No mind without body
Reflections on embodied learning of young children

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Abstract
Music abilities of infants and young children develop according to their level of aptitude, the musical environment, and the informal guidance of parents and/or teachers. However, the primary modality of music learning is connected with the body and bodily movement. Neurobiological research has demonstrated that learning causes structural and functional changes in brain areas. The question is how educators and care givers can get access to infants' brains to support those changes.
For more than 20 years the *Freiburg Gordon Institute for Early Childhood Music Learning* (children from birth to 6) has investigated the relation between musical abilities and movement in observational studies, test procedures and empirical experiments with electromyography (EMG). A *Criterion Based Observation Form* (CBOF) was deployed to collect data on children's musical (tonal and rhythmic) behaviour and their motion control. Other studies applied a motor test for children age 4 to 6 (MOT 4-6) to study proprioceptive abilities as well as reaction time, balance and fine motor coordination, and supplemented it by a music aptitude test (Gordon's PMMA). Finally, an EMG motion study focused on proprioceptive sensibility (PAR quotient) and related it to children's results in PMMA sub-tests. The paper presents research results that focus on body movement in early music learning and contributes to the embodiment of cognition.
All test procedures exhibit a strong association of musical abilities with motor development. The empirical results confirm what has been exposed by observation and testing: the higher the score in PMMA, the better the results of EMG measurement. There is a significant linear correlation of the percentile rank in motor and music abilities.
The recent focus in neuropsychology on embodiment underpins the educational value of learning through enactment. For young children, the body and bodily movement offer the most appropriate and effective means to children's learning. There is no learning and no cognition without an integration of body functions. Children do not learn and experience music only in their head, instead body movement opens an access to the mind and enhances the development of mental representations.

Keywords
early learning; embodiment; proprioception; motor development; mental representations

Introduction

Musical abilities of infants and young children develop according to their level of musical aptitude which provides them with the potential to learn. Additionally, parental support and beneficial environmental conditions have a strong impact on children's motivation to learn and their commitment to music. During the first years of life they lay the ground for their further musical involvement and achievement. And even at a very early age one can observe that and how the body and bodily gestures build embodied narratives to express themselves and load bodily gestures with meaning. "Children enter into a musical culture where their innate communicative musicality can be encouraged and strengthened through sensitive, respectful, playful, culturally informed teaching in companionship" (Malloch & Trevarthen, 2018)(p.1). And it becomes quite obvious that even small children internalize music through gestural movements. However, the way they move and use their bodies is rather diverse and differently cultivated.

This was the initial motivation to research infants' movements and look for potential correlations between their musical aptitude and motor control. In 1998 – 1999 we performed a longitudinal observational study with preschool children where body actions and musical articulations were rated separately using a *Criterion Based Observation Form* (CBOF). The focus was on the type (imitative vs explorative) and quality of movements (flow, coordination, synchronization) and on the accuracy of rhythm patterns as well as on the intonation of tonal patterns. The results clearly confirmed a significant correlation between bodily and vocal actions (Gruhn, 2002).

What does that mean? Does music support motor development or the other way around: does a good motor coordination indicate a higher degree of musical aptitude? To answer these questions we complemented the investigation by an empirical study on motor abilities and music aptitude. The first Freiburg movement study started in 2009. Four to six year old children performed a motor task (MOT 4 – 6) (Zimmer & Volkamer, 1984) where reaction time, fine motor coordination, balance and body control were tested, followed by an aptitude test consisting of tonal and rhythm listening tasks (Gordon's *Primary Measures of Music Audiation*, PMMA)(Gordon, 1979). The entire sample (*n*= 28) was divided into an upper and lower achievement group according to the results of the music aptitude test. Then, both subgroups were compared separately regarding their scores in the motor test (Gruhn, Haußmann et al., 2012). Again, children exhibited a strong linear correlation between music aptitude and motor development (figure 1).

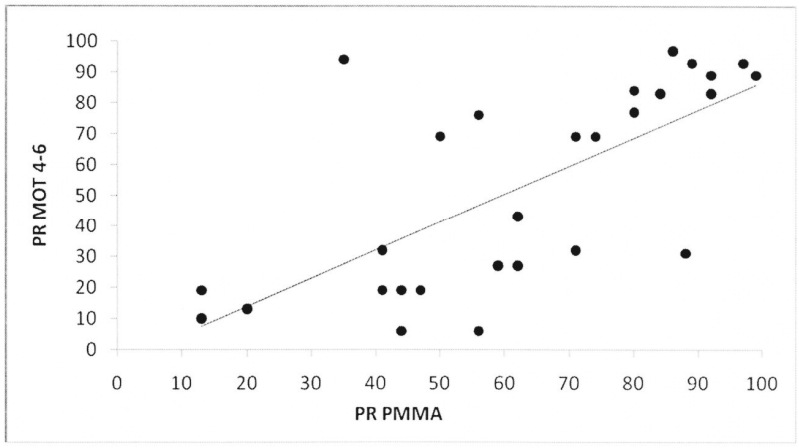

Figure 1
Linear correlation between motor control (y-axis) and music aptitude score (x-axis).

To prove these results, another physiological test was applied using electromyography (EMG) in order to measure the activity (tension) in the skeletal muscles (figure 2).

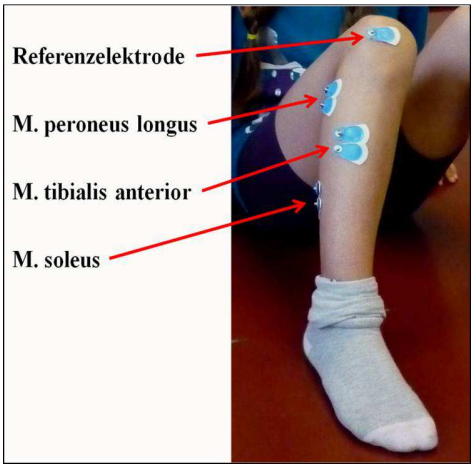

Figure 2
EMG measurement of the tension of three main leg muscles with electrodes on children's legs.

The results confirmed once again the former findings: the higher the music aptitude score the better the proprioceptive amplification ratio which indicates the motor sensitivity (Gruhn, Haußmann et al., 2012).
These findings support a strong connection or even an interaction between movement (body) and the musical mind (musicality), but not in a simple unidirectional way in the sense that movement explains musical abilities or vice versa, it rather makes clear that both activities develop in synchrony and on a similar level because motor activities reflect musical activities as embodied musicality. This also confirms former studies on the effects of integrated physical and music education (Brown, Sherrill et al., 1981) as well as the investigation of effects of early musical training on motor learning

(Penhune, Watanabe et al., 2005). These studies refer to a strong association of body movement and musical activities during an early stage of learning.

Thinking and movement

As demonstrated by empirical studies, cognitive processes are strongly connected with the body. Perception always simulates movement, and bodily conceptions shape abstract thinking. According to the neuroscientist Rodolfo Llinás, mindness is an evolutionary internalisation of movement (Llinás, 2001), 5). Movement is the core mode of the development of communicative interactions and has become a new focus of interest (Müller & Wolf, 2018). Whatever humans and other mammals do in communication is initiated or accompanied by movements. Therefore, the neurologist and movement expert Daniel Wolpert has emphasized that to understand movement is to understand the whole brain. From this perspective, he concludes: "We have a brain for one reason and one reason only, and that's to produce adaptable and complex movements. There is no other reason to have a brain. […] Movement is the only way you have of affecting the world around you" (Wolpert, 2011). Accordingly, when one studies memory, cognition, sensory processing at an early age, one has to focus on action.

This can be exemplified by the evolution of species, for example the sea squirt (*ascidiacea*), a translucent and gelatinous marine invertebrate animal which belongs to the chordates. At an early stage of development it shows a rudimentary form of a brain. Afterwards, it swims around, and the motor systems governs it to find a stable ground to settle. From that moment on the brain degenerates until it disappears nearly completely because it is no longer needed since there is no reason for further movement.

This elucidates that movement is the evolutionarily earliest and most important way to interact with the environment. All further elaborated forms of communication, such as speech, gestures, or writing, are also mediated via the motor system (see Wolpert, 2011). The interaction of thinking and movement must be seen as a vital condition for music experience and music performance (Gruhn, 2017; Hiekel, 2017; Oberhaus & Stange, 2017; Wöllner, 2018) and has established the prevailing concept of embodied cognition.

Experiencing music in early childhood

This is strikingly reflected by children's way of experiencing music. Jeanne Bamberger has researched on it throughout her academic life (Bamberger, 2013)and discovered different types of embodied representations which she called *figural* and *formal* (Bamberger, 1991). Based on experiments with children's notations that were seen as windows into their cognitive representations (Bamberger, 1982)she has demonstrated that children focus their attention on the flow and weight of the sound rather than measuring the height and duration of the notes(figure 3). It is obvious that in the upper and lower example the numbers do not indicate the order of the particular events, instead they refer to the felt weight of each sound while clapping the rhythm (figure 3).

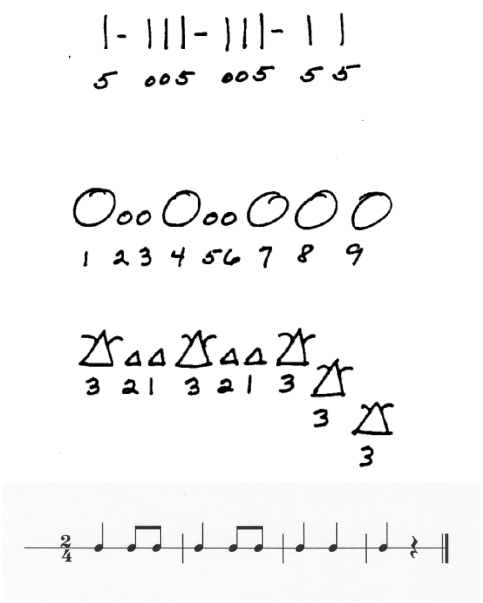

Figure 3
Children's notations of a simple rhythm with symbols and numbers (according to Bamberger, 1991, p. 72).

This makes clear that and how children experience sound in a different way compared to adults (Gruhn, 2018) who count and measure. The essential categories of weight and flow have been introduced by the dancer and dance theorist Rudolf von Laban (Laban, 1988). They precisely describe the characteristic mode of experiencing sound qualities which are unrepresentable in standard notation, but reflect corporeal sensations. Children's learning is grounded in mental representations that are gained and expanded through experience (Gruhn, 1997). Learning itself refers to changes and differentiations of those representations or – in other words – in changes of neural connections. Here, the question is how educators can stimulate those changes since we do not have immediate access to the brain – except through the body and its movements. Whatever is learnt musically is basically acquired through movement. Brain stem stimulation is the key entrance portal to the brain and its cortical development. What a syncopation means cannot be taught theoretically by means of verbal explanations rather than through body experience accompanied by rhythm syllables (rhythm solfège). Vocal performance and corporeal implementation prepare the musical mind to develop mental representations and, therefore, determine musical experience which, then, generates musical perception and cognition. Learning is essentially based on the differentiation of "same" and "different". However, this distinction calls for a cognitive act which is driven by different criteria. What "same" means for an experienced adult (e.g. 2 notes of an octave) seems "different" for a child without the knowledge of the different features of pitch class (chroma)and pitch hight (frequency). Through learning children develop their understanding of adults' conventions to focus on different aspects of the sound. As teachers we must understand the unbiased criteria for the differentiation of "same" and "different".

Embodied learning and communicative musicality of children

In recent years the concept of embodiment has become a rather favourite concept in learning theory and psychology (Gruhn & Röbke, 2018; Koch, 2013; Malloch & Trevarthen, 2009; Oberhaus, 2006; Paparo, 2016). If we see musical thinking as an internalized form of movement which has developed throughout evolution, then the constitution of musical thinking through *audiation* (Gordon, 1980)should be linked to the embodiment of learning. This refers to the integration of the entire body into the teaching and learning procedure. Learning calls for an enactive process where the objects are transformed into corporeal actions (Rowlands, 2010). Children gain knowledge through action and interaction; for the mind is strictly bound to the body. There is no mind without a body function. Thinking – and musical thinking as well – replaces and therefore represents movement (see Llinás, 2001, p. 62). Consequently, movement functions as a practical means to establish and nurture musical thinking. Therefore, who confines movement, confines thinking.

Furthermore, as far as music can be seen as expressing movements of the inner life one can consider motion as a form of a gestural narrative (see Malloch & Trevarthen, 2018). In the learning process a child connects the inner motion of music with the corporeal motion of the body. And this interaction entails embodied learning, i.e. learning with and through the body. Here, Malloch and Trevarthen speak of motor intelligence (2018, p. 3) which is based on the intention of an envisioned purpose. By this, the connection between intentional thinking and movement becomes manifest. In music learning educators should, therefore, play on this intentional corporeal thinking.

Through body movement the brain and its mental representations can be stimulated immediately and most efficiently. The neural structures immediately reflect the activities of children's body actions which terminate the process of building mental representations.

Conclusion

These basic assumptions about learning in early childhood lead to the following consequences:

1. Learning can be defined by the development of mental representations. This is a process that happens within the neural structure of the brain and relies on a physiological change of the neural connectivity. By this, neural conditions on the molecular level merge with cognitive functions of learning. Therefore we argue that

2. early childhood education should integrate the body as a primary source of learning. It is not the head (brain) that learns, not the eye that watches, not the ear that hears, it is always the entire person – the body and the mind – that are involved in perception and cognition. That is what René Spitz has addressed as *coenesthetic* perception (Spitz, 1965) which means a general permeability of one's own body.

3. Since all cognitive functions of perception and cognition, of learning and understanding are bound to a body where thinking is represented by movement, no mind can grow without a body. Early learning, therefore, can

only be achieved when we view the body as a condition of the mind. Learning, then, turns into embodied cognition.

References

Bamberger, J. (1982). Revisiting children's drawings of simple rhythms: A function for reflection-in-action. In S. Strauss (Ed.), *U-shaped behavioral growth* (pp. 191 - 226). New York: Academic Press.

Bamberger, J. (1991). *The mind behind the musical ear*. Cambridge MA: Harvard Univ Press.

Bamberger, J. (2013). *Discovering the musical mind. A view of creativity as learning*. Oxford, New York: Oxford University Press.

Brown, J., Sherrill, C., & Gench, B. (1981). Effects of an integrated physical education/music program in changing early childhood perceptual-motor performance. *Perceptual and Motor Skills*, *53*(1), 151-154.

Gordon, E.E. (1979). *Primary Measures of Music Audiation (PMMA)*. Chicago: GIA Publ. Inc.

Gordon, E.E. (1980). *Learning sequences in music. A contemporary music learning theory*. Chicago: GIA Publ. Inc.

Gruhn, W. (1997). Music learning - neurobiological foundations and educational implications. *Research Studies in Music Education*(9), 36 - 47.

Gruhn, W. (2002). Phases and stages in early music learning. A longitudinal study on the development of young children's musical potential. *Music Education Research*, *4*(1), 51 -71.

Gruhn, W. (2017). Was der Körper nicht lernt, lernt der Kopf nimmermehr... Lerntheoretische Überlegungen zur Bedeutung der Leiblichkeit des Lernens. In L. Oberhaus & C. Stange (Eds.), *Musik und Körper. Interdisziplinäre Dialoge zum körperlichen Erleben und Verstehen von Musik.* (pp. 105 - 119). Bielefeld: transcipt.

Gruhn, W. (2018). Wie Kinder Musik wahrnehmen und erleben. Kognitionspsychologische Grundlagen ästhetischer Wahrnehmung in einer an Kinder gerichteten Musikvermittlung. *zeitschrift ästhetische bildung*, *10*(1), www.zaeb.net.

Gruhn, W., Haußmann, M., Herb, U., Minkner, C., Röttger, K., & Gollhofer, A. (2012). The development of motor coordination and musical abilities in pre-school children. *Arts BioMechanics*, *1*(2), 89-103.

Gruhn, W., & Röbke, P. (Eds.). (2018). *Musiklernen. Bedingungen - Handlungsfelder - Positionen*. Esslingen: Helbling.

Hiekel, J.P. (Ed.). (2017). *Body Sounds. Aspekte des Körperlichen in der Musik der Gegenwart*. Mainz: Schott.

Koch, S.C. (2013). *Embodiment. Der Einfluss von Eigenbewegung auf Affekt, Einstellung und Kognition*. Berlin: Logos.

Laban, R.v. (1988). *Die Kunst der Bewegung*. Wilhelmshaven: Noetzel.

Llinás, R.R. (2001). *I of the vortex: from neurons to self*. Cambridge, MA: MIT Press.

Malloch, S., & Trevarthen, C. (Eds.). (2009). *Communicative musicality. Exploring the basis of human companionship*. Oxford: Oxford University Press.

Malloch, S., & Trevarthen, C. (2018). The human nature of music. *Frontiers in Psychology*, *9 (doi: 10.3389/fpsyg.2018.01680)*.

Müller, B., & Wolf, S.I. (Eds.). (2018). *Handbook of human motion*. Basel: Springer International Publishing.

Oberhaus, L. (2006). *Musik als Vollzug von Leiblichkeit* (Vol. Detmolder Hochschulschriften, 5). Essen: Die Blaue Eule.

Oberhaus, L., & Stange, C. (Eds.). (2017). *Musik und Körper. Interdisziplinäre Dialoge zum körperlichen Erleben und Verstehen von Musik*. Bielefeld: [transcript].

Paparo, S.A. (2016). Embodying singing in the choral classroom: A somatic approach to teaching and learning. *International Journal for Music Education*, *34*(4), 488-498.

Penhune, V.B., Watanabe, D., & Savion-Lemieux, T. (2005). The effect of early musical training on adult motor perfomance: evidence for a sensitive period in motor learning. *Annals of the New York Academy of Sciences*, *1060*, 265-268.

Rowlands, M. (2010). *The new science of the mind. From extended mind to embodied phenomenology*. Cambridge, MA: MIT Press.

Spitz, R. (1965). *The first year of life (ed. 2007)*. Boston: International Universities Press.

Wöllner, C. (Ed.). (2018). *Body, sound and space in music and beyond: multimodal explorations*. London, New York: Routledge.

Wolpert, D.M. (2011). The real reason for brains. *TED Talk*: TEDglobal (www.ted.com/talks/daniel_wolpert_the_real_reason_for_brains/transcript).

Zimmer, R., & Volkamer, M. (1984). *Motoriktest für vier- bis sechsjährige Kinder, MOT 4 - 6*. Weinheim: Beltz.