SPECIAL ISSUE
Dalcroze Eurhythmics in music therapy and special music education

Article

Émile Jaques-Dalcroze as a visionary pioneer of Neurologic Music Therapy

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ABSTRACT

Émile Jaques-Dalcroze (1865-1950) anticipated contemporary neuroscientific concepts in his educational method of learning and experiencing music through movement, namely Dalcroze Eurhythmics. He developed the idea of sensorimotor integration as it relates to musical experience and thus contributed crucially to the emergence of Neurologic Music Therapy. Here, we comment on his ideas on learning and integration in the light of modern neurosciences, with emphasis on new findings concerning the dynamics of brain plasticity and the existence of mirror neurons. Auditory-motor co-representations develop rapidly when learning to play a musical instrument and constitute the basis of rehabilitation of neurological impairments with instrumental playing. The theoretical background of neurorehabilitation has been broadened during recent years by the emerging concept of embodiment. We exemplify this by describing a therapeutic approach utilising the sonification of arm movements in stroke patients to improve motor control of the paretic arm and to support emotional and bodily wellbeing.

KEYWORDS

brain plasticity, Dalcroze Eurhythmics, embodiment, multisensorimotor integration, neurologic music therapy, stroke

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INTRODUCTION

> "If nerve specialists would be good enough to study my experiments carefully, they would speedily recognise the therapeutic value of exercises that control muscular contraction and relaxation, in every shade of time, energy and space, for instruction thus given must inevitably stimulate intuition and endow the pupils with bodies perfectly organised, both mentally and physically" (Jaques-Dalcroze 1930: 105).

Émile Jaques-Dalcroze (1865-1950), the eminent Swiss composer, musician and music educator developed a method that became known in anglophone cultures as Dalcroze Eurhythmics, a way of learning and experiencing music through movement. The Dalcroze method was based on experiences Jaques-Dalcroze made during his activities as a pedagogue, whilst teaching harmony and solfège at the Geneva Conservatory from 1892 to 1910. At the core of his methodological approach was his strong belief in the interrelatedness, or unity, of auditory perception, somatosensory and visual experience and movement structuring. In order to facilitate this process of multisensorimotor integration – to use contemporary neuroscientific terminology – Jaques-Dalcroze developed techniques that combined hearing with physical movements transferring auditory perception into a holistic bodily experience. Here, his main goal was to develop the inner ear to facilitate musical thinking, reading and writing music without the help of an instrument.

While continuing to develop his method, Jaques-Dalcroze noticed that the piano students, who could not play music in time, were able to walk in time, could tap the beat using their feet, or move their heads and bodies in synchrony to music. Furthermore he noticed that these students would change their movements when following a crescendo, and would respond physically to the accents of the music. They also relaxed their muscles with the endings of phrases. As they seemed to hear the music and feel its effects, he concluded that the students themselves were the 'true' instruments, not the piano. However, students frequently failed due to inhibitions caused by cognitive interference; their exaggerated will to control movements and to synchronise them to music prevented them from utilising the subconscious, naturally inborn auditory-sensorimotor integration patterns. Jaques-Dalcroze felt that it was important to overcome these inhibitions by teaching students to trust in their instrument, the body, and by increasing mental and emotional awareness. In modern terminology, we could say that the aim of Dalcroze Eurhythmics became one of creating a stable embodiment of the outer world, through multisensorimotor integration and through audiation.

Implicitly Jaques-Dalcroze extended his method to therapeutic approaches; he believed that the way to health was through a balance of mind, body, and senses. He had discovered that many people were able to improve and refine skills by rehearsing a combination of movements, first in real movements and then imagining going through these movements mentally with flowing kinaesthetic imagination. Accordingly, it is possible then to allow the improved flow of kinaesthetic mental representations to carry over into actual movement (Abramson 1980). A further aspect of music therapy in Eurhythmics is the fact that typically Dalcroze lessons involve activities that require mental and bodily kinaesthetic awareness. Thus, the lessons are presented in a somatic approach that allows participants to hear and react physically to the musical stimulus, which produces body awareness and sensations (Greenhead & Habron 2015). These physical sensations are transmitted again back to the brain as emotions and a more developed comprehension of the experience (Damasio 2003).

There are many further theoretical and technical similarities between Dalcroze Eurhythmics and music therapy. Some of these, such as the primacy of rhythm in entraining the body have been pointed out in previous papers, for example Skewes and Daveson (2002). Others, including communication through musical improvisation and attunement in playing for movement, are extensively discussed (for an excellent discussion on this topic, see Habron (2014)). At a time when Neurologic Music Therapy has established itself as a field of research in its own right (Thaut & Hoemberg 2015), it seems to be important not only to honour the role that Dalcroze Eurhythmics can play in neurological rehabilitation, but also to make use of current theories to enhance our understanding of how it does so. In what follows, we provide a theoretical overview of the concepts that Jaques-Dalcroze anticipated with respect to modern Neurologic Music Therapy.

MULTISENSORIMOTOR INTEGRATION: DALCROZE EURHYTHMICS TRANSFERRED TO MODERN NEUROSCIENCE

Playing a musical instrument, such as the piano, requires highly refined motor skills that are acquired over many years of extensive training, and that have to be stored and maintained as a result of further regular practice. Auditory feedback is needed to improve and perfect performance (Zatorre et al. 2007). Performance-based music making therefore relies primarily on a highly developed auditory-motor integration capacity, which can be compared to the phonological aural-oral loop in speech production. In addition, somatosensory feedback constitutes another basis of high-level performance. Here, the kinaesthetic sense, which allows for control and feedback of muscle and tendon tension as well as joint positions that enable continuous monitoring of finger, hand, or lip position in the frames of body and instrument coordinates (for example, the keyboard, the mouthpiece), is especially important. In a more general context, the motor system of music performance can be understood as a sub-specialty of the motor systems for planned and skilled voluntary limb movements and it is never solely a motor system – it is always an integrated auditory-somatosensorimotor system (for a review, see Altenmüller & Furuya 2015).

Practising an instrument, therefore, involves assembling, storing, and constantly improving complex sensorimotor programmes through prolonged and repeated execution of motor patterns under the controlled monitoring of the auditory system. It is therefore not surprising that musical training clearly influences the auditory system as well as the motor system. For example, musically trained individuals have enhanced brainstem representation of musical sound waveforms (Wong et al. 2007) while at the cortical level they can also show stronger responses to such stimuli (Schneider et al. 2002). Not only are auditory and motor systems independently related to musical training, there is also direct evidence that their interactions are enhanced in musicians. For example, auditory and pre-motor cortices are co-activated when pianists play music without auditory feedback or listen to music without playing (Bangert et al. 2006). In a longitudinal study, it was possible to show that the formation of such neuronal multisensory connections between auditory and motor areas needs less than six weeks of regular piano training (Bangert & Altenmüller 2003). This demonstrates how dynamically brain adaptations accompany musical learning processes. These adaptations usually are referred to as ‘music-induced’ brain plasticity.

Activation of motor representations can occur in trained pianists not only by listening to piano tunes, but also by observing finger movements of pianists. In a study by Haslinger and colleagues (2005), observing muted videos of a moving hand at the piano produced a marked activation in the observers’ motor brain regions. Besides the motor hand area in the primary motor cortex, the secondary auditory cortices in the temporal lobe, the multisensory association cortex in the parietal lobe and the cerebellum are activated. This neuronal network corresponds to a ‘mirror neuron network’. As a consequence for musical practice, it follows that careful demonstration at the instrument may enhance learning. Such a teaching method based on demonstration and imitation is widely used at all levels of musical training in Dalcroze Eurhythmics, and would appear to be particularly effective in cases where teachers and students demonstrate an action or series of actions that are carefully and methodically observed by others.

EMBODIMENT

The term “Embodiment” emphasises the constitutive roles of our body and environment in driving cognitive and emotional processes (Lakoff & Johnson 1999). Embodiment is a way to overcome dualism, which has been one of the most influential philosophical concepts derived from Plato’s philosophy, with its hallmark of separating the body and mind, sometimes referred to as spirit or soul. According to embodiment theory, body, brain and environment do not relate only causally, through a sequential input-output network of computations; rather, they are dynamically enfolded in each other, being mutually implemented by the concrete patterns of actions adopted by the cognitive system (Leman 2007). Jaques-Dalcroze intuitively recognised the relevance of embodiment and its potential beneficial applications for music education and music therapy (Jaques-Dalcroze 1930: 105).

Indeed, in this context it might be worth mentioning that it has recently been observed that participation in music making, music education and music therapy not only affect movement-related skills, which are often associated with the excitability of the neural circuits that facilitate the abovementioned neural plasticity, but also

contributes to stabilising physiological functions and improving socio-affective behaviours and emotion (Vink et al. 2011). For example, long-term practice of Dalcroze Eurhythmics reduces the risk of falls in the elderly and improves gait patterns (Kressig et al. 2005; Trombetti et al. 2010). Along these lines, it has been demonstrated that visual and rhythmic perception are shaped by body movements in both infants and adults, that motor experience facilitates memory for musical excerpts, and that walking is crucial for an infant's cognitive development (see Schiavio & Altenmüller (2015) for a review).

The embodied approach refers to four different fields of brain-body-environment interaction: Embodiment, Embedment, Enactivism and Externalism (sometimes labelled as the 'four Es'), which all aim to capture how bodies, brains, and environment successfully interact in real-time. Transferred to a Dalcrozian methodological approach and to music, these 'four Es' can be exemplified as follows:

- Musical acting does not depend solely on brain processes, but results from structures widely distributed across the whole body (*musical acting is embodied*).
- Musical acting arises from interactions with the social and physical environment; it is actively immersed in the world (*musical acting is embedded*).
- Musical acting can reach beyond the boundaries of skull and skin, integrating resources internal and external to the individual (*musical acting is extended*).
- Musical acting is sense-making, understood as an emergent, skilful 'knowing-how' that consists in interactions between the individual and its environment. Through this dynamic interplay, the individual enacts (or brings forth) its own domain of meaning (*musical acting is enacted*). (Modified after Schiavio & Altenmüller (2015))

It is beyond the scope of this article to discuss each of the 'four Es' in detail; thus we will concentrate on a particularly interesting dimension of embodiment with respect to Dalcroze Eurhythmics and Neurologic Music Therapy, which is sensorimotor coupling. As mentioned above, sensorimotor coupling refers to the integration of sensory and motor information occurring in the human brain and the embodied forms of mutual determination established by organism and environment. Perceptual processes are identified with a unidirectional stream of data from the world 'out there' that is retrieved, codified, and represented in the brain, eventually leading to a behavioural output, which is movement. The traditional view is that this process is made possible by an exchange of information proceeding from the sensory cortex to the association cortex and from there to the prefrontal, decision-making cortex and finally to the motor cortex. Modern neuroscience, however, is well aware of the limitations of this standard classic model.

We now know the existence of the abovementioned 'mirror neurons', mainly within the frontal cortex and the polymodal association cortex in the parietal, temporal and occipital areas, which are elicited not only when performing a given action, but also when observing and/or hearing another individual performing the same action (Rizzolatti & Craighero 2004). Thus, we argue that in the brain, perception and action are not separated entities somehow encapsulated in autonomous and independent modules. Rather, they are always mutually integrated through a complex network of sensorimotor connectivity, involving anticipatory mechanisms that enable the system to respond adequately to the demands of the environment. This mechanism has been pointed out by Greenhead and Habron (2015), when they write: "the touch-like nature of sound not only makes contact with the body, inciting physical and emotional movement, but also develops awareness of self, others and environment due to the social nature of musical participation in general and of the rhythmics class in particular" (Greenhead & Habron 2015: 93).

EMBODIMENT IN NEUROLOGIC MUSIC THERAPY

An embodied approach to Neurologic Music Therapy in a Dalcrozian way considers not only multisensory stimulation, but also creative and intersubjective dimensions as fundamental for the treatment of the patient. This will influence the degree of mutual interaction and affective experience according to the motor knowledge of the patient. For example, a musical stimulus is not only a 'timekeeper', but a meaningful event that affords a variety of self-regulative, interactive, and sensorimotor processes depending on the agent-music interaction's degree of complexity.

As an illustrative example, we briefly describe a therapeutic approach based on musical sonification of arm movements in stroke patients (Scholz et al. 2015). In this clinical trial we applied small position

sensors to the paretic arm of stroke patients and connected them wirelessly to a computer interface. A programme was developed which transformed three-dimensional movement data into music: in the vertical dimension into discrete pitches, in the horizontal into sound timbre and in the third (sagittal) dimension into sound volume. In other words, the arm of the patient became a musical instrument. Thus, real-time movement feedback in three dimensions was given, informing the patients about the way they move and about the position of the arm. With the musical sonification therapy, patients repeatedly trained movements with their affected arm in a predefined space. They first explored the three-dimensional sound-space by moving the arm in a playful manner without any specific instructions. Thus, they formed associations of their relative arm-position in space and the corresponding sound at this specific position. Subsequently, exercises demanding incremental degrees of difficulty followed: at the beginning of each training session, patients had to play four upward and downward C major scales followed by playing musical intervals by moving their arm faster, but as precisely as possible. The final goal of the training was to teach patients to play several simple nursery rhymes or other familiar tunes only by moving their affected right arm in the three-dimensional sonification space. The experimenter gave verbal instructions for the training procedure and provided visual cues, without touching the patients, where to move the arm. Musical sonification not only improved motor control, since potentially lost proprioception might be substituted by auditory real-time feedback of the patient's arm movements, but it also contributed to the motivation and wellbeing of the patients due to its playful, creative and overall positive emotional character (Scholz et al. 2015).

The results of a larger clinical sonification study showed that this musical sonification therapy is a promising new way of treating motor impairments after stroke. It improved motor abilities and wellbeing more efficiently than alternative training methods (Scholz et al. 2016). The novel aspect of our approach is that music is not only a by-product of, for example, a grasping motion, but also a manifestation of an embodied world, since arm movements in this context resembled a novel musical instrument. Hence, our sonification training in patients was designed to be something more akin to a music lesson rather than shaping a movement during sound playback. Clearly, this multi-modal learning could help to close the sensorimotor loop, which may be affected by the stroke.

We consider our sonification therapy as a Dalcrozian integrative embodied approach that may transform motor rehabilitation into a participatory activity where motion, emotion, listening, and neural networks are all involved in a complex interplay. It demonstrates that human musicality is deeply *embodied* (being constantly implemented by sensorimotor feedbacks and real-time bodily activities), *embedded* (as it is always situated in specific sociocultural niche), *enacted* (relying on the history of structural couplings between musical agents and musical environment) and *extended* (as no clear boundaries between internal and external resources exist in driving emotional cognitive processes).

CODA

This article set out to demonstrate how prophetic the approaches of Jaques-Dalcroze with respect to the emerging field of Neurologic Music Therapy were. Jaques-Dalcroze anticipated in theory and practice the neuroscientific findings of multisensorimotor integration by more than half a century. He developed and refined his approach in the 1920s and contributed crucially to ideas of body-awareness, mindfulness, imitation learning and embodiment. These are all constituents of modern Neurologic Music Therapy, established around 1990, when the potential of learning-induced neuroplastic reorganisation of injured brain networks became apparent. Although he did not consider himself a therapist as such, Jaques-Dalcroze laid the theoretical and practical ground for music-based therapeutic applications in neurorehabilitation.

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