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Brief review of Music and Embodied Cognition

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Music, a part of human existence, has great potential for exciting memories, creating emotions (Boltz, 2018; Koelsch, 2014; Levitin, Grahn, & London, 2018; Mahendran et al., 2017) and reactions (Caparros-Gonzalez, De La Torre-Luque, Diaz-Piedra, Vico, & Buela-Casal, 2018; Hillier, Kopec, Poto, Tivarus, & Beversdorf, 2015; Semenza, 2018). Studies show that listening to music is associated with decreased regulation in the hypothalamic-pituitary-adrenal (HPA) axis, as well as a reduction in cortisol concentration pathways in both experiments and clinical contexts (Kreutz et al., 2012), promotes changes in the autonomic nervous system such as decreased heart rate and blood pressure (Hodges, 2011), and interferes with cortisol levels (Chlan et al, 2013, Han et al., 2010; Chanda & Levitin, 2013; Linnemann et al., 2015).

Music also has a great influence on cognitive processes, since any musical activity involves practically all cognitive functions (Zatore, 2005). These listed cognitive functions are: attention, perception, language, memory, and intellectual reasoning (Damasceno, 2012).

Cognition, in general, according to Hockenbury and Hockenbury (2003) refers to the mental activities involved in the acquisition, retention and use of knowledge. For this, cognitive processes such as perception, learning, and memory are important so that new knowledge is acquired and stored. The manipulation of mental representations, of information acquired to produce inferences or conclusions, is termed thought. In other words, thought corresponds to conscious mental activities, both for the acquisition of new knowledge, and for memories, plans, or fantasies. In this way, thought can be said to be active mental processes, often directed toward an objective, a purpose, or a conclusion. Therefore, when we think, we use two forms of mental representations, that are: a) the mental image, which is the mental representation of goals or events that are physically absent; b) concepts that, in general, consist of a mental category that is based on similar characteristics, shared by objects, events or situations.

For a long time, the classical concept of cognition argued that the acquisition of knowledge occurred through sensory and motor representations translated in the form of symbols with contextual linkages, like a group of data. Therefore, previous mental representations were seen as necessary for the acquisition of knowledge. In this perspective, the brain was considered the only behavior generator (Leman, 2007). In this classical view, the tendency was to presuppose the existence of internal representations, performed by underlying and highly specific mechanisms in the brain. These mechanisms, in turn, were shaped by natural selection and encoded in genetic structures. Cognitive phenomena could all be explained locally and elements beyond the limits of the brain were interested only in providing sensory information and generating behavioral results (Wilson, Robert, Foglia, & Lucia, 2017).

In an attempt to redirect the cognitive sciences to a phenomenological perspective, Varela, Thompson and Rosch in the book “Embodied Mind” (1991), introduced the concept of “enaction” to present and develop a structure that strongly emphasizes the idea that the world that is being experienced is portrayed and determined by mutual interactions between the physiology of the organism, its sensorimotor circuit, and the environment. From this, the concept of embodied cognition, considered not only representations of the existing world, but the mutual relationships between mind and world that are established through the evolutionary history of the actions of the organism in the environment.

Embodied cognition is the product of the dynamic interaction between neural and nonneural processes, including bodily experiences and real-life contexts, ie, the body integrates with the cognitive process (Wilson, Robert, Foglia, & Lucia, 2017); a sensorimotor interaction of the organism and the environment, making perception-action and context inseparable in the process of acquisition and storage of information and knowledge (Leman, 2007). Following this thought, Moroni (2014) believes that the connection between humans and their environments reinforces the existence of an interdependent relationship between perception, action and the external environment. The body then becomes understood as an active agent in the learning process (Storolli, 2011).

In order to deepen the knowledge of this relevant subject, this study proposed the application of a brief review involving music and embodied cognition that aimed to identify and review articles elucidating this theme. For this, the following search terms were used “Música” and “Cognição Incorporada” (Portuguese) and their correlates in English “Music” and “Embodied Cognition”, which were applied in the PubMed and Scopus databases. Articles to be included were in the Portuguese or English languages, published between January 2013 and December 2017, presented abstracts, had at least one of the search terms in the title, in any of the proposed languages, and form of musical intervention. Review articles, book chapters, and conference reports were excluded. Data were collected using a standard form that contained the following items: article title, year, journal name and publication language, research objective, subject(s) characteristics, data collection instruments, activity description, and results obtained.

The search was performed in December 2017. The search returned 92 articles (58 in Scopus and 34 in PubMed). The search, reading of abstracts, and exclusion of articles was performed by two reviewers when there was consensus in the results, and by three when an article presented discrepancy or doubt in the exclusion or eligibility. The review steps and search results are presented in the Prisma Flowchart (2009) (Fig. 1).

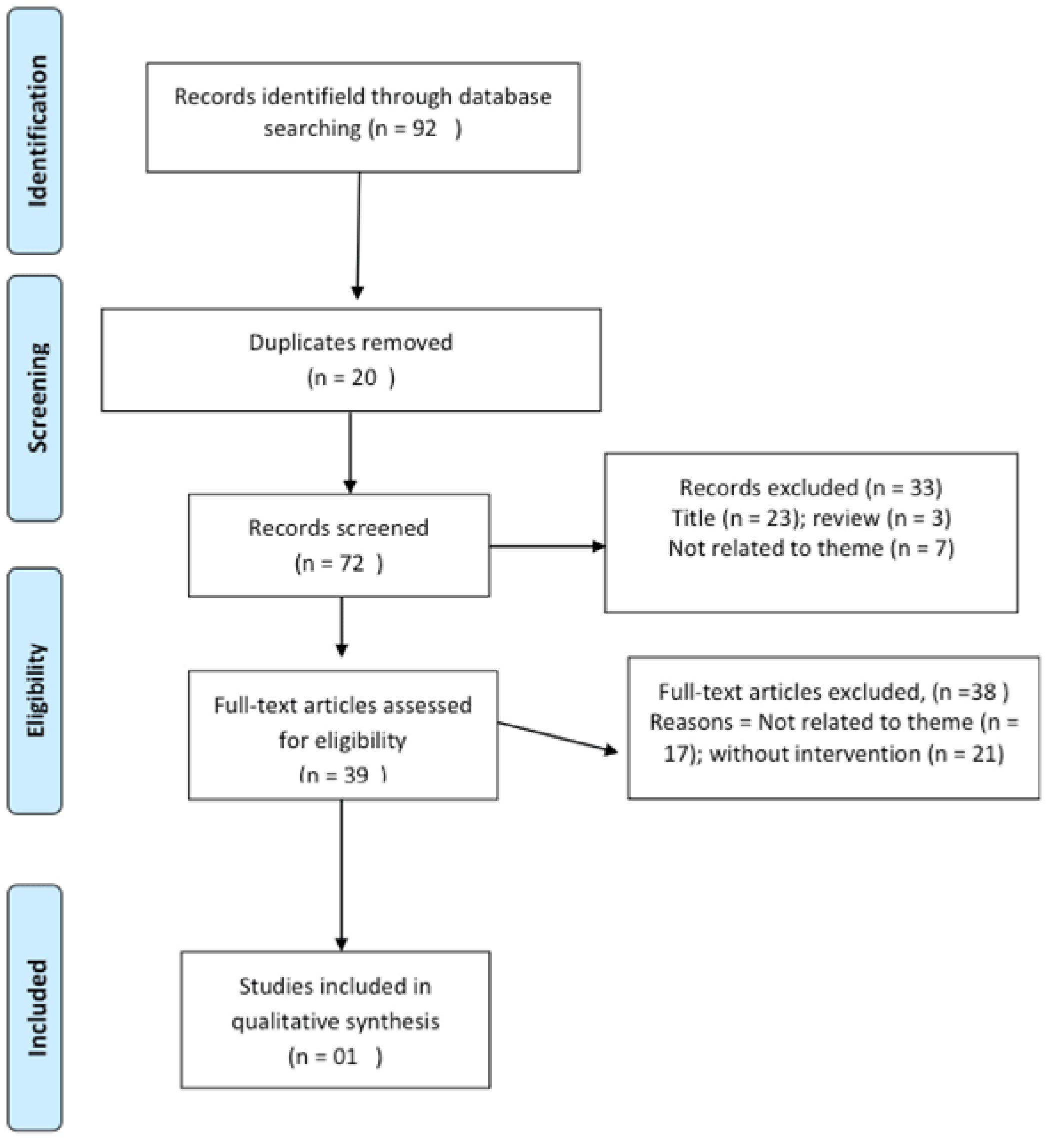

Figure 1. Review steps and search results (Prisma Flowchart, 2009)

The only article which fulfilled the inclusion criteria was "Shifting the paradigm of music instruction: Implications of embodiment stemming from an augmented reality guitar learning system" (Keebler et al., 2014). This study aimed to verify if new technologies that use augmented reality could help in reducing the initial difficulties involved in learning music, compared to traditional methods. Fifty-five undergraduate students (30 women and 25 men) over the age of 18 years, right-handed, without prior training (formal or informal) on string instruments participated in the study. The study was divided into two experiments (1 and 2), and for both participants they used a traditional electric guitar, model FG-521.

Before beginning the experiment, all participants were given instructions on the basics of the guitar through a PowerPoint presentation and videos with a tutorial that showed how to hold and position the hands on the instrument. After completing this phase, each participant received 30 exercises for training, aimed at learning a minor scale. After this initial phase of familiarization, the participants were randomized and allocated to one of the groups (Fretlight® method or diagram method).

Experiment 1 was conducted to evaluate differences in performance during the learning of a minor scale using the Fretlight® method and with a diagram. For this, the study was performed with two groups: a) the Fretlight® learning method and the learning method using the diagram. In the first, LED lights were used to signal the sequence of notes to be played by the participant during the training; b) in this learning method, a diagram was given to the participants, which was a sheet of paper that contained the notes, to guide the participant during the exercise.

In Experiment 2, performed in conjunction with Experiment 1, the purpose was to evaluate the keep time of guitar learning, comparing the two methods used in experiment 1. Participants in experiment 2 (6 participants – 2 women and 4 men, mean age between 24-39 years), followed the same inclusion and exclusion criteria of Experiment 1, as well as the learning procedures. The difference between the experiments was: the experiment 2 group was evaluated two weeks after the conclusion of the training, so that level of learning retention was evaluated.

The results of experiment 1 showed that the participants using the Fretlight® method during training had less resistance in relation to their initial contact with the instrument, fewer wrong notes during training, less inconsistency in the time between the notes of the scale in comparison to the diagram method, and that the Fretlight® method contributes to more consistent learning. Experiment 2 demonstrated that participants using the Fretlight® method had greater engagement during training, significantly better performance, and longer learning retention compared to the diagram, showing greater benefit for learning the instrument. The authors concluded that the perception of external stimuli (in this case the LED lights) is incorporated and promotes a response, which is the case in the learning of the instrument. It means that the body becomes understood as an agent in the process of knowledge acquisition. In this way, embodied cognition contributed to the teaching and learning of music, breaking down barriers that are created when confronted with the instrument or theories, in addition to approaching them in a pleasant and at the same time effective context.

Some interesting aspects of this article in relation to the learning of the musical instrument from the perspective of embodied cognition:

Less resistance to the musical instrument, more consistent learning and greater memory acquisition were observed in the unconventional method. Based on these data, we asked: why did the unconventional method show better results in terms of learning when compared to the traditional method, according to the experiments presented in the included study?

Firstly, all participants underwent the same procedures and used the same musical instrument for learning, except for the method of presenting the scale. In this way, everyone was in an unknown situation. Dealing with new situations can increase the level of anxiety and decrease the level of attention, which leads to diminished acquisition and maintenance of knowledge (memory), which usually does not occur in familiar situations (Lopes & Alcântara-Silva, 2017). The strategy used by the authors to present a tutorial before direct contact with the instrument may have eased the sensation of discomfort generated by the unknown circumstances. We emphasize here the importance of preparing the participant before introducing something new, either in the educational or therapeutic context.

Secondly, the participants were subjected to learning new information, that is, learning to play a melodic scale on a musical instrument. This demands actions that are cognitive (especially perception, attention, memory, and language, among others) motor (body actions) and emotional (mainly motivation) in the research environment, which act concomitantly. Although in the traditional view of cognition, the psychology of music understands that the creation and production of musical phenomena in terms of representations and internal processes are related only to the brain (Kersten, 2017), nothing prevents the musical experience from being inserted into the context of embodied cognition, because within this context occur the interactions between states, body processes, sensorimotor integration and musical cognition (Maes, 2016), influential body interactions, and music (Leman et al., 2018).

In concordance with this idea, Varela, Thompson and Rosch (1991), affirm that there is no way to separate the thought from the body, perception from action. These authors continue to say that our representations of the world are also constructed by the experience that the external world generates through our actions. These are understood as an intermittent and inseparable cycle between perception and action that would form an open field of knowledge in which interactive objectives and agents would be interactively involved and the body acts as mediator in the formation of meanings (Leman, & Maes, 2015), as in the musical experience.

Musical embodied cognition implies that within the interaction between motor systems (gestures, body movements) and musical perceptions, the body is understood as a mediator between the physical environment (music as sound waves moving in the air) and subjective musical experience (feeling in response to music) (Leman, 2007; Godøy & Leman, 2009). In this context, musical gestures are described, objectively, as an important component of musical experience, which is related to intentions, goals and expressions (Visi, Schramm, & Miranda, 2014). Musical gestures, the authors explain, are constitutive of this repertoire, that is, the interaction between actions and perceived sensations, which form a mechanism of orientation for understanding the music which gives the listener the ability to relate the physical aspects of movement in space, with expressive qualities, intentions and internal feelings. They further add that this connection between perception and action forms the basis of intentional and expressive musical communication which, in turn, incorporates musical affection and emotion, activates the reward and motivation systems, and raises various social phenomena such as empathy and social bond.

Kerten (2017) further claims that musical phenomena interact and are sustained by bodily and environmental elements, that is, music acts not only as an external resource that affects internal processes but also as part of emotional and cognitive processes as well. Therefore, the neural systems of music and body improve attention, and regulate motor and emotional processes. Music activates cognition and the motor system, forming an integrated system that is actively linked to emotional and attentional processes. We have here a fact that can explain the consistent learning and retention of information for a longer time, alluding to the results presented in the article included in this review. When guided by the visual track (LED light) used to signal the notes of the scale to be played (unconventional method), they were using hearing, touch, and vision, in addition to body movements. Therefore, in that context, one more of the senses was included. In addition, following the LED light helped the participant to maintain attention in the exercise, imperative for the acquisition and maintenance of information learned in memory.

Maes et al., (2014) say that musical cognition emerges from the interaction, in real time, of specific multisensory and motor processes (planning or execution of body movement), which in turn can influence perception, which, according to Schiavio et al. (2015) involves multisensory processes, in addition to aggregating the sensorimotor, cognitive (attention, memory, metacognition, etc.), affective and environmental systems, all being equally important in the acquisition of knowledge (Leman & Maes, 2015) the processes that occur within an individual in interaction with their sensory environment, may be dynamically linked to their social environment, leading to phenomena such as interpersonal coordination and synchronization (Maes, 2016).

The acquisition of musical knowledge, for example, learning to play a minor scale on the guitar, as seen previously, implies a body action that originates in movement. If they occur through incentives, these body actions can provide an innovative way of musical learning, whose support lies in the concept of musical embodied cognition (Storolli, 2011). In this way, the body, through different movements, can mediate activities involving perception and internalization of rhythm, height intensity, as well as the development of expressiveness (Souza & Joly, 2010). Following this proposal, playing a musical instrument would not be defined in terms of theoretical knowledge about the instrument, but as an abstract relationship between the intention to play and the sound produced (Leman, 2007).

Finally, playing an instrument requires coordination of muscle activity to control the musical instrument or vocal folds, in the case of singers. The sensorimotor activity, the planning and control of movements are also organized in the areas of cognition (Allman et al., 2014; Balasubramaniam, 2014). The temporal integration of the actions and their sensorial results – acquired through systematically repeated sensorimotor experiments – establish what is called the internal model (Maes et al., 2014). The internal models allow the synchronization of movement with a regular beat and maintain the responses without the existence of the external stimuli, because the predictability was generated. However, in the case of discrepancies between internal and external pulse, the human being is able to correct these discrepancies, adapting spontaneously to actions or perceptions, potentially leading to an update of the internal model (van der Steen and Keller, 2013). This may serve to justify the result presented by the researchers who verified, during the training of the participants, fewer wrong notes and less inconsistency in the time between the notes of the scales which contributes to more consistent learning.

Given that the participants were not musicians, it can be inferred that the results of the research can be applied in other non-musical contexts, what we call "generalization" in cognitive rehabilitation, which means, non-musical gains can be transferred to daily activities. In this perspective Billhiartz et. al. (2000) argue that there is a link between musical instruction and development in non-musical skills.

From the presentation of the article included in this brief review of some authors that deal with this theme, on which we weave some reflections, we agree that music is an important element in human life that can be used in many contexts. The musical activity is multisensorial, simultaneously integrating several systems, mainly the sensorimotor, cognitive, and affective, within a specific context, which consecrates in the sphere of embodied musical cognition.

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REFERENCES

- Bilhartz, T. D., Bruhn, R. A.;, & Olson, J. E. (1999). The effect of early music training on
- child cognitive development. Journal of Applied Developmental Psychology, 20(4), 615–636.
- Boltz, M. G. (2018). Auditory driving and affective influences. Applied Cognitive Psychology, 32(4), 512-517. https://doi.org/10.1002/acp.3420
- Caparros-Gonzalez, R. A., De La Torre-Luque, A., Diaz-Piedra, C., Vico, F. J., & Buela-Casal, G. (2018). Listening to relaxing music improves physiological responses in premature infants. Advances in Neonatal Care, 18(1), 58-69. https://doi.org/10.1097/ANC.0000000000000448
- Damasceno, B. (2012). Questões metodológicas da pesquisa em neurologia cognitiva e do comportamento. In Teixeira L; Caramelli P. Neurologia Cognitiva e Comportamento. Rio de janeiro: Revinter.
- Hillier, A., Kopec, J., Poto, N., Tivarus, M., & Beversdorf, D. Q. (2015). Increased physiological responsiveness to preferred music among young adults with autism spectrum disorders. Psychology of Music, 44(3), 481–492. https://doi.org/10.1177/0305735615576264
- Hsieh, S., Hornberger, M., Piguet, O., & Hodges, J. R. (2011). Neural basis of music knowledge: Evidence from the dementias. Brain, 134(9), 2523–2534. https://doi.org/10.1093/brain/awr190
- Keebler, J. R., Wiltshire, T. J., Smith, D. C., Fiore, S. M., & Bedwell, J. S. (2014). Shifting the paradigm of music instruction: Implications of embodiment stemming from an augmented reality guitar learning system. Frontiers in Psychology, 5, 1–19. https://doi.org/10.3389/fpsyg.2014.00471
- Kersten, L. (2017). Extended music cognition. Philosophical Psychology, 30(8), 1078–1103. https://doi.org/10.1080/09515089.2017.1350946

- Koelsch, S. (2014). Brain correlates of music-evoked emotions. Nature Reviews Neuroscience, 15(3), 170–180. https://doi.org/10.1038/nrn3666
- Leman, M., & Maes, P.-J. (2015). The role of embodiment in the perception of music. Empirical Musicology Review, 9(3–4), 236. https://doi.org/10.18061/emr.v9i3-4.4498
- Leman, M., Maes, P., Nijs, L., & Dyck, E. Van. (2018). What Is embodied music
- cognition? . In R. Bader (Ed.), Springer hadbook of (systematic musicology pp. 747–760). Berlin: Springer-Verlag. https://doi.org/10.1007/978-3-662-55004-5
- Lesaffre, M. (2018). Investigating. In R. Bader (Ed.), Springer hadbook of systematic musicology pp. (779–791). Berlin: Springer-Verlag
- Levitin, D. J., Grahn, J. A., & London, J. (2018). The Psychology of music: Rhythm and movement. Annual Review of Psychology (September), 1–25. https://doi.org/10.1146/annurev-psych-122216-011740
- Lopes E.;, & Alcântara-Silva T.R. (2017). Ritmo musical, improvisação e cognição como elementos importantes na formação do instrumentista – in LOPES, E. Tópicos de Pesquisa para a aprendizagem do instrumento musical – Research themes for learning of musical instruments – Goiânia: Editora Kelps,
- Maes, P. J. (2016). Sensorimotor grounding of musical embodiment and the role of prediction: A review. Frontiers in Psychology, 7(MAR), 1–10. https://doi.org/10.3389/fpsyg.2016.00308
- Mahendran, R., Rawtaer, I., Fam, J., Wong, J., Kumar, A. P., Gandhi, M., … & Kua, E. H. (2017). Art therapy and music reminiscence activity in the prevention of cognitive decline: Study protocol for a randomized controlled trial. Trials (18)1, 324. https://doi.org/10.1186/s13063-017-2080-7
- Peretz, I., & Zatorre, R. J. (2005). Brain organization for music processing. Annual Review of Psychology, 56(1), 89–114. https://doi.org/10.1146/annurev.psych.56.091103.070225
- Semenza, D. C. (2018). Feeling the Beat and Feeling Better: Musical Experience, Emotional Reflection, and Music as a Technology of Mental Health. Sociological Inquiry, 88(2), 322-343. https://doi.org/10.1111/soin.12194
- Storolli, M. A. (n.d.). O corpo em ação: a experiência incorporada na prática musical, 131–140.
- Styns, F., van Noorden, L., Moelants, D., & Leman, M. (2007). Walking on music. Human Movement Science, 26(5), 769–785. https://doi.org/10.1016/j.humov.2007.07.007
- van der Steen, M. C. (Marieke), & Keller, P. E. (2013). The adaptation and anticipation model (ADAM) of sensorimotor synchronization. Frontiers in Human Neuroscience, 7(June), 1–15. https://doi.org/10.3389/fnhum.2013.00253
- Varela, F., Thompson, E. & Rosch, E. (1991) The embodied mind: Cognitive science and human experience. Cambridge, MA: MIT Press.
- Visi, F., Schramm, R., & Miranda, E. (2014). Gesture in performance with traditional musical instruments and electronics. Proceedings of the 2014 International Workshop on Movement and Computing – MOCO '14, 100–105. https://doi.org/10.1145/2617995.2618013
- Wilson, R. A., & Foglia, L. (2017) “Embodied Cognition”. The Stanford Encyclopedia of Philosophy (Spring 2017 Edition), Edward N. Zalta (ed.), Retrieved From: https://plato.stanford.edu/archives/spr2017/entries/embodied-cognition/

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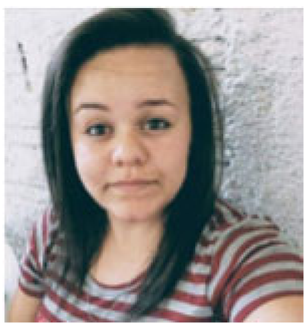

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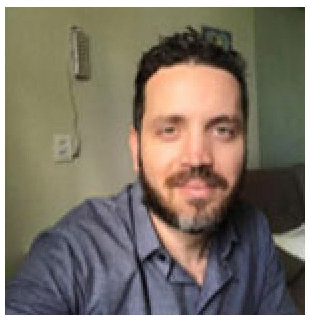

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