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# PEDAGOGICAL CONNECTIONS BETWEEN MUSIC AND LANGUAGE NEW PERSPECTIVES IN MUSICAL NEUROEDUCATION FOR CHILDREN

# CONNESSIONI PEDAGOGICHE TRA MUSICA E LINGUAGGIO NUOVE PROSPETTIVE IN NEUROEDUCAZIONE MUSICALE PER BAMBINI

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**Abstract**
This essay presents an integrated music education project aimed at developing pre-school children's language skills. Several neuroscientific studies shows that children exposed to musical experiences in early childhood have a higher IQ, leading to the hypothesis that music can nourish brain plasticity and positively influence the process of language acquisition. Indeed, music and language share many physiological aspects, starting with the receiving organ and certain cortical areas involved in the processing of certain parameters characteristic of both phenomena, as well as the specific activation of cerebral hemispheres linked to specific structural functions (phonetics, semantics and syntax). But there is also a link between the two on an ontogenetic as well as phylogenetic level. Musical practice is one of the most complex brain activities; making music profoundly changes the sensitivity of the auditory system, improving the ability to process language sounds and to understand the nuances of meaning communicated through voice modulations.

Questo saggio presenta un progetto di educazione musicale integrata volto a sviluppare le competenze linguistiche dei bambini in età prescolare. Diversi studi neuroscientifici dimostrano che i bambini esposti a esperienze musicali nella prima infanzia possiedono un QI più alto, questo porta a ipotizzare che la musica nutra la plasticità cerebrale e influenzi positivamente il processo di acquisizione del linguaggio. In effetti, musica e linguaggio condividono molti aspetti fisiologici, a partire dall'organo ricevente e da alcune aree corticali coinvolte nell'elaborazione dei parametri caratteristici di entrambi i fenomeni, così come l'attivazione specifica degli emisferi cerebrali legati a specifiche funzioni strutturali (fonetica, semantica e sintassi). Ma esiste anche un legame tra i due a livello ontogenetico e filogenetico. La pratica musicale è una delle attività cerebrali più complesse che coinvolge molte connessioni neurali; fare musica cambia profondamente la sensibilità del sistema uditivo, migliorando la capacità di elaborare i suoni del linguaggio e di comprendere le sfumature di significato comunicate attraverso le modulazioni della voce.

**Key-words:**
Music, language, childhood, school readiness, neuroeducation.
Musica, linguaggio, infanzia, preparazione scolastica, neuro-educazione.

## 1. Introduction

This paper draws on research conducted between 2019 and 2020 on a sample of children attending pre-school (3-6 years old), to investigate how the use of an integrated music education format could affect the development of a range of skills and competences, specifically language, of the subjects involved (D'Amante, 2021). McMullen and Saffran (2004) postulated that language and music share relevant processing mechanisms, especially during childhood, based on the use of sound. A relationship between categories of linguistic sounds such as phonemes (phonological awareness) and categories of musical sounds such as notes has been highlighted. Starting from a preliminary study based on important neuroscience research applied to music, we can assert that not only the study of music but also musical experiences in early childhood have a significant impact on child development (Dege, Kubicek, Schwarzer, 2011) both in neurological terms (the morphology of the brain changes as a result of the increase in synaptic connections) and in socio-affective-relational development (music affects expressive-communicative and therefore relational, affective and emotional capacities). As a result of this data collection, an integrated music education model called musical atelier was elaborated, which, using music as a learning language, could allow the interaction of all the objectives pertaining to the fields of experience that make up the preschool curriculum (D'Amante, 2021b). It was decided to develop an educational programme based on the integration of different expressive languages. This choice is motivated by the fact that the child's musical learning, throughout the whole sense-motor stage and for a large part of the pre-operational stage, takes place through a global involvement of the essential functions and by means of the three channels ear, body and voice. In fact, the child needs to touch the vibrations of the sound, to move to the rhythm of the music he or she perceives in order to follow its pulsations with the body; he or she must be able to experience music through all the senses, starting from a kinaesthetic approach to sound. The application of this educational model based on the use of music has the main objective of promoting transversal learning mechanisms through musical experiences that stimulate transfer processes and encourage the development of linguistic skills.

## 2. Music acquisition device

We started by considering music as a biological trait of every human being: many important studies confirm this assumption, noting that the human brain has a kind of language acquisition device for music, what Chomsky (2006) claims to be at the basis of the innate human predisposition to language learning. For this reason, we wonder whether it is possible to speak of a musique acquisition device, since, if musical abilities are built on the basis of innate capacities, all human beings are musical beings. So what allows us to talk about musical talent? Music is inside each individual, since intrauterine life, in fact we begin to organise our sound experience even before we are born (Lacanuet, 1996) and at birth we are able to remember a stimulus received in the last three months of pregnancy. The ear is the first organ to develop and the human being's first experiences are of a sound nature: the "envelope" of the Self is initially a sound envelope in which all the sounds and noises of the body and the environment are mixed in an undifferentiated way between the Ego and the world (Anzieu, 1976). Since perinatal life, the child is able to perceive musical parameters from the symbiotic relationship with the maternal voice (Imberty, 2000).

Music nourishes babies born prematurely who, left in an incubator, suffer the absence of their mother and therefore inevitably produce the stress hormone that could further affect the slowing of development (Haslbeck, Stegemann, 2018). They listen to a repertoire of music that alleviates anxieties and fears, and regulates the balance of the sleep-wake rhythm, acting as a therapeutic tool for the child's physiological well-being.

Musical experiences in the first years of life influence the improvement of short-term memory (Fujioka et al, 2006), as well as spatial intelligence (Rauscher and Shaw, 1993), if stimulated through a suitable repertoire such as Mozart. Music also appears to bring about significant improvements in spatiotemporal ability, mathematics, vocabulary and verbal memory (Patel and Iverson, 2007).

Thus, the more we are exposed to music in early childhood, the more profoundly a stage of neural coding in the musical sense will accompany us throughout our lives. Several studies have found that children exposed to music education experience higher IQ.

Music education changes the connections between different areas of the brain, thus increasing connectivity. Studies show that musical activity makes children much more efficient in performing any cognitive task, outperforming peers who do not play music and scoring higher on IQ tests than peers who do (Schellenberg, 2004). Music education improves brain plasticity, a characteristic of children's minds, and increases the number and quality of neuronal synapses. In fact, it has been found that in the brains of musicians there is greater development of the area of the cortex responsible for processing acoustic stimuli; greater development of the corpus callosum, composed of nerve bundles linking the two hemispheres, in response to the need for coordination between the two hands and to connect the two hemispheres; development of the cerebellum, due to the need to synthesise and coordinate responses to motor, emotional and cognitive stimuli; and an increase in grey matter, linked to greater motor development.

3. From music to language

We have focused on the link between music and language and, starting from the connections between the two processes, we have examined possible reciprocal influences. Music and language share many physiological aspects, starting with the organ of reception and the organ of phonation for singing and wind instruments; certain cortical areas involved in the elaboration of the characteristic parameters of both phenomena, as well as the specific activation of the cerebral hemispheres linked to specific structural functions (phonetics, semantics and syntax). But there would also be a link between the two on a phylogenetic as well as an ontogenetic level. The ontogenetic commonality investigated by some scholars is based on the fact that, in the life span of every human being, music and language are inseparable from intrauterine life, when the foetus is already able to perceive sound stimuli and respond to them through kinaesthetic reactions, then manifesting a clear sensitivity to the mother's voice in its melodic, timbre and rhythmic characteristics: this phenomenon is commonly called infant directed speech or motherese (Popošek, 1992). Children are also sensitive to the emotional colours of the mother's voice, as well as the melodic aspects of language and the emotional-affective connotations, which are captured through the action of the right hemisphere, which is more developed in childhood than the left (Trevarthen, 1998).

From this point of view, some researchers agree that the initial stage of language, also from a phylogenetic point of view, coincides with a form of musical language in which language and music are one and the same thing (Brown, 2001). In this regard, the example of some indigenous peoples who still communicate through sounds using the whistle in its infinite modulations as a semiological code can be cited. Before being a signifier (Saussure 2007), language is an expression (Eco 1995) and a vibrating matter, a sound concreteness (Tomatis 1995), and therefore language is first of all made up of sounds.

The analogies between music and language can be explained according to an evolutionary thesis. Although there is no biological explanation in terms of cause-and-effect as to why human beings feel the need to make music and listen to it (Sacks, 2007), many studies show that it is possible to talk about the music/language link by referring to an evolutionary continuum whose two poles are represented by music and language: Music would have gradually, over the course of historical eras, taken on connotations more and more similar to the human language we now speak, codifying and structuring itself as a symbolic system (Boulez, Changeux, Manoury, 2016).

Language and music exhibit a wide sphere of structural similarities and both are connoted by forms of sound such as accent, intonation, duration of sounds and overall speed of vocalisations, intensity and pitch, timbre and articulation (Brown, 2001; Patel, 2007; Lerdahl, 2013). Music and language have a common basis in early child development. Within the first interactions between adults and children, adults use child-directed forms of language and music. Children prefer these forms of child-directed speech and songs from an early age (Trainor, 1996; Masataka, 1999). Moreover, child-directed speech is often referred to as a type of musical speech (Fernald, 1991), sharing Koelsch and Siebel's (2005) hypothesis that the early-developing brain processes language as a type of music.

Although the lateralisation of language is confirmed (linguistic functions are mainly carried out by the left hemisphere, where morpho-syntactic and semantic information is processed, while the right hemisphere appears to be involved in the recognition of prosody), the areas responsible for syntax and semantics are located in the left hemisphere, while prosodic information (the melody of language) is processed by the right hemisphere, which is involved in the affective-emotional components (Friederici, 2004). These two areas collaborate in the analysis of language, sharing the same material to be examined and carrying out different functions that, however, involve and interpenetrate each other.

It seems that the elaboration of linguistic and musical processes would be based, at least in part, on a common syntactic processor. Indeed, music and language adopt a combinatorial syntax mechanism. Music, just like language, is able to produce related sentences in which some of its elements can be legitimately changed, just as one does with a verb or a noun (Scaglioso, 2008).

Similarly, notes and chords can be substituted for each other in different positions (Ball, 2010). Linguistic syntax is processed not only in the left frontal lobe but also in the corresponding area of the right hemisphere. This suggests that the brain uses the same mechanisms to interpret linguistic and musical syntax, but not that the two types of syntax are equivalent (Maess, 2001). According to the Shared Syntactic Integration Resource Hypothesis (SSIRH), incongruous chords in an harmonic sequence can give rise to the same detectable signals in brain activity that occur in the case of a violation of linguistic syntax. These harmonic errors are quite similar to hearing a nonsensical sentence and giving rise to a moment's puzzlement (Ball 2010, p. 441).

A fascinating interpretation of the analogies between linguistic syntax and musical syntax is the assumption that tonal knowledge is the aspect of music that comes closest to a syntax. Considering harmonic inconsistencies in music as equivalent to grammatical inconsistencies in language, Maess's team (2001) demonstrated that the area involved in the processing of musical syntax was Broca's area. Consequently, it can be assumed that linguistic syntax is processed not only in the left frontal lobe but also in the corresponding area of the right hemisphere. This suggests that the brain uses the same mechanisms to interpret linguistic and musical syntax, but not that the two types of syntax are equivalent. Musical syntax would therefore also be elaborated in these same areas, but with a difference: if for language the area of the left hemisphere assumes a decisive role, for music the analogous role is played by the area of the right hemisphere. The right hemisphere is mainly responsible for musical cognition in its melodic and accent components, while the left hemisphere seems to respond more strongly to the parameters of rhythm and pitch.
The cerebral areas activated for music seem to be different and adjacent to those typical of language (Peretz 2002, p. 254). There are neuronal circuits dedicated specifically to music, located in the upper part of the temporal lobes (Peretz 2002, p. 256). Listening to a melody, as well as to a word and its recognition, implies the activation of a series of modules, that is, for music the identification of the profile, intervals and tonality, for words the sound, the meaning and the intention of the sender. But words, as we see, are first of all sounds, and when they are processed by the brain as sounds, exclusively as acoustic stimuli, it is the right hemisphere that is involved.
But let's think about singing. Singing, like language, uses the same phonatory apparatus and many studies have shown the many similarities in the initial learning strategies between the two (Sloboda, 1988). Some research has shown that music and speech share some cortical areas and neuronal mechanisms (Patel A. D., Iversen J.R., 2007).

## 3. The children's development through music

The practice of music is one of the most complex activities of the human brain, because it is able to involve many neural connections through the activation of motor, auditory, visual, analytical and emotional areas. The musical stimulus is processed by the right temporal lobe in a global form, but is analysed by the left one and also activates some sub-cortical areas in the limbic area which regulates vital functions and is the seat of emotions, both in musicians and non musicians (Sloboda, 1988; Peretz, 2002).
This allows us to state that adequate music education can increase the number and quality of neural synapses, affecting, among other things, the development of language skills. Making music profoundly changes the sensitivity of the auditory system, improving the ability to process the sounds of language and to understand the nuances of meaning communicated through voice modulations.
Starting from a phonological sharing between music and language, music can be a powerful pedagogical tool to develop neurodidactic and neuroeducational models aimed at stimulating the linguistic skills of pre-school children. Above all, looking at the learning prerequisites for primary school to be acquired in kindergarten, music can play a vehicular and propaedeutic

role in the acquisition of the skills necessary for reading and writing. One thinks of the language rehabilitation techniques based on voice intonation that have been developed for patients suffering from aphasia, or those involving the use of musical material to be listened to in order to develop or re-establish the fundamental functions of auditory discernment. It is easy to imagine the educational and didactic consequences of these analogies, especially for the age group referred to in this study, that is 3-6 years, an age in which children do not yet use a written communication code but an oral one made of sounds.

Lamb and Gregory (1993) conducted an experiment on preschool and primary school children starting from the hypothesis that there is a correlation between auditory pitch discrimination and phonetic pitch discrimination and verifying that the discrimination of musical sounds is correlated with reading performance, and that the influential factor in this relationship is a specific awareness of pitch changes. The relationship between specific music education and reading ability is therefore based on phonological competence. From auditory discrimination, a metacognitive ability can easily be introduced with respect to reading competence, whereby the child realises that the ability to recognise a word that is composed of interrelated sounds is the same as the ability to distinguish individual sounds.

Gromko (2005) has demonstrated that the ability to recognise that a word is made up of related sounds refers to the same brain areas and cognitive processes that are activated to recognise and symbolise the melodic and rhythmic elements of musical language. He verified on a group of children who attended a preparatory course for primary school and who followed a specific musical training, that the children obtained better results in reading-writing tests, and with this he was able to assert that musical education in pre-school age can contribute to the cognitive development of the child, also in the phonological sphere.

It is phonological awareness that is the lever for a music education programme aimed at developing language skills (Degé and Schwarzer, 2011; Bolduc, 2009), as it is the basis for promoting early reading skills in pre-school children (Anvari, Trainor, Woodside, Levy, 2001). Furthermore, music can activate prelinguistic functions through the stimulation of prosody (Fernald, 1991).

Based on this link between music and language, leading music educators have long turned their attention to "music as language" in order to develop music pedagogies based on the same mechanisms underlying mother tongue learning. Gordon (2003) elaborated the music learning theory, a method that envisages learning music through processes of sound exploration and assimilation through sound immersion, as happens with language. Suzuki (2009) developed the mother tongue method on the basis of the strong conviction that music is the mother tongue of every human being and that it can be learned simply by considering it as human language.

We have traced some correlations and analogies useful to suppose a fruitful synergy between the processes underlying the brain mechanisms of language and music and we have grafted the neuroscientific discoveries in the field of musical learning on the didactic theories of Suzuki, Gordon, Dalcroze and Kodaly to elaborate an educational format called musical atelier for kindergarten children. This model focuses in particular on the stimulation of the child's auditory abilities because it is primarily through hearing that the child absorbs the world of sound and can carry out experiences of "exploration, expression, organisation" (Delalande, 2016) of sound through play, which can then be transferred to language learning. So, through the developed didactic proposals it nourished the children's phonological awareness. The musical repertoire used consists exclusively of classical and jazz music, because they present a complexity (syntactic and harmonic) that is useful for stimulating the skills we have been talking about. All the activities proposed are based on play, through which the child can explore the soundscape, sound objects, musical alphabets, musical language, instruments and voices. Through play the child can follow a musical score written with an unconventional conductor; he can acquire a rhythmic sense and bring it back into the use of words; he can listen to Vivaldi's Four Seasons and reproduce them with a graphic gesture as sound forms.

## 4. Conclusions

Music education in pre-school age can activate a ramified series of learning processes that generate a domino effect on cognitive growth and trigger learning transfer mechanisms that are also valuable in terms of lifelong learning. This makes it possible to think of music not only as a specialist language for musicians alone, but to use it as a transdisciplinary teaching tool to develop integrated education projects in schools. A well-developed music programme can have a positive impact on children's development in terms of school readiness, i.e. making them ready to learn, starting with the formation of reading and writing prerequisites.

We revive the validity of the proposal of Lurija, Vigotsky's assistant, who hypothesised that the activation of a cognitive function depends on the coordinated activity of numerous cortical centres. Specialised areas of the brain enter into functional relationships with each other during ontogenesis (formation of the human being from embryo to the complete individual) depending on environmental stimulation as well as organic maturation. Primary functions such as visual perception, language, etc., which depend on the activity of specific brain centres, enter into new connections with each other, giving rise to more complex specific functions. The function may be that of a single organ or that of several organs as a result of the integrated functions of various cerebral functions. This means that different structures and functions can be involved in performing a given task, depending on the environmental circumstances and the needs of the organism.

What characterises a person's brain is ultimately not its anatomical structure, but rather the way it functions in relation to the cultural context in which it moves and acts. From the educational point of view, we can say that the environment is the only element to which pedagogy can turn in its desire to bring about a change in the child's neurological organisation. In fact, the structure of the learning environment favours the development of the neuropsychic capacities necessary for the complete development of language, the kind of learning based on the interaction of the right and left hemispheres. The right hemisphere is specialised in deciphering new stimuli, while the left hemisphere takes over the linguistic material at a later stage. This process describes neurological bimodality and is the basis of the bimodal learning model in which sensoriality and experience are of great importance.

Music education makes the processing of phonetic and auditory, linguistic and non-linguistic information such as phonemes more sophisticated. It is therefore clear that early music education can also contribute to counteracting or curing dyslexia in genetically at-risk children, particularly with regard to auditory processing, phonological awareness, rapid spectrotemporal processing and metric processing.

Numerous studies have investigated the correlation between early music education and dyslexia prevention/cure. Studying music from an early age modifies the neural mechanisms for reading words (Proverbio et all, 2003). Indeed, the symbolic understanding of notes requires a refined global spatial analysis in which the right hemisphere excels, which then associates with the activation of the visual cortex of the left hemisphere when reading words. The neuro-educational benefit for children at risk of dyslexia lies precisely in the fact that the study of music at the beginning of the literacy phase would develop a centre of symbolic visual analysis on the right, which would then be used for both words and notes, compensating for the atypical or insufficient activity in these subjects of the visual region for words on the left. Considerable benefits are also found in the case of phonological dyslexia.

Making music profoundly modifies the sensitivity of the auditory system, improving the ability to process language sounds and to understand the nuances of meaning communicated through small changes in the tone of voice, so much so that music education could be a strategy to help children with language disorders or autism to process language sounds more accurately (Kraus, Chandrasekaran, 2010).

On what levels/aspects can music help develop linguistic, communicative and expressive skills? On the level of listening: assimilation of rhythm, accents, tones, melody; on the level of attention: the listener is able to pay attention to different elements of communication, both structural/formal and content-related; on the level of roles and management of conversation times/spaces: those who know how to listen are able to perceive when it is the other person who takes part in the discourse, are able to offer the right space in the conversation and know how to respect the timing of the exchange of information; on an emotional level: our language communicates and absorbs moods and emotional positions that the word reverberates and feeds on: music is able to develop communicative and interpretative skills linked to the meaning of tones, rhythms, harmonies and melodies that can be transposed into the communicative context of human language and used both to convey messages and to receive them, giving communication colours, movements and dynamics appropriate to the context, the situation, the interlocutor; on an expressive level (music involves performing skills that require a type of circular learning, i.e. an osmotic and reticular acquisition of skills linked to cognitive, emotional, affective-relational, logical, mnemonic, kinesthetic functions, etc.).

For these reasons, according to several scholars who argue that music education affects the processing of auditory stimuli, so starting from the purely sound dimension (Tomatis, 1995), still devoid of musical organisation, and then with this, then through complex music, art music, made of a very elaborate combinatorial syntax and articulated harmonic structures, it will also stimulate the cerebral hemisphere involved in the processing of syntactic structures of language, activating early modular functions that will necessarily be solicited for the learning of reading and writing.

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