics and the body) that make their verbalizations meaningful, such as to motivate the listener to participate in the "dance".

The role of motor activity in the construction of the mind is evident from the point of view of the first developmental steps. The innate movements of the embryo and the increasingly refined movements of the infant are the building blocks of motor behaviour and of a consequent number of "sequential" activities. At first the newborn has a predominantly passive role and merely notices a series of movements and actions that cause events concerning her/his well-being. Every movement of the mother (or father) generally has positive consequences on her/him: caresses meet the need for physical contact, food satisfies her hunger, maternal gestures and words respond to her curiosity and her need to explore the world. An adult who approaches him, who speaks to him, who smiles at him, who cradles him, who feeds him: this is the initial world of the newborn, made up of the movements of the adult that generate in his mind temporal connections (before and after) and causal connections that will be the basis of linguistic movements and meanings.

Soon, however, it will be the infant himself, with his increasingly precise and selective movements, who will produce actions that involve changes in the environment around him. The development of motor skills takes place gradually after birth and through specific stages. After a few weeks, the infant is able to make coarse movements, for example to bring an object closer to his body through a non-selective arm movement. From the second to the fourth month, he can grab his foot, simultaneously clutching all the fingers of his hand; later, he will be able to orient his hands and develop what is called a precision grip, namely, to oppose the index finger and thumb of the hand to grab a small object, such as a spoon. These motor actions are increasingly coordinated and based on a succession of acts that depend on memories encoding concatenations of movements capable of responding to specific situations. These motor procedures are also enriched with complex muscle sequences aimed at imitating the facial expressions of the adult. Limb movements and mimicry form an initial nucleus of motor patterns, muscle memories around which subsequent memories are developed, as a kind of warp that will gradually be worked by the succession of experiences and activities of the mind. These muscular or bodily memories – the technical term is procedural memories, as they involve a series of procedures and not meanings, as is the case with declarative memories – are the starting point of subsequent linguistic learnings, also based on motor sequences that are not very different from the organization of hand or head movements but that serve to produce a coordinated series of significant sounds (Oliverio, 2007, 2008).

In essence, the infant learn from the gradual internal logic of movements and actions the principles of sequentiality and causality, essential to structure language, to produce congruous phonatory movements, to sort words according to a "logical" progression, similar to those movements that he has early produced – such as grasping, sitting, walking – (Libertus, Violi, 2016; Walle, Campos, 2014) or that he saw realized early around him. Motor control is somewhat the opposite of what happens in the case of perception: perceiving means constructing a representation of the outside world as the action begins with an image of the desired consequences of a movement and then continues in its execution. Thus acting, e.g., making movements, means starting from a map of the environment, that is from coordinates that depend on the parietal cortex and the hippocampus, a subcortical structure responsible for many aspects of spatial memories. This way of looking at mental reality can seem paradoxical and provocative: generally motor functions are considered to be low-level, subordinate to those structures that are at the basis of highest cognitive activities, rationality of "pure" thought.

Our brain is a huge archive of motor repertories, complex patterns guarded and implemented by the basal ganglia and cerebellum, which the Russian psychologist Aleksandr Lurija (1975) called "kinetic melodies" to indicate the complex fluidity that each of us implements in the different acts of daily life. Brain imaging techniques (such as PET and nuclear magnetic resonance) have contributed to the knowledge of motor patterns: if you ask a person to think about moving the hand, as if he wants to grab an object, his premotor cortex, located in front of that motor cortex in the frontal lobe, becomes active, which indicates that there are areas of the brain that predispose movement and areas that realize it. This parallelism between anticipation and action also applies to imagination and sensation: thus, just imagining an object, for example a rose, leads to the activation of the areas of the visual cortex that are activated when that object is actually perceived.

Another level of the relationships that exist between anticipation and action concerns the existence of mirror neurons studied by Rizzolatti et al. (1996, 2002): these are localized in the premotor cortex and are activated when human and non-human primates observe another individual performing a movement. For example, if one observes an individual grasping an object, those neurons that could prepare other neurons in his motor cortex to carry out such an action get activated. These mirror neurons, which establish a kind of bridge between the observer and the actor, are therefore at the centre of imitative behaviours which play a fundamental role in the development of movements, including those related to the production of vocal sounds.

Generally, we are inclined to separate the various aspects of mental functions from each other believing that they are modules with their own autonomy. However, the mind, be it language as well as other cognitive and perceptive functions, has its own unity and is affected by a component, the motor one, which is the oldest from an evolutionary point of view and which depends on systems – cortex, basal ganglia and cerebellum– that add in their motor, motivational and cognitive functions (Libertus, Violi, 2016). This motor dimension has so far been underestimated at the expense of a "disembodied" cognitive dimension. As many pedagogists have observed, including Maria Montessori (1949), a fundamental aspect of development concerns motor control and the direct involvement of the child: it has important repercussions on cognitive functions and emphasizes the close interweaving that exists between mind and body at every age of life. Thus, we must keep in mind that the child must develop a complex motility, must learn to "do", that is to change reality with his hands, so as to undertake an empirical path that later will have more general repercussions on his confidence in being "actor" rather than user, in other words an adult confident in his ability to change reality.

Today, our goal is to use current knowledge about the brain to learn how to use its abilities and to stimulate its various areas, creating different forms of connection between them. Take, for example, a practical case related to reading learning by means of a method adopted by some kindergartens. In addition to ears and eyes, children who need to learn to read use touch, the sense that in early childhood is more developed and natural. Reading is thus learned in three different dimensions: it is a matter of favouring the integration between the visual form of a letter – which is treated by the visual area of the brain – and the corresponding sounds, treated by the auditory area. To facilitate such associations, touch is added. With this method children learn to recognize words much faster than with the traditional method (Dehaene-Lambertz, Gentaz, Huron 2011). Today there are many neuropedagogical strategies (Oliverio, 2017), for example they exploit the association between positive emotions, learning and memory, a method that is based on the association between different aspects of an experience (Borel-Maisonny, 1969).

Within the embodiment theory of education (Kiefer and Trumpp, 2012), a strategy is to encourage in children associations between motor representations and learning. This strategy has been defined "recited learning ". The technique exploits the fact that procedural motor memories (related to repetition and the refining of the execution of a particular movement) are particularly robust while declarative memories (e.g., related to the meaning of words) are more fragile. "Recited learning" was used to improve learning a second language: children must recite in group a series of words and accompany them by gestures and movements that represent their meaning. A study on efficacy of this method indicates that students achieved a performance three times higher than students who followed the conventional method. Also performing music, possible in younger children thanks to improvised instruments and vocalizations, improves cognitive functions as evident by earlier development of the cingulate cortex. To this, must be added the fact that a collective musical performance also acts on social cohesion and social maturation.

As previously indicated, it has been argued that motor and cognitive processes are functionally related as supported by clinical and neurophysiological data showing that some brain regions integrate both motor and cognitive functions. In addition, cognitive processes coincide with complex motor output. A large body of data support the converse notion that motor processes can contribute to cognitive function (Best, 2010; Leisman et al., 2014, 2016). Another aspect of motricity concerns the relationship between aerobic activity, brain trophism and cognition, both in children and old age. Several studies (Ratey, 2008; Perini et al., 2016) have shown that there are clear relationships between aerobic physical activity (running, cycling, chasing, practicing movement games) and the functioning of the hippocampus and prefrontal cortex that are at the center of cognitive and executive functions, such as attention (Chaddock et al., 2010; Raine et al., 2013).

Physical exercise improves cognitive functions because it acts on brain plasticity processes. It stimulates the formation of new blood capillaries, the production of synaptic contacts between nerve cells and can even lead to an increase in the generation of new neurons in the hippocampus thanks to the production of BDNF, the Brain-derived neurotrophic factor. These positive effects are particularly evident during childhood and adolescence, when the brain is still developing, especially with regard to the prefrontal cortex which is one of the last parts of the brain that mature in the course of development. In children, after less than 30 minutes of aerobic physical activity (running) the ability to concentrate greatly improves due to increased blood circulation in the frontal lobes responsible for many executive functions such as attention, working memory, learning. This knowledge should result in an anticipation of the time of physical education at the beginning of the school day or in taking short breaks of physical activity during school hours. More generally, it has been found that in children with attention deficits the practice of exercises based on motor control increases concentration capacity (Berwid, Halperin, 2012; Erickson et al., 2015; Hilman et al., 2008; Raine et al., 2013). Aerobic activity also exerts its positive effects in adults and the elderly as a good level of blood oxygenation leads to an increase in brain plasticity (Doyon, Benali, 2005).

As a whole, these studies indicate that increased aerobic function triggers the processes of brain plasticity resulting in complex functional changes at the cortical and subcortical level such as those at the ground of memory and learning (Ferretti et al., 2010; Manago et al. 2012)

2. Plasticity and epigenetic mechanisms

When considering plasticity in terms of changes in the nervous system and nerve function induced by the environment, an historical turning point concerns studies on the effects of an enriched or impoverished environment. In the mid-1960s, a group of comparative psychologists from the University of California, Berkeley, led by Mark Rosenzweig and Coll. (1962) completed an experiment in some ways heretical with respect to the theories of the brain then current. The brain was in fact considered as an organ practically impervious to the effects of the environment. Programmed by genes, equipped with a set number of neurons not able to multiply after birth, the brain seemed to have structural characteristics, relationships between neurons and circuits that were considered as invariants, absolutely not liable to change. The experiment designed by Rosenzweig involved the immersion of two different groups of rats in two opposing environments, one rich and one poor in stimuli. Raised in the two contrasting environments, the animals showed that they were deeply affected by different youthful experiences as the brains of "enriched" animals were heavier, characterized by a thicker cortex, a greater number of glia cells and finally neurons with a greater number of dendritic spines, the subtle extensions that form synapses between neurons. In essence, Rosenzweig and his collaborators demonstrated that the structure of the brain is not completely predetermined but that it is susceptible to significant structural changes that can lead to behavioural differences, such as increased learning ability evident in adulthood in the animals raised as young in an enriched environment.

Starting from these data that indicated how brain structure and function did not respond to a rigid determinism, neuroscientists indicated that in the first years of life the human brain is positively – or negatively – affected by an enriched or impoverished environment. The most striking data concern the effects of the hemispherectomy, the removal of the cortex of an entire cerebral hemisphere. When it is practiced on children, the residual hemisphere is able to take control of a function for which it is not generally capable. For example, the removal of the left hemisphere – which controls language ability and movements of the right half of the body – can be compensated by the right hemisphere taking on linguistic tasks and controlling movements of both sides of the body, not just the left side as is normally the case.

Hemispherectomy is an extreme example of childhood plasticity. Other examples show that the relationships between structure and function are very plastic, in the sense that experience can change the area of the cerebral cortex dedicated to controlling a specific function and how the extension of this area can change over time depending on the situation and needs of the organism. For example, some functions, such as sensory functions, are located in a specific area of the somatosensory cortex where it is possible to identify the topographic map (homunculus) that allows to pinpoint the location of neuronal populations that correspond to the peripheral territories from which they receive information. The boundaries of these topographic maps can vary throughout life, adapting to new needs and situations of peripheral territories. The results of different experiments show that the representation of a particular sensory function at the level of the somatosensory cortex is highly variable, very plastic and subject to profound remodelling.

Take, for example, the somatosensory area or 'homunculus', so defined because the map is deformed by the fact that some peripheral territories, such as the hand or face, are represented by more neurons than the trunk or legs, due to the complexity of the functions necessary for fine manipulation, facial expressions or language. Well. the homunculus, instead of being a map invariable over time, varies in its shape – that is, it reflects a different numerical relationship between neurons and peripheral territories – depending on the situation of the periphery, that is, the use or disuse of limbs and muscles. Let's imagine that as a result of a traumatic injury a person loses a limb: several studies indicate that the cortical map of the peripheral territories goes through deep adaptive changes, by allowing more space or central "representation" to those areas of the body that could now vicariate the missing function: the other limb, the residual stump of the limb, etc. However, there is no need to hypothesize such a drastic situation as the loss of a limb to study and understand the plasticity of the homunculus and therefore of the cerebral cortex: it has been observed that an increase in the function of a peripheral territory – think for example of the hand of a violinist or the arms of a juggler – involves a dilation of the cortical somatosensory map (see for a review Neville, Sur, 2009). In other words, more neurons take charge of a particular function, as if the cortical map were drawn on the surface of a rubber balloon and this was more or less inflated or deformed.

The role of experience, whether positive or negative, refers to a fairly recent acquisition of biology, e.g., the so-called "gene expression", regulated by those environmental factors that manifest themselves throughout life. Much research indicates that there is a significant relationship between early experience and brain function. The most recent studies refer to epigenetic mechanisms, e.g., persistent alterations in gene expression resulting from early experiences. Epigenetics – from the Greek epì (above) and gennetikos (related to family inheritance) – refers to those changes that affect the phenotype (the set of all the characteristics observable in a living being, such as the colour of the eyes or hair) without altering the genotype (the set of genetic characteristics of an organism). Epigenetics therefore describes all those heritable changes that change gene expression while not altering the DNA sequence, and therefore the hereditary phenomena in which the phenotype is determined not so much by the inherited genotype, but by the overlap with the genotype itself of an "imprint" that alters the degree of activity of genes without however changing the information contained in them. Whereas in the past it was believed that the mechanism of hereditary transmission essentially depended on DNA and was "impervious" to the environment in which it occurred, today it is known that the so-called DNA methylation (the process consisting of binding a methyl group, – CH_3, to one of the nitrogenous bases that form the double helix) regulates gene transcription processes and gene expression. Some of these genes govern increased sensitivity – or resilience – to stressors, others intervene in the course of new experiences (learning, memories, etc.) by permanently modifying neural networks. In essence, epigenetic mechanisms are the basis of neural plasticity.

3. Prevention of involutive phenomena

Today it is well known that in early years plastic processes ensure that when a nervous network loses efficiency, another network is functionally capable of performing the functions exercised by the former. This means that the greater the number of networks, the higher cognitive flexibility, memory capacity, learning, etc. (Oliverio, 2021) Over the years these brain abilities are reduced: but if the brain benefits from previously accumulated capital, the so-called cognitive reserve, it can compensate for the damage that manifests itself with age.

How to encourage the presence of alternative circuits and/or increased coding? An indication emerges from a study showing how the cognitive abilities of those who have done early musical practice positively affect the elderly. The research was carried out on a sample of healthy elderly people divided into three groups based on childhood musical experiences: in the first were included those who had never practiced music, in the second who had practiced it for a few years (nine at most), in the third those with more than 10 years of experience. Several neuropsychological tests indicated that those who had studied music longer achieved the best results, while non-musicians scored lower in all tests. One may wonder whether the best performance of people who have played longer is related to the fact that they continued to play in the years of late maturity or old age, thus keeping the brain engaged and stimulating it for a long time. However, the answer is negative. The positive effect on the brain comes essentially from having stimulated it early: there are, in fact, crucial periods of brain plasticity that have a greater impact on the development of the nervous system and of its functions. In essence, the sooner musical practice is done, all the better for the brain. Playing an instrument involves, in fact, numerous brain functions, from linguistic to sensory, motor, as well as enhancing executive functions such as attention and memory.

More generally, these and other data indicate that brain stimulation in early years contributes to making the brain plastic. Learning a second language, playing an instrument, developing the mind through different strategies, not only represents a concrete advantage in the immediate future but constitutes a capital that will come in handy in old age. On the other hand, statistics show that people who have carried out intellectual activities are more protected against cognitive deficits that manifest themselves in old age. In conclusion, a change of strategy is necessary for the future, a preventive perspective that, collectively and individually, considers that old age must be prepared and addressed from the years of youth. The perspective with which we look at the elderly must be different from the past, aiming to overcome cultural stereotypes that no longer correspond to the current and future situation of old age. In other words, it is our mentality that needs to change so that mind and brain can adapt to the new demographic situation.

4. Conclusions: *Use it or lose it*

Studies on the characteristics of the senile brain and of the factors that, by counteracting its aging, can result in better condition from a cognitive point of view have multiplied in recent years. These studies concern the choice of a lifestyle that hinders those involutive phenomena of the body and mind that manifest themselves in old age. In simple terms, today we know that the health of the body (and with it of the brain and the mind) depends on appropriate stimulation, as indicated by the saying "Use it or lose it". This maxim sums up an important cornerstone of modern neuroscience. The structure and functions of the brain change in relation to the environment and our experiences: in positive, if these are stimulating, in negative, if the brain lacks the "food" it needs.

In general, and as obvious as this may seem, in the old age the most important thing is to keep alive interests and hobbies that keep busy, stimulate the mind, maintain memory efficient. Several studies have shown that memory needs to be stimulated and exercised, also through the old strategy of learning by heart: this training is poorly useful in youth but improves the mnemonic performance of the elderly because the so-called "working memory store" (the circuits where memories are kept for a short time before being converted into lasting memories), does not "shrink", remains elastic, ready to expand to welcome and record new experiences. It is therefore essential to keep the mind alive and to continue to update mental patterns by making as far as possible, new experiences. Even if the brain is fed in the best way, if the excesses related to alcohol or smoking are avoided, if vascular damage is kept under control, the brain feeds mainly on stimuli, maintains its efficiency based on daily experiences.

Many studies now prove the existence of a positive relationship between stimulation and cerebral well-being. It is possible to improve memory and learning strategies through short training courses, learning a new language, active participation in cultural activities. The case of learning a new language is particularly significant as it "sets in motion" the whole brain. Until adolescence, in fact, the mother tongue and a second language mainly involve the areas of language located on the left hemisphere, the linguistic half of the brain. Starting in late adolescence, and even more so in adulthood and old age, learning a second language involves a "fragmented" distribution of semantic (linguistic) memories in various non-linguistic areas of the cortex of the two hemispheres, left and right. While it is true that this leads to a greater difficulty towards bilingualism than in a child or boy, It is also true that the "set in motion" of both hemispheres represents an important form of cerebral and mental gymnastics.

In conclusion, studies on the brain and the infantile mind indicate how body and mind are closely intertwined, how movements and sensations have an impact on cognitive functions, how plasticity is a process that continues over the years. This and other knowledge in the field of neuroscience allow us to look at a pedagogy that is not divided into distinct sectors but concerns a training that embraces the life span.

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