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MEMORIZATION AS A STRATEGY IN MUSIC INTERPRETATION FOR PIANISTS

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MEMORIZATION AS A STRATEGY IN MUSIC INTERPRETATION FOR PIANISTS

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“Il n'est pas sans intérêt de noter que la complexité des dispositions papillaires est en rapport avec le développement de l'activité cérébrale”

Marie Jaëll (1846-1925)

DEDICATÓRIA

To Lars Tyrenius, my father and mentor

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Abstract

The goal of this research is to investigate the correlation between memorization and the interpretative processes in piano playing. This investigation aims to develop and deepen some assumptions about how pianists memorize the music they are about to play and how the use of senses in this process also can be a strategy in music interpretation. The bibliographic review constitutes the main method within a methodological frame. Firstly, a survey was accomplished on the literature related to music interpretation. Secondly, an overview on the literature dealing with memorization and techniques for retrieving information was also accomplished. Following, the outcomes of the literature review were analysed and processed so broadening up the comprehension of these two subjects. Finally, the processes of memorization and interpretation were further developed in a cognitive frame with focus on interactions with the senses. In addition to the collected literature, my lifetime practical experiences as pianist and piano teacher were used to support some discussions here attempted. It is expected the results of this dissertation can broaden perspectives related to piano teaching, supported by the hypothesis that memorization techniques can be used as a basis to conceive a musical interpretation.

Keywords

Memorization, Interpretation, Piano performance, Piano teaching, Senses.

Memorização como estratégia em interpretação musical para pianistas

Resumo

O objetivo desta pesquisa é investigar a correlação entre a memorização e os processos interpretativos na execução ao piano. Esta investigação pretende desenvolver e aprofundar alguns pressupostos sobre como os pianistas memorizam a música que vão tocar e como a utilização dos sentidos neste processo também pode ser uma estratégia para a interpretação musical. A revisão bibliográfica constitui o principal método dentro do quadro metodológico. Primeiramente foi realizado um levantamento da literatura relacionada à interpretação musical. Em segundo lugar, também foi realizada uma revisão geral da literatura que trata da memorização e de técnicas de recuperação de informações. A seguir, os resultados da revisão de literatura foram analisados e processados ampliando a compreensão desses dois assuntos. Por fim, os processos de memorização e interpretação foram desenvolvidos num quadro cognitivo com foco nas interações entre os sentidos. Além da literatura coletada, minhas experiências práticas de vida como pianista e professora de piano foram utilizadas para apoiar algumas discussões aqui promovidas. Espera-se que os resultados desta dissertação possam ampliar perspectivas relacionadas ao ensino de piano, apoiado na hipótese de que técnicas de memorização podem ser utilizadas como base para conceber uma interpretação musical.

Palavras-chave:

Memorização, Interpretação, Performance ao piano, Ensino de piano, Sentidos.

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Introduction

Engaging in memorization, how to learn to remember music, is a process. Likewise, is the procedure for interpreting music. Regardless of style, genre, level, or in which environment the activity takes place, both concepts should be able to be connected. Can this relationship be modelled more precisely by using memorization as a strategy in interpretation? And how can memorization and interpretation be highlighted in a relevant way that is applicable and included in music education?

This investigation aims to avoid getting stuck in "now tired debates"[1] about interpretation (DREYFUS, 2020, p.184) related to outdated (dogmatic?) tracks. It also intends to explore alternatives to the ambiguous commands of the art of interpretation, in cases where there is a lack of a more detailed description of what it is, why, and how, to do, then simply expressing: "'Mind the music line! Make the melody clearer! Play with more feeling, please!'" (FRIDELL, 2009, p.1).

The attempt also aims not to repeat already existing findings[2] related to memorization (i.e., to start talking about Clara Schumann (1819-1896) and Franz Liszt (1811-1886), to define memorization as rarely taught[3], to judge memorization as mechanistic, only for experts[4]). According to Mishra (2010), the research of articles on memorization (years 1898 to 2003), resulted in: "the proportion of articles specifically advocating an analytical or conceptual approach to musical memorization has changed little over the century" (MISHRA, 2010, p.10).

Therefore, my intention is, based on the application of, among other things, a (neuro)biological perspective, to try to unite interpretation and memorization, as integrated with

[1]"It is only when one steps back from the now-tired debates about musical interpretation, then, that the cultural power of this conceptual metaphor becomes apparent and the varieties of artistic fruit it has borne can be surveyed and assessed: musicians, after all, have adapted "interpretation" to all kinds of contrary purposes, and to stunningly positive effects. On the other hand, when one reconsiders the relatively recent vintage of the metaphor and shoots a glance back at earlier notions of music-making, it is striking how performance as interpretation—by virtue of its "high" ideational station—has eclipsed and suppressed equally compelling ways to think about musical performance" (DREYFUS, 2020, p.184).

[2]See: Jennifer Mishra, Playing from Memory. A Century of Memorization Pedagogy, 2010. Available at: https://www.jstor.org/stable/20789876

[3]"Given the difficulty of playing long, complicated programs flawlessly from memory, and the public humiliation that attends memory lapses, it might be expected that the pedagogical traditions in music schools and conservatories would include detailed strategies for ad- dressing the problems involved. This proves not to be so. Conservatory training provides plenty of experience with performance, but memorization is seen as a largely idiosyncratic matter" (CHAFFIN; IMREH; CRAWFORD, 2002, p.xii).

[4]"Expert musical memory has been the fundamental focus of research in the field of musical memory, and this line of research has demonstrably informed the ways memory is understood by the current generation of music professionals (...) the recent 'genetification' of musical memory, together with the narrow expert gaze, may further reinforce old dichotomies between the talented and untalented, abled and non-abled. Through a critical lens towards the politics of knowledge production in memory studies, we argue that there is a need for a more critical, holistic and ethically reflexive understanding of memory in professional education in music and music education" (ODENDAAL, et al, 2020, p.360).

each other. The literature review is intended to demonstrate whether knowledge from the past or present, or a mixture, will be decisive for the result.

As most things in life are about the relationship between thought and feeling, so is the educational perspective related to music; teaching, learning and performance, no exception. The relationship between cognition and emotion, can appear as a constant dilemma. Thus, we end up in life-sustaining functions, how to survive and feel good: "we humans cannot divorce ourselves from our biology" (IMMORDINO-YANG; DAMASIO, 2007, n.p.).

Based on the current state of knowledge, logical thinking and factual knowledge are often rewarded, not least when it comes to children. This, despite the knowledge of the importance of emotional aspects for in-depth learning that also enhances links to experiences in one´s real life[5] (IMMORDINO-YANG; DAMASIO, 2007). Already Chopin (1810-1849) stated in his *Projet de méthode* that the expression of thoughts, as well as feelings and perceptions, were considered equal, defined as a source for creating art, "use sounds to make music", just as words construct language (EIGELDINGER, 1996, p.14).

So far, one wonders if an investigation into memorization and music interpretation might not seem far-fetched in this context. But is it not precisely this quality or ability that most music educators strive for, to "make meaning", to fulfill this desire to be "touched", to feel, hear or see, a "touching" performance, to be "moved", valid for listeners as well as for musicians and composers?

How does music interpretation deal with these circumstances, linked to aspects related to memory, and memorization or vice versa? Human senses are also fundamentally the origin of music interpretation and memory—the very essence of memorization. A seemingly complex area to analyze, explain and understand. Not least, Immordino-Yang & Damasio (2007, n.p.) specifically announce the importance of implementing processes such as "learning, memory, decision making, and creativity, as well as high reason and rational thinking". In this context, they also pinpoint "the influence of the mind on the body and of the body on the mind" (n.p.), which makes everything seem connected[6].

[5]"As both the early- and late-acquired prefrontal damage patients show, knowledge and reasoning divorced from emotional implications and learning lack meaning and motivation and are of little use in the real world. Simply having the knowledge does not imply that a student will be able to use it advantageously outside of school" (IMMORDINO-YANG; DAMASIO, 2007, n.p.).

[6]"In this mind/matter relationship, the human body can be seen as a biologically designed mediator that transfers physical energy up to a level of action-oriented meanings, to a mental level in which experiences, values, and intentions form the basic components of music signification. The reverse process is also possible: that the human body transfers an idea, or mental representation, into a material or energetic form. This two-way mediation process is largely constrained by body movements, which are assumed to play a central role in all musical activities" (LEMAN, 2008, p.xiii).

Other aspects that form the basis of my personal drive and proposals for this investigation aimed at music education, can be described as: “sources of flow and self-other understandings is the unique materials and requirements of musics, namely sonic-musical events created and shared by and for others at specific times and places” (SILVERMAN, 2007, n.p.).

This work, with its three main topics, intends to be approached in line with an overarching open question (i.e., not to be “replied”, as an ordinary research questions), as part of a justification: why do interpretation, memorization, and the senses, matter in relation to music education? A similar question is posed by Silverman (2023, n.p.): “Why does music matter related to one's education?”[7] The answers she presents are: “Self-other understanding”, “community”, and “happiness” (*idem*). I have a personal relationship with these concepts for the following reasons:

First, a self-perceived incident related to memorization increased the knowledge of my *self*, in the perspective of a meeting with a composer, as *understanding* the *other* – a meeting of minds.

Second, in the phase of (re)creation, a mutual interaction, a communication between composer and interpreter, blending of each other's “inner selves”, a non-chronological activity, united, in a virtual unsynchronized *community.*

Third, the effort to define the underlying features and factors, constituting the strategies I learned to use when memorizing, taught me “freedom”, “security” and a sense of interpretive thinking that caused *happiness*[8].

This dissertation exemplifies piano playing, which is my main field. The intention is, however, that the content should be able to be applied and reshaped for both music education and performance. Although more factors unite than separate, a general hierarchical division (and separation) is often seen here, although the common denominator is still music[9] (MeSH, 2024).

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[7]See: Music Matters a Philosophy of Music Education (Blog, 2023). Available at: https://www.musicmatters2.com

[8]“The fourth hypothesis is based on the notion of self-motivation. In learning to play a musical instrument, often there is a balance between skills and challenges. Playing a musical instrument starts with the imitation of low-level skills and low-level challenges. However, as skills improve, the challenges can rise to a higher level. When skills and challenges are in equilibrium, this gives rise to an optimal experience or pleasure. Csikszentmihalyi (1990) calls this a negentropic state of consciousness which is intrinsically rewarding. Thus musical learning is done for pleasure; it changes mood or provides consolation” (LEMAN, 2008, p.107).

[9]Definition of music: “sound that expresses emotion through rhythm, melody, and harmony” (MeSH, 2024). Svensk MeSH, Karolinska Institutet, NIH, National Library of Medicine. Available at: https://mesh.kib.ki.se/term/D009146/music

Memorizing involves the process of learning something "by heart"[10]. In a musical context this means going through a process with the intention of remembering the piece you want to play. But, what exactly should be remembered, kept in memory? If Carl Philipp Emanuel Bach's 271-year-old definition of musical performance in *Vom Vortrage*[11] (1753) can still be considered valid, a possible task to be accomplished could be:

> (…) true content (…) associated thoughts (…) and feelings (…) embodies jolly (…) as violent (…) emotions (…) be moved (…) so as to move (…) listeners (…) communicating, with (…) face and body (…) appropriate gestures (…) sensing (…) satisfying all kinds of listeners (…) arousing their empathy (…) through the expression of (…) own emotion (…) "One sees and hears it…" (…) trust (…) own ample insights (…) explain its true content (…) shun (…) mechanical attitude (…) exploit the freedom (…) make music from [the] soul (…) capture the author´s emotions (…) hit on the right delivery proper to any particular thought (DREYFUS, 2020, p.169).

In addition, Dreyfus (2020) resumes Bach´s instructions as "a virtual simulacrum of the human being himself" (p.169).

When memorizing music, what happens in relation to the continuous and simultaneous multisensory and multimodal process that musicians call music interpretation? How does memorization affect the interpretative process? Or, perhaps, could it be the opposite, that music interpretation impacts the memorization process?

What is all this called, the activity of pianists (which includes pressing, striking, playing keys on a keyboard) of memorizing and interpreting? Based on neuroscientific explanatory models, it is understood that: "performing music at a professional level is probably the most demanding of human achievements" (ALTENMÜLLER; SCHNEIDER, 2008, p.332). Such a "human achievement" should also be understood, related to, and commensurate with, all levels of music-making, even a beginner's, where everything must have begun. So, is it informative enough to name this activity as "playing the piano"?

Starting from these initial questions, this study intends, through bibliographical review, to broaden the perspective regarding memorization in its relationship with interpretation, seeking to discover its underlying structures.

Linked to these questions, one could also ask: what could or should a pianist do first to complete a memorization process? If we don't know how to think, it becomes difficult to

[10]"new understanding of the physiology of positive emotions and the key role played by the heart in the generation of emotional experience have exciting implications for higher-order thinking skills, learner readiness, decision making, and test-taking, as well as for social and emotional behavior" (MCCRATY, 2003, p.1) Available at: https://www.heartmath.org/resources/downloads/scientific-role-of-the-heart-in-learning-and-performance/

[11]"Carl Philipp Emanuel Bach's impressive chapter "Vom Vortrage" [On Delivery] from his Versuch of 1753" (DREYFUS, 2021, p.169).

identify what is happening and what should be done. How should the process be approached strategically, given that it is carried out simply by the act of doing, that is, practicing and playing?

Remembering the pianist Errol Garner, who played thousands of songs by heart: "I don't know what I do or how I do it (…) I relive my life at the piano. I just like looking at people and joking and smiling, and having them by my side"[12] (MORGENSTERN, 1981). Perhaps one of Garner's (unconscious) skills and abilities was based on "concentration", which according to Hughes (1915) "is the main, the most necessary factor" (p.596) – in musical memorization. Or did Garner adopt a strategy, similar to how Dahlitz (2017, n.p.) put it: "the heart informs the mind in unique ways"?[13] Today's knowledge has reached the following consensus: "we now know there is more neural "traffic" from the heart to the brain than the other way around" (McCraty, 2015, apud DAHLITZ, 2017, n.p.). Therefore, there are still areas to investigate (and perhaps reinterpret) regarding the concept of "by heart", of importance for music education.

Like Garner's personal experience as a musician, and also referring to O'Toole and Beckett (2010), when they claim research depends on multiple contexts where motivation is driven by passion, from which the (research) question arises per se, or as a hunch, the initial idea of this dissertation is based on incidents I experienced myself, referring to the day my piano teacher, literally took away my sheet music.

Growing up as a girl playing "classical piano", I ended up being formed (and judged) as belonging to a certain elitist culture, and because of this I suffered some class prejudices. Some comments from my youth, claiming that I was conservative, playing from sheet music, pearls in my ears, still hurt. Especially as I experienced the piano as a part of me – my body and soul. Since then, I refuse to participate in, or promote, any type of snobbery (too common), regardless of the type of guild, musical style or genre. Not least, different types of music practice, both related to music education and performance have far more common denominators than is normally presented. Therefore, I prefer to be called an omnivore in the culture.

[12]Available at: https://media.music.txst.edu/morgenstern/morgenstern-grammys/garner.html

[13]"In the 1960s and 70s, researchers John and Beatrice Lacey established scientific evidence that the heart communicates to the brain in a way that affects how we perceive and react to the world (Lacey & Lacey, 1974) (...) the heart informs the mind in unique ways. One such possibility lies in the capacity of our nervous system to sense electromagnetic fields, which the heart both produces and is sensitive to, and is referred to as cardioelectromagnetic communication: The heart is the most powerful source of electromagnetic energy in the human body, producing the largest rhythmic electromagnetic field of any of the body's organs. The heart's electrical field is about 60 times greater in amplitude than the electrical activity generated by the brain" (DAHLITZ, 2017, n.p.). Available at: https://www.neuropsychotherapist.com/guide-to-the-brain-brain-body-connections/

But since a still prevailing view, which is not always challenged and questioned: “that a musician's success is based on their innate musicality, which they call talent” (KARTOMI, Margaret, 2014, p.198), my constant stance and conviction is to always fight against this type of biased ignorance. Furthermore (at the risk of creating further conceptual confusion) the pianists' dedication (i.e., practice) is undermined as if just something “given out of nowhere”. Which of course is completely wrong.

So it is anything but “elitism” and “talent”. On the contrary, it is about understanding how the body's senses are characterized by an (evolutionarily) predetermined exploratory “will” to investigate the world. This happens via sensitivity, interpretation, memory and expression.

Once my fingers gained greater independence and stability when playing the keys, my mind gradually externalized via the piano. As if my inner life was exposed, via the sounds, the music I created, the piano became my “extended mind”[14]. I could express, feel, be happy. So, discovering a magical world of sounds, I spent all my free time at the piano. I played every piece of music I could find, as I remember the feeling of first encountering the major 7th and 5+ chord in popular music. I sang all the time and played the violin, trying hard to be a Jascha Heifetz (I failed). For a long time I believed that I knew how to memorize and play “by heart”. It was just “letting go”, the less you think, the better. It would happen through repetition, using mechanical memory (rote memory). I used the same approach in preparing for solo concerts and in the entrance exam for higher education.

Like a homemade memorization mix, the brain, which always wants to “interpret” (BUSZAKI, 2006, p.47), probably tried to form and offer me a cognitively[15], comprehensive internal counterpart for the musical score. An underlying biological and evolutionary based function of the brain's continuous interpretation, even during playing the piano. Thus,

[14]“In philosophy of mind, the extended mind thesis says that the mind does not exclusively reside in the brain or even the body, but extends into the physical world. The thesis proposes that some objects in the external environment can be part of a cognitive process and in that way function as extensions of the mind itself. Examples of such objects are written calculations, a diary, or a PC; in general, it concerns objects that store information. The hypothesis considers the mind to encompass every level of cognition, including the physical level. It was proposed by Andy Clark and David Chalmers in "The Extended Mind" (1998)”. Available at: https://en.wikipedia.org/wiki/Extended_mind_thesis

[15]“Cognitive processes include perception, recognition, imagining, remembering, thinking, judging, reasoning, problem solving, conceptualizing, and planning. These cognitive processes can emerge from human language, thought, imagery, and symbols. In addition to these specific cognitive processes, many cognitive psychologists study language-acquisition, altered states of mind and consciousness, visual perception, auditory perception, short-term memory, long-term memory, storage, retrieval, perceptions of thought and much more. Cognitive processes emerge through senses, thoughts, and experiences. The first step is aroused by paying attention, it allows processing of the information given. Cognitive processing cannot occur without learning, they work hand in hand to fully grasp the information”. Available at: https://en.wikipedia.org/wiki/Information_processing_theory

constructing a platform for (subliminal) understanding, since it (by then) happened more or less "unconscious" to me.

This is because "I" (my brain/mind[16]/body/thoughts/consciousness) was apparently (unconsciously) still "aware" of a struggle and a goal: remembering the music by heart. At first, these unconscious and randomly memorised patterns seemed to rely only on motor memory in combination with some elusive and non-verbalized formats. But even today, if faintly (albeit 36 years ago), I remember parts of Bach's *Partita No.2 in C minor, BWV 826*, there must have been some form of structure. I can still recall, although indescribable in words, various patterns on the keyboard, just as I can still "see" some pages of the music score, even feeling it in my hands, in combination with auditory melodic cues. Now with hindsight, the process was of course intertwined with auditory and visual memory.

A procedure based on constant auditory knowledge, using around 100 muscles (JAYNES, 1994), i.e. motor memory, in combination with endless hours of practice. Thus, gradually establishing clues about "what comes next," as Winslow (1949) defined "a chain of mechanical response" (p.16), similarly, Chaffin et al. (2008) describe "associative chaining" (CHAFFIN; LOGAN; BEGOSH, 2009, p.353).

What I did, by relying mostly on muscle/motor memory, was to build a (false) sense of a "safety net" (CHAFFIN; LOGAN; BEGOSH, 2009, p.361). A diffuse method as a mental image of a "whole", working most of the time, yet not a "whole"[17] as described by Matthay (1913), since it was shown to be anything but a "safe" procedure.

Not even at the age of 20 years old and playing Bach, *Partita No.2 in C minor, BWV 826*, I faced a serious lapse in memory – a blackout. I stopped playing and the audience applauded, assuming it was the end of the piece. I announced a continuation, (magically) finding a way back, playing to the final chord without further interruptions. At this point my confidence and desire to play by heart decreased. Only after my sheet music was literally taken away by my teacher I learned how to actually memorize. A feeling that has since (positively) affected my entire approach to music, i.e., performance, teaching, learning, interpretation and

[16]"mind in the Western tradition, the complex of faculties involved in perceiving, remembering, considering, evaluating, and deciding. Mind is in some sense reflected in such occurrences as sensations, perceptions, emotions, memory, desires, various types of reasoning, motives, choices, traits of personality, and the unconscious". Available at: https://www.britannica.com/topic/mind

[17]"we should vividly remember the exact proportion of musical importance attaching to each of its component sections and climaxes, to its variously contrasting subjects, sentences, phrases, ideas, down to the actual importance of each note employed. Only by such perfect memory of all its constituents can we hope to produce a musical picture (...) as a Whole (...) necessity of constantly keeping in mind the Whole – the teacher nevertheless must unremittingly insist on the pupil attempting this task, from his veriest beginnings in the simplest music" (MATTHAY, 1913, pp.57-58).

memorization. Gradually I increased my perspectives on interpretation, with greater control and deeper contact with the musical material, as well as greater contact with myself, implying an ability to "express" what I wanted.

Obviously, my piano teacher knew that I could not memorize. Without the sheet music it was impossible to verbalize the notes of the first chord and how they were divided between the hands, the exact rhythm, the duration of each note, motives, description of musical ideas, keys, initial and final notes in the passages. Apparently, I was unaware of the piece's structure, ideas, organization and overall form.

Although the piece I was playing reading a sheet music sounded good, I could not describe to myself what I was playing. Therefore, the educational objective was to make me know music (as Hughes (1915) says: "I *know* that I know every note", p.597). Thus, I passed from unconscious ignorance to a stage of conscious awareness. Understanding implied building a cognitive capacity to describe verbally and show it in a practical way to myself (and to my teacher).

My strategies for memorizing were: 1) place the sheet music away from the piano[18]; 2) describe each measure out loud with as much information as possible, "so that the ears hear your own thoughts", as my teacher Lars Sellergren said; 3) return to the piano, playing (from memory) repeating the "information", simultaneously describing out loud the tasks for each hand, the chords, the progression, finger by finger, "thumb of the right hand, supported in F, fourth finger repeats Bb", "fifth of the left hand in Ab"; 4) return to the score, reread, remember, repeatedly, if something was not clear.

The power and usefulness of the memorization process was also exemplified to me by an episode involving my teacher. He was going to perform in Vienna. However, still at the airport, before the flight departure, he received a call from the producer who asked him to play a specific piece as an "encore" that he had never played. Consequently, the only time for "practice" was during the flight. And that is what he did. Just by looking at the score, reading, repeating, recognizing, he memorized the music and played it by heart on stage[19]. There are other stories telling similar situations, like Errol Garner, for example, who composed "Misty" during a trip, to be performed and recorded upon his arrival.

[18]Identical suggestions are demonstrated:"if you are playing from memory [..] [it] is very important to go through the music away from the piano and go through it from memory" (FONTE, et al, 2022, p.9).

[19]"For substantial excerpts of previously learned music, there was no significant difference in error rate between playing with or without sound. In simple sight reading tests, however, although the absence of auditory feedback had no effect on performance from the score, it did have a deleterious effect on the accuracy of the music when it was subsequently repeated from memory, indicating that it remains important for the initial stages of learning even in experienced players" (WATSON, 2006, p.536).

So, I started trying to memorize all the works I had to play. Initially, my idea was to use my personal vocabulary to know each part, being able to stop and start again in each measure. So, I started paying attention, informing myself "mentally", speaking out loud. "Practice and memorize as if you were teaching a student next to you", as my teacher said. Breaking "the whole" into small parts and building it again, like a puzzle, part by part.

I was also inspired by Sellergren's proposal, and tried to decipher "the composer's working chamber" (an expression from Sellergren). In this way, trying to detect the formation of ideas, putting them together in an order that makes sense. This procedure increased my ability to remember and helped memorization, due to the process of learning how to create and perform music by heart.

Suddenly, playing the piano for me went from a merely intuitive state of action to something more intellectual, similar to a process of planning, calculation. It was not easy since I started to feel like in the story of "the butterfly and the scientist": the scientist is fascinated by the way a butterfly can fly. After dissection the intire insect, nothing was found. However, the butterfly could never fly again. Initially I felt something similar[20].

Because piano teaching is often based on an oral tradition, even these "theoretical" suggestions were initially described verbally to me. But as my practice progressed, playing and interpreting were gradually intertwined with those more "theoretical" reflections, so a new type of consciousness was quickly developed. I "felt" a cognitively heightened sensation, even though it was difficult to describe exactly what it was, how it happened, and why. But I was fascinated.

Later, the literature showed me similar examples. Fleisher (2015) describes the pianist as three-divided, in which I was soon able to identify as myself, with my own process, thus demonstrating my own sensation:

> Because I think we are three people in one: we are person A who hears before they play, we are person B who actually does the playing, who puts down the keys, and we are person C who sits a little bit apart and listens. And if what person C hears is not what person A intended, person C tells person B what to adjust. And this is a process that goes on constantly, simultaneously, every moment that you are making music (FLEISHER, 2015, p.171).

[20]"Activities such as reasoning, interpretation, and evaluation may disturb the feeling of being directly involved because the mind gets involved in a representation of the state of the environment, which distracts the focus and, as a result, may break the ''magic spell'' of being entrained. That is why the measurement of musical involvement by in- trospection is so difficult. Asking a subject to move a slider according to the self-evaluated degree of resonance with music engages the subject's mind in a process that may break direct involvement" (LEMAN, 2008, p.5).

The task of reaching this state (A+B+C) required a lot of work and concern, as I was forced to leave my comfort zone. That is, I had to re-learn how to not only assimilate music by sight-reading, without the need to "think", as I was used to, to just feel that the piano playing was "magic".

Consequently, in some way, being very young, being forced to reflect, to make decisions, to choose how to work with musical material, how to form it, how to approach it, was in some way "looking inside myself" in search of tools I did not know I had. Similar to self-education, my autonomy as a musician increased. Through this memorization strategy, my internal state of consciousness transformed my interpretation into a multivariate palette of musical choices. After going through this process empirically, the result came as expected, according to my teacher's prophecy. Exactly as in the dialogue with Fleisher (2015), the interviewer said: "work away from the piano, sit down and read a score. This is something you often refer to in your interviews" (p.171), and Fleisher responds:

> It's a way of working music: one makes music on the piano, one makes music on the kazoo, one makes music—wherever, wherever your choice of instrument is. There is nothing special or sacred about the piano. What is special and sacred is music (*idem*, p.171).

This feeling, of having become accustomed to following a score on a stand in front of me, focusing on a continuous shift between hundreds of symbols to decipher and control, and then moving on to having no paper to look at, involved several questions: what to focus on, where is the resting point? Without my eyes being absorbed by the score, an internal communication with myself gradually expanded, as well as other sensations related to other senses. My playing developed when I felt I could form sentences in another way:

> We often close our eyes when we explore objects with our fingers to reduce the dominance of the visual system over our other senses. Here we show that eye closure, even in complete darkness, results in improved somatosensory perception due to a switch from visual predominance towards a somatosensory processing mode (BRODOEHL; KLINGNER; WITTE, 2015, p.1).

So, having learned that vision is a dominant sense that easily surpasses other senses, I was finally able to understand what happened, or rather, why my experience of both tactile and auditory sensation subtly changed.

For me, this strategy of memorizing music turned into developing an internal interpretative guide. It took a long time to build an internal map, like an internal score,

equivalent to the functions of an external one. During the process I compared playing with and without the score (by heart), noting the differences in relation to the sensations perceived.

Therefore, my own experience has convinced me that memorization is a valid resource in music interpretation. With this in mind, I intended to develop this strategy and bring scientific confirmation to this finding. In this sense, I structured this research into 3 chapters, in line with the following objectives:

Main goal

I am working with the hypothesis that memorization can be used as a strategy in music interpretation. However, for the purposes of this research, this objective is mainly aimed at the performance of pianists, although I believe that the same could apply to other instruments. To support this proposal, the general objective of this research is:

• identify common factors and features related to memorization (through the compilation of measurable technical variables and musical elements) that have an impact on musical performance

Specific objectives

• carry out a survey on the music literature that deals with the relationships between memory and interpretation to identify the similarities between the authors and the scientific foundations that support these relationships (between memory/memorization and musical interpretation)

• compile a set of strategies that can be used as support in the memorization stages and that will consequently influence music interpretation

• propose the use of strategies as auxiliaries in the piano teaching and learning process

• describe, based on the bibliographical review, the synesthetic impact of the senses on the processes of memorization and interpretation

As a first step towards achieving these objectives, it is necessary to discover what relationships exist between memory and interpretation. Therefore, this investigation initially suggests how these relationships can be identified as such. An analysis of the significant characteristics of each area can point out some common denominators. Subsequently, since the possible similarities and points of contact have been identified, these factors can suggest forms and possibilities of interaction between themselves.

It's a kind of common sense among musicians that when you can play a piece by heart (as memorization is called among musicians) fluency and self-confidence increase (GINSBORG, 2004). It is an assumption that memorizing will help performance. This is the main motivator for encouraging memorization. It is also relative, conditional, because collaborative and

chamber pianists do not memorize. They memorize – but use scores (conductors alike). However, I am particularly interested in understanding another level of this process, especially since it is not explicitly stated "why"?

Therefore, I question whether the interpretative process in music could also benefit from memorization. As obvious as it may be, when I began surveying the literature on this subject, I became surprised to notice that there is no substantial corpus of literature combining memorization as a tool for the interpretative process. For this reason, I decided to raise, albeit preliminarily, some research questions:

- How can memorization be used as a tool for building an interpretation?
- How can we learn to remember and play music by heart? What are the strategies suggested in the literature to better memorize a piece of music?
- How are the processes of memorization and interpretation related to each other?
- How do the senses interact during the process of memorization and interpretation within the scope of the piano repertoire?
- What can be presented as evidence that better performance is related to better memorized music?

Analysis of the literature associated with these two areas inevitably brought new territories to examine aspects of practice and performance. By establishing various assumptions based on underlying features and factors, during this research I was guided by the described hypothesis with the intention of proving or refuting it. Furthermore, all the steps presented aim to illuminate and describe the sequence of events in a context where the pianist is the center to exemplify this process.

Methodology

The main research method used here was the bibliographical review. In view of this, a survey was carried out of several authors who wrote about forms and processes linked to memorization associated with interpretation. This procedure is in line with what Umberto Eco described as "reexamining the topic in the light of the documents collected" (ECO, 1977, p.6). At the same time, both the literature review and the contents of the other chapters were always guided by the hypothesis of this research, seeking its confirmation or refutation.

After the literature review, I tried to accomplish a kind of confrontation between the authors and their respective proposals. Right of the bat, I can say that the initial contact with the literature showed relevant findings related to other areas of study, such as musicology,

history, philosophy and cognitive neuroscience. These findings brought to light new (sub)questions, also related to the topic under investigation. Whenever possible, these questions were incorporated into the text (see below).

The systematization for the selection of texts for further reading occurred as follows:

a) an initial search on Google with the descriptors “memorization” “interpretation” “senses”. This more generic search served to show an overview of how and in which areas these topics have been investigated.

b) a specific search on Google Academic under the same descriptors.

c) a specific search in Orebro University Library, JSTOR and the Academia.edu database using the same keywords.

d) an initial reading of the Summaries of the texts found in the previous searches was carried out in order to discard works that were not related to the topic of this research.

e) the works considered relevant to this research were read in their entirety and compared with each other in order to provide a diagnosis of how the authors have positioned themselves in relation to the topics researched.

f) the central themes of this research (memorization, interpretation and senses) were displaced in separate chapters.

The use of concepts such as “center” and “periphery” (ECO, 1977, p.111), proved to be extremely valuable, as: a) the topics memorization and music interpretation in some cases were detected as “common sense” or “preconceptual knowledge” (in relation to an ancient verbal, written, and oral or auditory tradition), which can be interpreted as both “center” and “periphery”.

But precisely because broad areas (such as interpretation and memorization) can be treated “subjectively” here I tried to focus on points of contact, so to speak. However, it turns out that this “center” also has an inherent “periphery” character, thus making the entire process more complex. Still, the objective is to at least try, based on the main points of the investigation, to reach some kind of conclusion.

The bibliographic review can be described as a round table between all the authors debating. At first, I just watched them, listening. But suddenly I found myself involved in discussions, among these authors who even started to “talk” to me. When trying to follow the conversation I noticed that the discussions also involved philosophical questions, sometimes very long, as well as very in-depth perspectives on neuroscience and psychology, notions that

definitely had a significant impact on this research. The points of contact I have tried to highlight and discuss are an attempt to shed light on piano playing from a different perspective.

Thus, after having sought to define what is interpretation and what is memorization, the incisive question so emphasized by Kate Turabian remains: *"So what?"* (TURABIAN, 2007, p.7). Thus, the next step was to justify the reasons for this research: what and why to interpret? Why and what to memorize?

In these apparently simple questions, new sub-questions immediately arise, as mentioned above, "center"- "periphery" (ECO, 1977, p.111). To answer the Turabian´s "So what?", it is necessary to postulate some connection between interpretation and memorization (common features, factors, technical variables, musical elements). In view of this, other sub-questions appeared: What type of correlation? Are they really necessary? In what contexts? For which authors?

Based on these questions, the chapters were then organized: On Interpretation; On Memorization; On Senses. These chapters begin with a brief overview presenting the main contents and their central questions, always in connection with the research objectives.

I can say right away that the Bibliographical Review pointed to typical patterns well known to pianists who work in the so-called Western classical music tradition. It may seem obvious to draw a parallel with a pianist playing the piano, making music, such as: pianist + piano = music[21] (NEHUHAUS, 1993). But even so, this idea formed a useful basis for establishing a line of reasoning. The pianist interacts with the piano and the piano interacts with the pianist. Related to Bruno Latour (Actors Network Theory), Dankert (2011) describes: "interaction between actants is necessary to establish and maintain connections between them. (…) Interaction is like a flow: something flows from one actor-network to another. The research conducted by ANT wants to track these flows" (DANKERT, 2011). Reading Latour served as inspiration for the construction of a mind map demonstrating preparation for the topic. This map (Figure 1) also highlights my practical life experiences as a pianist and piano teacher, which will be used to support some discussions attempted here, in addition to the literature collected.

[21]"Every performance–the problems of performance will be the main subject of these pages–consists of three fundamental elements: the work performed (the music), the performer and the instrument. Only a complete mastery of these three elements (and first of all, the music) can ensure a good artistic performance" (NEUHAUS, 1993, p.1).

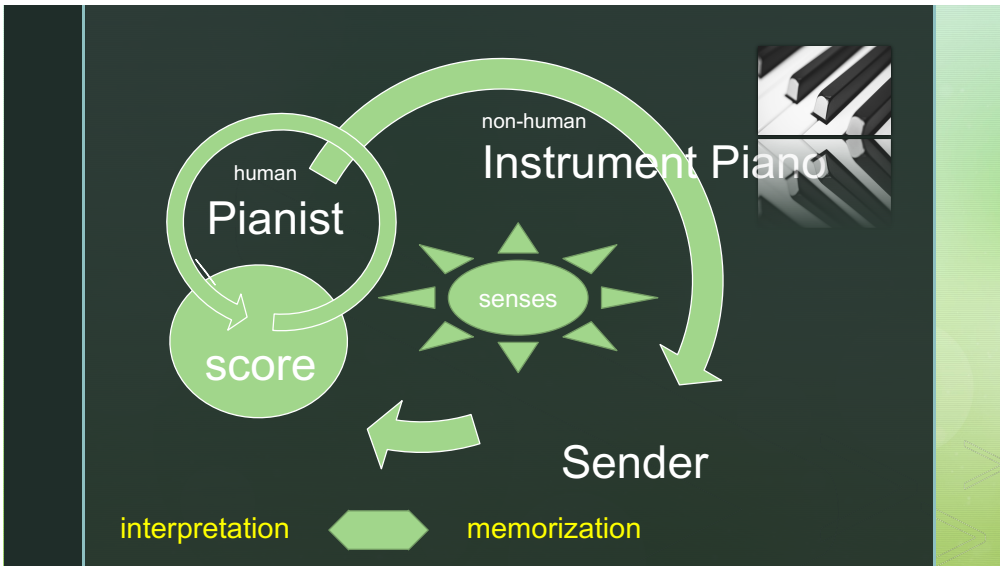

Figure 1: mental map showing the feedback proposal involved in the interpretation process.

This mental map is intended to show how new structures, connections and angles of approach began to emerge. What initially seemed familiar when approached with neuroscience immediately changed the degree of epistemological interpretation. Certain underlying structures have been crystallized through bibliographical literature as demonstrable features, factors, and unifying characteristics. These topics are detailed in the chapters of the dissertation.

Chapter 1 is titled "On Interpretation." The concept of interpretation was considered through a literature survey carried out with the aim of compiling musical elements and technical variables in the field of musical interpretation with a focus on pianistic interpretation.

Chapter 2 is titled "On Memorization". There is a synesthetic presentation of aspects relating to human memory, considering what is meant by memorizing, what happens when we memorize something. There is also a description of the concept of memorization among musicians, here specifically related to pianists.

Chapter 3 is titled "On Senses". Neither piano teachers nor the public can avoid observing that pianists require active coordination of physical movements at any level, involving all fingers, hands, arms and feet, in a bodily manner. This motor-kinesthetic activity normally occupies the main attention, but the other senses: vision, hearing, touch, also interact and, act as integrative controls during an interpretation.

"Discussion". When transmitting memories, considered in neuroscience as experiences, they can reverberate music interpretation in all its stages, the concepts of reciprocity perception, based on experiences of multisensory sensations linked to musical meaning, confer an expressive character that reflects everything we are, we think, and we do. This suggests that our

past (autobiographical memories[22]) constitutes a platform upon which fantasy forms imaginative tools that we all have access to, if we allow and enable experimental music interpretive creations (such as predictions of our future).

[22]"The amygdala, on the other hand, is responsible for the subjective personal events that contain powerful emotional significance to stay part of our autobiographical memory. The hippocampus and amygdala are ideally situated to combine information about the cognitive and emotional areas and bind that information into a bodily-tactile memory trace that codes for all aspects of a personally experienced episode" (NICHOLAS et al, 2019, p.39).

Chapter 1: ON INTERPRETATION

What is Interpretation

This chapter aims to develop some perspectives on music interpretation. The idea is to discuss authors from the past and present, but also in other areas than music, where their perspective on the subject will be presented and analyzed. Once having selected some definitions in line with the goals and hypothesis of this investigation, the basis will be constructed as a foundation to assist my proposal for a more comprehensive assessment on music interpretation.

Since specified gaps require further investigation, some selected areas and aspects are examined based on the questions: what, why, how, and when. The goal is to identify various features and factors, technical variables and musical elements related to the conceptualization of characteristics of music interpretation. Initially an etymological description of the concept, followed by *De Interpretatione*, seen as an overarching title, defining an attempt to *interpret the interpretation*. After that, the work of an interpreter will be highlighted, which will be further analyzed in a hermeneutical subchapter, where philosophical paths signify the person behind the actions. To conclude *What is Interpretation,* it will be proposed an interaction format which combines the performer, the teacher, and the learner.

Etymology

This subsection describes some definitions related to the word interpretation. In one of the most comprehensive books about this theme, Rachel Mairs (2015), describes an ancient relief which may be one of the oldest[23] surviving examples of what constitutes an interpreter:

> the depiction of foreigners on reliefs in the tomb of Horemheb at Saqqara (c.1350 BCE), in which individuals in Egyptian dress are shown spatially in between the king and the assembled Asiatics, evidently relaying information. Linguistic mediation may be inferred but cannot definitively be proven (MAIRS, 2015, p.138).

Carved in stone, it shows a merchant in a marketplace, with two silhouetted profiles, haggling before selling or buying, meaning to be in between, between prices, in line with its

[23]Source: Unprofessional Translation, blog (2010): "the earliest known graphic depiction of an interpreter at work" Available at: https://unprofessionaltranslation.blogspot.com/2010/07/earliest-depiction-of interpreter.html

etymological roots referring to Latin: *inter* + *pretium* (between prices), but also: *inter partes* (between parties), to take different positions and assessments (GIULIA, 2014).

Figure 2: Horemhab's Tomb in Saqqara (credits: Rijksmuseum van Oudheden)
Source: Giulia, 2014.

Suppose Horemhab´s tomb in Saqqara (Figure 2), dated 1330 B.C.[24] (GIULIA, 2014), illustrates an interpreter, with two faces, negotiating between sets of values, thoughts, and ideas, which also means compromising, with the intention of getting others to understand, or to offer something.

Interpret, can therefore relate to meanings, according to Giulia (2014): "to spread, to make something known", intelligence, cognition, to show, manifest, say, negotiate (a deal), go between, mediate, negotiate, Dutch: praat (chat), Greek: "*pernemi* (to sell)" (GIULIA, 2014). In Swedish, "prata" means, to talk!

It is perhaps a rather imprecise comparison, to define a pianist's work in music interpretation with the help of an ancient etymological source, but as a hypothesis this relief represents part of what pianists do. Once having learned to speak the language of music, it is also important to "translate" (i.e. performing) the content to others:

> For the word "interpreter" as a profession, dictionaries describe "someone who translates speech orally or into sign language" (Oxford Dictionaries); "person who translates the words that someone is speaking into a different language" (Merriam Webster) making it sound like a mechanical task" (GIULIA, 2014).

Interpreters stand between sets of values, thoughts and ideas and make them known so they can be understood. Interpreters also negotiate because all interpretation may involve a bit of compromise. An interpreter can also be, according to Giulia (2014): "someone who explains

[24]Available at: https://wordsofnona.com/en/blog/totherootofinterpreting/

things that are obscure or unclear", based on the Treccani dictionary, "someone who explains the feelings and thoughts of others", or "someone who plays a part" (Garzanti dictionary), and the more poetic version: "someone who makes known the affections and movements of the soul" (Real Academia Dictionary)[25] (Source: GIULIA, 2014).

These definitions can also be related to music, although pianists do not explicitly recode *words.* Instead, they translate signs or symbols into music, or, they translate already heard and remembered sounds, into a new sounding creation. But like how "words" must be put together in an order to make sense, music is also said to be organized into a certain structure, like how: "the art of producing pleasing or expressive combinations of tones especially with melody, rhythm, and usually harmony"[26][27].

If comparing a pianist with someone who translates speech orally or into sign language could, in an opposite way, be related to a pianist translating a score (defined as "speech") and since we think about speech as something we (hopefully) have understood, so it means that the pianist understands the score (or a sounding source), but translates it another way around, to make it "hearable", using "sign language", through the hands and fingers on the piano into sounding "signs".

Other etymological explanations for the word *interpretation* are described as: "*interpretacion, entrepretatiun* "explanation, translation" (…) *interpretationem* (nominative *interpretatio*) "explanation, exposition," noun of action from past participle stem of *interpretari* "explain, expound; understand"[28]. Other synonyms to interpret found in dictionaries are: elucidate, simplify, spell, decipher, decode, solve, sort out, make comprehensible, understand, comprehend.

Each of these concepts can be used as an overall descriptive framework, and later some of them will be used to show a practical and theoretical example. Consequently, the interpreter's role can be described as "putting words into meaning", or "putting meaning into words". In music, it would then mean "making sense" (meaning) of music.

[25]Available at: https://wordsofnona.com/en/blog/totherootofinterpreting/
[26]Available at: https://www.merriam-webster.com/dictionary/music
[27]"That one of the fine arts which is concerned with the combination of sounds with a view to beauty of form and the experience of emotion; also, the science of the laws or principles (of melody, harmony, rhythm, etc.) by which this art is regulated'. *Webster's Third International Dictionary* (New York, 1981) begins: 'the science or art of incorporating pleasing, expressive, or intelligible combinations of vocal or instrumental tones into a composition having definite structure and continuity'" (NETTL, B. Grove´s dictionary, 2001, n.p.).
[28]Available at: https://www.etymonline.com/word/interpretation?utm_source=related_entries

De Interpretatione

How to “interpret” interpretation? How would you describe the concept *interpretation* more precisely if you were asked the question? Perhaps there are more musicians who reflect on its perhaps too uncritical daily use, eager for an update of explanatory models. At least this was the reason in my own case.

One of Freeman Tilden´s (1957) pillars for interpretation were: “Interpretation is an art, which combines many arts” (VEVERKA, p.21). According to Haynes (2007, p.102), François Couperin, in L’Art de toucher Le Clavecin (1717), said: “just as there is a great distance between grammar and Eloquence, there is the same infinity between notated music and music played well”. Thus, experiences of music affect those who are involved, in one way or another. There are different interpretations about the concept of interpretation. Dreyfus (2020) exemplifies by referring to: “Emanuel Bach's “explanation of a piece's content” or from Casals's “reconstitution of an author's mind” (p.185). Furthermore, it can be discussed whether interpretation is performed continuously during the musical performance, on stage with an audience, or as a prophylactic act in solitude: “it seems more appropriate to restrict interpretation to a stage of study and reflection *before* a musician begins to play” (DREYFUS, 2020, p.185).

After having chosen the title *On Interpretation*, I was acquainted to the predecessor Aristotle, of this title: *De Interpretatione*, about which Whitaker (2007) tells: “scholiasts (…) explain that ‘on interpretation’ means ‘concerning the assertion’ (…) assertion interprets (…) the knowledge in the soul (…) experiences of the mind” (WHITAKER, 2007, p.6). Based on texts by Aristotle, other suggested definitions are: “linguistic expression, and even for animal communication. 'Expression' or even language' would therefore serve as a better translation. All birds have expression” (WHITAKER, 2007, p.6).

Therefore, in addition to the listed “old” definitions of *interpretation*, this chapter is inspired by authors as Snowdon, Zimmermann and Altenmüller (2015), who purposed the hypothesis based on the evolution where sounds as signs for communication lay ground for the intrinsic features of music[29].

[29]“Emotions can be expressed in music and there have been several attempts to describe the structures that convey emotions. Scherer (1995) suggested that sadness is conveyed by slow tempos, a narrow frequency range, decreases in pitch, and a slow rate of articulation. (This is similar to the intonation contours that lead to calming in pre-verbal infants and nonhuman animals.) Joy is conveyed by fast tempos, increasing pitches that are highly variable, and by increased rates of articulation. (This is similar to the intonation contours that lead to increased activity and arousal in preverbal infants and nonhuman animals.) Anger is conveyed by an increase in fundamental frequency and by higher intensity (amplitude), and fear is shown with an increase in fundamental frequency, many high-

If we agree, as Dreyfus (2020) states, that the concept of interpretation might be developed by new and updated explanatory models, regarding aspects linked to music interpretation, we will see what Mazzola (2011) visualized and externalized as a pianist's reality is seen slightly beyond the common perspective:

> A well-educated musician must know for what rationale his/her performance is shaped in one or another way, and which are the parameters that are responsible for the performance's specific qualities (MAZZOLA, 2011, pp.viii).

To further understand these underlying aspects of didactical[30], methodological, and pedagogical coherence, this discourse has as its purpose to *reinterpret* music interpretation, since authors; educators and performers (JAËLL, 1897[31]; MATTHAY, 1913; SILVERMAN, 2007; FRIDELL, 2009; MAZZOLA, 2011; KRIVENSKI, 2018; DREYFUS, 2020), have highlighted the importance of updating perspectives regarding *music interpretation*.

Mazzola (2011) uses a descriptive image (Figure 3) to illustrate an innovative and broadened perspective on the subject, aimed to demonstrate a variety of those multifaceted layers which altogether form the whole basis of piano playing and its inevitable constituent levels of music interpretation.

frequency components, and a faster rate of articulation" (SNOWDON; ZIMMERMANN; ALTENMÜLLER, 2015, p.25).

[30]"While didactics is a discipline that is essentially concerned with the science of teaching and instruction for any given field of study, pedagogy is focused more specifically on the strategies, methods and various techniques associated with teaching and instruction". Available at: https://reflectiveteachingjournal.com/difference-between-didactics-and-pedagogy/

[31]Jaëll (1897) foresees the increased science, related to "touch", and how it will transform music education, i.e., totally aware about the impact of the own body, as a touch from the soul, the link to expressivity, as a manner to enhance emotional/musical content.

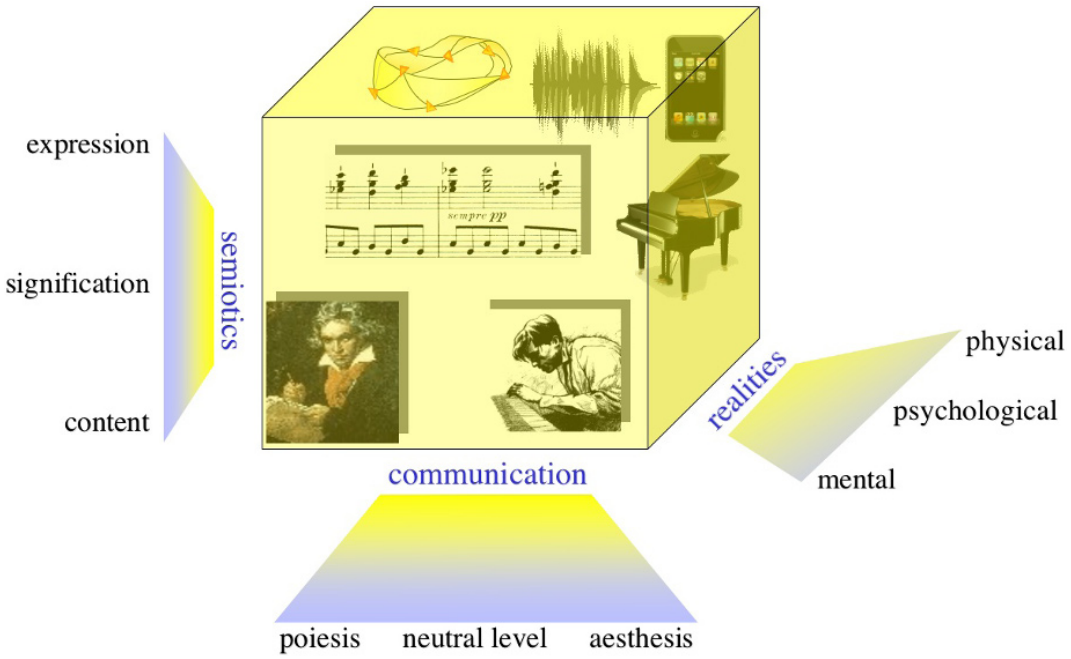

Figure 3: Mazzola´s (2011, p.25) "three-dimensional cube of musical ontology" which in this context specifically draw attention to the "neutral level", here defined as the zone for the *self,* before, while, and during, making music interpretative decisions.

In this context, a performance is thus intended to be interpreted as an ability to happen at any so called "level". Claiming that playing piano can occur as a performance with or without an audience – since the self is also a presumable attentive listener (LEMAN, 2008). Thus, performing, playing, and even interpreting, while listening to (or communicating with) the *self,* has been interpreted in different ways and presented in a variety of concepts related to areas of cognition.

According to Mazzola (2011, p.15), how could Riemann´s (1849-1919) "shaping of musical thoughts", as Schenker´s (1867-1935) "expression of analytical facts", which led to Adorno´s (1905-1980) "analytical performance", be accomplished at all, if not based on a *listening to oneself,* or *one´s self*, as an inner communicative decision-making-process? In addition, the results of the collaboration between Adorno and Benjamin (1892-1940) formulating performance as "a micrological procedure that penetrates the infinite precise dimension of performative activity" (MAZZOLA (2011, p.16) highlights two concepts of interest. Specifically, the area of piano playing renders "infinite" optative technical and musical "choices", requiring a decision-making-executor, in line with the former aspects of "listening". The words: "infinite" and "precise" (Adorno; Benjamin, apud MAZZOLA, 2011, p.16), a contra dictionary, however, dualistic perspective enters in the context, defining interpretation. As the mechanistic idiomatic possibilities at the instrument piano offers such "precise"

"infinite" options, this also implies, that the source of production (pianist) might mirror all musical nuances possible to execute, at the keys, and pedals, using the hands and fingers. Thus, a perspective on piano playing rises based on tactile actions, touching the keys, in combination with joined processing of senses as hearing and sight, equivalent as braille[32], if impaired vision[33].

According to Dreyfus (2020) the concept of music interpretation, as we know it today, was not incorporated as an accepted concept until after about 1840 (p.161). But of course, this does not mean that the musicians previously performed music completely aimlessly. A proof (among multiple) can be found in the book, *Versuch über die wahre Art das Clavier zu spielen* (1753), where Carl Phillip Emanuel Bach (1714-1788) gave (over)clear instructions and description of a musician's main task, when making music. The requirements are extensive and described in detail.

We must not forget Couperin, *L´Art De Toucher le Clavecin* (1716). Therefore, there is reason enough to consider this seemingly outdated information, even if it is a few hundred years old. Upon a closer analysis of the chapter *Vom Vortrage* (BACH, 1753), reflecting on the goals of the investigation, it must be considered that the overall assessment of a musician's (pianist's) duties can be defined in the light of research findings, also related to neuroscience, psychology, cognition, physics.

Different aspects and levels of cognitive neuroscientific explanatory models will serve the focus of aspects related to the behind lying procedure of music interpretation.

Thus, *neuroscience,* as the missing link*,* gradually filled in gaps, earlier shrouded in mist, which at least in my interpretation transformed *Cogito ergo sum* into, *Sentio ergo sum* (I sense/feel therefore I am), or *Experior ergo sum* (I experience, therefore I am).

[32]See: NLS MUSIC NOTES Resources for the Blind & Print Disabled Available at: https://blogs.loc.gov/nls music-notes/2022/09/braille-music-basics-reading-notes-and-octave-signs/

[33]"Several scientists have demonstrated that those who are born blind or acquired blindness in early childhood utilise the 'vacant' cortical visual area in the occipital lobe when they read the Braille alphabet with their fingers (...) in a blind person, the sensory and visual cortices work together to generate a reading experience transmitted via the finger pulps (...) Both the sensory and visual cortices are activated when the fingers move over the dots. This means that more nerve cells are involved in the sensory experience, and more brain resources contribute to a refinement of the tactile sensibility of the fingers" (LUNDBORG, 2014, p.109).

The Interpreter

This part aims to describe a pianist as an interpreter. The intention is to delineate features and factors based on collecting arguments and definitions from different perspectives, as linguistics, which might assist in finding new perspectives on music interpreters.

It is proposed that "Performance is meaningless without interpretation" (KHARICHEVA, et al, 2020, p.130). Such claims are supported by other sources and musicians. By using the concepts *homo faber* (the making man) and *homo sapiens* (the thinking man) Neuhaus (1993) claimed as both being required for an artist (p.55). As an example, Neuhaus (1993) refers to Anton Rubinstein, saying: "You think it is one instrument? It is a hundred instruments!" (NEUHAUS, 1993, p.55). Also, Carl Czerny used the digit "100", to illustrate the possibilities of how to handle a piano tone based on: "one hundred dynamic gradations" (NEUHAUS, 1993, p.55).

Wilcox and Shaffer (2005, p.40) present a problem within the area of language interpreters whose work can be described as: "the awesome and mysterious task that they perform: speaking for another" (*idem*, p.45), which in a musical context could be compared to how a pianist interpret music, especially if the music is composed by another.

Thus, to assume that a certain communicative task requires some preparation, should also be valid in areas of linguistics as music. But Wilcox and Shaffer claim to have failed: "our models of interpreting simply do not do justice to the act of communicating" (*idem*, p.45). So, Wilcox and Shaffer´s perspective, if (language) interpretation is just based on grammar, will fail aiming the explicit purpose with interpretation as communication: the message, and the bigger picture. Likewise, to ground a music interpretation just on correct analysis of music theory (musical grammar) does not necessarily create a "meaning". But not all analysis is only structural. Sometimes understanding the structure illustrates the hidden meaning. Analysis is a useful tool, if used properly.

It is exactly because of these intricacies these authors conclude that interpretation: "is not to extract meaning from words, it is to put meaning into words" (*idem*, p.46). But what is meant by the commonly used term "meaning"? Is it not also the opposite, so that in the building blocks of music there is already a built-in "meaning" to be found?

Based on the belief that models can visualize often difficult-to-explain concepts, i.e., the underlying "invisible" processes in music interpretation, a figurative model related to linguistics is adopted. In Wilcox & Shaffer (2005), Colonomo´s (1992) model of a "non-linguistic" message, shows an (language) interpreter in eight (8) steps. Though here redesigned

for a pianist. The features are the same: 1) the process for the interpreter starts within a context (“Source Message”), related to either a sounding (by ear), visual (by score), or tactile (by braille) source; 2) the information to be processed, passes through the perception of senses (“Receptive channels”); 3) the input of stimuli is processed (“Analysis Factors”) based on former memories (experiences); 4) the understanding gradual unfolds as a reflection (“Source Representation”) (of the initial Source Message) however altered based on former memories (experiences based on interpretation of senses) (“Analysis Factors”); 5) the interpreter has reached a sense of (“non-linguistic”) “meaning” (“Formless Message”); 6) the “Formless Message” starts to “make sense” for the pianist, initiating an initial phase, planning for “re-creation” (“Target Representation”); 7) like how factors for analysis (3) decoded the initial "source message" (1), in the same way a (alternatively) new "Source Message" is (re)constructed through “Composition Factors”; 8) based on the initial "Source Message", a new interpretation has been created (“Equivalent Target Message”), formed into a new context.

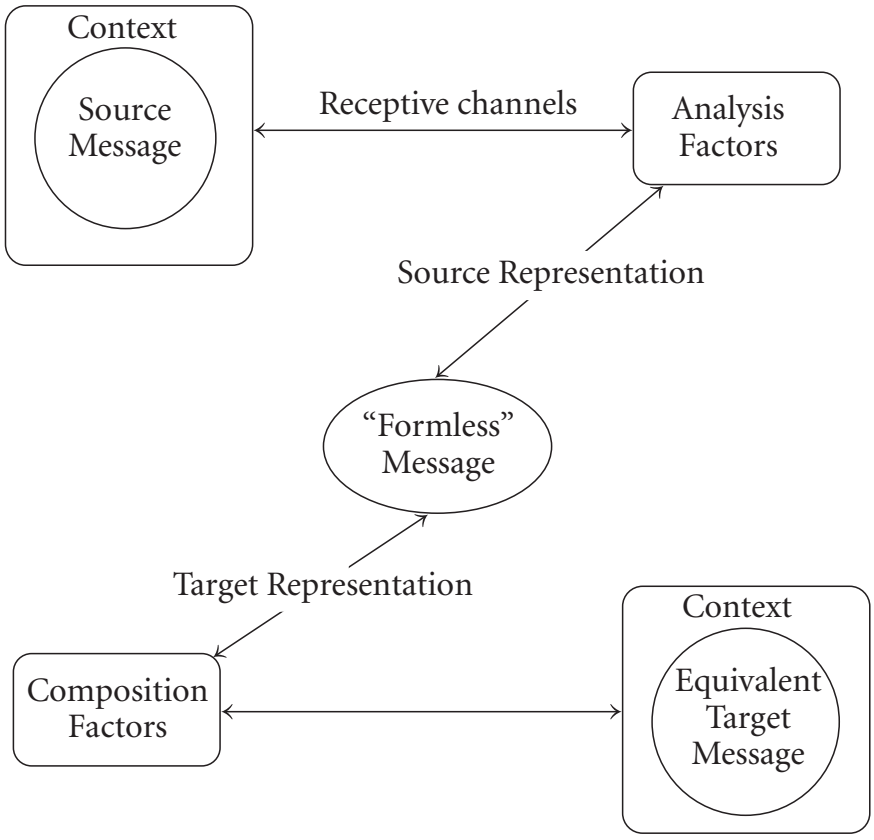

Figure 4: a pedagogical model, illustrating an interpreter processing a “non-linguistic message”, by Colonomos (1992), based on Seleskovitch (1978), here adapted to a pianist’s perspective.
Source: Wilcox & Shaffer (2005, p.31).

Consequently, a pianist's task is, both beyond, and via, musical "grammar", i.e., musical features and factors, to extract and understand an inherent (human/musical) meaning. Initially, the understanding is designed as a formless unarticulated "message". The inherent meaning of the message is gradually recreated, via various processes. Not least via so-called emotional intelligence. Thus, the interpreter, is making meaning, to be the medium. It is also at this point, when the pianists´ individual fingerprints, the touch (as embodied memories) will affect the interpretation. The fingerprint on the key, is a direct communication, from a "self" to the other.

One of the reasons in this research, the background, and choice, regarding the reference to language interpreters and linguistics, not least the use of the format "translator" (pianist), derives from common norms based on Chopin's (1810-1849) position, as well as Goethe´s, that music is a language: "the language of the inexpressible" (EIGELDINGER, 1992, p.15).

Moreover, in line with the French saying of the last century: "'*dire* un morceau de musique" (to 'tell' a piece of music)'" (EIGELDINGER, 1992, p.15). Also J.S. Bach (1685-1750) is said to have emphasized musical performance as "speaking", which is said to have been heard when he played: "[Bach] 'knew how to introduce such variety to his performance that each piece, under his fingers, sounded just like a speech'" (Forkel, 1950, p.33 apud EIGELDINGER, 1992, p.15).

But as highlighted earlier, there is a contradiction, a built-in problem for the interpreter, to interpret, or "translate" if one now wants to test this linguistic approach.

The big question is how can we relate to music interpretation of today? How can we use historical knowledge, with the present, and interweave into a new discourse applicable to different musical styles, genres, levels, and different formats? Not least since a pianist needs to challenge certain approaches, according to Stravinsky[34]: "'The sin against the spirit of the work always begins with a sin against its letter" (1947, p.124), a reversal of the view expressed by Liszt to Richard Pohl in 1853, whereby '*the letter killeth the spirit*' (La Mara, 1894)" (PACE, 2022, p.8).

The 19th-century emerging concept of Werktreue[35] (DANUSER, 2015), as well as Texttreue and the early 20th century movement, Neue Sachlichkeit (PACE, 2022) sum up (in

[34]"Stravinsky was more emphatic about a new role for the performer, above all in his 1939-40 Charles Eliot Norton lectures at Harvard, later published as *Poetics of Music*. Arguing that "Having been fixed on paper or retained in the memory, music exists already prior to its actual performance"; he finds that most of the problems in contemporary performance are rooted in a conflict between "execution and interpretation" (PACE, 2022, p.8).

[35]"This loyalty to the work—Werktreue in German, a concept championed by Carl Maria von Weber—introduces an ethical category into the idea of textual fidelity: the composer has left us his text and the text is a stand-in for his intentions. Render the text without making alterations or deletions, and one is being faithful to it and, by extension, to the venerated composer who commands such respect" (DREYFUS, 2020, p.171).

broad terms) an overall backlash against subjectivity and freedom, an “eschewal of overt manifestations of subjective expression” (PACE, 2022, p.7). The so-called “new age” developed through influences such as: “folk-inspired work of Stravinsky, Bartók and Janáček, Debussy's inspirations from painting, the rhythmic energy of jazz and other music inspired by dance and the work of Hindemith (who would become most prominently associated with the new aesthetic)” (PACE, 2022, p.7). What was generally prized in this “epoch”, is presented as a focus on accuracy and objectivity, because as Hill (1994) described: “a new prominence, with regular talk of 'Overcoming Romanticism' (Hill, 1994)” (PACE, 2022, p.7).

There is a neuroscientific explanatory mode in this context related to (the mind of) an interpreter's musical approach (and choice) towards “subjectivity and/or objectivity”. Namely, delineated aspects in areas of mindfulness-based interventions (MBIs), (SCHUMAN-OLIVIER et al, 2020) expressed as: “the capacity to shift experiential perspective–to step outside one´s immediate subjective experience to a more objective, non-identified awareness of one´s experience”. Schuman-Olivier et al (2020, p.374) call it: “*decentering, metacognitive monitoring, or meta-awareness*”, a conscious ability to cultivate mind awareness and consciously shift attention.

Yet, the contradiction is that this form is also identified as a state of “extinction of emotional reactivity” (*idem,* p.374). It might sound odd, when music is defined as emotion (MeSH, 2024). Although an interpreter must deal with, or bargain, like the Saqqara figure, between different types of subjective or objective feelings and points of view: “learn to be mindful of emotions, the capacity for *emotion differentiation* (…) with an enhanced ability for emotion regulation” (SCHUMAN-OLIVIER et al, 2020, p.374).

Consequently, it seems that the topic changes depending on the epistemological definition within which the field itself is discussed. It is related to how the effect of the music affects the interpreter and the interpreter's awareness of which context should be “chosen” as an analysis filter.

Therefore, in Colonomo's model, it is demonstrated (at least) eight (8) steps an interpreter (here: a pianist) must go through, which also require memory and memorization on different levels. Obviously, there are many aspects to consider related to interpretation in general, which can still unfortunately sometimes be portrayed as just about playing right or wrong. The purpose here has thus been to (partly via linguistics) reinterpret interpretation, not least to be implemented as a didactic figurative model in music education. Regardless of what music is played, the model seems to be able to describe the internal process as an explanatory prototype.

Perhaps, as one of this purpose, Mazzola´s (2011, p.viii) "rationale" and "parameters" will hereby take a turn, in opposition towards an ancient [and still existing?] view[36] upon the *performer* as belonging to the "lowest level, musica instrumentalis (…) singers and instrumentalists (…) excluded from a true understanding of musical science and are of servile rank to scholars exploring the other two levels" (Chadwick, 1981, apud ALTENMÜLLER, et al, 2015, pp.149-150).

Along with these authors and based on the understanding that everything we do is based on interpretation, I would argue that everyone who plays in some way acts as an interpreter. Specifically of importance to highlight in all levels of music education. It is neurobiology. Whether you play by heart, by ear or by score, instantly improvising, or prima vista, or "just" any playing. Even though, interpretation is not always explained in this way (see, for instance, DREYFUS, 2020). But to be aware of one's own interpretation, to what extent must the basic and constitutional grammatical basis be fully embodied in an interpreter? What is required to have any capacity of being meaningful, suggestive, or to convey meaning?

Hermeneutics

As previously presented, one of the possible etymological meanings of interpretation, (*inter pres)* if similar *in between parts*, in a musical context would aspire or imply the in-betweenness, amid the generalized view of; a) the composer and the performer, or b) the performer and the music score, or c) the scenario inside the pianist, balancing, judging, managing perceived musical input and expected expressed musical output. Another possibility is visualizing an interpreter as identical with the Saqqara-relief: d) in between the performer´s own conditions and abilities to "draw the meaning out" of the text (as musical content), employing the ancient concept *exegesis*[37]. But also, how to make use of the opposite concept, *eisegesis*, which means a simultaneous requirement to add personal "meaning *into* the text"[38].

[36]"This scholarly appraisal for the *text* over the *music*, since not a recent phenomenon, have been expressed in many ways, as here, enforced by the Roman philosopher Boethius´s (c. 480-524) view upon the *performer*: "The lowest level, musica instrumentalis, actually refers to audible music and is performed by singers and instrumentalists, who, however, are excluded from a true understanding of musical science and are of servile rank to scholars exploring the other two levels (Chadwick, 1981)" (ALTENMÜLLER, et al, 2015, pp.149-150).

[37]"Exegesis, as indicated by its etymology, is the act of critically interpreting a text in an attempt to "draw the meaning out" of the text. (This is in contrast to what has come to be known as *eisegesis*, where one reads his own meaning *into* the text". Available at: https://hermeneutics.stackexchnage.com/questions/36/what-is-the-difference-between-exegesis-and-hermeneutics

[38]*Ibidem*

Making decisions about how music can and should be interpreted can be difficult. But just as "difficult" it can also be made easy, by being allowed to try and test, as Schnabel (1988) wrote: "A call must precede the echo. The caller who hears no echo will change his place, will utter his call from another. (…) In any case, someone must first call" (SCHNABEL, 1988, p.233). An analogous hermeneutic dialectic outlook unfolds in Richardson, Fowers & Guignon's (1999) assessment: "Our nature or being as humans is not just something we *find* (as in deterministic theories), nor is it something we *make* (as in existentialist and constructionist views); instead, it is *what we make of what we find.* (p 212)" (EATOUGH; SMITH, 2017, p.6).

All is based on physiologic, bio-mechanic, philosophic, sociologic, and neuroscientific tools, of which perception[39] and involvement of senses are part. The in-between-something, discriminates even further additional levels, if one wants to go that far, as to relate to the interstice, between something, where something is the axons and dendrites in the brain.

Nevertheless, even if music interpretation mostly is aimed at the in-betweenness between the composer´s musical score, or even without any score, the interpretative performer needs to act related to certain commands, choices, and decisions, regardless genre, style, instrument, and culture. If a human being is treating an instrument of any kind, these abovementioned (neurobiological) interpretative choices, are always present. Even an interpreter-robot ought to be programmed in advance, to at all, implement anything similar music.

Danuser (2015) explains how to make meaning of interpretation, as linked to: "something not comprehended in itself and that therefore it stands in need of explication" (p.185). Furthermore, he argues, interpretation is not only linked to "hermeneutic exegesis", as an explanation of meaning-making, nor as a "sonic realization" (p.185), but also the actual translation of the musical "text", with its behind lying understanding: (Hans Heinrich Eggebrecht (1967a, 408) apud DANUSER, 2015, p.185):

> *Interpretation*, the sonic realisation of a piece of music by an instrumentalist, singer, or conductor, means not only the explication (Lat. *interpretatio*) of a vehicle of meaning, but also the translation or recasting of a written vehicle into a sonic vehicle. On the level of understanding or comprehension, the quality, subjectivity, and history of interpretation all come into play in the gap between musical notation, which reckons with and depends on this act of translation, and its sonic reproduction.

[39]"The process by which the nature and meaning of sensory stimuli are recognized and interpreted". Svensk MeSH, Karolinska Institutet, NIH, National Library of Medicine. Available at: https://mesh.kib.ki.se/term/D010465/perception

Therefore, since working with sound, the interpretation here will be closer to the concept of "performativity" (KARTOMI, 2014, p.192), i.e., which "condition and behaviour" are assumed to constitute a background context. Even though, as Kartomi (2014) argues: "Music is, of course, performed sound, yet many musicologists have researched western classical music primarily on the basis of score analysis" (KARTOMI, 2014, p.194). In this sense, it can also be discussed how handwritten sheet music can demonstrate and transmit feelings and sensations according to the figurative (visual) format alone, compared to digitalized scores.

Regardless of the type of musical source, on learning music by ear, with a sonorous result (the musical experience for the listener), or on a written notation (note symbols or tactile braille), still, Leonard Bernstein's[40] definition of music is valid:

> find out the meanings for yourself just by listening to it" (…) "without any explanation from anybody" (…) "listen to the notes, feel them move around jumping and hopping and bumping and flashing and sliding (…) just enjoy that" (…) "It´s just good, exciting, music", – someone has to make the sounds!

To observe oneself percept (while playing); listening, touching, seeing, then makes sense. Also, as an interoceptive function, which we will discuss later.

Music Performance in Music Education

In general, regardless of style, genre, level, and which instrument, playing music includes musical interpretation. To perform[41] is about how to value and shape music: "two tones, always equidistant from one another in pitch, may be so transformed by means of varying their metrical distance and their dynamic strength, that the faster and louder reproduction has no resemblance to its slower and softer version" (SCHNABEL, 1988, p.231). A (seemingly) simple and short description of how to play a single tone and combine it with another, to form a phrase as in a meaning:

> By varying tone sequences in this way without changing their pitch one may, indeed, create the impression that the one is completely contrary to the other, that the one reflects utmost joy and the other utmost sorrow (SCHNABEL, 1988, p.231).

[40]Youtube: Teachers and Teaching by Leonard Bernstein (47:50). Available at: https://www.youtube.com/watch?v=U6JsfDIo4TA

[41]"Performativity, on the other hand, refers to all the describable and analysable aspects of a performer's or group's competence or accomplishment while performing, including the sounds, movements, and gestures that the artist(s) produce. Thus a musical event may be said to be 'performative' because it is performed by musicians, is usually experienced directly by an audience, and it exemplifies performance-related issues and techniques. Music may also be imagined performatively in a person's mind, as when a conductor studies a score and 'hears' it in his/her head, or a jazz musician 'hears' an imaginary new take on an old song that may affect his/her conceptual approach to performance" (KARTOMI, 2014, p.190).

This defines the stimulating challenge for a pianist, how to set and start the individual communication, similarly an inner (sounding) dialogue with one´s self in the working process[42]. Is this also a starting point to think about how the music could be designed, where aspects of imagination (imagery) come into play? Or like what Gordon (2011) described as *audiation*?[43]

Neuhaus (1993) is dedramatizing piano playing by claiming it is "easy" (p.83), repeatedly saying: "the better a pianist knows[44] the three components (…) (first the music, secondly himself and thirdly the piano) the greater the guarantee that he will be a master of his art" (NEUHAUS, 1993, p.87). A pianist´s work at hand Neuhaus (1993) designs as:

> first–the image (i.e. the meaning, content, expression, the what-it-is-all-about); second–tone in time[45]–the embodiment, the materialisation of the image, and finally, the third-technique as a whole (…) solving the artistic problem of piano playing (…) i.e. mastery of the muscular movements of the performer and of the mechanism of the instrument (NEUHAUS, 1993, p.57).

Those abilities, how to "learn to coordinate ear, eye, and hand (…) or imagine in their mind" are seen as important practices if applied in a context "aural and creative form of musical performance" for increased "musical growth" (MCPHERSON; BAILEY; SINCLAIR, 1997, p.126). Interpretation then becomes a mixture of handling a "real" instrument, and a virtual tool for the musical properties, related to key terms, designed to create music. An overall result, based on these authors investigation of the five areas, as included in music performance: "Sight-read", "Play by ear", "Play from Memory", "Perform Rehearsed Music", "Improvise" (MCPHERSON; BAILEY; SINCLAIR, 1997, p.126), tended to enhance the importance of "exposure to aural and creative forms of performance".

Perhaps these seemingly all-encompassing areas are only on par with the complex activities of the brain when playing and performing (the piano), described as:

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[42]"development of genuine musical representations that immediately represent musical properties as musical units but not in terms of visual or verbal features calls for a musical thinking that attributes intrinsic musical meaning to musical sound. This ability is called *audiation* by Gordon (1980). Mental musical representations define the psychological correlate of and prerequisite for music audiation. Audiation is the process by which one activates already-established familiar musical patterns that are stored as mental representations. Therefore, any learning efforts should be directed to establish mental images of sound prior to the training of mere motor or reading and writing skills" (PARNCUTT & MCPHERSON, 2002, p.79).

[43]"Hearing and comprehending in one's mind sound of music not, or may never have been, physically present. It is not imitation or memorization. There are six stages of audiation and eight types of audiation" (GORDON, 2011, p.49).

[44]"Please remember once and for all that When I speak of the "knowledge" of an artist, I have Always in mind an active force: understanding plus action. Or simpler still: acting correctly on the basis of correct thinking" (NEUHAUS, 1993, p.87).

[45]"It would be more accurate to say: working at "time tone", since rhythm and force are inseparable" (NEUHAUS, 1993, p.57).

> Musical performance is probably the most complex field of music. It comprises the study of a composition, understanding its expression in terms of rationales stemming from analysis, emotion, and gesture, and then its transformation into physical, i.e. acoustical and embodied reality. Performance communicates its contents and does so in the rhetorical shaping of abstract score data. It comprises a creative interpretation that turns formulaic facts into dramatic movements of human cognition (MAZZOLA, 2011, p.vii).

However, since McPherson; Bailey; Sinclair (1997) highlight the hand: "learn to coordinate ear, eye, and hand" (p.126), it is on its place to mention how the "touch" has been a distinctive feature in piano (music) education for centuries:

> The reform of music education on a scientific basis is now only a matter of time. Surely acquired facts are opposed to persevering in the practice of insufficient, erroneous means. Thanks to experimental analysis, the multiple influences exerted by the touch of the artist on the character of the depression of the key, are explained[46] (JAËLL, 1897, p.5).

Performing music have been argued to imply an already set (prepared) interpretation (DREYFUS, 2020), other suggesting, it occurs, even when in front of an audience, but regardless, mostly with the purpose resulting in a music performance. Thus, as a main goal, either if approaching music performance, or music education, it might be necessary, before getting deeper into both interpretation and memorization, to understand some aspects related to this issue – playing music.

According to a study by Fridell (2009), investigating processes of interpretation, "participants expressed an analytical and reflecting approach towards music", where among the participants phrases such as: "'the theories make us free in a way'" (p.208), were suggested as being a result of predetermined interpretative choices. As such, forming an increased understanding in relation to the music, it was defined as: "felt more free after deciding the musical interpretation in broad outlines before a performance" (p.208).

Consequently, there is always room for interpretation, even what is considered correct and what is not. Because of Ravel's now historic claim: "'Interpreters *are* slaves!' when pianist Paul Wittgenstein claimed to the contrary (Ivry, 2000)" (PACE, 2022, p.8), there are always different perceptions of what is measured as subjective or objective.

Given that compositions are models, whether sheet music, tactile braille, or "aural editions", which seem to show in detail exactly how the player might play, still only show

[46]In the original: La réforme de l'enseignement musical sur une base scientifique n'est plus aujourd'hui qu'une question de temps. Des faits sûrement acquis s'opposent à ce qu'on persévère dans la pratique de moyens insuffisants, erronés. Grâce à l'analyse expérimentale, les influences multiples exercées par le toucher de l'artiste sur le caractère de l'enfoncement de la touche, sont expliquées.

suggestions for interpretation. The result is that even interpretation must be interpreted. These understandings of performance enable further development: what factors will affect the concepts of teaching and learning?

Teaching and Learning

Feed-back[47] has been stated as one of the best motors and inspiration for developing "learning" (PANADERO & LIPNEVICH, 2022). Therefore, Leonard Bernstein´s statement: "when I teach, I learn, when I learn I teach"[48], is in one way, or another, connected to processes of "feedback". The process of interpretation in music education is no exception.

In other wordings, one could say, regarding those interchangeable concepts (teaching and learning), that in a long run the intention for any learner is to be self-sufficient. Conceivably, the idea is to awaken and inspire learning to interpret music through increased awareness of self-feedback as soon as possible.

Regarding self-feedback in music, it is quite logical that it is what you hear that generates the "response". It is, in addition to an auditory proof, also a visual, and tactile, haptic proof of one's own expression. Krivenski (2018) exemplifies how self-recording can assist: "allow a performer to maintain one's own sense of agency and evaluate the usefulness of the feedback received" (p.108). Seemingly an easy-to-adopt approach to developing self-response:

> The aspects I got more feedback on, and I certainly agree as I started to use a recorder and listen to myself, are being too loud at points and not having enough dolce pianissimos. (Bianca, 3rd year student) (KRIVENSKI, 2018, p.108).

Not least relevant in situations where students (or maybe even the teachers?) tend to transfer decisions regarding music interpretation to the teacher. According to Matthay (1913), we must fight against and counteract a certain state of passivity through "purposeful brain-use" (p.3), a case (like the quote above) that also appeals to self-listening. Then the measure of recording the performance with an external device and listening afterwards can be an important step.

But since the goal of interpretation is also to learn to become aware, through increased sensitivity, as parallel simultaneous and momentary (somatosensory) feedback, perhaps it is also precisely this development of self-listening that will play a significant role in this

[47]"feedback is a key variable in instruction and learning. Far from being a discovered land, feedback researchers are pushing towards new domains by reconceptualizing our understanding of it – from the more simplistic, teacher-driven, behavioral approaches of the very early days, to more complex scenarios where feedback should be not only actively received by the students but also created" (PANADERO; LIPNEVICH, 2022, p.17).
[48]Youtube: Teachers and Teaching by Leonard Bernstein (1:20). Available at: https://www.youtube.com/watch?v=_lvgPUpaumM

investigation. It is interesting (even today) to compare Matthay (1913) striving towards an ability to reason with oneself–not only during class time. It is precisely this that remains to be discerned. How to emphasize increased presence in the present, to learn to observe and pay attention to musical events.

As Matthay (1913) argued: "teacher and pupil must learn to think" (p.3), the responsibility of music education is [still today], regardless of level, to assist the student to construct an individual practice process. But if a student "cannot use his brains" the fault is with the teacher, Matthay (1913, p.4) argues. Thus, a challenge in teaching and learning concerns how to balance between (practical) execution and thinking. Therefore, concepts of automaticity linked to music performance have long been presented as mechanical and soulless:

> It must be constantly insisted upon, that if we try to make the piece, or study, or technical exercise "go by itself," this, so far from being "practice" is indeed the opposite – it is un-practice. For in trying to turn ourselves into human automata we are doing all we can to render it impossible for us to acquire those habits of mind - of attention – which enable us to play with success; and we shall, in the end, find our head listening merely to the doings of our spine! (...) And this is no mere figure of speech, for it describes quite accurately what does occur in such cases; that is, we here have the conscious, could-be intelligent brain engaged in merely noticing (instead of directing) (MATTHAY, 1913, p.5).

As seen, Matthay (1913) makes a demarcation between how to *notice* and how to *direct.* It should be a present thought even when interpreting, to identify and choose among different postures: "go by itself and "un-practice", or focused "attention" as real "practice". On the other hand, a certain amount of automaticity is a prerequisite for being able to learn at all (see Chap.2 On Memorization). The more something is repeated and rehearsed, whether it concerns muscles, hearing or vision, the more the memory structures are linked to the senses (see Chap.3 On Senses).

But, even if in contrast to automation, it is quite a task how to define, teach and implement interpretative creation in music education. Perhaps Krivenski (2018) presents a solution: "self-recording could also facilitate one's creative approach during practice sessions and the exploration of musical ideas" (p.109). On the other hand, countless variables are still possible: "different types of interactions seem almost endless", by the compilation of: "mode x loudness and mode x pitch interactions (…) and tempo x mode interactions" (GABRIELSSON & LINDSTRÖM 2008, p.242).

The conclusion even more proves the difficulty of designing music interpretation in detail: "there is practically no planned research regarding interaction" (Lindström, 2000, apud GABRIELSSON & LINDSTRÖM, 2008, p.242).

If teaching interpretive “creation” is not a completely clear-cut act, what kinds of vocabularies and sounding models are there to implement?

Therefore, the contradictory essence of music interpretation, as practice, as well as presumptive theoretical conversation topic, is still a source of innumerable learning models:

> It would seem that direct involvement is what most people are looking for in music, whereas description is a disturbing factor in our relationship with music (…)Thus, description can open the ears to unknown aspects of the music [49] (LEMAN, 2008, p.6).

Yet, there is often uncertainty, fear and feelings of inadequacy, of not being able to perform the 'only' correct 'version'. Interpretation is (still) not infrequently demonstrated as strictly authoritarian where learners show tendencies to be restrained, unable to feel the right to express, and to deviate from fidelity[50] to the score (KRIVENSKI, 2018). But considering that “authenticity” (faithfulness to the composer) can neither be explicitly specified, nor accurately followed, because of the multifaceted nature and multi-interpretation of music, such a formulation can also function as an immediate “limiting” creation-inhibiting part (MALONE, 1998). In that case, it is only a mental representation that hinders and blocks the interpreter's work.

To remedy this, I recall when I played violin in Mozart's Clarinet Concerto in A major, K 622. We in the orchestra had a guest visit from the Swedish composer Sven-Erik Bäck[52] (1919-1994), whose alternative method of interpretation has followed me ever since. All instrument groups changed roles, scores and even chairs. I switched place with a cello and “sounding singing” the cello's score, while the cellist took my violin score. Suddenly, the entire orchestra was transformed into a sounding “voice-song-choir”. The goal was to test different types of articulation, dynamics, phrasing, etc., where Gabrielsson & Lindström's (2008) x-factor could clearly constitute a decisive formula.

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[49]”It would seem that direct involvement is what most people are looking for in music, whereas description is a disturbing factor in our relationship with music. Yet descriptions of music have a strong appeal to human communication needs as well. After all, the sharing of experiences by means of descriptions, shapes social bonding and is self-rewarding. Information from other persons can establish the cognitive apparatus required to be able to make sense of music and thus to be involved with it. For example, modern music can be difficult to understand, but a proper description of the cultural context in which the music has been created may help greatly in appreciating it. Thus, description can open the ears to unknown aspects of the music. That is why talk about music is a daily occurrence. Even when the descriptions are incomplete, vague, and even partly incorrect, talk is often the only vehicle by which we can communicate about musical experiences, share our experiences, and make sense of them” (LEMAN, 2008, p.6).

[50]“This loyalty to the work—Werktreue in German, a concept championed by Carl Maria von Weber—introduces an ethical category into the idea of textual fidelity: the composer has left us his text and the text is a stand-in for his intentions. Render the text without making alterations or deletions, and one is being faithful to it and, by extension, to the venerated composer who commands such respect (DREYFUS, 2020, p.171).

[52]Swedish Composer, Sven-Erik Bäck. Available at: https://en.wikipedia.org/wiki/Sven-Erik_Bäck

It was a successful and inspiring interpretation experience that accelerated the "real" performance. What happened, was a sense of "sharing" music-making, a sense of the "right to interpret". It was made possible by not playing "for real". Yet all expressed music. Nevertheless, the same piece of music was played.

It indicates how a sense of interpretation can suddenly change completely, just as Clynes (1983) describes notes being played: "even a few seconds apart, perceived in relationship to one another can produce varied meaning and vitality" (p.82). Already 1913, arguments as: "*unless we analyse the impressions* made on our nerve-ends; unless we (consciously or unconsciously) investigate the impressions there received, we notice nothing, learn nothing, and do not really see [or hear] *anything*" (MATTHAY, 1913, p.6). According to Clynes (1983), "It would seem that the microstructure is in fact more effortlessly experienced than the macrostructure" (CLYNES, 1983, p.82), i.e., a way of making the music comprehensible.

But how can this (best) be achieved, considering how the characteristics of music described affect us: "to 'pierce the heart directly'" (Oliver Sacks, 2008, p.329, apud SWART, 2016, pp.125-126). Once, described as: "a medium in and through which autoregulation of emotions can be practiced" (Levitin, 2006, pp. 202–203 apud SWART, 2016, pp.125-126), it sounds like a subject that includes (desires) for expressiveness and experimentation of multisensory aspects, linked to kinesthetic, auditory and visual sensibility. If, according to Sacks (2008, pp.327-328), music can be: "joyous or cathartic, and has the potential to allow emotion to flow again in individuals whose feelings have become 'frozen', or who have become depressed and anhedonic" (SWART, 2016, pp.125-126), is it not that how musicians should be trained, to become like a medium?

What to Interpret

What is it in music that can be interpreted, so that the excitement of something, at first unknown, gradually creates some kind of anticipation that forms interest and curiosity? In 1874, the piano teacher and pianist Mathis Lussy (1828-1910), presented a systematized thesis[53] to demonstrate how musical interpretation is linked to a clear set of rules based on the inherent structure of music (GREEN, 1994, p.197). In a preface is written: "brilliant execution is still far oftener met with than expressive playing" (LUSSY, 1892, p.iii), which he explains can be solved with attention: "in musical execution, all is cause and effect, connection and law, and

[53]"Mathis Lussy, *Traité de l´expression musicale–accents, nuances et mouvements* (Paris: Heugel, 1874)" (GREEN, 1994, p.196).

that in a truly artistic interpretation not a single note can be arbitrarily accented" (LUSSY, 1892, p.iv).

But, to find the expression in the music, to actively search for the suggestions intended, specific notes and phrases that affect the musician emotionally, implies: "to discover the *cause* and to determine the nature of their action on the sentiment; in short, to formulate the law of that action" (GREEN, 1994, p.196). Like the definitions of music today, Lussy (1828-1910), in his *Traité*, explains music as tonality, meter, rhythm (GREEN, 1994, p.197), when music interpretation deals with variety and stimuli, both in tempo, dynamics and gestures, connected to different forms of movement (GREEN, 1994, p.204).

Parts of what is to be interpreted could be described according to Lussy: "a gradual decrescendo, passing through a thousand delicate nuances, and by a proportional slowing down" (GREEN, 1994, p.204). For this purpose, the Italian music terms are a pianist´s companion. But the challenge to make the assessment "proportional" can also be viewed from without the know-how of Mathis Lussys´s *Traité de léxpression musicale*: "[I]t is precisely these unexpected, irregular, exceptional notes, without musical logic, which most particularly have the ability to affect the sentiment" (GREEN, 1994, p.197). In this context Lussy speaks about: "the extreme susceptibility, the extreme sensibility in the perception of the slightest *tonal, modal, metric, and rhythmic irregularities* (GREEN, 1994, p.197), which demonstrates the variables possible.

On the other hand, if following statement: "listeners tend to like music that they remember and to remember music that they like" (STALINSKI & SCHELLENBERG, 2012, p.1), then should regularity and repetition of musical processes be of importance. At least the concept: "*mere exposure effect*": "the finding that incidental exposure to a neutral stimulus leads to increases in liking when the stimulus is reencountered (e.g., Bornstein, 1989; Zajonc, 2001)" (STALINSKI; SCHELLENBERG, 2012, p.1).

A contradictory situation, or perhaps logical, not least as stated at the outset, that emotions are an important part of learning processes (IMMORDINO-YANG & DAMASIO, 2007) which then both correlates to familiarity – and the suddenly unexpected.

Although, how often do we not hear students worry about their "rights" (and insecurity) to interpret the music in one way or another?[54] Is it therefore Dreyfus (2020, p.138) speaks

[54]"More perniciously, the elevation of historical evidence to esthetic importance creates an inordinate amount of guilt in performers—since who can ever have enough historical information to back up one's work?—and guilt leads not only to insecurities in performance but also to a puritanical attitude that inhibits experimentation and free play" (DREYFUS, 2020, p.183).

about “this war of interpretations”[55]? Even if a music score is full of pages, it is as Deborah Rambo Sinn[56] puts it, reviewed by Mortensen (2013): “Piano voicing needs to be taught and demonstrated with a vividness that is probably not possible within the pages of a book” (n.p.).

So, if “the Soul of Interpretation”[57] has been described as designing “nuance”, is that what it is all about? Also, Cooke (2008) argues: “the art of musical performance lies largely in nuance” (p.1186), which musicians deal with, in varying degrees of awareness. Cook (2008) further explains: “making notes longer or shorter than they are written (...) Performers don't generally have explicit theories of these things, as it's all done by ear” (p.1186). So, is it about figuring out what, how and when, this “something” should be expressed and implemented?

Therefore, perhaps as Dreyfus (2020) pinpoints: “the time might be ripe to abandon our habit of asking: “should I interpret the music this way or that?” and revel in the wealth of experiential possibilities open to us as lovers and players of music” (DREYFUS, 2020, p.186).

Suggestions, if applied to performances that focus and pay attention to the feedback that the music generates, should generate a deepened approach to music interpretation. If based on this context to be included in a field of music education, this would enable the improvement of observations of one's own sphere of experience, of one's own played music:

> the performer looking at the score in front of him has got to reconstitute, not a so-called objectivity, but all the different phases which the author’s mind went through when creating this work, and in doing so, observe the reactions which they produce deep down in his own mind (Casals, apud DREYFUS, 2020, pp.180-181).

In other words, this example, describes a deconstruction of the music. How a process of *to reconstitute* will serve the purpose to enter, as in a time-machine, going backwards, to reach the composer´s phase, the very moment of the music creation. Meanwhile, to *observe,* one´s own *reactions,* is another state of to *focus,* to *pay attention,* and to *concentrate,* identical typical features related to the “science” of memory with the purpose to let short term memory enter long term memory (see Chap.2 On Memorization).

According to Neuhaus (1993), music “speaks only with sounds” (p.54), however, “as clearly and intelligibly as do words, ideas or visual images” (p.54). And as everybody knows,

[55]“Given this war of interpretations, musicians risk losing the confidence to decide if a particular bit of historical reconstruction is esthetically relevant” (DREYFUS, 2020, p.183).
[56]Available at: Playing Beyond the Notes: A Pianist's Guide to Musical Interpretation, by Deborah Rambo Sinn. New York: Oxford University Press, 2013.
[57]“Auer, Violin Playing as I Teach It, 173–74. Chapter 10 is entitled “Nuance—the Soul of Interpretation”’ (DANUSER, 2020, p.180).

on a piano, the music is produced and accomplished by a touch of the finger on the keyboard which, Neuhaus (1993, p.54) claims, must be developed as "the primary duty of any performer".

One of the first books ever using "interpretation" as part of the title, is: "The Interpretation of Piano Music", by Mary Venable (1913):"Each tone should have its due proportion of sound so that the ear shall easily perceive either its detachment from other tones or its connection with other tones" (VENABLE, 1913, p.4). Similar "technical" terms related to music interpretation has its basis in how to best render music intelligibility out of articulation and as such, choose among, (not forget mentioning all the written notes) but also remark the (composer´s) "double-stems, dots, dashes, tenuto marks, slurs, accent marks, dynamic signs, tempo marks, fingerings, and notes of different sizes" (VENABLE, 1913, p.4).

Although music is claimed to be "The most immaterial of all the arts, music appeals to the noblest essence in man´s make-up" (STOJOWSKI, 2020), we must also be aware of the contradiction in meaning, regarding the complex (bio)mechanical and technical variables that are assumed for the creation of music, which altogether makes the area a little more difficult to cover. In the same wake, sometimes music and sound are intervolved in a very complex way:

> A frequent approach is to analyze music in terms of acoustics: vibrations, rhythm, resonances, wave-lengths and frequencies, pitch, overtones, dissonance, and harmony. But acoustical physics is not the subject of this article. To show the difference between the physics of music and the music of physics we begin with the scientific approach to music of Pythagoras and his mystical yet mathematical philosophy based on the connection between music and numbers. He concluded that all of nature is in harmony, and thus arises from numerology (SMENTEK, 2011, p.21).

If music is expected to be interpreted as *emotion,* one of the purposes for the pianist must be to regard music performance: "as a means to create specific sensations such as tension, sadness, euphoria, happiness, rest and completeness" (FEBRES; JAFFE, 2017, n.p.). These authors attributing Leonard Meyer (1956), as the one: "who pioneered the analysis of music as a phenomenon capable of creating emotions", deepening "the expectancy experienced by the listener" (FEBRES; JAFFE, 2017, n.p.).

But Meyer (1956)[62] also "described the emotions caused by music as the result of the interaction between the sound patterns perceived and the brain" (FEBRES; JAFFE, 2017, n.p.).

[62]"In his [Meyer´s] words: "The mind, for example, expects structural gaps to be filled; but what constitutes such a gap depends upon what constitutes completeness within a particular musical style system. Musical language, like verbal language, is heuristic in the sense "that its forms predetermine for us certain modes of observation and interpretation."† Thus the expectations which result from the nature of humana mental processes are always conditioned by the possibilities and probabilities inherent in the materials and their organization as presented in a particular musical style." († Edward Sapir, "Language," Encyclopedia of the Social Sciences, IX (New York: Macmillan Co., 1934), 157.)" (FEBRES; JAFFE, 2017, n.p.).

Juslin, in his chapter, shows some connections involving communication and interpretation by using expressive cues, emotion categories and emotion dimensions (JUSLIN, 2008). Those concepts are relevant for the musical intentions: "affects almost every aspect of the performance; that is, emotional expression in performance seems to involve a whole set of cues - or bits of information - that are used by performers and listeners" (JUSLIN, 2008, p.314). In a 19th century, it was put like this:

> And what the emotions lose in intensity and fervor by this process, they gain in clearness and homogeneity; whereas, without the association of thought, emotions would either pass away unexpressed, or remain vague and complex, unable to find expression (CHRISTIANI, 1886, p.11).

Despite a consensus: "each tone needs to be individually shaped in accordance with the musical requirements" (CLYNES, 1983, p.78), the exact point at which each note, the key, is to be pressed down, or left, the finger leaving the key, is never given in a musical score more than this, if there are any descriptions at all. Playing two or more notes on the piano using the following concepts: staccatissimo – staccato – non legato – legato – legatissimo, connecting them together sounds like a common daily task for a pianist. Then imagine how many versions that combine notes there are. In addition, an already played, struck, pressed, piano note constitutes the decay of the sound.

What more than this explanation needs to be clarified for the pianist? Especially if agreed upon that performers have "the freedom to shape each tone" (CLYNES, 1983, p.78). Already Jaëll (1897) argued for, by addressing the importance and awareness of tactility, "touch", which she claimed would reform "music education".

Although we may have to ask ourselves: did "touch" become a major issue in music education today? How clearly and in what ways is the meaning of the fingers presented, in terms of sensitivity and expression? And maybe "touch" is more than just contact with the "fingers"?

Even if music is described as *emotion,* many times the first point of departure is the music score as source for the pianist (in the western classical music concept): a set of visual instructions analogue of musical sound, either as a record of sound heard or imagined. If it was Felix Mendelssohn (1809-1847) having written in a letter: "You must hear it for yourself", thus, introducing the concept "decoding" (DREYFUS, 2020, p.172), that led to the development of how we today still deal with music interpretation; to decipher a "printed score". Compared to how CPE Bach (1753) focus aimed at the musician, "playing", only gradually an increased

overweight seems to have pinpointed the "text". A common perspective at least among piano players belonging to a western classical art music tradition.

A different aspect is Dave Brubeck´s notion about how to render a personal touch and strive for an individuality regarding "sound": "cultivate their own expressive styles either to give a particular song a unique color and mood or to distinguish their performances from those of other expert musicians (Repp, 1995, 1997)" (BROWN, et al, 2015, p.58).

It would be interesting to deepen discussions about interpretation and clarify whether personal expression and individual interpretation are rewarded more in certain styles of music than others, or when instead it is mostly about playing correctly? At least think about how this is weighed, and how precisely the "attitude" affects the result. Then also considering the complexity since even strictness generates a form to be free within.

According to Fridell (2009), one fundamental method performers use when interpreting is based on analysis and music theoretical understanding (p.208). However, there are even variations of how to approach *analysis*, implied an individual structuring of the music based on format exemplified as "indication of 'high points' on different hierarchical levels" (p.208).

Due to the expendable character of *music* and its multi-layered epistemological significance in relation to all above researchable areas, a comprehensive bibliography can be found. Hence, even if almost everything related to *music interpretation* and its executive formats can be found in written, its inborn and orally based character of transmission in a performing, teaching, and learning, master-apprentice paradigm, often prevents further investigation as such, in line with updated neuroscientific findings. As the singer Lotte Lehman advocates:

> Interpretation means: individual understanding and reproduction. How then is it possible to teach interpretation? It seems almost paradoxical to emphasize the necessity for individuality in interpretation and the same time want to explain my own conceptions of singing (...) developing their own interpretation which should spring with originality and vitality from their own minds and souls. For imitation is, and can only be, the enemy of artistry (LEHMAN, 1985, p.10).

Others, as Joan Last (1960), argues, that teachers underestimate the importance of teaching interpretation to students, claiming: "to interpret music is not just a heaven-sent gift" (Last, 1960, p.xii, apud BURWELL, 2003, p.10). Some authors speak about interpretation mostly as if it was a pure mental construct, by focusing on how to analyze the behind lying *meaning* of the composers work and intention merely regarding how to *think* than how to *do*.

By practicing and studying the "mechanical means of expression (…) accents; dynamics; time" (CHRISTIANI, 1886, p.21), any pianist may enter a state realizing how human senses

and their functionalities are included in the process. As an interconnection even to "that divine spark, the *"feu sacré",* that source of all artistic creation, "fantasy, imagination;" that sixth sense, "the power of conceiving and divining the beautiful" (…) the aesthetical sense" (CHRISTIANI, 1886, p.13). Although in 1886 this meant: "which is given to some elect natures only" (CHRISTIANI, 1886, p.13), science now demonstrates the source of music, and its roots due to evolutionary findings:

> acoustic structures that communicate emotion in music and present evidence that these emotional features are widespread among humans and also function to induce emotions in animals. Similar acoustic structures are present in the emotional signals of nonhuman animals (SNOWDON; ZIMMERMAN; ALTENMÜLLER, 2015, p.17).

To adopt the idea that "Music is the language of the emotions" (CHRISTIANI, 1886, p.11) it is impossible not to consider "Thought must first prepare the way by concentrating them into some definite idea or ideas" (CHRISTIANI, 1886, p.11). Daugherty (1996, n.p.) addresses a similar however different perspective: "Music should be taught, says Reimer, because it systematically develops a form of intelligence that affords "meaningful, cognitive experiences unavailable in any other way…" (p. 28)". This approach towards *music* can also be found in Christiani´s work from 1886, where he formulates *intelligence,* as guidance towards "cultural refinement", applying: "exercise of thought and mind, including self-control, mastery of emotion, and repose" (p.14).

In this sense, Christiani (1886) was not alone. Also, other writers, pianists, and teachers (MATTHAY; JAËLL; VENABLE) from the 19th century addressed *emotions* as something similar *emotional intelligence*[63]*,* today described as:

> The ability to understand and manage emotions and to use emotional knowledge to enhance thought and deal effectively with tasks. Components of emotional intelligence include empathy, self-motivation, self-awareness, self-regulation, and social skill. Emotional intelligence is a measurement of one´s ability to socialize or relate to others (MeSH, 2023).

Consequently, if "Emotional intelligence is a measurement of one´s ability to socialize or relate to others (MeSH, 2023)" and if "When the desired sequences of sounds are heard from the producer, strong emotion will be evoked in the perceiver (Salimpoor et al., 2011)" (HOU et al, 2020, p.210), in this sense, the investigation of music interpretation and memorization also affects communication:

[63]Svensk MeSH, Karolinska Institutet, NIH, National Library of Medicine. Available at: https://mesh.kib.ki.se/term/D056348/emotional-intelligence

> if the goal of music-making is to reconstruct the states of the composer's mind and transmit one's own empathetic reactions, is Casals actually speaking about interpreting the text at all? Or is the metaphor of *performance as interpretation* teetering on the brink of unintelligibility? (DREYFUS, 2020, p.181).

It seems more as an interpersonal relationship: "The reciprocal interaction of two or more persons"[64] (MeSH, 2023).

Why Interpretation

This subsection presents aspects of *why* interpretation occurs, or is required, or happens. In a musical context, primarily because if anything needs being retold, as in the case a composed music already exists, it must be recreated. For this purpose, the music terminology with its signs and symbols that have been developed since thousands of years, assist the transfer of knowledge, from a composer to a performer[65], the co-pilot. However, the score is limited in several aspects, regarding *what* exactly are, and *how* to define the performer´s "needs", but also aspects of the free will, the *freedom* as Neuhaus (1993) writes about. This suddenly put the topic to another level, where the decision-maker and subjective and/or objective standpoint views start to interfere.

From being just, a matter of replying to a question: *why* interpretation, other than *to render or make meaning* of made music*, to make sense* of, the topic can also be viewed and analyzed based on a neuroscientific reality claiming all we do is interpretation (BUZSÁKI, 2006). Interpretation just happens, whether we like it or not.

The human being always interprets just by existing. This happens because we make a massive use of our sensory memories[66]. Sensory memories for this part make up most of (new research on the brain also shows other interesting findings) our contact with the outside world and form the way for us to communicate with the world, i.e. express our inner reality, in an external way, which thus aims to be a prerequisite for communication. This is a complex

[64]Svensk MeSH, Karolinska Institutet, NIH, National Library of Medicine. Available at: https://mesh.kib.ki.se/term/D007398/interpersonal-relations

[65]"Whereas an artist's personal engagement with the notated musical text had previously been paramount, the historical performer had recourse to a far more objective authority: that of History itself, especially as transmitted by the rapidly expanding discipline of historical musicology (...)Placing the authority for musical interpretation largely in the hands of a scholarly discipline—a phenomenon that has failed to take root in theater or ballet, for example, and which has had limited success in the case of opera" (DREYFUS, 2020, p.182).

[66]"Sensory memory is an ultra-short-term memory and decays or degrades very quickly, typically in the region of 200 - 500 milliseconds (1/5 - 1/2 second) after the perception of an item, and certainly less than a second (although echoic memory is now thought to last a little longer, up to perhaps three or four seconds). Indeed, it lasts for such a short time that it is often considered part of the process of perception**,** but it nevertheless represents an essential step for storing information in short-term memory". Source: The Human Memory. Available at: https://human-memory.net/sensory-memory/

process that is also a link to our older long-term memories, as well as to our subliminal memories.

According to Buzsáki (2006, p.47) our brains are always interpreting. Meaning, all that we touch, hear, and see, our brain then wants to *interpret.* Because of this characteristic, if a person for some reason misses a finger, the other remaining fingers representational areas will increase inside the brain[67]. This human physiological feature (which I think to be an evolutionary *need*), in addition, increases its individual area, meaning, it is like to consider the brain almost as a separately living organ, "who" wants to expand itself and fill all areas which are then stimulated.

In a music learnt by a score, the process of forming a music interpretation often starts by decoding what was written by the composer. However, this process already brings together the fact that the hands and fingers (as constituting a huge sense organ) also participate in this epistemic process.

According to Lundborg (2014) "Exploratory movements by the fingers" (p.71) derive from a state where: "sensitivity and motor functions work together actively exploring objects" (p.71). Lundborg (2014, p.71) refers to Gibson (1962), who discussed different ways how to *touch*, as "passive and active" (LUNDBORG, 2014, pp.71-72). The "touch", deriving from the Greek word *aptesthe,* which was developed into today´s "haptics" [used in touch screening-technique[68]], imply the former concept: "active" (LUNDBORG, 2014, p.72).

Thus, if interpretation is about to make meaning, to express, to "speak", so even playing piano must be a tool equivalent to "language". It is needed, therefore, to have in mind: "the language generator in the brain must be indifferent to the form and medium through which its messages are transmitted"[69] (WILSON, 1999, p.325).

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[67]"neuroplasticity changes in the somatosensory cortex may also occur as a result of disorders or deprivation. For instance, a neuroimaging study on people born with one hand (congenital one-handers) indicated that the missing hand area in the somatosensory cortex is functionally modified to support other body parts, including the arm, foot, and mouth (Hahamy, et al., 2017). Furthermore, neuroplasticity following sensory deprivation has als been demonstrated. For instance, expansion and reorganization of the cortical finger representation in the somatosensory cortex has been reported in blind proficient Braille readers (Sterr, et al. 1998; Burton, et al., 2004)" (NICHOLAS et al, 2019, p.42).

[68]Available at: https://www.ultraleap.com/haptics/

[69]"Interestingly, knowledge of how tactile-based language is processed in the brain has not only furthered our understanding of the brain itself but has also played a part in quashing the notion that these bodily-tactile signs are simply a loose collection of bodily gestures strung together to communicate spoken language. A neuroimaging study has shown that a tactile-based language activated brain areas similar to spoken language in an acquired deafblind subject (Osaki, et al., 2004). Similarly, a fMRI brain imaging study found that in the case of combined early onset visual and auditory sensory deprivation, tactile based communication was associated with an extensive cortical network implicating occipital as well as posterior superior temporal and frontal associated language areas (Obretenova, et. al., 2010). These two studies may be suggesting that (a) the same neural architecture is involved in spoken and tactile based language; (b) the brain structure for language develops in response to language input regardless of the modality of that input" (NICHOLAS et al, 2019, p.42).

If one of the characteristics of our brain is the ability to explore the surrounding material, consequently, it is not too exaggerated to think this is also valid for the exploration of the piano keyboard. Lundborg (2014) describes this phenomenon as: “the hands’ ability to feel pressure and vibrations through such activities is based on a complex interaction among several various types of mechanoreceptors in the skin of the fingers” (p.72).

Similarly, the way we use our vision to get an overview of our location and surroundings, the audition, the hearing mechanism, replaces the touching mechanism, in aspects related to a superficial, horizonal, “exploration” of touch. Since, no input will appear, meaning, no change of surfaces. On the other hand, almost as if the grading of how to touch the key, the vertical pressing of the key, then constitutes the “explorative” curious brain activity–if we allow this to happen, with curiosity.

From an interpretive perspective, this can mean that how the handling of the vertical playing style is handled by the performing pianist, a sensibility must be assumed, of course. First, to be able to carry out such subtle differences in how to press down a key, but also to be able to connect exactly how the actual pressing of the key takes place in parity with which kinds of sounds, and which colors of piano tones this is created.

Since the hands, the fingers, and fingertips, only have a physical contact with this plain and smooth, equally constructed key-surfaces, the sensation-perspective must then be consequently and immensely sensitive to other types of forms and shapes. The fact that the brain always is open for stimuli, even multimodal sensory effects, and that the senses have their respective place in the brain, the more we use, more the senses are activated.

The surface of the keyboard is the same for all keys and for all fingertips, but the way a finger can press a key differs. Calibrations of how the hands´ muscles are used will be the next issue. The hand analyses the environment, and the brain describes for us how the reality around us is constituted. However, in piano playing an interesting aspect occurs. When playing, valuing the muscular weighting, each finger´s pressure on the keys, another sense is activated: our ears. Through the (active/passive) activation of the audition when playing a tone, the feedback process to the performer is initiated. Consequently, the hands are shaping and forming initially by the mere touch: music.

How to Interpret

Experimenting with cognitive approaches linked to language interpreters, Daniel Gile (1983) suggests the three “efforts” as: “comprehension of the source speech, one

to the production of the target speech and one to the memory storage and retrieval of information over short periods" (GILE, 2015, p.135). This aspect of memory retrieval is meaningful for all types of interpretation.

Since the letterpress was not yet invented 1330 B.C., music played and performed by then were to be attended to one´s memory. All since, if a desire to *interpret* music, it had to be remembered, and interpreted, as means of recreation and refinement, out of one´s memory. According to Dreyfus (2020), summarizing historical perspectives[70]: "it is worth thinking about the ways in which, when we play, we are imagining music, fantasizing about it, which is the same as saying that we picture and project an expression of its lived experience" (p.185).

Turning back to Saqqara relief (Figure 2) we can have a similar analogy. First, turning to one side, to the music source, and then to interpret and to process the information, and then to "play-back". Could be three scenarios: by ear, by braille, or by vision (learnt from the score) followed by turning to the other side, as turning to an audience, transmitting, or "describing"[71] sounds. Thus, as a "physical mediator" (LEMAN, 2008, p.5) for the listener what the composer wanted to express, when the pianist needs even though to use a personal approach, transformed into a "non-linguistic message", "sounding" ("telling") the content. Like all animals that communicate through sound (SNOWDON, et al, 2015). By using a pianist "describing" the music, does not imply to underestimate a listener in relation to decipher the "meaning". Instead, to identify the need of a musician, sounding, interpreting – for the listener to at all have (access to) live music.

But, this two-headed figure, might also visualize how to bargain, how to go in between different options, as orienting oneself. How to make the musical decisions when playing.

According to Hallam (1995), it was [already by then] "little research considering how musicians learn and interpret music" (p.111). By claiming a lack of specific literature on how to make possible an explicit analysis of the subject, Hallam (1995) suggested a "theoretical framework to guide in the interpretation of research findings" (p.112). Although Hallam (1995) lists some authors (Swanwick and Tillman,1986); Serafine, 1988, Gardner, 1973; Heargreaves and Galton, 1992; Sloboda, 1985), the applied pedagogical frame used was however found elsewhere [in psychology], than in the music field: Pask (1976) and Perry (1970). So did

[70]"by Emanuel Bach, E.T.A. Hoffmann, Wagner and others" (DREYFUS, 2020, p.185).

[71]"Next, consider the indirect way of being involved with music. This way proceeds by means of a mediator, such as a linguistic description of music, a score, or an audio player. The score and the linguistic description are examples of symbolic mediators. They mediate access to music as mental representation, but not access to music as sound energy. In contrast, the audio player is an example of a physical mediator. It mediates access to music as sound (or physical) energy, and via this way it is possible to form a mental representation of the music that is heard"(LEMAN, 2008, p.5).

Silverman (2007, p.104), who also turns to a methodology by Louise Rosenblatt (1905-2005), the "transactional theory"[72] adapting into a musical context while discussing (and practicing) interpretation. Therefore, based on a strategy by Pask (1976), Hallam (1995) demonstrates how its posture supports a more consciously "top-down approach", implied as "comprehension learners", seen as "analytic/holists", and, a more unconscious "bottom-up approach", founded as "intuitive/serialist" (p.126). As the habit mostly follows, even Hallam (1995) turns to expert performers, how to apply Pask (1976) as interpretative support. But the idea is also to use a strategical lens and understand that behind every expert is a beginner.

One central element stated as of importance for how to interpret music, is the capability to hear the music internally (HALLAM, 1995, p.127). On the other hand, Fridell (2009) demonstrates a prototype called "visual tools", resulting in enhanced reflections, and "a rich inner life, *fantasy,* and *imagination* linked to the process of musical interpretation" (p.209). In addition, Fridell´s (2009) results show "a desire of *exploring* new interpretative solutions (…) discovered new interpretative options" (p.209), that due to this "study [which] had 'forced' her to reflect deeper on the music" (FRIDELL, 2009, p.209). Aligned with this, Marcuse (1955) consider: "Phantasy plays a most decisive function in the total mental structure: it links the deepest layers of the unconscious with the highest products of consciousness (art), the dream with the reality" (MARCUSE, 1955, p.140).

According to Hallam (1995) there were no model (by then, 1995) of how to teach and learn interpretation encompassing "dimensions relating to planning and sensitivity" (p.127). Consequently, Hallam (1995) discusses possibilities of the framework by Perry (1970) "versatile learning" [of music interpretation] outlining two types of musicians' styles regarding how to learn new repertoire: "analytic/holist (…) emphasis on listening to and discussing alternative performances" (p.127). The other is "[i]ntuitive/serialists (…) unconscious processing to develop interpretation". The latter happens "through the internalisation of aspects of phrasing, style and musicianship until they become automated" (HALLAM, 1995, p.127).

[72]"During the 1960s and early 1970s, a shift occurred in the literature classroom. The focus of attention moved from the text as 'authority' to the roles of the *readers* and their relationship with the text. When teachers of literature turned their attention to the minds of their students, they began to understand and apply what Rosenblatt had been proposing for many years. Teachers began to see the relevance of Rosenblatt's thesis that a reader's engagement and involvement with a text is what 'makes' poems. In other words, a poem is not something that exists on the printed page; it is something that happens at the intersection – at the joining – of a reader and a text. Rosenblatt (1938) explains: The special meaning, and more particularly, the submerged associations that these words and images have for the individual reader will largely determine what the work communicates to him. The reader brings to the work personality traits, memories of past events, present needs and preoccupations, a particular mood of the moment, and a particular physical condition. These and many other elements in a never-to-be-duplicated combination determine her response to the particular contribution of the text (pp. 30–31)" (SILVERMAN, 2007, p.104).

To discuss and/or imitate, Hallam (1995) claims to be two different learning processes and suggests how the approach to develop alternative interpretations can be based on "encourage imitation of different styles and types of playing" (p.128).

The text section illustrates a complexity. At first, seemingly with no connection to sounding music at all. Dreyfus (2020) therefore highlights the importance of how to promote areas for playing music such as: "a loyalty to the playful and emotive elements which are music's greatest joy. After all, it is they, and not the cognitive, intellectual, and academic challenges, that attract us to music in the first place, a fact which is all too easily forgotten" (p.186). The simple phrase "playing music", not least linked to interpretation, is consequently part of multi-faceted aspects, existing and challenging dichotomies, which also largely (need to) affect music education and performance.

Transmission of Music

An interpreter of music, that is, a musician who interprets music, can be described as in a similar scenario as the Saqqara relief. To stand between prices, i.e., "shop and haggle" equated as to choose among musical options. The Saqqara-interpreter shows two sides, one that receives information from an external source in one direction, and then outputs information to an external source in another direction. A type of transfer process. However, the material must somehow and somewhere be processed, broken down, deciphered, interpreted. But the question is of how, in what way, a piece of music could, can, should, ought to, be performed.

As described in the former subchapter *What to Interpret,* to transmit the content of the music a "deal" must be established, this substance forms the prerequisite for how to explain *how to interpret.* The pianist as a *mediator* has to consider and deal with these relationships, among even more, in between a three dimensional multimodal reality[73] related to 1) physical sensuous sensations, initiated by tactile perceptions, impressions, sounds and vibrations, including touch, vision and, audition; 2) perceived, deciphered, recognized, comprehended, intuited, or sensed emotions; 3) cognition, as defined in a dictionary as: "conscious mental activities; the activities of thinking, understanding, learning, and remembering"[74]. All these

[73]"With "18th century Irish philosopher and clergyman George Berkeley (...) Hegel claimed that the only sense which can give a sensation of spatial depth is touch, because touch 'senses the weight, resistance, and three-dimensional shape (gestalt) of material bodies, and thus makes us aware that things extend away from us in all directions' "(PALLASMAA, 2007, p.42).
[74]"Cognition." Available at: https://www.merriam-webster.com/thesaurus/cognition

areas must be handled in a single scope, which means that *what* to interpret, will answer the question *how* to interpret music.

Unlike the trader in the market who may loudly and audibly discuss and deal with other sellers, a pianist in an initial phase will only be referred to hen self. Although a possible final goal is to display the entire interpretive product. Therefore, the Saqqara relief could also correspond to and make visible the internal positioning that also underlies the interpretation process itself. That is, a visualization of the state inside the interpreter who negotiates within the self. As a dualistic, unconscious, or conscious, verbal, or non-verbal communication, highlighting the interpreter's positions regarding which interpretive choices will be considered and carried out.

The two-headed Saqqara relief then illustrates this symbolic (and normally invisible) features, as an interpreter´s "mind", with the prediction and intention to give meaning to the performance itself, simultaneously communicates with the hands, clearly gesturing. To describe the immanent meaning of making (planning, playing, performing) a musical interpretation, common and neutral, non-musical verbs can be used: reproduce a version, make a construction, make a production. Probably, "interpreter" is associated by most people as someone who constructs meaning by deciphering and explaining one language to another. Transferring this linguistic idiom into a musical purpose, one can easily see adjacent points of contact in the concepts: "encoding", "channel" and "decoding".

Since Plato until today it is agreed upon that listening to music arises different feelings inside us. The affective power of music induces and stimulates emotions in listeners (MEYER, 1956, p.7). Music can also be seen as an agent, or a medium of transmission in communication between people, as an activity to enhance a deeper interaction with the *self.* As Meyer (1956) heighten, formulating an exact discrimination between *feeling, affect* and *mood*:

> The emotional experiences which our observers reported are to be characterized rather as moods than as emotions in the ordinary sense of the term…The emotion is temporary and evanescent; the mood is relatively permanent and stable. As a matter of fact, most of the supposed studies of emotion in music are actually concerned with mood and association (MEYER, 1956, p.7).

The demonstrable and complex neural process that occurs when the pianist adjusts the fingers to the keys of the keyboard, calibrating pressure in relation to outgoing and incoming sounds while using multifaceted senses, is most easily compared to, and understood for how a sound-engineer works on a mixer, controls sound (music) input and output levels:

> The focus on the *audio recording* of a performance makes it important to recognize that every recording contains processing choices and interventions by the production team with potential impact on the expressivity of the recording. Maempel (2011) discusses as main influences in the context of classical music the sound engineer (dynamics, timbre, panorama, depth) and the editor (splicing of different tracks, tempo and timing, pitch). These manipulations and any restrictions of the recording and distribution medium are part of the audio to be analyzed and cannot be separated anymore from the performers' creation (LERCH; PATI; GURURANI, 2020, p.222).

Consequently, the aspects of interpretation and memorization will differ, depending on whether the pianist records the performance in a studio, which has been described as: "Katz (2004) points out that in such a session, performers will listen to the recording of themselves and adjust "aspects of style and interpretation." In addition, the producer might also have impact on the recorded performance (Maempel, 2011)" (LERCH; PATI; GURURANI, 2020, p.221).

Obviously, in the studio, the pianist can listen to the playing afterwards, change some takes, redo, maybe make it "better" or different. The "memory" although external and recorded, functions as a kind of "chunking". In memorization, the "memory" is found only within the human body, but can still be "heard", "seen", "felt" and "experienced", as if it were "live".

Concerning "touch" and "tone production" mentioned earlier, the understanding of "The Interplay of Physics and Music" (1989) are invaluable facts – in piano playing, that a note can be depressed in several different ways:

> There was a book published in 1911, by one Tobias Matthay, which lists 42 different ways to play a single note. On the other hand, the physicist looks at the action of the piano and notices that, in the fraction of a second before the hammer hits the string, it has been thrown clear of the mechanism (…) Some careful experiments done in the 1930s showed that, although notes produced with the same loudness on the same piano always sound exactly the same, notes played with different loudness can have very different timbres (JOHNSTON, 1989, p.85).

In this view, there are hardly any "mysterious creative processes" if one clinically understands that a piano note can be played "mechanically" in 42 different ways. In addition, one source says: "The most effective piano technique involves perhaps 100 little details of hand motion, taking advantage of every little detail of the anatomy of hand and arm" (JAYNES, 1994, p.604). One must be necessarily creative to manipulate well so many different touches.

Decision-Maker

Many authors talk about the importance of inner hearing (VENABLE, 1913; HUGHES, 1915; GIESEKING & LEIMER, 1972; GORDON, 2011; FLEISHER, 2015) as a prerequisite to be able to form a musical idea, nota bene: *before* playing. Inner hearing should be encouraged

from the first lesson. Hearing within oneself is otherwise a condition often attributed only to advanced musicians. Perhaps this is one of the biggest challenges for music education in order not to exclude students (who do not immediately "seem" to reach this phase) from entering an inherent musical sphere.

Kratus (1991) describes *intentionality* (p.6) also in a manner mentioning the importance of not judging a performer just by the executed sounds, rushing into a prejudicial thinking of hen to be unmusical, because of difficulties in the performance. But, also, pinpointing that the musical ideas can already be there, under the surface, although not brought forth due to absence of sufficient motor skills to execute the intended sounds. A tricky balancing, which impact all levels of interpretation choices.

One of the first bibliographic text I studied was Fridell (2009), according to whom difficulties arose regarding how to: "explain and discuss musical ideas, experiences, emotions, and other issues related to musical interpretation in a comprehensible way by means of just the verbal language" (p.211). Therefore, Fridell (2009), developing "visual tools (…) designed for the purpose of expressing *subjective* musical experiences by means of illustrations drawn by *free hand*" (p.211). Although, with emphasis based on a standpoint view that "music is a subjectively experienced phenomenon, it has the power of creating experiences shared by several human beings" (FRIDELL, 2009, p.212).

Consequently, this author also approaches a field, where musical utterances have a bearing on a universal basis, such as communication between people, but in music, my idea with this investigation is to reinforce and deliver an experimental attitude. With the belief that the more you know, the more you feel accustomed to habits, *hexis*[75] (JÄRNEROT & VEELO, 2020), which can appear as a safe place of departure, providing a tool for courage, curiosity, and desire to dare to try, and let the evolutionary joy of discovery of the senses lead.

When judging one´s own playing and performing, it is often a personal issue, handed over to either a teacher, or one´s self, as any performer, regardless level. Fridell (2009) strives to form a "starting point for verbal discussions between musicians (…) facilitating the communication of interpretative matters" (FRIDELL, 2009, pp.209-210). Some of the

[75]"founded on Aristoteles concept of "hexis" (habit) and the authors thoroughly discuss the blessings and the curses of habits of the three dimensions of episteme, techne and phronesis. It is not habit as mechanical routines, but as a confident base, which makes teachers openminded and prepared to innovate their practices. Habits can increase a person's sensibility for wanting change as well as increase resistance to it. If you incorporate a reflecting approach, habit becomes a state of mind and the teacher students can go from being passive recipients to active creators of their teacher identity" (JÄRNEROT & VEELO, 2020, p.65).

discussed results concerned aspects of paying attention "not only to *the big musical lines* but also to a lot of *musical details*" (p.208). Apparently, according to Fridell (2009) discussions followed about "phrasing curves" which caused Fridell (2009) to set up *'disobedience',* as concept, implied as a state of students rejecting certain interpretative ideas, although still valuing certain stylistic standards and conventions related to the repertoire studied (p.209).

A first reflection, regarding how we "interpret" our own choices (concerning music listening) is it that we normally just *feel* our reasons? Probably we would describe this *feeling* as "I like", or "it is my style", "my identity". We seldom choose music which will not *move* us, in one way or another. According to Belfi & Jakubowski (2021): "Listening to music can bring back vivid memories from one's past. In recent years there has been an increase in both scientific and public interest in the ability of music to evoke vivid, emotional, and rich autobiographical memories" (p.1). Perhaps it is because of these aspects the teachers make use of their own *memories* when trying to teach a student how to interpret, even though music teaching is often based on a sign and symbolic language:

> essentially an oral culture imagining itself to be a written culture. Musicians learn their craft via practical, one-to-one studio teaching (supplemented by workshops, masterclasses, and rehearsals) in which beliefs about how scores should be played are passed on orally and by example (LEECH-WILKINSON, 2016 p. 325).

It is not seldom that teachers pass on their personal and individual tastes and concepts, related to their own pianistic upbringings (education). Although continuous reflection and critical thinking further reinforces the motto that music is inherently multi-interpretable. For the decision-maker there is thus a complexity, not the least of which is dealing with a "thing" outside one's own body.

Piano – a Non-Human Entity

When Neuhaus (1993) emphasizes "the theory of piano playing which deals with the hand and its physiology is distinct from the theory of music" (p.86), he not only presents as an idea, but also describes the reason to his focus on the mechanism and physics of the piano, and how its functions relate to the hand, fingers, arms (and even feet), which he describes as "the mass (*m*) of the body" (p.86). So, Neuhaus (1993) defines for his pupils how the energy affects the production of sounds by using a model with an *F* (force), *h* (hight, raised hand), *v* (the hand´s *velocity* striking the key), altogether "determines the energy which acts on the key" (p.86).

Thus, even if Neuhaus (1993) being aware about this procedure as a seemingly “dry and cerebral manner” (p.87) which may concern the ones preferring to “hold the “mystery” of art so dear” (p.87), he claims “the mystery of art remains unfathomed (…) as in life” (p.87). But, to highlight the importance of defining *what is*, to be defined and make intelligible, Neuhaus (1993) claims: “there is in *principle* nothing that is unfathomable is now know to every child” (p.87).

The occupation related to music will in this aspect be presented and described as a craft. Reaching this point by aiming a clarification of music interpretation, we also inevitably approach an area related to music production, mostly presented as music performance, *per se.* It aims at the inevitable physical actions the performer, in this case a pianist, needs to execute in relation to the instrument. These coordinating fluent physical movements with the arms, hands, and fingers on the keys of the piano might be the most conspicuous impression for an external audience. As well, the very premise for producing musical sounds.

The touch of the finger, in contact with the surface of a key, depressed, and the piano strings vibrating. A tone is sounding. One might address interpretation as one concept, and for a musician, to be able to at all dedicate effort and time to it, there must, or ought to be a goal, not to say many, to strive for, resolving, what there now is to be solved or clarified.

However, it is easy to figure out that the musicians prior goal constitutes in making music. This is the normal saying, making music, by cultivation and progress among musicians when performing. A musician produces sounds. Is it only when the sounds acquire meaning, that we can talk about interpretation? Because, any performance is preceded by an interpretative choice, consciously executed or not. A pianist needs an external object, a physical device.

Firstly, we must not forget that a piano is an instrument in need to be handled and understood also by its mechanism. It is easy for everyone to play a tone, or several, at the piano. But where is the line between what is “mechanical” and what is musical? This question was addressed to Christiani (1886), who replied: “Mechanism ends where thought is added to it” (p.14). Therefore, if one plays without “any directing thought” it should be considered as “mechanism” (p.14). But a thought can also be “corporeal”.

As such, beyond the thought, it also encompasses: “fingering, which precedes mechanism; as to tempo, which governs mechanism; as to force, which qualifies mechanism; as to touch, which ennobles mechanism” (CHRISTIANI, 1886, p.14). So, when can be determined what is considered mechanical, or when it is, so to speak, dignified?

When Interpreting

This phase will be categorized as a physical, visually, and invisible, although detectable "touch" with the rest of the body as a somatosensory unit (since all senses are a "touch"). *When* interpreting the sensory memories are activated, or as Neuhaus (1993) writes, the dialectic process, that the *how,* defines the *what,* resulting in that the *what* defines the *how,* which will occur, a temporal, *when.* Neuroscientific explanatory models show differences in body perception (proprioception) depending on the type of passive or active "touch" applied, which is essential when interpreting.

As Buzsáki (2006) writes, everything is interpretation, from a neuroscientific perspective.

When interpreting it is conditioned a stage of processes where sensory memories affect our perception, leading to short term memories which (eventually) turn into long term memories. *When* interpreting, the incoming stimuli are compared to former stored memories, i.e., experiences (O´KEANE, 2021) which will form a pattern for the receiver, for increased comprehension of the world (the music).

According to Buzsáki (2006) exemplifying the eyes trying to extract, to *make sense* out of black and white dots, is one sign of how the brain *when* interpreting, is evolved into a state, *how* to understand the surroundings, evolutionary, and so even a music score with white and black patterns, by vision, or if braille, by touch, or if heard, by ear, a music, aimed to be played.

What aspects during the processes of interpretation, can make it *touching affecting*, and filled with *meaning*? How come we can notice, *hear* and/or *feel* the difference between "an arbitrary quality; it will be "just playing" without any clear aim (playing for the sake of playing and not playing for the sake of music), it will be "playing as it comes" (and very often it doesn´t "come")" (NEUHAUS, 1993, p.11).

Although, it is during this interpretation phase the decisions will be taken, regarding the musical features and factors, technical variables and musical elements involved. The in between balancing, division, discrimination of parts. And, if we all, as human beings, can differentiate this disparity, conscious or unaware, we ought to be equipped with "tools" to also execute corresponding *differences,* in parity with the sensitivity of our senses. This implies how science shows to what degrees and to which extent the perception span related to our senses can be measured, thus indicating what *can* be expressed, *externalized* as musical actions.

Godowsky is said to have taught by focusing on "maximum logic, accurate hearing, clarity, plasticity, through a scrupulous observance and a broad interpretation of the written score" (NEUHAUS, 1993, p.12), and he also suggested students to play one piece in "thirty-

three different ways" (p.13). One might reflect on this aspect, regarding when interpreting, musically forming and give "thirty-three" meanings to an identical piece of music.

According to Neuhaus (1993): "Present-day technology is striving to turn the machine into a human being (through the number and variety of operations it can perform)", which is a most suitable description, 50 years later. Today´s artificial intelligence, AI, is now occupying most areas all over the globe related to engineering and science, also music. Although, Neuhaus (1993) added: "but it is sinful and stupid to turn man into a machine" (p.89). To counteract this development aiming developing what he called "the musical faculties" includes "to improve and develop the ear (…) the faculty to imagine, to represent, i.e. the artistic ability" (p.89), which Neuhaus (1993) regarded as "intellectual qualities of the pupil" (p.89).

It is each interpreter´s task to enter the composer´s mind and writing-chamber, being able to fully grasp the content and core of the music itself. As part of the interpretative phase, studying the music, get totally acquainted to the score, with and without playing, just reading it, sounding, singing, conducting, the parts, as pretending you are the composer, of the overall content - also in order aiming playing all bars truly by heart, in the end. To have the complete and controlled knowledge of what the piece is about. To rewrite the music – on a sheet, just by memory, tone by tone. But not only the notes, also the emotional and expressive inner meaning. Finally, as an interpreter you must add and to blend the composer´s inner contents and suggestions to your own musical experiences (memories), how to define and interpret the music itself, aiming a true and touching performance.

The notes are combined in a variety of combinations. Motives and phrases can be designed endlessly: "to designate a melody extending through a series of measures and having a certain completeness larger than that of the phrase and comprising in itself two phrases and sometimes more than two" (VENABLE, 1913, p.3):

> defined as the act of forming, in song, or by means of instruments, or by combinations of any of these, the elements of musical language. The articulate character of music depends upon a division of collocated tones with reference to component single tones and the uniting of these together into intelligible groups to form so-called motives. Each tone should have its due proportion of sound so that the ear shall easily perceive either its detachment from other tones or its connection with other tones (VENABLE, 1913, p.4).

Her verbal explanatory models show how the intrinsic properties and factors of music interpretation can develop into musical articulation. Since proven that no score[76] will ever be

[76]"Expressive microstructure, essential for living and authentical musical communication, is present in musical thought also as an integral part of musical structure. Principal features of microstructure are distinctive amplitude

completely complete[77] (CLYNES, 1983) and therefore impossible to refer to a single correct "interpretive version", truly unimagined possibilities of interpretation are offered, enabling the development of "free" will and the excitement of experimentation. However, this does not necessarily mean that pupils, students, and musicians in general take this fact to heart. On the other hand, these interpretive options for the most part (SILVERMAN, 2007; KRIVENSKI, 2018) pose insurmountable demands to play correctly with an overwhelming sense of inadequacy.

Although over a hundred years ago, Matthay's (1913) description of "fear" and the solution he advocates via what he calls: "throw self overboard" may more easily teach us to care about Art, by identifying the concepts of "caution" and "care":

> From sheer wish to do right one may err. One may mistake *caution* for care. To be cautious — to be *afraid* of failing – will only chill one musically, and thus cause one to fail. To be *afraid* of failure does not constitute a care for Music at all; on the contrary, it is again a form of selfishness, and as such must therefore cause failure. To succeed in art as in anything we must be "unselfish," — so far as that is possible to us humans — we must throw self overboard, and really *caring for art*, we must wish to do well because art is so beautiful, so worthy, that any service we can bring to its shrine is as nothing (MATTHAY, 1913, p.9).

As Venable (1913, p.5) states: "musical articulation is only in small measure symbolized by the composer, who employs the signs only as suggestive guides to the intuition and skill of the player and not as a complete expression of his own intention". Venable (1913, p.6) concludes how: "Considerations of tempo, quantity, accent, emphasis, modulation of tone, grammatical and rhetorical articulation and pause, delicate variations from rigid rules, individuality."

So, with the perspective *when* interpreting, *how* can a deepened conceptual understanding develop a synergistic connection between the building blocks of music. And *how* can an increased sensitivity to one's own body's sensory experiences be enhanced. Jourdain (1998) describes it as a feedback-loop between brain and muscle and vice versa: "feedback from muscle to brain is just as important. It loops through the *somatosensory cortex* that interprets

shapes for individual tones of a melody, and duration deviations from the note values of the score" (CLYNES, 1983, p.80).

[77]"If modern electronic facilities had been available to earlier composers, so that they would have clearly known the various extent of these deviations, a more precise musical notation might perhaps have developed from the needs of musical expression. One may surmise that theorists would have been inclined to study these deviations carefully, certainly the exponents of the Affektenlehre in the eighteenth century, such as Marpurg, Mattheson, Quantz, Leopold Mozart, Car1 Phillip Emmanuel Bach, to name a few, all of whom specifically emphasized the importance of subtleties of inflections that need to be read into the score"(CLYNES, 1983, p.80).

sensations of touch coming from all parts of the body" (p.216). In other words, this is what this investigation is about, to suggest memorization as this tool.

Experience (emotion) as (inner) Guide

What steers a pianist´s interpretation process neurobiologically? According to Jourdain (1998, p.246): "musical phrases can wander in as many directions as pieces in a game of chess". This, also relates to Buzsáki (2006), claiming that the brain is always interpreting, making sense of the ontological aspects of "passively hearing" and "actively listening" [while the pianist interprets], which Jourdain (1998, p.246) claims such as: "searches for familiar devices and patterns in music". This "search" if related to listening is delineated as anticipation or expectation, why: "memory is essential to music perception" (JOURDAIN, 1998, p.246).

Another perspective in this process of interpretation, is the knowledge of the nervous system´s function. Its fundamental reliance on a reciprocal correlation to emotions while making musical decisions (i.e., interpretations): "[a] nervous system must always be on the lookout for the most important activities to which to devote itself. This is the ultimate purpose of emotion" (JOURDAIN, 1998, p.310).

Consequently, depending on the interpreter´s level of conscious attention and focus, to interpret can be an active action, having based the decision out of deliberate consideration[78]. Similarly, the expression: "to commit to one´s memory" (i.e., memorizing), resembles this inner dialoguing when performing, practicing, and interpreting, demonstrating a "listening" phase. In this sense, just referring to the semantic meaning of these words, implies how the concept (memorization) by using "to commit", as a "commitment", could also be interpreted as a phase of "attention", focus, concentration and will.

Consequently, "to commit to one´s memory" could be analyzed as an active verb relating to the *self,* seen as primarily an action of awareness, consciously aware about the actions, its implications, its procedure. But as we all know, "to remember" something, relying on our memory, might sometimes result in forgetting.

Concerning the act of interpretation, regardless how and why it occurs, it presupposes *something* to interpret, something in need of to be interpreted. Nevertheless, it always happens. It is through the senses we continuous interpretate the world. Thus, if considering any phase of

[78]"According to Fitts & Posner, 1967 "development of motor skill" consists of following steps:
"Stage I - The *cognitive-verbal-motor stage,* when achieve an ability to improve,
Stage II – The *association* stage
Stage III – The *deliberate practice"* (PARNCUTT; MCPHERSON, 2002, p.156).

music interpreting, vision, audition, and touch, remains. If focusing on these senses´ momentarily sensory impressions apprehended it might be important to further address their functions. It is often described, how the concept music interpretation, is presented as something (mostly) related to just how to decipher the "meaning" behind the (composer´s) musical ideas, or how to unfold the "hidden", as "exegesis".

Not least considering the perspective that music education also includes "self-growing" to build self-esteem, and self-confidence, communication, and happiness (SILVERMAN, 2023), emotion is described as a necessary part. It develops the ability to make decisions, in general, both in life, and to (dare) to make interpretive choices in music, regardless of which level or whatever context. That is, despite an often-one-sided focus on cognitive properties, not least regarding the vital function of survival: "we think of "decision-making" as the highest of cognitive feats", this is still the case in the oldest parts of our brain, i.e. centers for emotion, the limbic system and the hippocampus (JOURDAIN, 1998, p. 310).

The study Jourdain (1998) refers to is the book *Descartes´ Error,* Antonio Damasio, where a damage on a patient´s front lobe, resulted in "emotional "*flatness"* (…) [loosing] the ability to pick and choose" (JOURDAIN, 1998, p.310). Memories, as experiences, thus stand in relation to mechanisms controlling decision-making, motivation, deep learning, understanding – not least the ability to see new possibilities. Not least regarding musical decisions.

How Much Can a Pianist Consciously Interact?

It is of interest to enhance to what extent musical reactions related to the pianists' own senses do impact the instant present progress, when interpretating. Even if this process, most probably, (unconsciously) constitute the main source of decision-making, perhaps, the sources behind the assessments are in fact not explicitly enhanced as such. One might think that these (unconscious) actions (decisions regarding music interpretation) are based on (believed) objective standpoints views. However, regarding the fact that the processing of sensory information, how to select and choose among all vast number of stimuli, respond to an accomplished certain categorized assortment.

According to Clynes (1990) there are three definitions of a "good musical performer" (p.34). All three relate to "hearing": "1. Hear inwardly first. 2. Clearly execute what he hears inwardly.3. Listen to check what he plays is what he hears inwardly. These three functions go on continuingly and simultaneously! Not an easy task!" (CLYNES, 1990, p.34).

If it is possible to transmit an inner emotion, transferring an internal emotion/affect to/or through the hand, does this necessarily mean that the *touch* in the keyboard will execute an equivalent, measurable "touch" to those emotions? In 1972[79], CLYNES (1977) started to develop a concept[80] named *sentics*[81] where the pressure of the touch clearly showed how the intentional emotions transmitted by the sender was similarly received, and it could register what kind of emotions or feelings, like anger, happiness, caress, etc.

Similar results were achieved by the French pianist Marie Jaëll[82] (1846-1925). Her findings related to *Le mécanisme du toucher* show scientific approaches to neuroscience in the year 1897. Her data describes a relationship in between the "touch" and the "execution" of sounds. Thus implying, that, the tactile physical motor memory, (when playing and touching the keys) consequently, needs to have a memory of what was played and executed before (earlier playing experiences at the keyboard). It means that the very act of touch is an act of experimental of the *sense* (in Jaëll´s point of view: touch) however, any sense, consequently, need to have this possibility (ability) to be a part of a sensory experimental experiment?

In processes of music interpretation and memorization it has been argued for the importance of the auditive *listening* phase. As suggested by Pythagoras: "by listening to music, one could comprehend and retrace the outer "physical" harmony of the universe, which would lead to a state of inner "mental" harmony, thus re-establishing balance in the body and helping to cure mental disorders" (KULINSKI et al, 2021, p.390.) The precedent and continuing interpretative stage with its multisensory impact, thus incorporating the *self,* physically as well as emotionally, link memories as "mental" images, all of them as well constituting inevitable parts in a memorization process. Not least, since a long time ago, the "listening" to oneself was an accepted feature in teaching and learning music.

Already Gieseking & Leimer (1972) claimed in their book "Piano Technique" one of the main features of piano teaching is to "show[s] the pupil how to hear himself" (1972, p.5),

[79]CLYNES, M. Sentic cycles: The 7 passions at your fingertips. Psychology Today, 1972, May, pp.59-60, 68, 70, 72

[80]"Describes the theory and practice of "sentics," a scientific discipline devoted to studying the biological basis of emotional communication. Using the "sentograph," an instrument that measures and graphs emotional expression through the fingertips, the author has shown the existence of genetically programed brain and nervous system patterns for such basic emotional states as joy, anger, hate, grief, love, sex, and reverence" Available at: https://psycnet.apa.org/record/1978-04639-000

[81]"Sentics, from the Latin *sentire*, to feel, is Clynes's term for emotion. He argued that the experience of emotion is inevitably tied to its expression or perception, so the natural unit of emotion has the duration of a single expression—a smile, a shout, a sigh. Longer emotion episodes are compounded of repeated instances. Clynes focused on basic emotions, and argued that each has a distinctive temporal form, regardless of the modality by which it is expressed (tone of voice, facial expression, musical phrase)" (MCCRAE, 2021, p.4).

[82] Jaëll, Marie Le mécanisme du toucher. L'étude du piano par l'analyse expérimentale de la sensibilité tactile (1897).

which, in other words, is described by Jørgensen (2000, p.67): “your ears are your best teachers” (KRIVENSKI, 2018, p.101). Despite this, problems have been raised (in higher music education) regarding students' lack of 'self-evaluation' and 'self-feedback' (Gaunt, 2009, p.17), i.e. that teaching could be developed, pedagogically, in this respect (KRIVENSKI, 2018, p.102).

Such a perspective broadens the whole interpretative process in its link to (self) education. In this way, to interpret music, not only viewed in relation to how to form the music, but also a form of get to know yourself, deliberately acting and reacting in certain interpretative manners, thus interferes with the sounding result.

It is extraordinary to find certain formulations (GIESEKING & LEIMER, 1972) reflected in today's neuroscientific findings, which should be an important factor in music education. As Gieseking & Leimer (1972) claim, it is by using music's multifaceted interpretative possibilities that one learns to hear [see, feel] and thereby shape one's “self”:

> However, current research in neuroscience reinforces the notion that children’s experiences shape their biology as much as biology shapes children’s development. The fields of neuroscience and more broadly biology are leading education toward analyzing the dynamic relationship between nurture and nature in development and schooling (IMMORDINO-YANG; FISCHER, 2009, p.2).

Given the year, Gieseking & Leimer's (1972) “poetic” exhortation, the importance of training the ability to “hear oneself”, is considered by many to be outdated fact. However remarkably like today's descriptions of neuronal activity identified by Professor of Neurological Surgery, Edward Chang (2017):

> The first two groups of neurons turned out to be the same ones that Chang identified in an earlier study of how we process the changes in vocal pitch that lend meaning and emotion to speech. The third group of neurons, however, are solely devoted to predicting melodic notes and are described here for the first time[83] (MARKS, 2024, n.p.).

Perhaps we can read here a neuroscientific rewriting of the meaning of prediction, imagination and what is to come (i.e. the next note). Regardless of how the explicit meaning is to be interpreted, such findings still mean that the brain has an ability to expect how to interpret the music and allow change.

[83] Available at: https://www.ucsf.edu/news/2024/02/427116/to-appreciate-music-human-brain-listens-and-learns-to-predict

Chapter 2: ON MEMORIZATION

Hundreds of years ago, the memorizing-researcher, Dominican friar[84], Giordano Bruno (1582), assured that memorization strengthened not only memory, but also, "the powers of the soul (...) the key to spiritual enlightenment"[85] (FOER, 2011, p.136). What was said and claimed in the past: "the goal of training one's memory was not to become a "living book," but rather a "living concordance," a walking index of everything one had read" (FOER, 2011, p.131).

But the common view of memorization has changed in step with the development of written language, art of printing, and digital accessories. We cannot hide or turn a blind eye to the fact that our time, which Foer (2011) addresses as "The End of Remembering" (p.124), and its opposite [medieval] relationship, contrasts with "Memory: An Extended Definition" (ZLOTNIK & VANSINTJAN, 2019, p.1). Thus, stating our external digital device has come to be part of our memory. Now we type what we need to remember in our "extended mind" - always at arm's reach.

In some sense, music must be considered as an "extended item". Any music can be considered as an extension, an externalization of the composer´s mind – in form of a "notebook". In addition, it is an interpreter´s meeting point with a composer´s mind. The interpreter will internalize and memorize it. Then perform it. Correspondingly, the music can be transmitted via various external sources ("extended minds") with the goal of being reshaped into one's memory. This happens via a visual sight, i.e., by s, or whether be it a "sounding" music source, an "aural" score, i.e., by "ear", or by a "touching" score, "braille", by touch.

Nevertheless, the brain still wants to interpret everything it perceives and experiences (BUZSÁKI, 2006), since "It´s just a messenger service!" (WILSON, 1999, p.219), with aptitude for language regardless of which sense it uses. If not out via the mouth, it is released into the hands (WILSON, 1999). The inevitable and essential hand also wants to develop, explore, and discover the surroundings (LUNDBORG, 2014). Haptics, an ancient concept, but also crucial for our sensibility in [and with] the physical reality.

Another perspective might unfold by bringing some clarifications based on neuroscientist O´Keane (2021) presenting the impact of memory: "it´s everything from within us and from without us as well (…) the bodies are making the memories as well, the emotions we feel in our bodies"[86]. Without certain aspects of stored memories, it can be difficult to develop any

[84]"Ars memoriae", by Giordano Bruno (1582). Available at: https://it.wikipedia.org/wiki/Ars_memoriae
[85]'"[memorizing] will help not only the memory but also all the powers of the soul". Memory training, for Bruno, was the key to spiritual enlightenment" (FOER, 2011, p.136).
[86]Veronica O'Keane, neuroscientist, professor of Psychiatry, talking about "the world of neuroscience", in conversation with Ted Dinan: "Veronica O'Keane, "A Sense of Self: Memory, the Brain, and Who We Are"

interpretation, or better, if memory is experiences (O´KEANE, 2021) they ought to stand as a background for everything we face in life–including how to interpret and memorize music.

In line with today's understanding of memory, however, similarities with medieval philosophy about memory training can be discerned, to at all come into existence, depending on "all the information one had acquired" (FOER, 2011, p.131). Perhaps Foer´s (2011) examples, comparing ancient times with how we use our memory today, can assist us to imagine the Middle Ages. Just, knowing that everything learned must be committed to the memory, since the bookshelves were not yet invented: "a medieval scholar (…) a reasonable likelihood would never see that particular text again, and so a high premium was placed on remembering what you read" (FOER, 201, p.129).

Following findings in this area, I aim to present the authors' positions while defining the characteristics and factors inherent in memorization. Since memorization is based on memory functions and the ability to remember, some statements will be made about these definitions.

What is Memory

Perhaps Miller's (1955)[87] magical number[88] 7±2, is acknowledged by most people, indicating the ability and systematization of possible items for a human to remember, a maximum number of "things". To exemplify Miller's (1955) concept, try to remember 12 letters in this order: C, D, E, F, G, A, B, C, C, G, E, C. Then, adopting Bryant's (1986, p.27) explanation of what "chunking"[89] means, instead of remembering 12 different parts, transform into two: the C major scale and the C triad. Suddenly it frees up space to focus on new information and consequently, the ability to remember 6 more "items".

(2021). Available at: https://youtu.be/cGDDPT96GM8?si=YSOZRIwrvB8-CijZ

[87]Available at: https://www.interaction-design.org/literature/topics/human-memory

[88]"In addition to having a time limit, short-term memory also has a content limit of from five to nine (7 ± 2) *different elements*; seven on average. The term *element* here refers to any of the basic elements in a sequence; each element may consist of more than one of the same item without necessarily increasing memory load. This is the size of the basic STM "chunk." Because "chunking" is a hierarchical process, an element in this sense may be a grouping that itself consists of five to nine elements. A musical phrase of STM length may then consist of several groupings of notes. The upper limit on how many events can comprise a phrase is probably about five groupings of five events each, or about twenty-five events, depending on how it is organized" (SNYDER, 2001, p.36).

[89]"well known in the literature on expert memory and is often referred to as chunking (Gobet et al., 2001). This technique consists of grouping the pitches into meaningful units. In tonal music, musicians can chunk the information into well-known tonal patterns, such as chords, intervals or scales (Halpern & Bower, 1982). Triantafillou and Theodorakis reported using the same technique in contemporary repertoire but using different types of chunks. Triantafillou reported chunking the notes into hand shapes, a strategy reported in previous studies as blocking (Nellons, 1974)" (FONTE et al, 2022, p.12).

A memory system is described as a capability to encode, store, recall and retrieve information: sensory memory (SM), short-term memory (STM), and long-term memory (LTM). Each type characterized with different features. But, what to do with this information?

> Short-term memory, the working memory, lasts approximately fifteen seconds. In STM, information is encoded (put into a system or form that can be stored) through comparing it with LTM store, chunking, and rehearsing. The LTM store is previously acquired knowledge about music and performing. This information may be used to interpret received information, compare information to what is known, and to evaluate and associate for storage and retrieval. The amount of previous knowledge and experience about music aids in the interpretation and encoding of new material (BRYANT, 1986, p.91).

Our long-term memory thus helps us as a kind of comparison matrix when new material is to be learned and remembered. Still, most pianists (musicians) know how it feels when the fingers and their muscles just "run away from you", and we neither have time to correct mistakes, nor hear that the music was not shaped the way we wanted it to be.

An older experiment relevant for a piano playing context, highlighted, how the velocity of finger motions rapidly playing on a piano was compared to the current speed of the transmission in-between neurons. The result showed that the fingers moved much faster than earlier understood. These implications contradicted the accepted theory[90] of that time based on a process initiated by (tactile) sensory information from the finger, returning to the brain, passing the motor area, which then returned a motor impulse to the muscles of the finger (BEACH, 1961).

This discovery figuratively describing how the brain works, with different systems, in slow and fast movements[91], also indicating that in practicing and performing they might use separate functions (MCPHERSON & PARNCUTT, 2002). Not least in a memorization process it is important to know that either a slow or quick movement can have different bearing on the brain. Moreover, in fast tempo, the hands, fingers, muscles, the motor system, can exceed our possibility to pay attention and be consciously aware about all movements. These functions are

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[90]"…once [calculating] the speed of finger movements involved in playing a rapid cadenza on the piano and compared this with the known speed of neural transmission. The comparison revealed that the intervals between successive finger movements were too short to support the theory that each movement is aroused by motor impulses which in turn are set off by sensory impulses derived from the preceding finger movement. There is not enough time for a sensory message from the finger to go to the brain and pass to the motor area and then for a motor impulse to return to the finger muscles (…) example in support of the notion of central patterning of complex motor sequences" (BEACH, Frank, 1961, p.179).

[91]"Another unsolved problem is the neuronal basis of the transition from guided slow movements, which are performed under steady sensory control, to fast, ballistic movements, which have to be performed without on-line sensory feedback. It is assumed that different brain regions produce these two types of movements and the transition from one type to the other may be incomplete" (MCPHERSON & PARNCUTT, 2002, pp.76-77).

also defined by empirical findings among authors described as automaticity (BRYANT, 1986). Therefore, automaticity is an essential part of the puzzle, to understand and be aware of what memory can be in the memorization learning process – and its impact on interpretation. In this aspect, the concept automaticity and its functions handling speed and velocity, is a valuable finding for the understanding on how to *think, reflect* and *act,* not least in relation to the somatosensory systems.

Memorization obviously implies memory. But what does memory consist of, giving us the ability to memorize music? What is there to learn related to current definitions? For a long time, scientists tried to locate the "engram", the exact source and physical trace of memory in the brain. Today, memory can be described as "neurally-embedded experiences", stored as a surface, all over the cortex[92], and in deeper emotional layers[93] (O´KEANE, 2021).

In accordance with the definition of music: "sound that expresses emotion through rhythm, melody, and harmony"[94] (MeSH, 2024), the impact and relevance of emotion in memory must be considered as "the human condition of feeling" [95] (O´KEANE, 2021).

Since, in my youth, my father describing the book "Ulysses" by James Joyce (1882-1941), I have been fascinated with how to approach and demonstrate an inner monologuing of a person´s mental states, as in the book, during one single day. Therefore, when I found in the literature, O'Keane (2021), referring to Joyce in relation to the concepts of consciousness and memory, I began to associate this "stream-of-consciousness"[96] with memorization of music. Like a heightened sensory perception of the senses with interoceptive and proprioceptive elements (see Chap.3). Not least I gradually could relate to my own procedures towards memorizing music. As an awareness of, out of *what,* to construct memories, *how* to steer the

[92] *"mass action";* implying that "learning is mediated by the cerebral cortex acting as a whole" (BEACH, 1961, p.175), and *"equipotentiality";* meaning that all areas related to the cortex are included in, and of equivalent importance in learning processes (BEACH, 1961).
[93] O´Keane (2021) Available at: https://youtu.be/cGDDPT96GM8?si=YSOZRIwrvB8-CijZ
[94] Definition of "music" (MeSH, 2024). Svensk MeSH, Karolinska Institutet, NIH, National Library of Medicine. Available at: https://mesh.kib.ki.se/term/D009146/music
[95] Veronica O'Keane, neuroscientist, professor of Psychiatry, talking about "the world of neuroscience", in conversation with Ted Dinan: "Veronica O'Keane, "A Sense of Self: Memory, the Brain, and Who We Are" (2021). Available at: https://youtu.be/cGDDPT96GM8?si=YSOZRIwrvB8-CijZ
[96] "James Joyce and the stream of consciousness. Regarded as one of the most influential and importante authors of the 20th century, he championed a new style of writing based upon the stream of consciousness technique: when the written form attempts to mimic a character's immediate flow of thoughts and feelings, adding a heightened sense of realism and immedicay to his writing. In practice, this is similar to Shakespeare's use of dramatic monologue, except rather than have the character directly addressing the audience, the reader is instead privy to the character's internal discussion - an interior monologue. The technique aims to give readers the impression of being inside the mind of the character, offering them a window into their mental state, the complexities of their character, and a greater understanding of their motivations. Below is an example of stream-of-consciousness writing taken from James Joyce's *Ulysses*, a novel which describes the wandering appointments and encounters of the Middle aged Dubliner Leopold Bloom on one day of his life, 16 June 1904". Available at: https://www.kumon.co.uk/blog/james-joyce-and-the-stream-of-consciousness/

procedure, *why* it happens and, what happens during the process *when* memorizing. These findings seem to follow how Immordino-Yang & Damasio (2007) describe cognitive and emotional resources as interacting in the mind, as a basis for learning and understanding

The perspectives of memory today, that: "we live our memories as human beings". O´Keane claims that we too easily forget this condition, that just to *exist,* to *be,* consists of a mix between sensations and experiences, which we continuously interpret by using our memories.

So, to use O´Keane´s (2021) expression: "the process of living experience, which is what memory is for me", this chapter will emerge into some concepts of memory.

Nobel prize winner Kandel (2007) also relates similar aspects of memory such as: "We are who we are in great measure because of what we learn, and what we remember" (apud Kandel, 2007, p. 10, ZLOTNIK; VANSINTJAN, 2019, p.4). In addition, Zlotnik and Vansintjan (2019, p.4), expanded the definition of memory to help us shift from a focus on "experience" (which suggests an immaterial event) to a more material phenomenon: a deposit of events that may be stored and used afterward. These two different approaches to describe memory, where the latter is not so known as is Miller (1955), are still interrelated to one another.

Zlotnik and Vansintjan (2019) present another perspective with endless possibilities "to store information" in the "Information Age" based on concepts of *cyborg*[97] (p.4), resulting in a sensation that our mind, and brain are not [seemingly] stationary: "the memory it uses, is a work in process; we are not now what we were then" (ZLOTNIK; VANSINTJAN, 2019, p.1). In opposition towards the [at times] earlier existing and common perception that memory was something fixed in the brain, that exactly everything we do, thus, could be referred to, and constituted by, a process related to memory (ZLOTNIK; VANSINTJAN, 2019, p.2).

Thus, if memory and memorization were once regarded as inevitable tools in the Middle Ages and today have been exchanged and replaced by electronic devices, what then will happen with our mental awareness and consciousness regarding the realistic and evolutionary possibilities nature provided our bodies, minds, and senses?

[97]"integrated into our experience through multiple media. Second, it helps to conceptualize the relationship between biology, psychology, cognitive science, and computer science – as all three involve studying the transfer of information. Third, it opens up an interesting way to imagine our own future. If we accept that there is such a thing as the storage of information outside the brain – and that this organic, dynamic process can also be called "memory" – then we open the door to a very dierent world. The mind is not static. Rather, like early cells acquiring mitochondria, it incorporates information from its surroundings, which in turn changes it. The brain, and the memory it uses, is a work in progress; we are not now who we were then. Many have already noted the extent to which we are cyborgs (Harraway, 1991; Clark, 2003, 2005); this neat line between human and technology may become more and more blurred as we develop specialized tools to store all kinds of information in our built environment. In what ways will the mind-brain function dierently as it becomes increasingly more incorporated in its milieu, relying on it for information storage andprocessing?" (ZLOTNIK; VANSINTJAN, 2019, p.4).

To be equipped with just one´s self and must deal with an external *item*, the piano, might be in line with the concept of an "extended mind", as ANT–Actor´s Network Theory (LATOUR, 1996).

Also, O´Keane (2021) claims how the view of memory has changed a lot since the last decades, and remarkably in line with theories launched by how existentialists exploration the core and features of our conscious, about one hundred years ago. Those concepts as: "Consciousness is memory", preceded by philosophers[98] as Henri Bergson, is now validated[99] by O´Keane (2021) as signifying today´s interconnection between neuroscience and memory:

> an awareness of processing experience in the context of an individual memory. And the existential writers explored this before we understood what it was, so, I learned about mental experience from reading these, existential writers, and of course, they were pushing their frontiers of mental life, and the human condition through their writings (O´KEANE, 2021).

O´Keane highlights the impact of experiences in relation to how memories are processed by claiming: "The world as well as we, make our brains[100] (…) The hippocampus at the center of the brain is like a memory factory where all the neurons connect up together to make patterns" (O´KEANE, 2021).

But how often do we associate our sense of self with our own memories, once defined as "it is everything", as O´Keane (2021) argues. Thus, to bring perspectives of the close connection between identity, our sense of self, and memories, into an investigation about memorization might perhaps be clearer according to this description:

> the way we memorize the world, the way that the world comes at us, because of the kind of memory filter we have, because, of the way our brains are structured because of the experiences we have very much, this all comes together and give us, in adulthood and in childhood, a sense of what "oneself" is and you – it´s so basic that it´s difficult to imagine (O´KEANE, 2021).

Descriptions of memory (Figure 5) are often based upon the Multi-Store Memory Model by Atkinson & Shiffrin (1968):

[98]Available at: https://muse.jhu.edu/book/12690/

[99]O´KEANE, youtube (2022): How we make memories and how memories make us – with Veronica O'Keane. Available at: https://www.youtube.com/watch?v=TZMYvnL8dfI

[100]"The human brain is considered to be a highly dynamic and constantly reorganizing system capable of being shaped and reshaped across an entire lifespan" (NICHOLAS, et al, 2019, p.43).

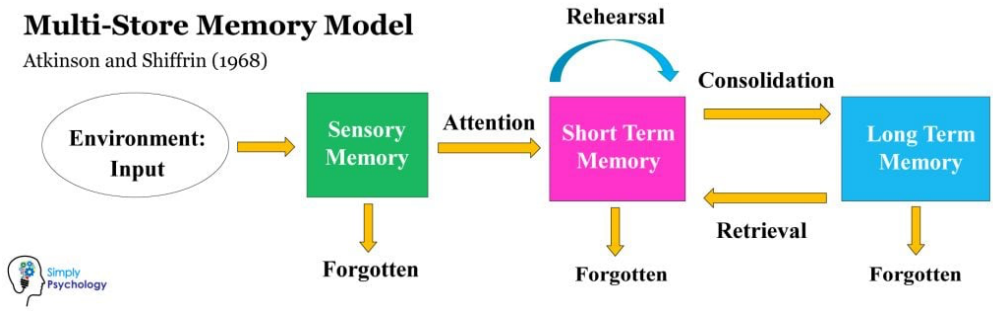

Figure 5: multi-store memory model
Source: https://www.simplypsychology.org/multi-store.html

Moreover, if science, regarding memory and memorization, relies on findings from the past, as "a dwarf on giant's shoulders" (ECO, 1977), one can see how in the era of Aristotle, *De memoria et reminiscentia*[101] (Aristotle, 350 B.C., apud BEARE (transl.), 2010; GLOOR & COESSENS, 2017)[102], the functions of memory and memorization were already identified, despite the lack of today´s technological equipment with brain-scanners, EEG, PET, MRI, and fMRI:

> In his treatise *De memoria et reminiscentia* (On Memory), Aristotle had already developed basic ideas and arguments that came to importance in psychoanalysis 2200 years later. Aristotle writes first about perception. According to him, perception triggers movement in the soul and in the body. If this movement is consciously kept, it leads to memory. Thus, memory is an image of the movement caused by perception. Memory is simultaneously part of both the soul and the body, and it does not depend on being remembered but can even exist without ever being used. (Aristotle 1984, 714) (GLOOR & COESSENS, 2017, p. 127).

If we compare Aristotle´s (A) concepts with today´s definition of the "Multi-Store Memory Model" (ATKINSON & SHIFFRIN, 1968) (AS) following results appear:

perception (A) = environment input (AS)

triggers (A) = sensory memories (AS)

consciously kept (A) = rehearsal (AS)

leads to memory (A) = consolidation (AS)

image of the movement caused by perception (A) = retrieval (AS)

[101]"On memory and reminiscence" (ARISTOTLE, 350 B.C. Translated by J.I.Beare).
[102]"Aristotle. 1984. On Memory. Translated by J. I. Beare. In The Complete Works of Aristotle, edited by Jonathan Barnes, 2 vols, 2:714–20. Bollingen Series 71:2. Princeton, NJ: Princeton University Press. Edition of On Memory first published in Aristotle: Parva Naturalia, edited by W. D. Ross (Oxford: Clarendon Press, 1955)" (GLOOR & COESSENS, 2017, p. 133).

even exist without ever being used (A) = forgotten [subliminal] / long term memory (AS)

Seemingly, already some hundreds of years B.C. at least Aristotle´s description proposed a hypothesis like ours regarding memory functions. Not least Aristotle´s reference regarding "soul" and "body", can be compared to today´s division between the sensory systems, a dual-action activity, also enhancing imagery. Perhaps Aristotle´s "movement in the (…) body", we can describe as kinesthetics, or proprioception, which relates to the perception of one´s own body. Focusing on the sentence: "perception triggers movement in the soul and in the body, and if this movement is consciously kept, it leads to memory". It is extremely like current neuroscientific data showing the effect of repetition (KANDEL, 2007; RÖSCH, 2013).

For pianists memorizing, repetition, can be a prerequisite for establish a long-term memory. The Nobel-prize winner Kandel (2000) stated:

> learning and memory have proven to be endlessly fascinating mental processes because they address one of the fundamental features of human activity: our ability to acquire new ideas from experience and to retain these ideas in memory[103](KANDEL, 2000, p.392).

According to Tobias Bonhoeffer and his team (MaxPlanck): "Learning and Memory leave behind anatomically visible traces. (…) the contact points between nerves, so-called dendrical thorns, and synapses (…) during learning some thorns newly develop and others disappear."[104] In other words, memory can be described as a muscle: "it grows in proportion to the demands put upon it [Figure 6]. Unfortunately, if not exercised, it can also shrink" (STREET, 1987, p.33). It was also explained that stress-related activities cause increased production of adrenaline with strengthening memory-functions and stabilize memorization processes (STREET, 1987, p.33), thus verifying a personal experience, although perhaps not to recommend.

Initial experiments performed in Alexandria 300 BC contributed to knowledge of the existence of "neurons" with connections to the brain (although vague regarding the actual functional process) (WILSON, 1999, pp. 96-97). In 157 AD, Galen of Pergamum presented findings relating muscle functions to voluntary acts, as well as definitions about muscle pairs as we still know them today: *agonist* and *antagonist*.

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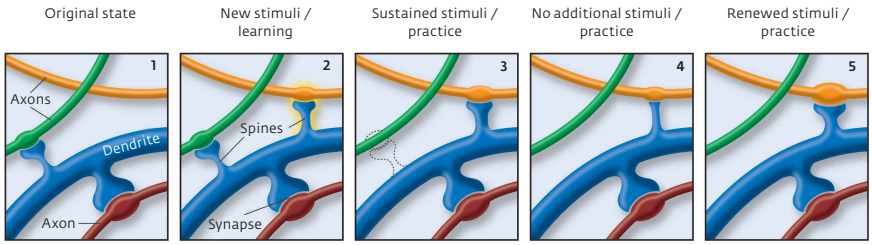
[103]The Molecular Biology of Memory Storage: A Dialogue between Genes and Synapses. Nobel Lecture, December 8, 2000, by Eric R. Kandel. Available at: https://www.nobelprize.org/uploads/2018/06/kandellecture.pdf

[104]How synapses spark Video June 25, 2013, © MPG/Massih Media, Brain Neurobiology
Available at: https://www.mpg.de/7331016/synapse-long-term-potentiation



How learning modifies the synapses: 1: A dendrite belonging to a nerve cell (blue) bears synapses with axons of other cells (green, red) on its spines. 2: Learning or a new stimulus causes a dendritic spine to "sprout," connecting the dendrites with a new cell (yellow). 3: If the learned information is supplemented or if the stimulus is sustained for a longer period of time, the synapse on the new spine is expanded and the old spine is no longer needed, and disappears. 4: If there is no additional learning or training, or if the stimulus is removed, the spine shrinks and the associated synapse is weakened or inactivated. 5: If the same skill is used again, the existing contact can be expanded. As a consequence, learning occurs faster.

Figure 6: illustration of the learning process impacting on synapses.
Source: Rösch, 2013, p.25.

The discoveries in the field continued and around 1900 explanatory models of sensory and motor nerves with links to the spinal cord was established (WILSON, 1999, pp. 96-97). In 1894, Ramón y Cajal opened the modern view upon memories, as a product of "strengthening of connections *between* neurons" (ZLOTNIK; VANSINTJAN, 2019, p.2).

Today we can literally and figuratively see (Figures 6 and 7) inside our own brain, axons, dendrites, spines, and synapses, thus understand how and when experiences, knowledge and memory are created, depending on how the growth of new synapses occurs and whether they increase or decrease:

> learning results from changes in the strength of the synaptic connections between (…) cells (…) synaptic plasticity emerged as a fundamental mechanism for information storage by the nervous system, a mechanism that is built into the very molecular architecture of chemical synapses[105] (KANDEL, 2000, p.401).

Spanish neuroscientist Santiago Ramon y Cajal (1852-1934) painted[106] (!) these processes, even without having seen them. Later, the processes of synapses strength were discovery (Figures 6 and 7), and an idea is that this basis could contribute overall with increased understanding also within teaching and learning, as a visual explanatory model, as a supplement in a teaching situation. Not least interesting to pinpoint is the existence of around 86 billion nerve cells in our brain[107] (AZEVEDO et al, 2009) which all communicate with each other through electrical and chemical signals.

[105]Available at: https://www.nobelprize.org/prizes/medicine/2000/kandel/facts/>
[106]Available at: https://courier.unesco.org/en/articles/santiago-ramon-y-cajal-first-map-human-brain
[107]"Approximately 86 billion neurons in the human brain. The latest estimates for the number of stars in the Milky Way is somewhere between 200 and 400 billion" Available at: https://www.nature.com/scitable/blog/brain-metrics/are_there_really_as_many/

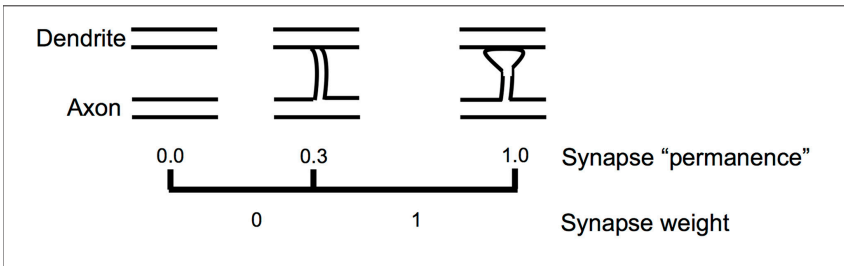


Figure 7: synapse "permanence", i.e., strength of the synaptic connections.
Source: Hawkins and Ahmad, 2016, p.23.

When knowing that as soon as "an impulse run along the nerve pathways it leaves a little trace in the brain" and that "[s]ynapses change depending on how much they are needed"[108] (RÖSCH, 2013), it suddenly provides an alternative neuroscientific explanatory model for music memory, memorization (interpretation, practising, performance, teaching, learning).

Another cognitive neuroscientific source portrays the impact of repetition[109] such as: "consolidation of long-term memory storage occurs through rehearsal of information (Kandel, 2006; Hardiman, 2003, 2010)" (TOWNSEND, 2017, p.6), which also ought to be valid for the processes of memorizing.

Not least, as we all sense and can experience what it is to forget, i.e., that connections fade away due to inactivated nerves, if seldom used (RÖSCH, 2013) but since "10% of them remain and are so to speak switched on to standby" the brain can restart the connections again, a function which Rösch (2013) describes as "permanent adaptation plasticity"[110].

Another process describing how come we can learn and remember is called: "neuronal plasticity"[111], defining "similarities between how the brain develops and the mechanisms responsible for altering the connections between nerve cells later on"[112]. Thus, memory is nowadays described as a neuro-chemical process with a capacity to store and retrieve information. Based on a combination of accumulated "knowledge, information and techniques" (ZLOTNIK; VANSINTJAN, 2019, p.3) it is indicated, that the experience available ought to constitute a foundation related to memories as such.

[108]Available at: https://www.mpg.de/7331016/synapse-long-term-memory.
[109]Available at: https://www.nobelprize.org/prizes/medicine/2000/kandel/facts/> (…) learning not only leads to changes in synaptic strength, it can also effect the excitability of neurons. (…) a given synapse synaptic plasticity can either be short- or long-lived depending on the number of spaced repetitions of the learning stimulus (…) long-term memory storage involves not only a change in synaptic strength, but also anatomical changes, changes in the number of synaptic connections" (KANDEL, 2023, pp.401-402).
[110]Available at: https://www.mpg.de/7331016/synapse-long-term-memory.
[111]Neuroscience - Science of the Brain an introduction for young students. British Neuroscience Association European Dana Alliance for the Brain. Available at: https://www.uni-heidelberg.de/md/izn/teaching/neuroscience/img/neuroscience-of-the-brain-english.pdf (n.p.).
[112]Neuroscience - Science of the Brain an introduction for young students. British Neuroscience Association European Dana Alliance for the Brain. Available at: https://www.uni-heidelberg.de/md/izn/teaching/neuroscience/img/neuroscience-of-the-brain-english.pdf (n.p.).

In a musical paradigm this ought to imply that, when learning to memorize a piece, using memories, remembering, aiming playing by heart, former "experience" is activated. Exactly what, this "experience" imply, requires further description, but according to Zlotnik and Vansintjan (2019): "experience involves retrieval of information, conversely, being experienced is the process of retrieving memory" (p.3).

Is it part of the fact that we are equipped with memory, that we can remember and memorize, based on a "high density of receptors and a correspondingly higher number of sensory nerves"[113] spread over our body, demonstrated in the *Homunculus* (Figure 8)?

According to Wang & Agius (2018), evidence presented by Pantev (2001) shows that specific fingers of the hand can be detected in their respective cortical (somatosensory cortex) representative area of the brain, demonstrate: "enlarged cortical representations in the somatosensory and auditory domains" (WANG & AGIUS, 2018, p.S591), which relate to findings by Pantev (2001), showing how playing music increases the plasticity of the brain.

Accordingly, the hands (Figure 8, *Homunculus*) are equipped with a huge quantity of receptors: '"mapped" across the somatosensory cortex to form a representation[114] of the body surface"[115] which can demonstrate how perception is built based on the senses:

> The neural body maps of the somatosensory cortex are an important part of how we build up an implicit sense of ourselves through the sense of having a body and feeling our body move. These neural maps are shaped by experience, especially when using active touch and motion in our environment (NICHOLAS et al, 2019, p.37).

The fingertips´ simultaneously contact with the internal and external surrounding world, as interconnected to vast areas of the brain, adequately visualized in the homunculus figure[116]:

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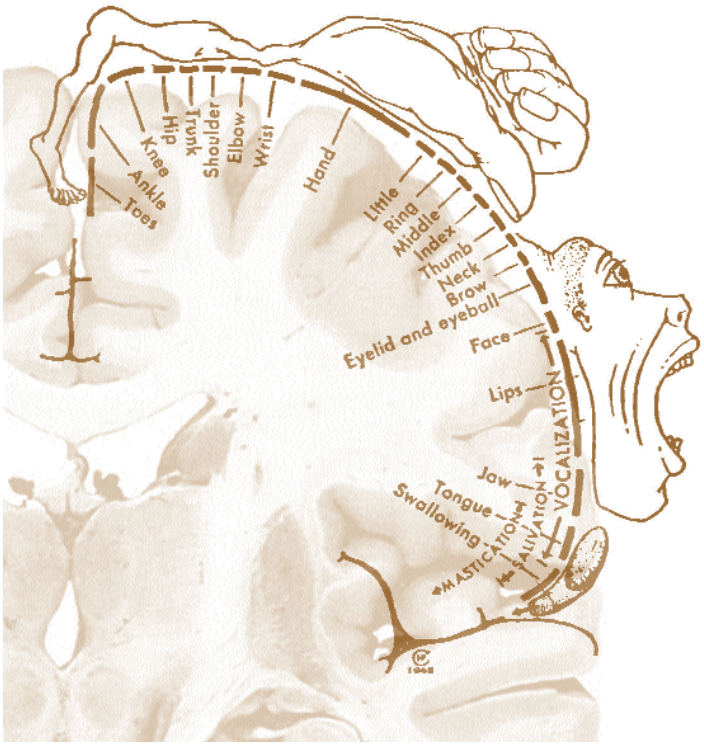
[113] *Idem*, p.11.

[114] *Ibidem*

[115] "Areas such as our back have far fewer receptors and nerves. However, in the somatosensory cortex, the packing density" (p.11)…. "of neurons is uniform. Consequently, the 'map' of the body surface in the cortex is very distorted. Sometimes called the sensory homunculus, this would be a curiously distorted person if it actually existed with its complement of touch receptors spread at a uniform density across the body surface." Neuroscience - Science of the Brain an introduction for young students. British Neuroscience Association European Dana Alliance for the Brain. Available at: https://www.uni-heidelberg.de/md/izn/teaching/neuroscience/img/neuroscience-of-the-brain-english.pdf (pp.11-12).

[116] "Body In The Mind Movement Imagery and Homunculus Man: the Science and Art of Movement, in all of its forms. In Latin the word *Homunculus* means 'little man'. In neuroanatomy, it refers to an area in our brain called the Somatosensory Cortex. It works as a visual representation of physical parts of the body in the brain aka. Body in the Mind (Louw, Pain Neuroscience Ed.), and its activity represents the movement, position and health of the body parts. The larger the representation of the body parts, the more sensory cells are present in the somatosensory cortex associated with "feeling" from that part. A recent buzzword in the medical community has been Neuroplasticity. We now know the brain is malleable and plastic, it can physically change, and the image that the brain has of your body can also change. For example, a Pianist will likely have really sharp images of his fingers, a pianist would also have a much larger as well as sharper picture than a non-pianist." Available at: https://backtoroots.community/blog/2022/6/6/myq0ll3tuoaeyyj0nh5qtbayk6tlla

Penfield's homunculus is shown with an outline which encompasses the area of cortical representation. What exactly does this outline represent, for we do not feel the outline or periphery of our bodies? As Schilder comments, "...the outline of the skin is not felt as a smooth and straight surface. This outline is blurred. There are no sharp borderlines between the outside world and the body". The homunculus, however, is outlined by an imaginary 'envelope' which does not exist. (...) Modern psychology has also embraced the homunculus-the concept of a little person within oneself, having a personal, internal role, and perhaps the inner person with whom one converses in internal speech: the function of this inner person is to provide an explanation or interpretation of the outside world–for example, an inner person that is responsive to one's pain, or to visual images, or other experiences (…) the hight priority that nature has placed on dexterity in the fingers and in the control of speech muscles. These two functional areas account for almost the total half area of the motor strip! (SCHOTT, 1993, pp.332-333).



The homunculus. The image of a person is drawn across the surface of the somatosensory cortex in proportion to the number of receptors coming from that part of the body. They have a most distorted shape.

Figure 8: Homunculus, p.12[117]

[117]Neuroscience - Science of the Brain an introduction for young students. British Neuroscience Association European Dana Alliance for the Brain. Available at: https://www.uniheidelberg.de/md/izn/teaching/neuroscience/img/neuroscience-of-the-brain-english.pdf (p.12)

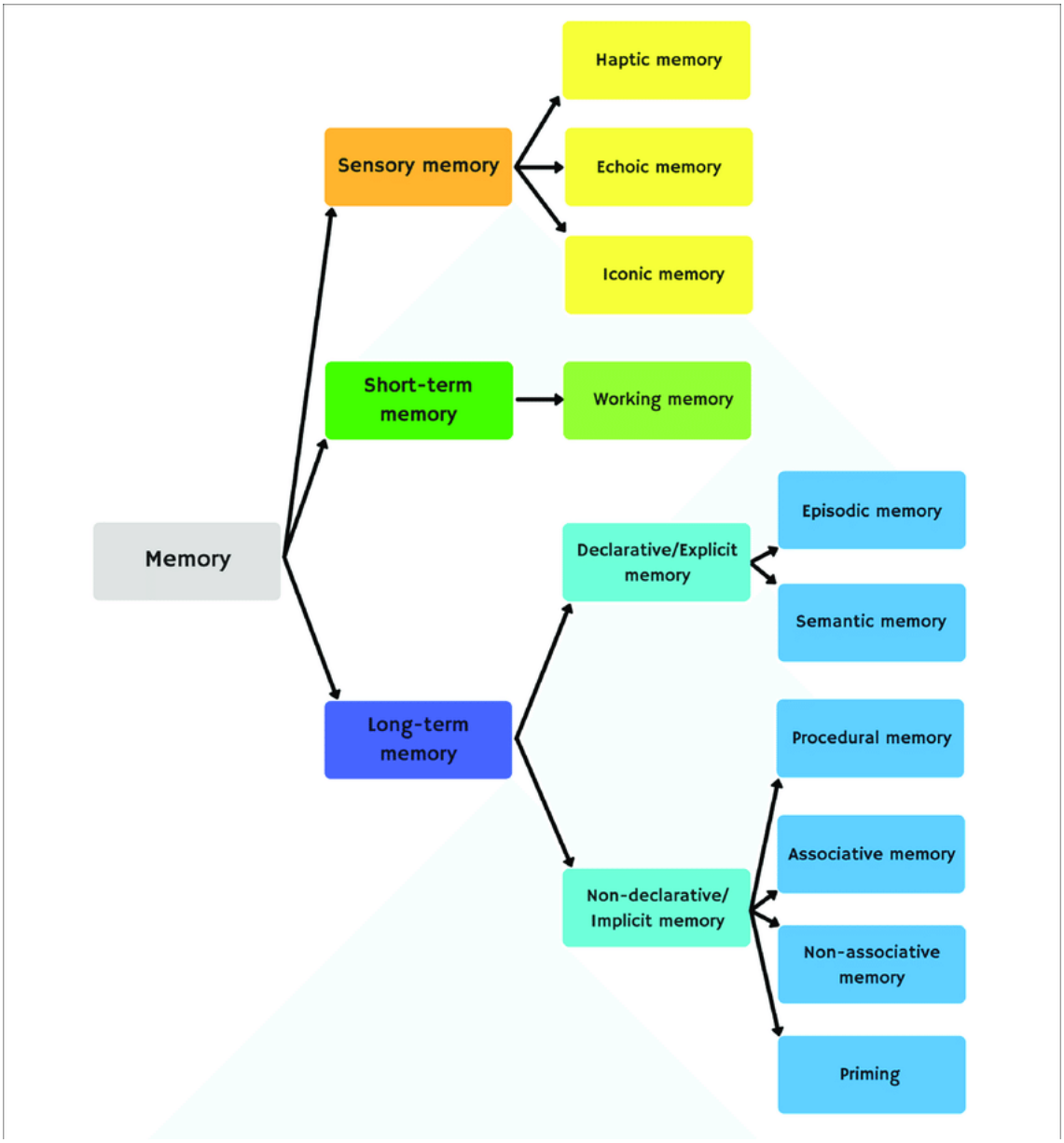


Figure 9: illustration of the organization of how memory models are classified.
Source: Guell & Camina, 2017, p.12.

By applying some concepts based on "cognitive information processing theory" and "somatosensory process system" (NICHOLAS, et al, 2019, pp.22-23), the intention is to provide an alternative explanation of how a pianist touches the keys. As an attempt to pinpoint "behind the scenes" of playing piano, i.e., the surface of the skin, and its [the skin´s] layers[118] and how the mind perceives this bodily-tactile experience as a memory. Touch, such as pressure

[118]Skin layers; Ruffini etc, and their functions, related to piano playing, "tactile/haptic" as in TWMS (tactile working memory scale) (NICHOLAS; JOHANNESSEN; NUNEN, 2019).

and vibration cause various body-tactile sensations linked to receptors in the skin which involves complex neural systems[119]. In addition, there is another area based on temperature and pain, and proprioception, as a third area, which senses the location and position of the body. The initial sensations are processed by memory-functions called the "sensory register" which depends on short-term memory (STM), working memory (WM) and long-term memory (LTM).

This somatosensory processing system thus constitutes a platform where these memory functions interact and interpret body-tactile impressions to create an understanding of how physical reality, the environment, is composed (NICHOLAS, et al, 2019, p.23).

Proprioception leads the body even if no vision ability. Thus, according to Nicholas et al (2019): "Consequently, our ability to sense touch and all the bodily sensations we feel appear to encompass several distinct sensory systems and should perhaps be considered more of a multisensory rather than a single sensory modality (Gallace & Spence, 2009)" (p.23).

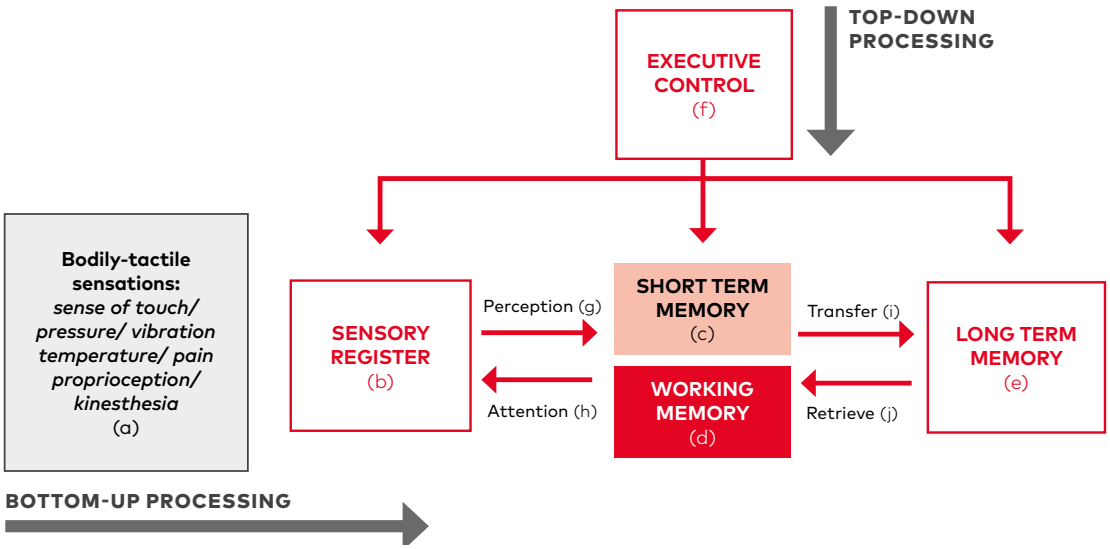


Figure 10: "how received bodily-tactile sensations can be processed in the loop of several processing units through which they pass. The processing units (a, b, c, d, e, f) and the chain of information processing (g, h, i, j) are illustrated in the figure".
Source: Nicholas, et al, 2019, p.22.

According to Nicholas et al (2019, p.23), this systematization assists and handle the reception of bodily-tactile information. How to choose among incoming (body-tactile) stimuli has been described by these authors (2019) as "tactile perception" (p.24). This implies that the interpretation done is based on former experiences related to "touch and motion". Moreover, the authors also define how: "the external environment is directly explored using the hand/body

[119]Available at:
https://www.kth.se/social/files/552f8dc0f276541752d1f347/KTH_Somatosensory_150410.pdf

in order to gather information about the surface properties (texture, hardness/softness, temperature) or the physical dimensions of objects (size, shape, weight,)" (*idem*, p.24).

A context compared to playing an instrument as piano would thus require certain levels of coordination of physical movements such as touching, pressing the keys, moving fingers, hands, arms, and touching, pressing the pedal(s) with a foot.

Tactile Perception

Normally we speak about: "sight (visual), auditory sense (hearing), smell, taste, and touch (skin sense) (Morgan, 1977, p.267)" (ÖZDAMAR, 2021, p.328), outlined as the five senses. The *sixth sense,* however, has been defined as the *kinesthetics*[120]. As closely related to *haptics* (see Chapter 3) the total sum of human sensory systems is thus identified. Even if this basic five senses still are the very core of science[121], today more than ten senses[122] have been outlined (ÖZDAMAR, 2021, p.327).

Piano playing is an activity which includes touching (keys) and moving (keys, fingers, hands, feet, body, emotion. Similarly, the concepts "tactile perception" and "haptic perception", according to Nicholas, et al, (2019) are described as: "the use of active touch and motion and refers to the sensory experience associated with use of the hands/body within active exploration (Prytherch, & McLundie, 2002)" (pp.24-25).

In daily life we use this concept. Moreover, Lederman and Klatzky (1987) found that "people use several exploratory procedures to explore and identify objects" (p.25). This procedure is "necessary for individuals" (p.25), as a way for all of us (since childhood) to find out how our environment is constituted. These senses are presented in five areas (NICHOLAS, et al, 2019): "(1) Lateral motion (rubbing/stroking action)" [of the keys at the piano], "(2) Pressure (pressing into the surface, bending or twisting)…" [the keys, the key bed], "(3) Enclosure (framing closely to the object´s surface) for encoding the global shape…" [of the keys played, holding the hands/fingers in certain formations], "(4) Contour following (following the object's surface or edges) for encoding the exact/detailed shape of the…" [keys

[120]Available at: https://link.springer.com/chapter/10.1007/978-1-4684-6760-4_17; and https://books.google.se/books/about/The_Kinesthetic_Sense.html?id=fkzoygAACAAJ&redir_esc=y

[121]"The psychologist James J Gibson regards the senses as aggressively seeking mechanisms rather than mere passive receivers. Instead of the five detached senses, Gibson categorizes the senses in five sensory systems: visual system, auditory system, the taste-smell system, the basic-orienting system and the haptic system (footnote 83). Steinerian philosophy assumes that we actually utilize no less than 12 senses (footnote 84). The eyes want to collaborate with the other senses. All the senses, including vision, can be regarded as extensions of the sense of touch-as specialisations of the skin" (PALLASMAA, 2007, pp.41-42).

[122]The Rudolf Steiner Archive. Available at: https://rsarchive.org/Lectures/19160620p01.html

surfaces and edges at the keyboard], "(5) Unsupported holding (lifting, hefting or wielding) for encoding the weight of…" [the pianist´s own hands, lifting them, in the air, calibrating positioning, jumps, etc., in relation to the keyboard and body] (NICHOLAS, et al, 2019, p.25).

In a piano perspective, this tactile/haptic memory could then act as a prerequisite for how to collect and store various (perceptions of) bodily-tactile memories. But also, to discover by active experimentation, how the keys at the keyboard act in relation to pressure, weight – and most of all, how and what the sounding outcomes might generate, as result, in a circular explorative investigation.

Especially since described as an "active learning process" (NICHOLAS, et al, 2019, p.25), which also presupposes a direct contact, relevant for a pianist, explicitly handling a physical item, keys at a keyboard. As mentioned, in piano playing the auditive dimension is also added (as the visual) which might imply the complexity among memory models and their multisensory functionalities. Thus, gradually one can identify how the use of bodily-tactile memories can develop a strategy in interpretation, as a base of experiences. Consequently, this bodily-tactile factor could motivate a piano player to accommodate these intrinsic features based on the piano playing as a physical reality:

> to systematically explore the surface textures (soft/hard, smooth/rough) (...) and the physical dimensions (size, shape, weight) of an object (tactile systematic exploration); to compare objects that are similar and contrast objects that express differences (tactile object identification); to identify the placement of an object in the immediate surrounding (tactile object location); to identify a location when moving about through an environment (tactile spatial reasoning/ spatial navigation) (NICHOLAS, et al, 2019, p.26).

Concepts as "self-generated" and "exploratory procedures" link to a piano playing perspective, where "detection", "physical dimension", "discrimination of an object (differences), and "identification of an object or a place (labelling)" (Figure 10) must be some of the utmost extremely basic parameters for all piano playing:

> This may require self-generated movements and/or exploratory procedures to tap into different tactile perceptual processes such as the detection of the physical dimensions/surface textures of an object (awareness), the matching of an object (similarities), the discrimination of an object (differences) and the identification of an object or a place (labelling) (NICHOLAS, et al, 2019, p.26).

Even aspects referred to by Nicholas et al (2019) as: "moving through an environment" "navigation", "location", "knowing which direction", "...of one´s body movements", "tactilely estimating the distance between objects [keys, positionings]", "how near or far away" (p.26), are all comparable to the challenges involved in playing the piano. Therefore, playing piano

must be in included in what Nicholas et al, 2019, describe as, the impact of training in relation to “perceptual strategies” as enhanced “cognitive functions, such as working memory (Parsons, et.al. 2014)” (p.26).

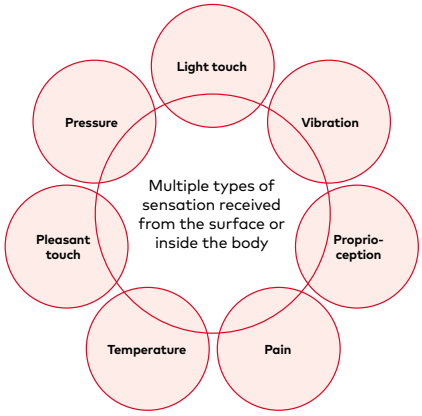


Figure 11: “The sense of touch comprises the processing of multiple types of sensation from the body”.
Source: Nicholas, et al, 2019, p.24.

“Selective attention” can be described as how to choose “task-relevant information and minimizing interference from irrelevant information” (Hasher, Lustig, & Zacks, 2008). Thus, a piano player using selective attention will imply “top-down processing” and “bottom-up-processing” (NICHOLAS et al, 2019, p.22).

Hypothetically, a pianist in control and aware of which “tools” to use aiming an “executive control” might understand the relationship of how the “sense of touch/pressure/vibration/proprioception/kinesthesia” (*idem*, p.22) stand in proportion to what can be played, and performed at the piano, i.e., the cause and consequence.

To understand how a deliberate action (playing/touching the kyes) affects the reception as reciprocal sensory stimuli could then be on par with how Nicholas et al (2019), describes as: “The initial interpretation of bodily-tactile sensations that serve as a basis for further processing is called *perception*. Perception that involves the detection, selection and categorization of bodily-tactile sensations is referred as tactile perception” (p.24).

The piano playing could thus benefit from this process of tactile memory, the somatosensory system´s sense of *touch*, if superficial or internal, in aspects of how multiple types of sensations (as pressure, light touch, vibration, proprioception etc.) could be saved, as a “tactile short-term memory-file”. But as short-term memories will not hold information more than some seconds: “Short-term memory, also referred to as short-term storage, or primary or active memory, indicates different systems of memory involved in the retention of pieces of

information for up to 30 seconds"[123], what a pianist can do is to put more focus on the procedures attended to. Then, once, an enriched mental attentiveness the tactile working memory (NICHOLAS, et al, 2019, p.27), will constitute a more secure platform, for remembering. This state has been described by Nicholas et al. (2019), as: "working memory directed attention" (p.27) where they also refer to the findings by Lepsien, Thornton, & Nobre (2011): "Attention facilitates target processing and enhances working memory. For instance, directed attention can modulate the maintenance of different kinds of information in working memory" (p.27).

The two different types of attention referred to are: "tactile focused attention" and "tactile sustained attention" (Nicholas et al, 2019, p.27) [concentrating on playing one part of the music, for longer time], implying that since working memory and attention are closely related to each other's functionalities, exchanging information. In addition, implying that their intrinsic collaboration if intensely exposed for repetition [as in piano playing: have been "rehearsed" many times] the probability for a transmission into the long-term memory increases.

Imagine a piano player, saying: "I am rehearsing, repeating the music I want to learn how to play!", but if aware about this (parallel) process within the body, based on information and data presented by Nicholas et al (2019, p.27), the pianist can instead argue as follows: "I am playing piano maintaining my cognitive strategies by repeating the tactile sensory-perceptual information, aimed to be stored in long-term memory. Thus, by enhancing this rehearsal strategy, letting long-term memory, and working memory interact, more information will also be retrieved from long-term memory to working memory".

And, if this pianist wants to have access to stored information in the long-term memory, there are certain strategies to be used, called "long-term working memory strategies". According to Nicholas et al (2019, p.27), to reach this knowledgebase in long-term-memory (LTM) presupposes strategies implying that certain "memory cues" stored in LTM can be "recalled" by working memory (WM) to be used and developed.

[123]Source: National Library of Medicine. Marco Cascella; Yasir Al Khalili. Available at: https://www.ncbi.nlm.nih.gov/books/NBK545136/

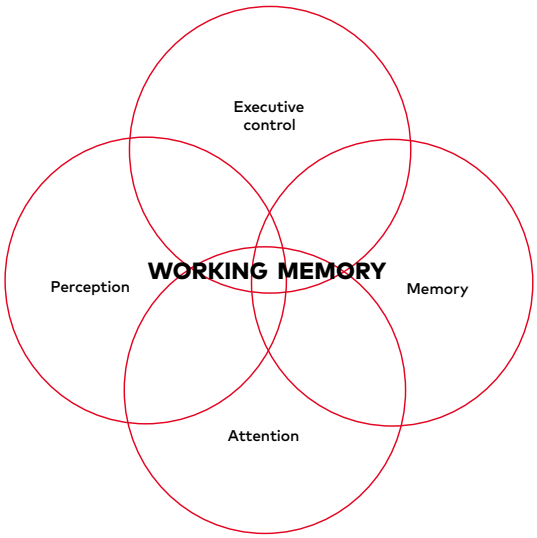


Figure 12: “a remarkable overlap between working memory and other processes of cognition”. Source: Nicholas, et al, 2019, p.30.

Snyder (2001) pinpoints the importance of how to understand “where we are” (p.xix) in the music, where the process of memory is divided into three parts: “echoic memory and early processing; short-term memory; and long-term memory” (p.xix). The long-term memory (LTM) consists of (also) unconscious (subliminal) memories which all together might be said to constitute a context for expectations (SNYDER, 2001) etc. I link this memory function to autobiographical memories, since the *feature extraction* and *procedural bindings* (Snyder, 2001), already closely in time after echoic memory, analyze and categorize all incoming sounds, relating and putting them in “boxes” to where they respectively belong.

The following images (Figures 13, 14) offer a sort of summary of the auditory memory. This hypothetic visualization demonstrates the procedure from the initial point when incoming stimuli or the echoic memories (unconscious) are processed within the brain. The figure illustrates the amount of incoming sensory input, it also shows, via the “oval” (close to the letters STM), the small extent we can perceive as “focus of conscious awareness”[124] (SNYDER, 2001, p.6).

[124]“All of the processes described in the diagram thus far are unconscious, indicated by a dot screen. At this point, some concepts become fully activated; along with current perceptions, they move into the focus of conscious awareness, represented by a small oval, and become conscious (the rest of currently semiactivated long- term memories remain part of unconscious context, as mentioned above). Like a “window of consciousness,” the oval represents the *only* point in the diagram where processing that is occurring is *completely conscious*, and thus is the only part of the diagram not covered by a screen of dots. That long-term memories may be semi-activated is indicated in the diagram by the decreasing density of the dot screen as we move upward toward the very top of the diagram; the degree of unconsciousness decreasing as we approach consciousness in the focus of conscious awareness. To repeat, a large percentage of the long-term memory in use at a given time is only semiactivated, and remains unconscious, although it has a large effect in guiding what we are conscious of—indeed, constitutes the meaning of what we are conscious of” “(SNYDER, 2001, pp.8-9).

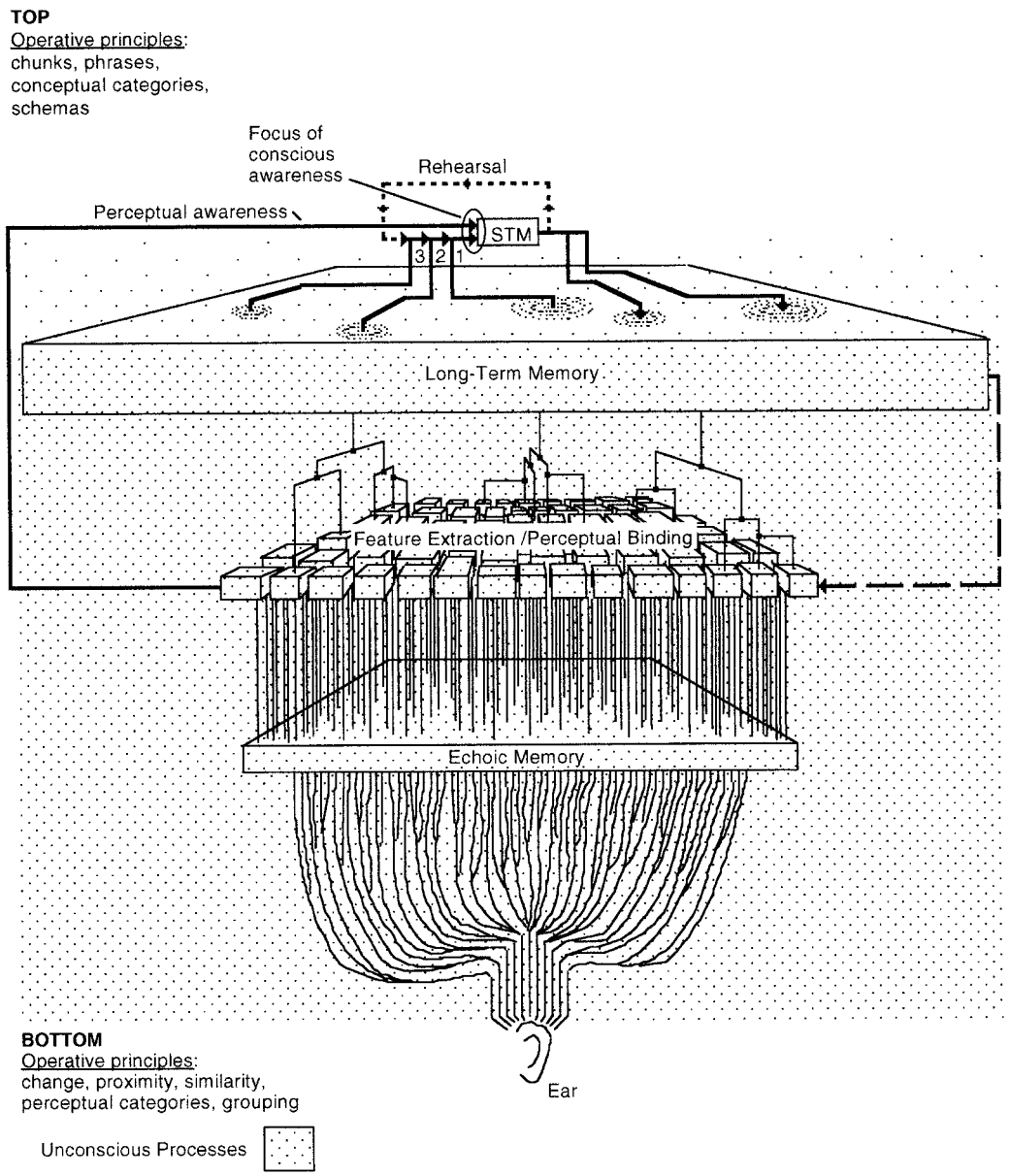


Figure 13: the process and relationship between memory forms (echoic, short-term, long-term). Based on the amount of input of echoic (sensory) memory, the "oval" within the red markers, shows how little of this that become "conscious". The fewer dots, the more conscious the process.
Source: Snyder, 2001, p.6.

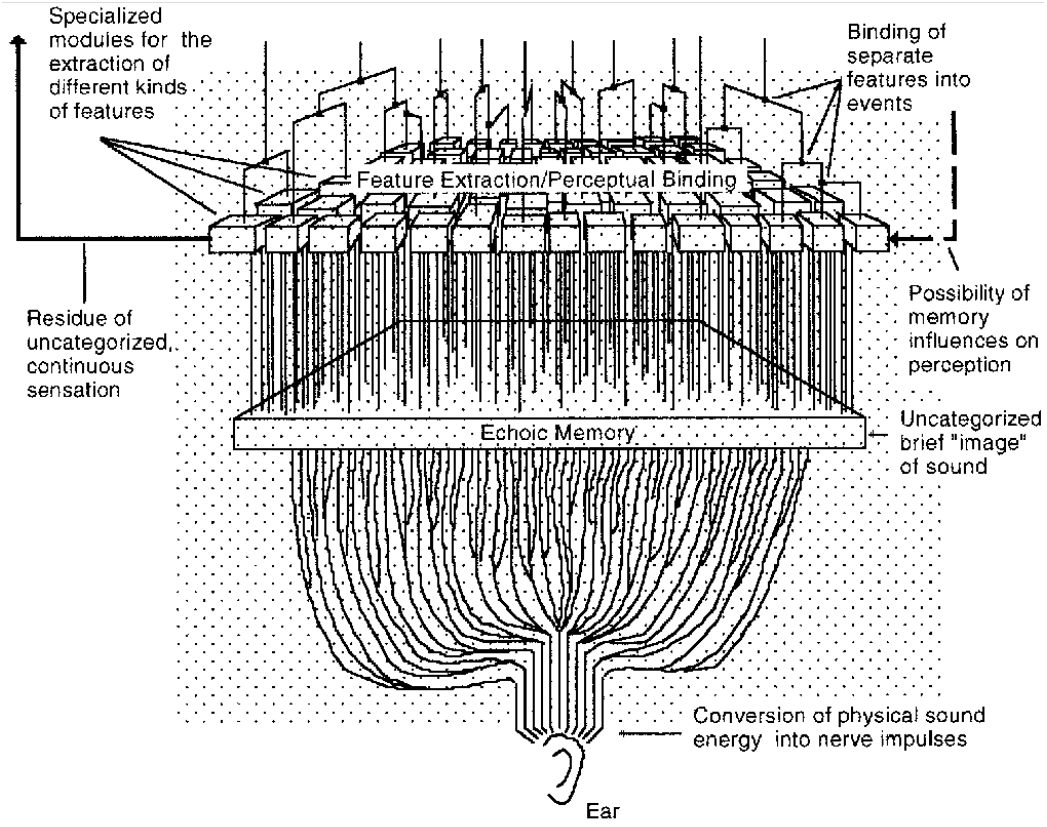


Figure 14: illustration of the vast input of echoic (sensory) memory and earlier processing. Source: Snyder, 2001, p.22.

According to Snyder (2001), the "oval" (upper part of the image) represents the only part in the memory process which can be consciously affected and deliberately altered. Firstly, this occurs by acts of concentration, a feature also highlighted by authors as of immense importance in the memorization process. Secondly, rehearsal of short-term memories can also contribute to the memorization. Each time heightened focus in combination with repetition, the better something is memorized.

If we not only *hear*, but really *listen* to certain music, the probability that also former adhesive autobiographical memories are activated causing feelings with certain equivalent sensational bearing in the body. This biological process might be a justification for *why* we consider ourselves as "liking" certain music. Certain music once heard can also have been stored in LTM as a subliminal memory.

What is Memorization

The start of this investigation was initiated based on a historical paper “The Memorizing of Piano Music for Performance” (SHINN, 1898), one of the first of its kind. Considering its question: “When a pianist plays from memory, by what powers of memory does he remember that which he plays?” (p. 2), it is interesting to see to what extent the functions of memory among pianists already by then provoked interest.

The piano performance involves, at least, four different types of memories, described by Shinn (1898) as “belonging respectively to the ear, the fingers, the eye, and the intellect employed more or less continuously throughout the progress of a piece” (p.1). This understanding later turned out to be acknowledged as a valid categorization (HUGHES, 1913; FRIEDRICH, 1950; BRYANT, 1986).

Today´s memory forms can still be comprised in the four that came first, even if their systematization related to music performance have been updated into: “multiple memory systems” consisting of “auditory memory”, “motor memory”, “visual memory”, “emotional memory”, “structural memory”, “linguistic memory”, “content-addressable memory” (CHAFFIN; LOGAN; BEGOSH, 2009, pp.352-363).

Furthermore, based on findings by Chaffin & Imreh (1997, 2002) and Williamon & Valentine (2002), Iorio et al (2022, p.239) suggested following division of memorization in six steps: 1. auditory memory, 2. motor memory, 3. visual memory, 4. emotional memory, 5. linguistic memory, and 6. narrative/structural memory.

Comparing these six concepts and applying Shinn's (1898, p.1) four-part format: “belonging respectively to ...”, and then adding, as he did, the names of each sense, would result in a definition of memorization according to the following: 1. ear, 2. finger, 3. eye, and 4. emotion, verbalization, intellect, i.e., as a combination between cognition and feeling.

Without a rigorous investigation on what has been said, written, or investigated in the area memorization from the era of Aristoteles until today, we can conclude that the functions of memory, some thousand years, engaging philosophers, and psychologists (see Aristotle[125], dated 350 B.C.). Although, Shinn (1898) highlighted the absence of literature on this subject.

But what also caught my interest was another article in the area, written hundred and twenty-three years later, concluding: “Although some music teachers explicitly provide music

[125]“Memory is, therefore, neither Perception nor Conception, but a state or affection of one of these, conditioned by lapse of time. As already observed, there is no such thing as memory of the present while present, for the present is object only of perception, and the future, of expectation, but the object of memory is the past” (BEARE, J.I. On memory and reminiscence Aristotle (ca.350 b.c.).

memorization techniques (Leimer & Gieseking, 1998; MacMillan, 2005), the discovery of such techniques may be left to students (Hays, 2002)" (IORIO et al., 2022, p.232). According to their findings:

> it seems that the MP [mental practice] and PP [practical practice] combination, relying on the abstract reasoning and the motor program memory, increases the learning and thus the memorization of the musical piece better than PP only. Although few music teachers have already recognized and proposed the effectiveness of MP and used it in their teaching method (Leimer & Gieseking, 1998), MP techniques are not usually explicitly taught in the music education domain (Clark & Williamon, 2011; Ginsborg, 2017; Hays, 2002) (IORIO et al, 2022, p.240).

This made me reflect, what did possibly go wrong regarding the implementation of memorization techniques in music education history. If Shinn already 1898 very explicitly described and defined "the intellect", in a manner seemingly like "mental practice", how come, according to Iorio et al (2022), this type of memory is not adopted and thoroughly implemented today?

Was memorization in the past different than today´s teaching practices? Was it something related to the functions of the instrument itself, or functions of the human body, fingers, arms, feet, audition, vision, motor, kinesthetically or intellectually, analytical, or overall mental state, or other features? These question does not necessarily need to be investigated further, humans have not changed in body and soul since 1898. Although, slightly mechanical functions in the piano-technical aspects have changed since the beginning of the 20th century, these changings were not to the extent to radically transform all the pianistic-idiomatic features. According to Iorio et al (2022): "music learning and memorization rely on different memory systems, including abstract reasoning about the musical piece and the motor programs required to play the piece" (p.239), already pinpointed by Shinn (1898).

Once starting to investigate the topic I analyzed texts by authors such as Venable (1913), Matthay (1913), Hughes (1915), Winslow (1949), Friedrich (1950), Rubin-Rabson (1950), Ross (1964), Laske (1977), Nuki (1984), Bryant (1986). As their collected findings relate to their professions as performing pianists, "true educationalists" (Matthay, 1913), and researchers, the mixture of empirical and theoretical material unfolded a profound richness.

As Shinn (1898), I soon became "filled with wonder at the power of memory…increases by use…The more you learn, the more you will be able to learn; I have found that in my own experience" (p. 18). Indirectly a kind of (empirical?) proof, although based on an older source, a historical testimony, that using memory, to memorize, improves learning and knowledge.

The authors explicitly suggest examples and exercises, pinpointing how to use and work with what Iorio et al (2022) defined as MP (mental practice), and in wordings such as "being

able to *say* the notes, or at least to bring up a very distinct mental picture of them" (HUGHES, 2015, p.597). Other aspects were highlighted, such as "concentration…*conscious* thought…conscious knowledge…study of the printed page away from the piano… must *know*…not simply *remember*" (HUGHES, 1915, pp.596-601).

Specifically of interest was the gradual unfolding features of how functions related to memory were described in relation to senses. Due to Shinn (1898), the memory forms were equated to the senses as if both were activated in a double-action-process. Thus, the senses (visual, aural, motor, intellect) could be presented as active and inevitable if aiming a well-structured, organized, and elaborated memorization process.

Even though, still in 1950, Rubin-Rabson (1950) criticized "pedagogical and musicological speculation" as "largely arm-chair theorizing" and lacked "critical and scientific attention [regarding] music hearing, thinking, learning" (p.22). She claimed that: a "Method" implies the organization and incorporation of known principles to construct an efficient procedure" (p.22), which she therefore developed during more than a decade, covering areas as: "the motor, kinaesthetic, temporal, spatial, aural, visual, intellectual, melodic, and harmonic" (p.45).

Moreover, developed findings: "the schemata of memory are mental images, both visual and auditory" (LASKE, 1977), brought further aspects related to senses and memory. To define one´s "mental images", how they appear for each individual pianist might even though differ.

Like how Neuhaus (1993) tried to simplify and reveal the secrets of piano playing, Dorothy Bryant (1986) wanted to change the view of memorization: "a mystery to most performing musicians and music educators" (p.1), as opposed to inaccessible. Instead, she wanted to find a solution with her research[126] which was successful: "The most notable result was that a lecture on human/music memory resulted in faster memorization" (BRYANT, 1986, preface, n.p.). The idea was based on "information-processing-theory of memory and the four components of music memory (analytical, auditory, visual, and motor)" (BRYANT, 1986, preface, n.p.).

Gradually, research involving memory have formally exploded, due to names such as Chaffin, Williamon, Ginsborg, Mishra and Snyder, among others, resulting in a big bibliographic library for the interested. In addition, the concept *mental imagery* expands, exemplified in the book "Music and Mental Imagery" (KÜSSNER, TARUFFI & FLORIDOU,

[126]Dorothy Bryant´s (1986) research resulted in: The Effect of Special Memory Instruction and Guided Analysis on the Memorization Efficiency of College Brass Players (BRYANT, 1986).

2022) which ought to even impact and have bearing on “MP (mental practice)” (IORIO et al, 2022).

How to Memorize

When the purpose is to memorize music, it is normally meant a conscious and deliberate act. But it also happens automatically, as a “natural course and develop spontaneously” (FONTE, et al, 2022, p.12). First, one must consider that the motor memory is adapted to quickly learn new movements. We can just refer to daily tasks, such as cooking, dishing, sewing, or even learn new dance steps. We seldom reflect over how each movement is executed.

To play piano is the same. If we learn how to press the fingers in a certain order, on a specific key, it is simply a physical movement which the body and muscles will remember: “I simply worked on it until I knew it” or “I practiced it so much that, when I attempted to play it from memory, it simply played by itself” (RUBIN-RABSON, 1950, p.23). However, until the regrettable moment, when we start to think too much, and perhaps even question what we did this simple task becomes complex, as stated by some authors: “Unfortunately, thinking about a skilled movement is a sure way to disrupt it, a phenomenon known in sports as “choking” (Beilock and Carr, 2001)” (LISBOA, CHAFFIN & DEMOS, 2015, p.2). Rubin-Rabson (1950), one of the pioneers in the field of memorization, describes this as a black-out. It can suddenly occur, not knowing at all “where” one is in the music, despite a built-up muscular automaticity. The only solution is to start playing from the beginning. Even if having passed hundreds of times playing the notes, and: “at the end of that time, only the most shadowy mental images of those symbols when they have been physically removed” (RUBIN-RABSON, 1950, p.23).

That is a reason for using a focused visualization: “our eyes must run over its various outlines again and again, until the rapidly gained memory of these details thus enables us to form a conception of the Whole” (MATTHAY, 1913, p.58).

Therefore, Rubin-Rabson (1950, p.45) developed a “method for memorizing” in six steps. All relate to an obligatory initial pre-study of the material –before the playing begins:

1) to decide a positioning and goal from the very beginning that the purpose is memorization. [Fonte et al (2022, p.7) describe a similar approach, as goal setting: “today I will learn this page”]

2) once the music has been analyzed and the memorization work begun, each practice session regards specifically memorization – not just aimless “practice”

3) the sheet music is only there to (when needed) aid memory – no playing from sheet music at all (waste of time)
4) mental practice should be applied specifically to technically complicated sections, which should then be practiced – without score. [Similar to findings by Iorio et al (2022), and Fonte et al (2022, p.9): “It is a really strong form of memory, actually, because you are not distracted by technical difficulties or actually putting the right notes down (...) as I would see it when I teach somebody”]
5) singing the music while memorizing is considered to simplify the process, not least learning the melody [as Chopin also pointed out! (EIGELDINGER, 1996)].
6) the more intensive mental training is applied, the more clearly a clear, inner, mental “mind map” is built [as Shinn (1898) pinpointed, see: Figure 15].

The prerequisites for success (and feeling confident, “really knowing”) are related to how much concentration, persistence and commitment are put in, to get an overall overview of how the building blocks of music are connected, e.g. the relationship between different chords etc. (RUBIN-RABSON, 1950). [Her strategies also coincide with Fridell (2009, p.208): “the theories make us free in a way”.]

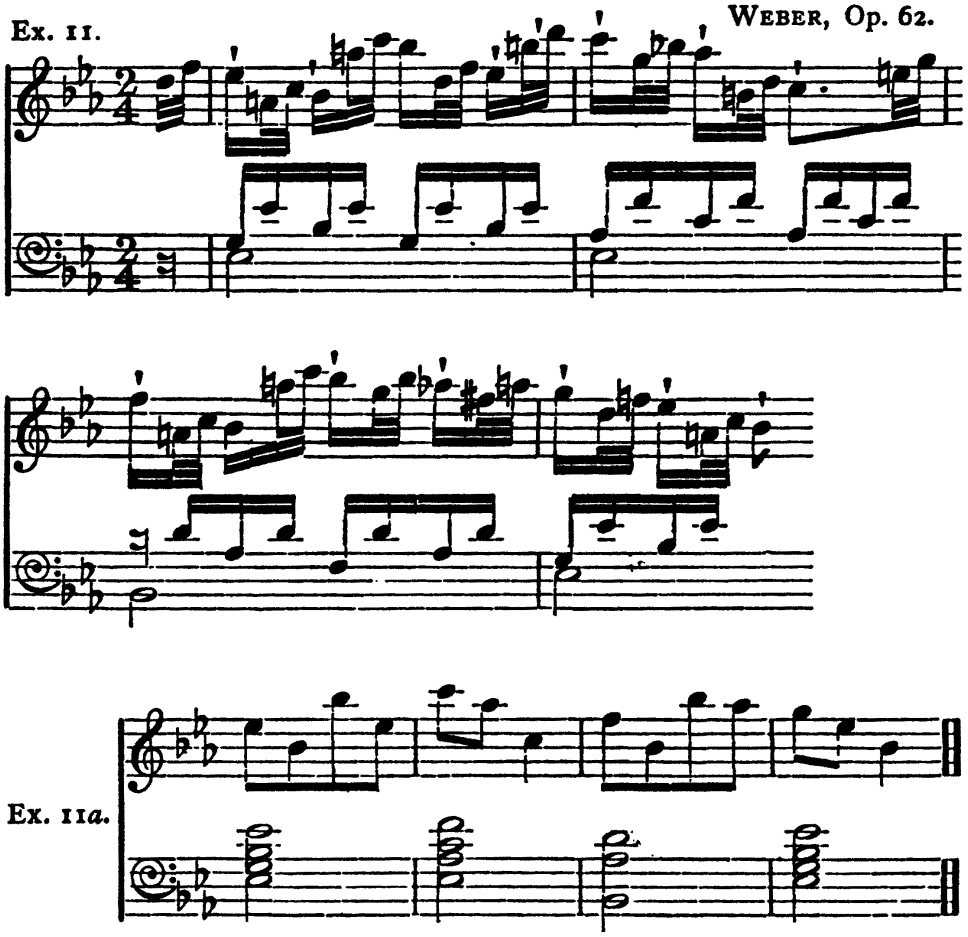


Figure 15: the use of "Intellectual Memory", making a reduction – similar [brain] "chunking". This overview clarifies "*theoretical* aspects of music". Simultaneously, it is demonstrated how the increased security, based on the foundation, can affect the focus and design of other notes.
Source: Shinn, 1898, p.15.

Example 10. Menuet from the *Notebook for Anna Magdalena Bach* with Reductions.

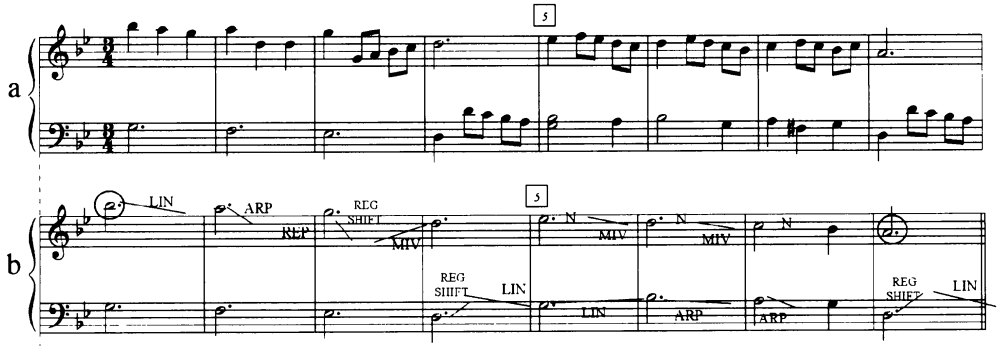


Figure 16: chunking as melodic reduction: a) structural overview, b) less material to remember, c) linear gestures, d) relieves vision in favor of inner hearing (interpretation of melody, choosing: "pitches, rhythms, articulations, expressive indications, dynamics, phrasing, pedaling, interpretation".
Source: Dickinson, 2009, p.278.

The case study from Lisboa, Chaffin, and Demos (2015) will provide some examples of *how* to memorize. They describe a piano student, 18 years old, playing: "Der Dichter Spricht" (The Poet Speaks) from R. Schumann's Kinderszenen Op.15. The piece is scored in 25 bars, so the total number of beats is 114 (see: LISBOA, CHAFFIN & DEMOS, 2015, p.3). Only this first seemingly simple insight is significant for the construction of an inner "map".

The process was organized into three phases: "Memorization (Lessons 1–4), developing interpretation (Lesson 5), and polishing (Lesson 6)" (*idem*, p.6). They also took into considerations some concepts previously defined, that showed to be consisting with: "safety net (…) mental map (…) keep track (…) landmarks (…) restart … (CHAFFIN et al., 2002, p.1).

Even if having the ability to play by heart, from the top going to the end of a piece, the risk is a memory lapse during a performance causing a break. Therefore, in opposition to this automaticity, the authors adopted the concept of "deliberate memorization" (LISBOA, CHAFFIN & DEMOS, 2015, p.2) defined as: "reflection and self-monitoring involved in reporting PCs, at least for experienced performers" (p.2).

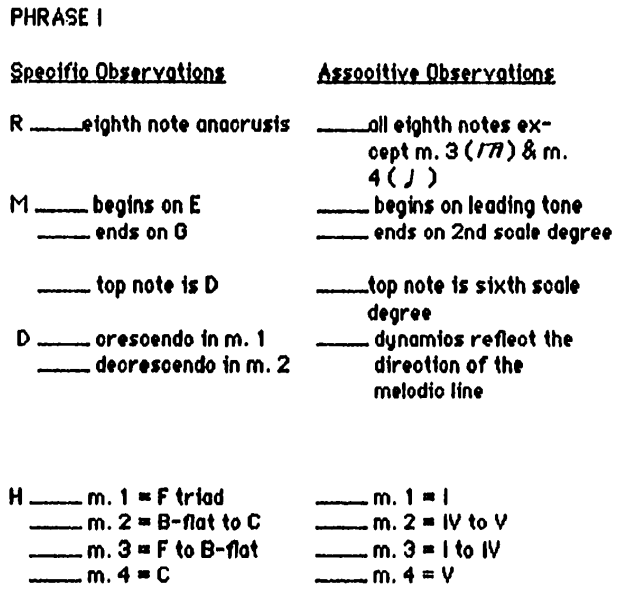
"PCs" in this context stands for "performance cues", that means, "what the performer thinks during a performance: "with feeling," "sing," "softer," "repeated note" (LISBOA, CHAFFIN & DEMOS, 2015, p.2). But since it might feel easier (and fun!) just (mechanically) relying on the motor memory, continue to "play", enjoying the music, than to dedicate time and effort to interrupt oneself, deliberately stopping the "flow": "even highly experienced musicians find reporting PCs burdensome" (LISBOA, CHAFFIN & DEMOS, 2015, p.2). The memorizing strategy based on how to use "cues", was also shown by BRYANT (1986), referred to as pinpointing certain musical features. In her "Memory lecture" (p.53-55) the idea was to detect, distinguish and identify these specific musical parts, thus investigating how this procedure could beneficiate the process of memorization.

Unlike other memorization techniques that often distinguish the theoretical analysis as a separate process from the playing, the concept of Bryant (1986) appears to be specific insofar as the thinking (i.e., here: talking out loud) occurs *simultaneously* with the playing process, as a "verbal protocol" (Ericsson et al, 1993 apud CHARNESS, 2021, p.131).

Bryant´s (1986) research is based on checklists for analysis, "to record thinking aloud", and protocols for how to play: "action protocol"[127] (p.82). The format is divided between

[127]"Thinking-aloud protocols are documentations of verbally mediated thought as it occurs during a problem solving session. Action protocols document the actions taken by a problem solver" (Laske, 1977, p.20 apud BRYANT, 1986, p.44).

"specific observations" and "associative observations" with subcategories as: form (F), rhythm (R), melody (M), dynamics (D), and harmony (H) (BRYANT, 1986),


PHRASE I

Specific Observations	Associative Observations
R ____eighth note anacrusis	____all eighth notes except m. 3 (𝅗𝅥) & m. 4 (♩)
M ____ begins on E	____ begins on leading tone
____ ends on G	____ ends on 2nd scale degree
____ top note is D	____top note is sixth scale degree
D ____ crescendo in m. 1	____ dynamics reflect the
____ decrescendo in m. 2	direction of the melodic line
H ____ m. 1 = F triad	____ m. 1 = I
____ m. 2 = B-flat to C	____ m. 2 = IV to V
____ m. 3 = F to B-flat	____ m. 3 = I to IV
____ m. 4 = C	____ m. 4 = V

Figure 17: one of Bryant´s (1986, p.85) proposals for checklists, here with subcategories rhythm (R), melody (M), dynamics (D), and harmony (H).

with notes listed on "rhythm (…) melody (…) form (…) overt responses (…) specific observations and associative observations on form, rhythm, melody and dynamics" (BRYANT, 1986, p.82). In addition, following discriminating concepts were used: "similar to, different from, sounds like (…) leading tone, phrase", which Bryant (1986) categorized as "associative observations and specific observations" (p.82). These factors and features, technical and musical variables, and elements, belonging to a category of former familiarity, as: "the phrase starts on E which is the leading tone" (BRYANT, 1986, p.82).

Bryant's (1986) proposed methodology [of ingenious simplicity] involves a discovery of concepts such as similarities and differences. This clarifies the musical structure. But the "differentiation task" also stimulates "the ear, the fingers, the eye, and the intellect" (SHINN, 1898, p.1). The concept therefore also appeals to beginners and can be applied not least for different functional variations to apply and test the result as a practical performance exercise, regardless of which sense is used. Seeking to understand and sort out, as a kind of discrepancy in interpretation.

Bryant (1986) implements ideas from Laske's (1977) "information theory process". By constructing musical blocks, applicable as practical empirical guidance, "verbal protocols"

(Ericsson et al, 1993) are used as companions and guides for one's own thinking (CHARNESS, 2021, p.131). Thus, theoretical aspects are used, built in, as a strategic tool to shape performance.

The inherent interpretive multisensory and multimodal abilities of the senses: audition, touch, sight, thus constitute a synesthetic tool for comparing and defining similarities and differences. Here is an example of twelve-tone music in four measures:

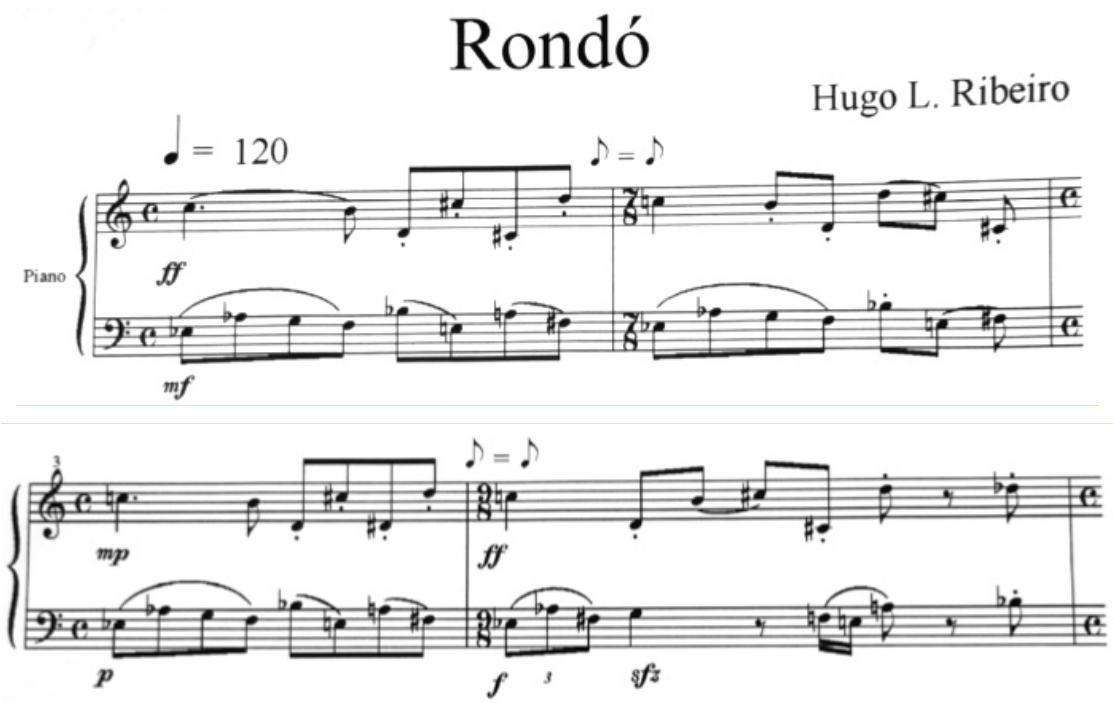


Figure 18: starting to build a mind map of Hugo Ribeiro´s "Rondó".

Look, and think: what do the thumb play in the right hand, first bar? "– D1 and C#1 on the 1st, 2nd, 4th bar, in 3rd bar, D and D#. Repeat saying, meanwhile going to a piano. Repeat saying, play, listen, look, feel, explore each sense, using focus, attention, and rehearsal.

A. Bryant's (1986, p.82) "similar to" + "different from" (focusing on *rhythm* and *meter/form*) is applied in the twelve-tone music (Figure 18). By using "thinking aloud" as a "verbal protocol" (talking to oneself) the results show: "– 4/4 in 1st and 3rd bar, 2nd 7/8, and 4th, 9/8"; "1st bar, R.H. (right hand), is identical to 3rd bar (R.H.)"; "– The 2nd and 4th bar, R.H. have identical rhythms until 7/8, where the 4th bar adds an 8th rest, and an 8th note (i.e., a quarter)": "– 1st and 3rd bar, L.H. (left hand) are identical, constituted by eight 8th tones"; "– The 2nd bar, L.H. is similar (the first four 8th notes), but then changes, since "a" is omitted"; "– The 4th bar stands out: L.H. starts with a triplet, quarter note, break, and sixteenth notes, etcetera".

B. Bryant's (1986, p.82) example “similar to” + “different from” (focusing on *melody*/*melodic material, articulation*): “– It can be stated that 1st to 4th bar, R.H. consist of in total 4 different tones: B, C, C#/Db, D”; “– As affirmed, 1st and 3rd bar R.H. are identical regarding rhythm but differs in the melodic material: in the 3rd bar´s 7th note. And, an articulation bow, in 1st bar”; “–The 3rd bar R.H. is slightly changed with a D switching place with C#”; “– In the 2nd bar we note 4/4 in 1st and 3rd bar, 2nd 7/8, and 4th, 9/8”.

C. Bryant's (1986, p.82) example "different from" (focusing on *“melody”)*: “– The difference between 2nd and 4th bar, R.H., is the order of tones”; “– 2nd bar, L.H. is identical to 1st and 3rd bars (L.H.) – until 6/8 but differs since (a) is omitted and replaced with the note (f#) – thus only seven 8th tones (7/8). The 4th bar, L.H. is marked differently”.

The other category she used was “specific observations” (p.82) such as: “the phrase starts on E” (p.82) which referred to items of no former familiarity. This means to apply critical “thinking” as an activity belonging to the rehearsal. This can offer a stable “safety net”. When practiced this way, the performer avoids the risk of “choking” so disturbing the “automaticity” intrinsic to play merely guided by motor memory.

As described, “choking” is due to the disruption of the automatic motor sequences created by thinking while playing. The act of thinking can become a substantial obstacle when it is not planned. Therefore, it can be overcome by practicing exactly what the performer will think while playing.

Bricard and Woods (1978) listed analytical and intellectual memory as constituted by complexity where “thoughtful” memory (p.105) might be of importance to remember. To use one´s own “thinking” might sound simple and logic, needed if in a memory loss, (BRICARD & WOODS, 1978, p. 105) but concrete and objective ideas of actions not often described.

Pianists with experiences about memory failure usually create and develop strategies aiming “safety nets” to avoid this scenario. By constructing an inner mental map for the music piece with all constituting musical parts included (held by memory) these types of incidents might be resolved when playing on stage (LISBOA, SHAFFIN & DEMOS, 2015).

According to Lisboa, Chaffin, and Demos (2015) in total four studies have rendered positive impact on the ability to remember and perform the music by heart, by the use and processing of PCs (performance cues). The functions of PCs have been defined as forming internal spots “providing a mental address” (p.12).

This in turn relates to Ericsson and Kintsch (1995) outlining: “Content addresses require the material to be organized in some way” (LISBOA, CHAFFIN & DEMOS, 2015, p.12).

As shown, a dedicated, deliberate structure aiming organization of musical material consequently increases understanding of the "whole" and the constituent parts. This is caused because memorizing assists the ability to transfer musical material into long-term memory.

Once the case study had finished (LISBOA, CHAFFIN & DEMOS, 2015) and having passed the applied strategy, the ability to perform the music by heart was acquired in no more than two months. This was due to the progress consisting of continuously "reports" shared among the involved.

During this process, the authors reported the use of typical key terms such as: "slowing at ends of phrases (…) using some dynamic contrasts (…) focusing on hand position (…) individual note and note sequences (…) switches (places where repetition of the same musical material invited confusion) (…) thoughts about expression (e.g., feeling, singing) (…) phrasing (…) dynamics and expression (…) starting softly (…) growing louder (…) breathe (…) *'first time'* (…) *'second time'* " (LISBOA, CHAFFIN & DEMOS, 2015, p.6). As seen, those parts are normally used in any performance or music education field, related to a teaching, and learning context. These expressions are referred to as the vocabulary of the teacher instructing the student.

"For example, at bar 7, beat 2, Maria reported thoughts about dynamics and hand position (Report 2), dynamics and pedal (Report 4), pedal (Report 6), and dynamics (Reports 7 and 8), and No Thoughts (Reports 1, 3, and 5)" (LISBOA, CHAFFIN & DEMOS, 2015, p.8).

> Fourth, Maria's thoughts about interpretation during her final performance served as retrieval cues when she came to reconstruct the piece from memory 9½ weeks later. This conclusion supports a central claim of PC-theory that PCs function as retrieval cues. Thoughts during performance not only direct attention to aspects of performance that need to be monitored, they also elicit memories for the upcoming passage from long-term storage (LISBOA, CHAFFIN & DEMOS, 2015, p.11).

"Pianists rely on their muscles, eyes, ear, and mind in varying proportions as they play (kinesthetic, visual, aural, cognitive modes). If one of these is consistently neglected in favor of another, its role in playing naturally diminishes over time" (STREET, 1987, p.32).

Why Memorizing

If we want to remember things we must memorize, otherwise we easily forget. A reminder, that to recall some things, others must be forgotten, not put into focused awareness. This feature of human memory is shown in the following image (Figure 19):

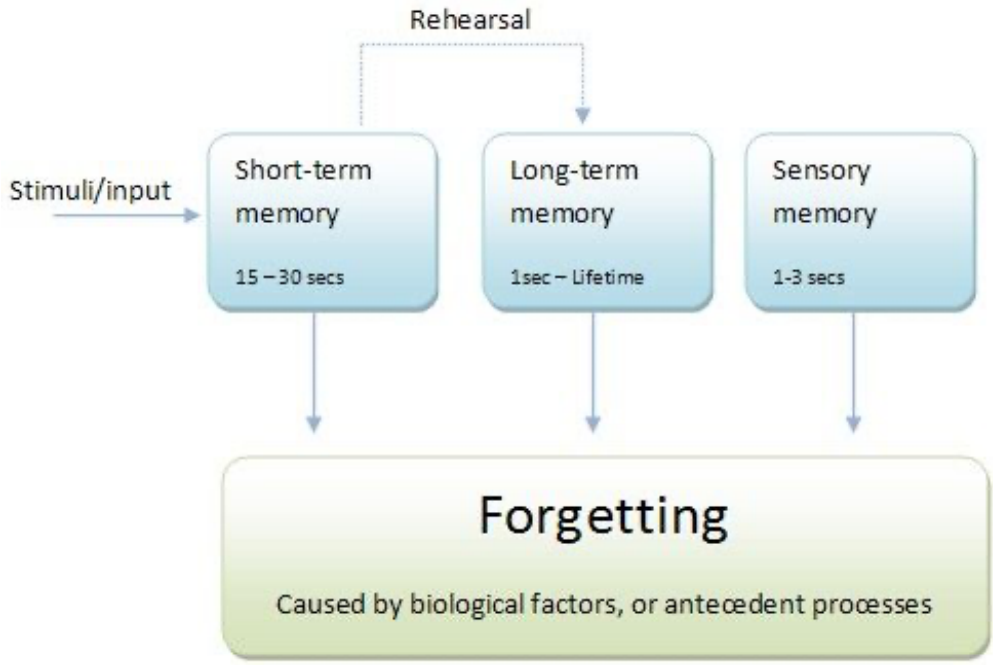


Figure 19: what causes forgetting? Unconsciously we "choose" sensory memories, selected ones are processed by STM, if attended and/or repeated, STM, turn into LTM.
Source: https://www.interaction-design.org/literature/topics/human-memory
Author/Copyright holder: JSpudeman. Copyright terms and licence: Public Domain.

Are there aspects in a memorized performance that really "improve" the interpretation of the performance? In general, the answer is quite natural, as always, when we try to do things "by heart", to remember a poem, or a speech. Why do we have this habit, wanting to "memorize" at all? There must be some hidden reasons, based on relevant scientific findings, more than just "cultural features" or "social norms."

Again, to refer to the "by heart" concept, the visceral sense (close to the heart), playing and interpreting must imply something like Clyne´s "mind body windows" (1990, p.35), discussion about "the motor system of a good performer". According to him, the main condition ["of a good performer"] was related to: "*freedom* to move in any manner required by the musical meaning, the emotional quality of every phrase not just the technical requirements" (CLYNES, 1990, p.35). Does this suggest that creativity comes from the freedom to move and that musical decisions are made from there? Clynes suggested that:

> freedom does not tell you what to do but allows you to move creatively, as the inner thought requires. In some ways this is rather similar to the Zen Buddhist tradition of emptying your mind. You empty your mind-body. Then you can shape it freely and naturally, and effortlessly (CLYNES, 1990, p.35).

Is this a state that comes naturally when having memorized music? And if so, it must imply that already in the memorization phase this transition will occur?

Memorization is a process aiming to play *by heart.* In a neuroscientific context, as above mentioned, it is part in the sensory system; proprioceptors, exteroceptors and *interoceptors,* deriving from Sherrington, who created these terms in 1906 (ÖZDAMAR, 2021, p.330). Our *heart* is included as inner organ in the visceral system, related to interoceptors. Searching for the meaning of the word *visceral*, sources[128] tell that it in 1570´s meant "affecting inward feelings". The Latin *viscera* related to "inner parts of the body", partly a seat of emotion. Another explanation describes visceral as "characterized by intuition or instinct rather than intellect"[129], or as: "When something's *visceral*, you feel it in your guts. A *visceral* feeling is intuitive"[130], or "obtained through intuition rather than from reasoning or observation"[131].

Here we detect an interesting point of view, in relation to what most prominent authors refer to, concerning the *will*, and aspects of *consciousness* and *concentration.*

Since stated that the long-term memory (LTM) (see Chap.2) stores musical memories (otherwise we would not be able to recall songs from our inner, or neither recognize music as already known), this would explain why beginners do not inherit as many musical phrases "heard", to be duplicated in new interpretations, at least as used parts of musical decisions. On the same time, it is stated that musicality is inherent in all human beings, as a universal language (HODGES, 2019), witnessing there are no specific part on the brain demonstrating "musicality" and people on a cinema can understand the meaning in the music (*idem*).

But the challenges are to guide a beginner with no inner guidance, to open this inborn musicality. It is also difficult for a score reader to get rid of the notes, to trust the ears and body, without having the order visualized as external guide. As well as difficult for a player to rely mostly on eye muscles (and functions behind) in reading music.

Music students when compared to athletes ought to have similar classes related to the good use of muscles. Programming of neuromuscular patterns aiming controlling and coordination of finger muscular actions, usually presented as *technique*, requires a highly developed cognitive process. Finger memory does not only address the physiology of the fingers and the hand. In relation to the rest of the body, the auditive and visual input as well as intellectual and emotional, results in consequences or possibilities of modification where the hands and fingers need fine caliber adjustment (BRICARD &WOODS, 1978).

[128]Source: Online Etymology Dictionary. Available at: https://www.etymonline.com/word/visceral
[129]Source: The Free Dictionary. Available at: https://www.thefreedictionary.com/visceral+receptors
[130]Source: Vocabulary.com. Available at: https://www.vocabulary.com/dictionary/visceral
[131]Source: Vocabulary.com. Available at: https://www.vocabulary.com/dictionary/visceral

Based on Shinn's (1898) writing, on the power of memory, it might be translated to a mental state of knowledge related to a) the auditive functions, to select among the musical sounds heard, having the ability to distinguish subtle musical structures and in addition recreate them later when needed. According to Shinn (1898) this requires b) an inner platform, as "some definite and well recognized basis" (SHINN, 1898, p.4) where the sounds can be understood, and interpreted.

It is also about the vision, the ability of the eyes to interpret and scan a music score, to know how to read music, and to understand the content behind the lines. When reading Shinn's (1898) explanation, which explicitly describes the presence of something internal, like a stable knowledge, it is inevitable not to associate the formulation with the storage of memories, although in Shinn's time the concept of *long-term memory* did not exist.

In addition, there are interesting synergistic effects, as this internal platform proposed by Shinn (1898), that could form the basis for further interpretations, based on what is already stored, and to compare it with new, incoming stimuli, which have not yet been "stored" as "stable knowledge".

However, according to Ren & Brown (2023): "people continue to learn and update their memory of music syntax through their experiences, which in turn can facilitate new music encoding and analysis of the hierarchical structure of a novel piece of music" (n.p.).

Another interesting perspective in relation to Shinn´s claim "something like internal knowledge" refer to as "the older evolutionary structures that are closely tied to feeling" (FELDENKRAIS, 1990, p.52).

When thus using the memory, processing music, trying to consolidate, to remember the full music, a process related to the long-term memory arises. The purpose with this is to establish an inner platform, as Shinn describes, where the material is ordered and collected, with an ability to address whenever needed.

Also, my current teaching taught me how to work more consciously with "focus", with all the senses, as a method, but also targeting each (of the sense functions) in different types of conscious constructions to explore. I just invented it myself, so demonstrating that, as soon as we learn something new, our brain can summarize and extract new ideas or models, as Bryant´s research (1986) showed: a guided memorization including lectures on memorization and enlightenment about the impact of the senses, just as such, increased the students´ ability to memorize, about how using, or how they think they use their senses.

When Memorizing

Memorization deals with layering and differentiation in music (likewise interpretation), highlighting certain melodies, the development of rhythms, keeping of certain sounds in the background[132]. A similar equivalent description is the "perspective" in painting when certain shapes, lines and colors appear more clearly than others, as "vanishing points to points of view"[133], or, as Cooke (2008) describes it: "You might even fantasize about music being mixed in the same way as paint" (p.1187).

Levels of attention[134], "to pay attention"[135], how to focus on something specific, imply that other stimuli stay in the background[136], a possible prerequisite for how perception of memory and the progress of how to commit to one´s memory interact on certain strategies.

According to Altenmüller and Schneider (2008), one of the main investigations related to how to handle these, "obstacles" related to "practising" was accomplished by Ericsson *et al*., a concept called "deliberate practice" (ALTENMÜLLER & SCHNEIDER, 2008, p.333). Their [Ericsson *et* al.] idea involved how to develop: "goal oriented, structured and effortful facets of practice in which motivation, resources and attention determine the amount and quality of practice undertaken" (ALTENMÜLLER & SCHNEIDER, 2008, p.333).

Other authors (FRIEDRICH, 1950; VENABLE, 1913; MATTHAY, 1913; BRYANT, 1986) emphasize the importance of *focus* and its similarities in name: concentration, attention, awareness, consciousness, etc. In addition, the next level related to these variables of having *focus* is exploring, approaching the upcoming data, observing and analyzing them, as above, a *verb* similar to activated *sense.*

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[132]"Mindfulness is present centred awareness. It is simply a practical way to notice thoughts, physical sensations, sights, sounds, and smells - anything one might not normally notice. Although most people knowingly experience mindfulness for very brief periods only, it can be developed with practice (Mace, 2007)" (SINHA et al, 2013, p.107).

[133]Source: Tate. Student Rescource. Perspective Coursework Guide. Available at: https://www.tate.org.uk/art/student-resource/exam-help/perspective

[134]"Attention is a cognitive system essential for many forms of learning, as well as for regulating one's thought, emotions, and actions" (SINHA et al, 2013, p.107).

[135]"Cognitive processes emerge through senses, thoughts, and experiences. The first step is aroused by paying attention, it allows processing of the information given. Cognitive processing cannot occur without learning, they work hand in hand to fully grasp the information". Available at: https://en.wikipedia.org/wiki/Information_processing_theory

[136]"Schenker recognized there are multiple levels in hierarchically. He identified three main levels:
• The foreground includes the musical surface, connections.
• The middleground reduces out chords of lesser structural importance. Performers think in terms of middleground connections when they play or sing "through a phrase" or "to a goal."
• The background is an important, more abstract level, guiding the overall coherence of a piece" (DICKINSON, 2009, p.272).

Cultivating the mind, as a method of memorizing, using the "powers" of memory as Shinn (1898, p.3) puts it, shows dedication, focus and attention. But how does it relate to the more explicit vocabulary-related concept of mindfulness?

Schuman-Olivier et al, (2020) show how memory also links to Buddhist thought:

> In 1881, the English scholar Rhys Davids translated the word *mindfulness* from the Pali word *sati* found in Buddhist texts, which meant "memory, recollection, calling-to-mind, being-aware-of, certain specified facts" but which has also been described as "lucid awareness" or "bare attention (p.371).

By actively steering one´s focus (for example: seeing (looking) at specific structures, patterns, forms, graphs) can result in, as Snyder describes (2001) audition, diverse levels of *attention* (focus, concentration). Knowledge that over a hundred years ago was described like this:

> there is nothing more fatal for our musical sense, than to allow ourselves—by the hour—to hear musical sounds without really listening to them; and this holds true whether the sounds are made by ourselves or by others; for unless we do listen attentively, we are at that moment inevitably forming habits of lax attention (MATTHAY, 1913, p.5).

Since humans need senses for most types of actions, these indications also gradually develop among the authors. Whether one chooses to "see" or "to look", "hear" or "listen", "touch" or "sensate", it can now be described in neuroscience as: "attention facilitates target processing and enhances working memory" (NICHOLAS et al, 2019, p.26). As such, the subject memorization can be used as a didactic tool aimed at increasing awareness in music education.

Regardless of what is being performed, all senses are alert, and active (in relation to functionality). In the case of sensory functional variations, there is the likelihood of other senses wanting to expand, "take over the scene", as already mentioned by Shinn (1898): "the Blind, that ten out of twelve pupils there have a sense of absolute pitch, and they have remarkable memories" (SHINN, 1898, p.23).

Similarly, a deepened focus on listening to oneself, resulted in piano students clearly improving their technique: "the balance of different parts, speed, rhythmic accuracy"[137] (KRIVENSKI, 2018, p.105). Thus, when memorizing, Shinn (1898), points out each sense as

[137]"And that's the, that can be- it can affect technique, because when they're not listening to the way they balance things or the speed they're playing at or they're not paying attention to the rhythm or god knows how many other things erm that erm that actually affects both their, their fluency and their perception of where they are technically. Erm and I think, you know, rhythm and listening are as big a part of technique as, as sort of virtuosity or fluency, whatever you want to call it. (Alan, instrumental tutor)" (KRIVENSKI, 2018, p.106).

a form of memory, indicating the interconnectedness of the senses, which he exemplifies with visual impairment: “they see through their fingers. Surely that is visual; it is not what we call sight, but it is feeling, which is their sight” (SHINN, 1898, pp.19-20).

So, the type of memorization we have decoded here, refers to an increased awareness during the process itself, by observing, a certain form of *focus*[138] (not just the verb, to *actively* do): “It facilitates the self-regulation of attention through an orientation to experience” (SINHA et al, 2013, p.107). This alignment of attention towards mindfulness, according to Posner and Petersen (1990), constructed by: “the three subsystems of alerting, orienting, and conflict monitoring” (SINHA et al, 2013, p.107), addresses the senses as crucial interacting stakeholders.

[138]“the main or central point of something, especially of attention or interest”. Available at: https://dictionary.cambridge.org/dictionary/english/focus

Chapter 3: ON SENSES

Is it not telling that senses and memories are interconnected merely by the name: "sensory memories"? This is perhaps one of the reasons why Shinn (1898) uses the word "power" of memory, knowing that "memories" affects us internally and consequently must impact our interpretative choices. We could therefore ask, in line with both ideas, sensory and power, is this the reason why we "close our eyes" when we need to focus or want to "feel" something?

In the book, *The Little Prince*, Antoine de Saint-Exupéry writes: "It is with the heart that one sees rightly; what is essential is invisible to the eye", a saying also expressed as: "seeing is believing, but touching is understanding" (LUNDBORG, 2014, p.vii). But if we understand[139] with our heart[140], then the expression "by heart" suddenly makes sense.

Since thousands of years, mankind has been fascinated by the senses. Both regarding their functions and how they have affected people´s lives. Not least, different senses have been discussed and debated for an equal length of time, where even their mutual value have been re-debated, as if some senses would have had a more prominent importance and were more noble than others (CHMIELECKI, 2021; PALLASMAA, 2007). According to Chmielecki (2021), the increased ocularcentrism during Middle Ages resulted in that: "the *Old Testament* was changed in the first centuries of Christianity, within the metaphoricity of language, from the Hebrew "hearing" to the Greek "sight" (p.969). Perhaps, even the biblical *fiat lux* (Let there be Light) was "Let there be Sound", or even "Let there be Touch", would be more precise?

> Wouldn't we say that nature has us, by the mechanism of the touch device, particularly predestined to make these minute distinctions? Why shouldn't we seek to use this ability to discern, through the transformations of visual representations that touch suggests to us, these tiny differences so important in art? For no method of measuring, even the most artistic, can reach the finesse of that offered by the tactile device[141] (JAËLL, 1897, pp.27-28).

Sometimes, when we want to remember something, or concentrate ourselves, we close our eyes. Does it sound familiar? As if we this way, I believe, we can reach our internal

[139] Laura Sanders, Science News, 2024: "We have forgotten that interactions with the internal world are probably as important as interactions with the external world," says cognitive neuroscientist Catherine Tallon-Baudry of École Normale Supérieure in Paris". Available at: https://www.sciencenews.org/article/heart-brain-mental-health

[140]"The heart is the most powerful source of electromagnetic energy in the human body, producing the largest rhythmic electromagnetic field of any of the body's organs. The heart's electrical field is about 60 times greater in amplitude than the electrical activity generated by the brain". Available at: https://www.neuropsychotherapist.com/guide-to-the-brain-brain-body-connections/

[141]In the original:"Ne dirait-on pas que la nature nous a, par le mécanisme de l'appareil tactile, particulièrement prédestinés à faire ces distinctions infimes? Pourquoi ne chercherions-nous pas à utiliser celte aptitude à discerner, par les transfor- mations des représentations visuelles que le toucher nous suggère, ces différences minuscules si importantes dans l'art?"

memories easier, finding the specific "folder" with details for that event we were just about to describe. Perhaps it is not a deliberate act at all, but more an instinct we follow, without a planned thought process. If so, does it assist us finding the memory we searched for, why, and how does this occur?

Do we react the same way, if we try to remember the music piece we want to play? Can we find it closing our eyes, in there, in our brain somewhere, in a stored "music-folder", to be opened whenever we wish, just telling us what, and exactly how, to play that specific song? If so, does it matter if we initially learnt the music by ear, listening, playing along with fellow musicians, a kind of imitation, or if the first comprehension was made, based on studying a music score?

Despite this clinical concept, this occurs in daily based experiences as "natural" function. As described in architecture, "The Eyes of the Skin" (Pallasmaa, 2007): "the significance of the tactile sense for our experience and understanding of the world" in which he addresses: "the dominant sense of vision and the suppressed sense modality of touch" (p.10).

According to Pallasmaa, the anthropologist Ashley Montagu defines the skin as: "the oldest and the most sensitive of our organs, our first medium of communication, and our most efficient protector" (PALLASMAA, 2007, p.11). Pallasmaa (2007) continues by referring to Montagu, claiming this initial haptic prerequisite as impacting all our senses: "Touch is the parent of our eyes, ears, nose (…) the mother of the senses" (PALLASMAA, 2007, p.11). Therefore, what additional ways can define the relations between memory, memorization and interpretation when aiming at a performance, and what will the literature show, in accordance with how Pallasmaa (2007) defines "touch":

> Touch is the sensory mood that integrates our experience of the world with that of ourselves (…) My body remembers who I am and where I am located in the world (…) as the very locus of reference, memory, imagination and integration (…) The sense of self, strengthened by art (…) allows us to engage fully in the mental dimensions if dream, imagination and desire" (p.11).

Thus, one can start with philosophical discussions related to the changed worldview, from being "a primordial dominance of hearing"[142] (PALLASMAA, 2007, p.24), into ocular

[142]"In Lucien Febvre's view: 'The sixteenth century did not see first: it heard and smelled, it sniffed the air and caught sounds. (…) only later that it seriously and actively became engaged in geometry, focusing attention on the world of forms with Kepler (1571-1630) and Desargues of Lyon (1593-1662) (…) Robert Mandrou makes a parallel argument: 'The hierarchy [of the senses] was not the same [as in the twentieth century] because the eye, which rules today, found itself in third place, behind hearing and touch, and far after them. The eye that organises, classifies and orders was not the favoured organ of a time that preferred

centrism, where Pallasmaa (2007) refers to the book "Orality & Literacy", in which Walter J Ong (1991) analyses[143]: " 'the shift from the primordial oral culture to the culture of the written (…) has caused on human consciousness, memory and understanding of space" (p.24)[144].

According to Pallasmaa (2007), Ong (1991) claims this development as causing "'an insistent world of cold, non-human facts'" (PALLASMAA, 2007, p.24). But, as Pallasmaa (2007) states, it is through poetry we can find "the center of an interior world" (p.25), in which music thus implies: "Artistic expression is engaged with pre-verbal meanings of the world, meanings that are incorporated and lived rather than simply intellectually understood" (PALLASMAA, 2007, p.25). This is similar to Snowdon et al (2015), describing how neuroendocrine functions, as well as human physiology and cognition, are affected by emotional stimuli, such as music: "Mithen (2005) has suggested this social cohesion function of music for our prehistoric ancestors" (SNOWDON; ZIMMERMAN; ALTENMÜLLER, 2015, p.19).

Perhaps, as Ashley Montagu, claiming[145] '"We in the Western world are beginning to discover our neglected senses", and continues: "the painful deprivation of sensory experiences we have suffered in our technologized world'" (PALLASMAA, 2007, p.37).

However, a thrilling challenge, that perhaps each one, somehow, is always expecting for something to happen. Most of us perhaps want to be or to feel moved. This might be a reason for we go to the movies, read books, and listen to music. Probably, the now well-known dopamine, or oxytocin, claimed as having arousal effects when listening to music.

If the brain always wants to interpret (BUSZAKI, 2006), as an evolutionary outcome in relation to an expansion of the senses (multi-sensory), competing about the extension of space in the brain, and/or working together (multi-modality), this activity could also be explained from without an explicit neuroscientific aspect.

All senses are touch, in some respects. Even though "tactile approach has long been neglected in academic circles" (REYBROUCK, 2024, p.37), it seems now as if areas of

hearing'" (PALLASMAA, 2007, p.25).

[143]"37. Walter J Ong, Orality & Literacy – The Tecnologizing of the World, Routledge (London and New York), 1991" (PALLASMAA, 2007, p.75).

[144] "In my view, poetry has the capacity of bringing us momentarily back to the oral and enveloping world. The re-oralised word of poetry brings us back to the centre of an interior world (...) the task of art (...) is to reconstruct the experience of an undifferentiated interior world, in which we are not mere spectators, but to which we inseparably belong" (PALLASMAA, 2007, p.25).

[145]"73. Montagu, p XIII" (PALLASMAA, 2007, p.77).

psychology and physiology start to show further interest related to tactual sensation (REYBROUCK, 2024).

In line with these findings, piano playing is also included in the body´s different sensory systems which covers specifically differentiated systems. The function of the senses is related to external stimuli, as input, but even if the process appears to be external, what we experience happens inside the body. Therefore, senses also relate to internal stimuli equivalent functions where the signals arise from inside the own body in some ways created.

To talk about touch might seem obvious, since the fingers´ touch on the keyboard constitute the main sense in playing piano. And even the absence of vision does not prevent us of playing and interpreting music.

Not only the "touch" is a touch. Even the audition and vision are a physical touch[146], even if the immediate impression is far-fetched[147]. This topic is developed by Reybrouck (2024) discussing how music as a "soothing" touch can offer similar comforting care as the examples he brings with kangaroo and baby, the close mother child skin to skin contact[148].

This imply that we also are touched when playing and performing. Thus, the interesting issue is how music with its touching quality can function in an identical manner, and how different types of touch (musically speaking) can affect the pianist.

If music will be remembered, and even memorized, i.e., will enter the long-term memory which goes deeper into a person's mind, the touches ought to be even deeper enhanced. If a memorization process consciously done includes aspects related to all senses, it should imply a larger amount of former stored memories activated. This must mean that an increased part of the self will participate in the (sounding) result.

[146]"When airwaves touch the ear, we call the effects "hearing" or "sound," and the disseminated, expansive operation of touch makes it more pervasive than the other senses and structurally supportive of them. The shaky ground of empirical assertion and power becomes even less firm under foot when we understand that sound is touch. The division of the sensorium into distant and proximate categories (distant: sight, hearing, and smell; proximate: touch and taste), becomes difficult to maintain once sound's absolute dependence on touch becomes manifest. Such a concept has ramifications for notions of distant and proximate sensory knowledge, the place of the self in the empirical and sensorial world, and the way we parse perception (...) what is thus rendered proximate or inscribed as distant all become increasingly difficult to discern with the simple observation that hearing is touch. But once we make this observation, we can safely say, also, that music is touch, and it is the gift of tele-touch (or telehaptics) that we encounter with any musical performance" (BISHOP, 2011, p.27).

[147]"Thus at its source, touch operates with and causes sound, and it is only through touch-at-a-distance that we have sound at all" (BISHOP, 2011, p.26).

[148]"There is a strong identity between the skin and the sensation of home. The experience of home is Essentially and experience of warmth (...) Home and skin turn into a single sensation (...) touch is the sense of nearness, intimacy and affection" (PALLASMAA, 1996, p.45).

Since a pianist´s hand and fingers are a prerequisite for making music and form the center of the action, the essential starting point is "touch", wherefore, the next phase will be to investigate touch of senses; touch, seeing, hearing.

In general, we mainly talk about "sound" as significative for music even if the unavoidable denominator in piano playing is the touch. Areas of physical contact that we can see concerns explicitly the fingers and feet in touch with the pedal. The ear can hear due to a "touch" contact with the sound waves (BISHOP, 2011), a physical touch on the inner ear. Also, the eyes (or its equivalent braille) need a "touch" to "see". These functions happen bio-mechanically.

These three sensory functions are parts of a music interpretation, all of them referred to as "touch"[149]. Touch, feeling, sensing, is described as tactile, motor, kinesthetics or haptic; hearing or listening are described as audition, auditive, aural, or echoic; and seeing or looking are called vision, visual or iconic.

Not only in piano but related to all instruments, including vocal folds, there is always a starting point related to a "touch". It is due to our hands and fingers that the piano keys can be played. Therefore, the human body, its senses and especially our hands (with their evolutionary based[150] inherent creative disposition and abilities), requires further explanation in this investigation.

Our inborn touch immerses from and develops based on our individual experiences and personalities. It is like our fingerprints, all individual and no one like another. We can use the sense of touch and thus expanding our sensation and learn about the world by evaluating all types and qualities of sounds, material, and views. We must not forget to continue our investigations regarding what we are already equipped with the utmost astonishing sensory systems ever created – the hand.

In the past, hands were described as "'the outer brain' (…) 'an extension of the human brain', a link between body and soul' (…) 'a proof of God´s existence' (…) 'the instrument of instruments'[151] (LUNDBORG, 2014, p.51). Findings that still might contribute to the contextualization of the proposed research.

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[149]Available at: https://www.nytimes.com/1964/03/15/archives/we-have-more-than-five-senses-most people-take-the-faculties-of.html

[150]About the "fish", from water, to land 375 million years ago. Available at: https://www.scientificamerican.com/article/how-a-380-million-year-old-fish-gave-us-fingers/

[151]"The human hand has always fascinated poets, philosophers and artists. René Descartes (1596–1650) called the hand 'the outer brain', and Immanuel Kant (1724–1804) regarded the hand as 'an extension of the human brain', a link between body and soul (Fig. 6.1). Isaac Newton felt that the thumb was 'a proof of God's existence'. For Aristotle the hand was 'the instrument of instruments', a universal tool that can have several functions and can perform a variety of tasks" (LUNDBORG, 2014, p.51).

In line with how Bryant´s (1986) lecture on human memory and the including senses resulted in an enhanced ability to memorize merely by mentioning the processes. So, it will be hypothesized that a similar "lecture" of the human senses brings increased knowledge of impact for a pedagogical, methodological, and didactic approach regarding interpretation and memorization.

Like the sense of touch, that develops since birth (WILSON, 1999; LUNDBORG; 2014), the sense of touch also undergoes a procedure inevitable for a musical development. The sense of touch in piano playing can be described as an instrument aimed at interpreting sounds. The more highlighted their sensibility, the better their susceptibility and receptiveness regarding their function handling the keys.

If a pianist undergoes an aware process of elaborated memorizing techniques based on consciously STM repetition, gradually transformed into LTM, the chunking process in the brain will release "memory weight" and the freedom of (the interpreter´s) hands will increase. Therefore, a systematization within the brain "chunks" what is familiar. If memories are stored as suggested (HUGHES, 1915; BRYANT, 1986; LISBOA et al 2015) the musical material can easily be recalled, retrieved and reperformed[152].

What needs to be considered while playing piano is that the structure of the keys is identical regarding the superficial physical structure. All difference is regarding the distinctions between the white and black keys. The latter are a bit higher and thinner in relation to the lower, flatter, and broader white ones. This is important because of the inborn explorative features of hands and fingers.

Even if the hands, its fingers, and fingertips are equipped with three layers of skin[153] each one with a specific area of expertise regarding pressure, grasping, drag, etc., there is hardly any need of exploring eventual differences in the texture of the keys since the surface is the same. Even if the pianist is continuously occupied with how to weight and calibrate the keys in a vertical manner (simultaneously with the ongoing horizonal movements, i.e., jumps, positionings, etc.) the main response regarding downward as upgoing movements (VENABLE, 1913) is also transformed into an auditive touch.

[152]"Consolidation: the process by which an initial memory trace stabilizes and becomes available for long-term retrieval. Reconsolidation: the process by which an existing memory trace restabilizes after having become labile. Matching: the process by which a preexisting neural state becomes associated with a novel circumstance or action" (BUZSÁKI, MCKENZIE, DAVACHI, 2022, p.189).

[153]"after the anatomists who first described them, Meissner corpuscles, Merkel cell neurite complexes, Pacinian corpuscles, and Ruffini endings". Available at: https://www.centropiaggio.unipi.it/sites/default/files/course/material/touch.pdf

Piano playing is a complex cross modal process in-between the senses. One example is how the touch of the hand more than the hearing alone can identify a certain piano from another (GOEBL; BRESIN; FUJINAGA; 2014). The hand and the fingers can also learn how to discriminate and choose among all possible layers (Figure 20) between “Top of key” and “Keybed” (IBES, 2010, n.p.):

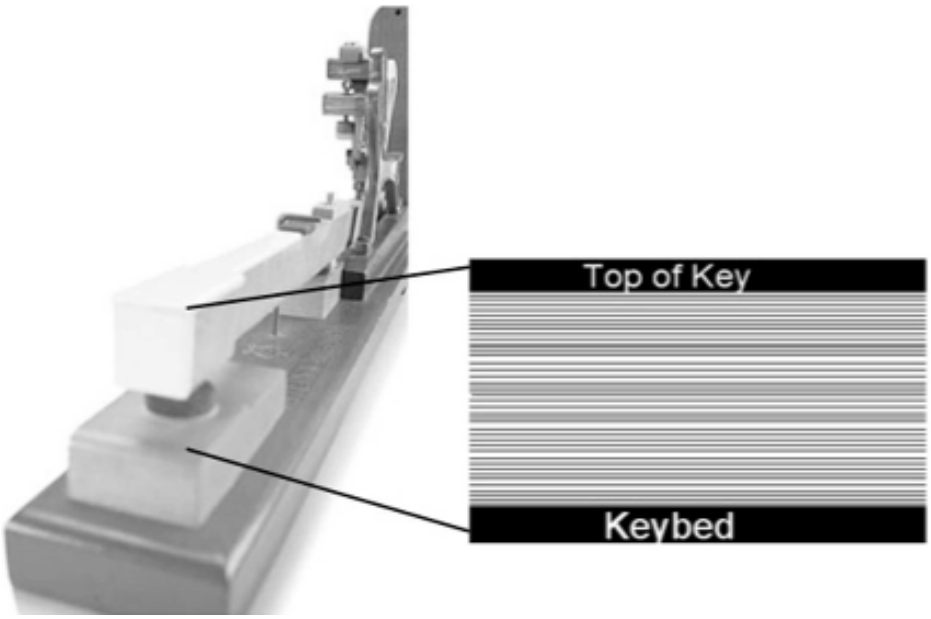


Figure 20: motor skills and auditory feedback connected as multisensory multimodality. The layers highlight what a human ear can perceive (and reproduce) as the multi-creation of touch. A demonstration of the pianist's ability to generate multiple expressions through “touch”.
Source: Ibes, 2010, n.p.

Ibes (2010) figure illustrates the (most common) external, “possible-to-see” aspect of playing piano, based on the perspective to press a key. Even though, it is not often these layers are similarly illustrated. Even music interpretation is dependent on this physical action which results in a hearable sound, impossible to see. This ability to adjust (tactile) pressure and make gradations of movements is affected by and depends on the sense of proprioceptive abilities (HO, 2019).

Another external aspect and perhaps the most common, if not merely aural transmission, is those signs in written: “indications which range from pp, seldom ppp, or pppp to f, ff, and more seldom fff, very seldom ffff” (NEUHAUS, 1993, p.58). Since these signs are still in use one might think they are enough when interpreting the music, but once compared to Ibes (2010) figure, the interpretable “grey zone” is vast. Clynes (1983) expression “Music is infinitely more subtle than can be notated in a musical score is known to every musician” (p.78), defines exactly

this unspecified “vacuum”. The issue is how close we can get to the real source, the very genesis in ourselves which decides over how to fill this gap. To what extent do our senses contribute and how come can we delineate cause, happening and consequence.

To compare all layers possible between the “Top of Key” and “Keybed” (IBES, 2010, n.p.) with a limited gradation using letters, p to f, x 4, the image (Figure 20) clarifies better the choices the pianist as decision-maker must deal with. But perhaps, fewer choices enhance the creativity better since the production of sounds must be somewhere there in-between. Thus, it is up to the interpreter to solve, or confront, this task based on the individual´s methodological tools to fill these dynamical gaps. In line with suggested ideas of what is an interpreter, some meaning based on one´s own experience, as memories (see: O´KEANE, 2021), ought to be at hand when and how applying the senses.

The ability to hear the tone before it is played (LEIMER & GIESEKING, 1972; GORDON, 2011; FLEISHER, 2015) is an often-highlighted feature, if not also a requirement in certain levels of performing, teaching, and learning. This is not always an easy task, neither for a beginner nor among professionals. Anyone can easily disregard or forget to consider the instruments´ inherent nuances possible. Also, if in combination with a lack of intentionality, as described by Kratus (1991), a possible result of this is that the one´s self´s sensibility towards the own senses are at risk to be neglected. Therefore, another methodological proposal is the use of digits as an alternative tool to visually describe (Figure 21) the pianist´s touch in the keyboard[154] (DICHLER, 1990). Figure 21 illustrates Josef Dichler's proposition, which imagined a gradation of 100 possible intensities. Thus, 1 is the softest and 100 the loudest possible way to press the key. In the example, the numbers indicate exactly these nuances of touches involved in Beethoven's Sonata Op. 13.

[154]In original: “Zu diesem Zweck denken wir uns eine Unterteilung aller Lautstärkengrade von 1 bis 100. Stärke 1 wäre also die kleinste praktisch verwertbare Endgeschwindigkeit des Hammers, 100 die größte, oder anders ausgedrückt: 1 ist der leiseste musikalisch brauchbare Ton, 100 der lauteste” (DICHLER, 1990, p.37).

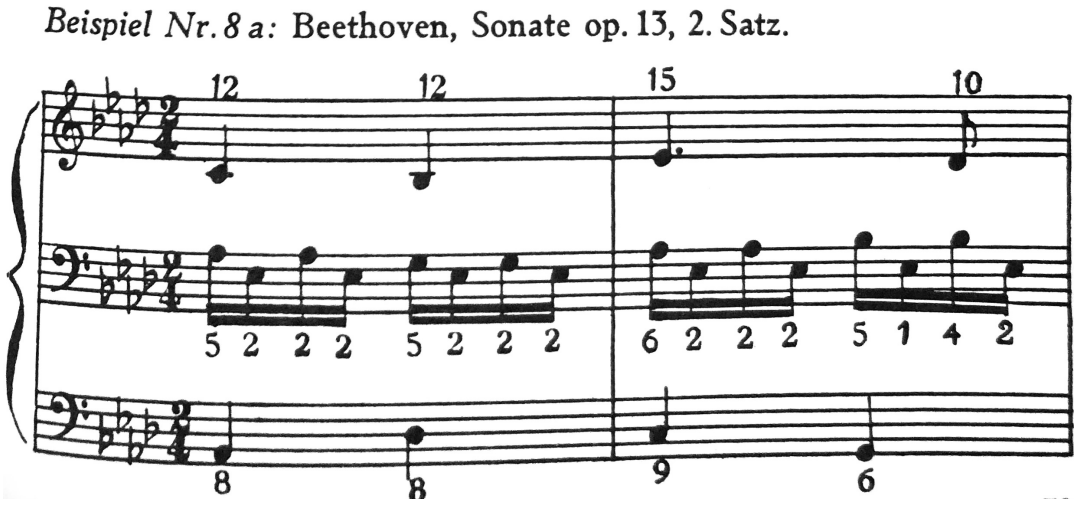


Figure 21: Dichler's (1990, p.39) proposal for intensity grading. A methodological model based on "numbers" in the calculation of dynamics. The approach enables varied interpretive experimental approaches via interchangeable numbers related to touch.

The three above mentioned suggestions regarding intensity of touch could be thought as: 1) "imagine a thousand thin layers between the top of key and the key bed, layers which we first compress downward and then feel pushing up against our finger" (IBES, 2010, n.p.), 2) the ordinary concept: p – f, and 3) applying a dynamic scale, grading dynamics p-f as 1-100, can be described verbally. This might imply that the performer and teacher, (implying students) in a talkable manner can discuss various interpretative standpoint views on how to use the senses as a didactical tool.

By watching the Figures 20 and 21, and the letters designating dynamics (p, mf, f, etc.), the sense of sight can be associated with verbalization to raise thoughts about alternative interpretative choices. This procedure can also enhance a practical hands-on (tactile) understanding of how to apply an experimental approach with musical phrases, melodies, and harmonies, where the outcomes can be developed innumerably in relation to the hearing.

Those variants can be used externally by doing, i.e., touching, hearing, seeing but also create an imaginary platform to pretend how certain variables can be combined during the interpretation. Like memorization, is also relevant to stress the importance of "attention" as a factor of keeping track and not lose focus. In the same way, the concept of mindfulness[155] was

[155]"*Mindfulness* is commonly defined as the awareness that arises when paying attention to the present moment nonjudgmentally" (Kabat-Zinn J. *Full catastrophe living: using the wisdom of your body and mind to face stress, pain and illness,* 1990, apud SCHUMAN-OLIVIER et al, 2020). Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7647439/

suggested to “develop our ability to remain present to the sound that is and not be distracted by what is to come” (IBES, 2010, n.p.). Ibes (2010) exemplifies this idea by emphasizing the touch “when the finger moves up vertically to leave the key” (IBES, 2010, n.p; see also, Venable, 1913).

Touch is of utmost concern for all performers. Either a violinist developing a vibrato or a singer calibrating the oscillations of the vocal fold, “without that mastery of touch, music loses much of its meaning” (IBES, 2010, n.p.). In line with this, Ibes (2010) characterizes the piano as consisting of a horizonal and vertical axis claiming the focus mostly to be based upon the horizonal aspects defined as: “the accuracy, the dynamics, the speed to get from one sound to another” (IBES, 2010, n.p.). Like Fleisher (2015, p.175) questioned: “How are we going to produce this irresistible sense of movement and direction horizontally by a totally vertical activity? You put little keys up and down; they don’t go sideways, they go up and down, exactly 3/16th of an inch. That’s our challenge” (p.175).

But what really matters for the pianists is to identify expressivity, and to broadcast the instrument´s ability in: “expressing that whole *scala* of human affective responses, but increasingly rare is the artist who is able to convey that full range emotions” (IBES, 2010, n.p.).

In the past, the hand as the touch, all senses, were highly regarded in different ways (CHMIELECKI, 2021; KNUUTTILA & SIHVOLA, 2014; LUNDBORG, 2014). It seems as if the fascination about the functions of the senses developed fantasizing and creativity both regarding visual arts (CHMIELECKI, 2021) as in touch which Jaëll (1897) proves in her dedicated effort and research about “Le mécanisme du toucher – L´étude du piano par l´analyse expérimentale de la sensibilité tactile” (1897):

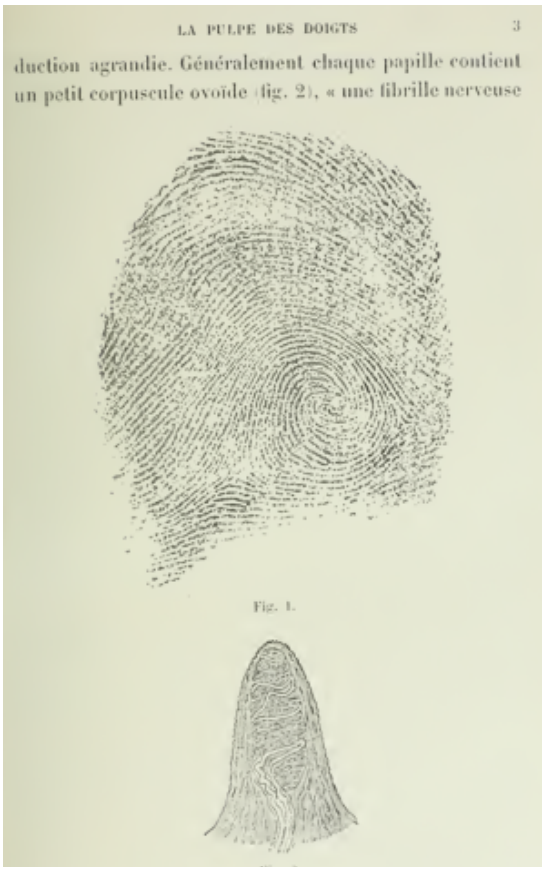
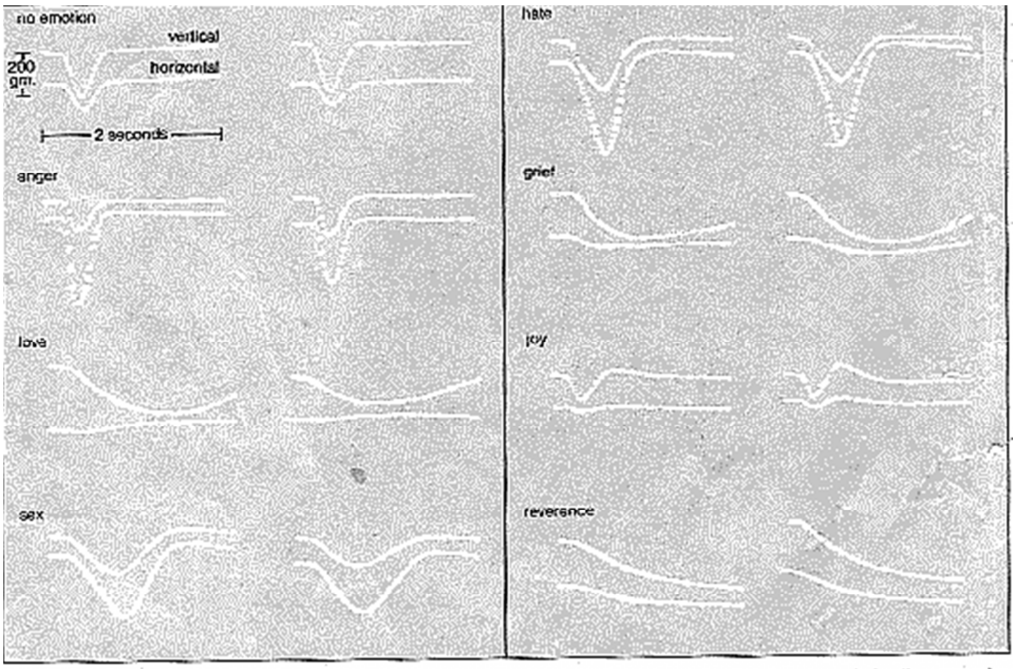


Figure 22: the awareness of sensitivity of these complex papillary arrangements (touch) – also related to a development of brain activity.
Source: Jaëll, 1897, p.5.

Since we all have individual fingerprints (Figure 22), maybe these inherent multifaceted features do assist when working with music interpretation. Due to Clyne's (1977) development of a concept named sentics[156] (*idem*), the finger pressure of the touch clearly showed how intentional emotions transmitted by the sender were similarly received. The machine could even register what kind of emotions or feelings, like anger, happiness, caress, etc. the producer aimed at, which showed to be identical with the analyzed results. Ibes (2010) refers probably to the same research[157] (Figure 23):

[156]"In a sentic cycle, an individual seated at a sentograph is prompted to express (with finger pressure) a series of emotions in a fixed order: anger, hate, grief, love, sexual desire, joy, and reverence (Clynes, 1977). Multiple trials are given for each emotion before moving to the next. About 4 min is allotted to each emotion, so a single session requires about one-half hour. After 4 min, the felt emotion begins to fade—a phenomenon Clynes (1988) attributed to saturation of its neurohormonal substrate. Participants find it easy to switch to a new emotion, and any emotion can succeed any other, but with some carry-over effects: "Each state appears to cast its shadow on the following ones" (Clynes, 1977, p. 147).
[157]"Clynes, M. (1972b) "Sentic Cycles: The 7 passions at your fingertips", Psychology Today, May, pp.59, 60, 68, 70, 72"

> In a study, published in the seventies in "Psychology Today," a number of participants were placed in front of a mechanical device that measured downward and sideward pressures. They were then asked first to imagine "no emotion" and after about ten seconds to depress a key-lever. Other imagined emotions followed such as anger, love, reverence (IBES, 2010, n.p.).



SHAPE OF EMOTIONS. Two sets of repeated measurements from each subject record changes in finger pressure during the expression of *no emotion* and seven fantasy emotions. Each form is the average of 50 trials. The upper tracing measures vertical pressure: downward pressure from the finger sends the line down; as the pressure is released, the line rises. The lower tracing measures horizontal pressure away from the body (a downward swing) or inward (a rising line). Each tracing represents two seconds; most expressions are completed in that time, but in some expressions (e.g., reverence) three or four seconds elapse before the finger pressure returns to its base line.

Figure 23: the survey involved participants using their imaginations to imagine different emotions: love, sex, hate, grief, joy, reverence, and no emotion. At the same time, they pressed their finger into a mechanical device that demonstrated the above results.
Source: Ibes, 2010, n.p.

Previously to Clynes, similar research had been conducted by the French pianist Marie Jaëll with correspondingly findings[158]. Her discoveries (The mechanism of touch. A piano study by experimental analysis of tactile sensitivity), already in the year 1897, had shown scientific approaches to neuroscience.

Her data describes a relationship between the "touch" and the "execution" of sounds. It implies that the tactile physical motor memory is associated with earlier memories of something that had been played and executed before (earlier performing experiences). This means the very act of touch is an act of experimentation of the sense:

> differentiations of sensitivity exert a great influence on the execution, because it is with the contact made on the most sensitive region that we obtain the strongest, most

[158]Jaëll, Marie Le mécanisme du toucher. L'étude du piano par l'analyse expérimentale de la sensibilité tactile (1897).

> vibrant sonority; and the character of the timbre changes depending on the region on which the touch is performed[159] (JAËLL, 1897, p.6).

Therefore, it seems logic to define "the finger in the brain", by referring to Jaëll (1897) developing "Le mécanisme du toucher": "n'est pas sans intérêt de noter que la complexité des dispositions papillaires est en rapport avec le développement de l'activité cérébrale" [It is not without interest to note that the complexity of the papillary arrangements is related to the development of cerebral activity"] (JAËLL, 1897, p.4).

Perhaps our fingerprint is one characteristic of music, the cause for how music´s expressivity and expression can differ between practitioners, or as suggested by Venable (1913): "the difference between players principally depends upon the intensity of the hearing of the imagination" (p.220). Consequently, concepts as musical sense, imagination, key pressure, related to the development of cerebral activity, were relevant aspects for an enhanced musical performance, already 110 years ago. Jaëll´s intention was to prevent performers transform into an "automaton".

Being an automatous implies to execute a task always in the same way. Some authors, on the other hand, consider this automaticity improbable to musicians. Silverman (2007) for instance, while "examining the nature of musical interpretation" (p.103), argues: "…`great pianists sound the same´ (…) have nothing personal to say (…) more or less the same `copy´ of the same piano repertoire" (p.112). Hence, it seems as if Matthay´s (1913) argument: "you must force him to use his judgement and imagination" (p.158), continues to be a valid topic, considering how Silverman (2007) puts it:

> I suggest that the lack of musical individuality, originality and creativity that I and perhaps many other listeners often experience when listening to live and recorded performances stems mainly from the kind of conservatory 'drilling' traditions and competition procedures that exclude the personhood and personality of student performers (SILVERMAN, 2007, p.112).

[159]In Original: différenciations de la sensibilité exercent une grande influence sur l'exécution, car c'est avec le contact réalisé sur la région la plus sensible que nous obtenons la sonorité la plus forte, la plus vibrante; et le caractère du timbre se modifie selon la région sur laquelle le toucher est réalisé (JAËLL, 1897, p.6).

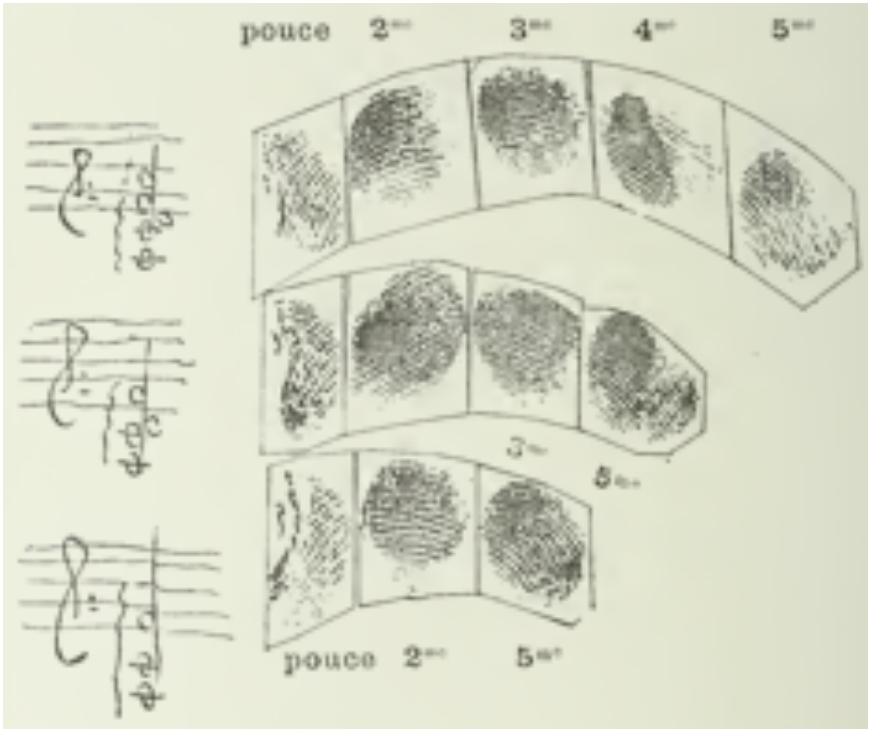


Figure 24: Jaëll´s (1897, p.84) research visualizes how fingerprints serve as a mental representation of, not only the touch, but also, how the movements involved impact the musical results[160].

Silverman´s statement met a possible solution in Venable´s (1913) "Interpretation of Piano Music", where she proposed that lack of imagination inhibits musicality. Her solutions were how to develop the student's awareness of: "key pressure (…) the study of tone color (…) conceived within himself (…) pressure (…) felt on the key (finger-tip)" (p.227).

If the use of imagination can be employed as a tool to increase personal expression, the question is how to develop a strategy extensive to all senses, not only the touch, as part of a sensory experiment? Jaëll, Clynes, Dichler, and Ibes findings demonstrate one possible way by using didactic tools (Figures 20-24) which by their illustrative models activates the vision as well as an auditive and tactile imagination.

Thus, merely by knowing how the touch of senses in the keyboard allows the transmission of emotions bring together on auditive, tactile, or visual stimuli. Similarly, but in opposite way, the very execution per se creates an equivalent measurable "touch" impressing emotions on the

[160]In original: "On ignore à quel point la faculté de nous représenter mentalement les mouvements que nous faisons en interprétant une œuvre musicale contribue à notre dévelopement artistique. C'est par cette faculté que nous nous rendons musiciens, parce qu'elle nous permetd'apprendre à penser déplus en plus nettement toutes les notes que nous jouons" (JAËLL, 1897, p.87) [We do not know to what extent the ability to mentally represent the movements we make while interpreting a musical work contributes to our artistic development. It is through this faculty that we become musicians, because it allows us to learn to think more and more clearly of all the notes that we play].

performers, since the musicians are also affected by what they are playing. Nevertheless, it is through the hand this internal and external emotional and affective process is executed.

Interesting in the context is how Cook (2013) identifies music interpretation in similar terms: "an almost schizophrenic dissociation between the discursive, academic knowledge (…) and the actual tacit, action-based knowledge that they rely on as performers" (COOK, 2013, p. 23).

The behind lying factors which transformed us into a homunculus (Figure 8), "the homunculus, —a human figure that is used by representation of the human brain process during an image interpretation" (CHMIELECKI, 2021, p.967), demonstrate how our brain chose to use the hands as tools to externalize itself. Since the findings (LONG; CLOUTIER, 2020) identifying how our "ancestor", the fish, "375-million-year-old fish, *Elpistostege watsoni*"[161] went up on land and gradually developing hands and fingers out of fins, even gave credit[162] to Darwin (1859).

Also: "this specimen of Elpistostege seems destined to serve as a Rosetta Stone to solve the mystery of how limbs evolved from fins—and thus how vertebrates conquered land"[163]. But not only the hand, also our sounds, made possible to be created as a reminiscent vocal heritage from evolutionary findings related to expression and communication (SNOWDEN; ZIMMERMAN; ALTENMÜLLER, 2015).

The sensory system in music performance acts as a multi-sensory and multimodal process:

> visual and somatosensory inputs have been observed in the auditory cortex, auditory and somatosensory inputs have been observed in the visual cortex, and visual and auditory inputs have been observed in the somatosensory cortex. Therefore, the brain is composed of several multisensory regions, making it possible to handle the sensory challenges of our multisensory world (ZIMMERMAN & LAHAV, 2012, p.179).

[161]"an extraordinary fossil—a complete skeleton of a 375-million-year-old fish, *Elpistostege watsoni*—that goes a long way toward filling that gap in understanding. The fossil preserves in its fins bones comparable to the ones that make up our fingers, showing that digits evolved before vertebrates left the water. This discovery overturns the conventional wisdom about when and how the hand evolved and shines new light on the rise of tetrapods, a pivotal event in the history of life on earth (LONG; CLOUTIER, 2020). Available at: https://www.scientificamerican.com/article/how-a-380-million-year-old-fish-gave-us-fingers/

[162]"In 1859 Charles Darwin remarked on the similarities in *On the Origin of Species:* "What can be more curious than that the hand of a man, formed for grasping, that of a mole for digging, the leg of the horse, the paddle of the porpoise, and the wing of the bat, should all be constructed on the same pattern, and should include the same bones, in the same relative positions?"Available at: https://www.scientificamerican.com/article/how-a-380-million-year-old-fish-gave-us-fingers/

[163]*Ibidem*

In addition, since the brain as a unit communicates with the outside world through the somatosensory apparatus (NICHOLAS, et al., 2019), and as such is adapted by evolution[164], one can say, as Zimmerman & Lahav (2012): "We live in a multisensory world, and as a result, the brain is equipped with many multisensory areas" (p.179).

This is an immensely important information, since, as the "robot"-article demonstrates with one type of measurement in relation to the sensitivity of the touch, the skin of the fingertips: "They can communicate details of an object as small as 40µm (about half the width of a human hair), discern subtle differences in surface textures"[165]. From without Zimmerman & Lahav (2012), this must imply that the sensibility matches both ways, i.e., if we can feel and sense a "hair" on our hand, or fingertip, it means that we can retribute, and "touch" the same way.

This is what Reybrouck (2024), in the article about the touch-mother-baby, brings up as twofold: we can execute but we can also receive, and vice versa. In a music context related to hearing it means that we can hear all range of "sensibility". From this one could argue, if, or to what extent, we really do use this knowledge in a teaching and learning context? Do we go to the limit, using this range of sensory possibilities, regarding the now stated sensibility of the senses, and their impact on the brain, and the multi-sensory functions?

We tend to take for granted that we have the necessary condition to interpret the world around us. It is the same concern when we assume an ability to remember. That is, to what degrees of a functional memory which we are equipped with. Although it must be emphasized, that without the interaction of the senses (depending on levels of their interaction and functionality), these two processes, how to remember (a memory) and how to interpret (items related to the world), would not occur. The sensory systems interact whether we reflect upon it or not. The story of Helen Keller (1880-1968) widens the perspectives:

> an illness at 19th month [of age] that left her blind, deaf, and mute. Until she was nearly seven, she lived in darkness and silence alone beyond human reach, unaware, untaught. (…) [until she was led into] …an unimagined world of sight and sound, that communication was possible between human beings (…) [Annie Sullivan´s] fingers spelling every lesson into her hand (…) Blind, deaf but no longer mute, she was ready to face the world[166].

[164]"As articulated by Owren and Rendall (2001) for animal signals, emotional signals can induce emotional states in others that can lead to social cohesion with shared emotions and increased cooperation within a group" (SNOWDON; ZIMMERMAN; ALTENMÜLLER, 2015, p.19).
[165]Available at: https://news.engin.umich.edu/2021/12/mimicking-a-human-fingertips-sensitivity-and-sense of-direction-for-robotic-applications/
[166]Available at: https://www.youtube.com/watch?app=desktop&v=0QODz_xciKY (4:52–12:57)

As the case of Helen Keller shows, our body is equipped with systems far beyond daily acknowledgement[167]. Wilson (1999), observing deaf people signing in collaboration with psycholinguist Ursula Bellugi 1973, describes our brain as: "It´s just a messenger service!" (p.219) with a capability and aptitude for "language", regardless which sense it uses: "if you can't put it out through the mouth, you put it out through the hands" (WILSON, 1999, p.219). When there is an impairment of senses (as blindness) the awareness and receptivity of the "hands" take over: "vacant cortical visual areas become involved in processing the sensory stimuli from the hand" (LUNDBORG, 2014, p.103). Another description for this concept is: "cross-modal neuro plasticity" (NICHOLAS et al, 2019, p.17), meaning, that other senses assist and expand their "territory", on behalf of the one inactivated.

Another sensation (like visually shutting the world out) is "cross modal attention"[168]. A similar description by Lundborg (2014), exemplifying a situation of lack of electricity, and everything goes dark. In this situation, a person must look for matches to light a candle and consequently there is a sudden change in attention from "been able to see" to "being deprived of vision". It means we must be able to deal with the problem in the absence of vision relying on our hands and fingers. This search is likewise assisted by an auditory guiding, that can indicate, for example, if the match box is empty or not. Consequently, in the dark, the tactile sense in combination with audition is seemingly (temporarily) the most relevant.

A similar situation can be transferred to involve playing the piano, practicing by closing the eyes, as if in the absence of sight, developing an increased sensitivity to succeed in finding and pressing the keys.

Consequently, (un)conscious attention can change the balance and relationships between the senses. When it is dark and you cannot see and must find something, the sense of your hand gets increased resources to solve the task. If certain occasions when closing your eyes, you might hear, and feel better[169] (PALLASMAA, 1994).

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[167]"Blind humans exhibit enhanced capacity to discriminate auditory, olfactory, and somatosensory information (Goldreich & Kanics 2006, Renier et al. 2013, Röder et al. 1999). This is possible because brain circuits are malleable or plastic, and thus, upon the loss of a sensory modality, the associated sensory circuits reorganize (Ricciardi et al. 2014). (...) Plasticity operates throughout life, and it is mainly driven by experience, that is, the interaction between the environment and the individual through its sensory systems. For instance, in blind humans, the fingers used to read braille have better discrimination acuity than the other fingers (Wong et al. 2011)". Available at: https://www.annualreviews.org/doi/10.1146/annurevneuro111020-104222

[168]"Crossmodal Attention. Attention refers to those processes that allow for the selective processing of incoming sensory stimuli. Mechanisms of attention help us to prioritize those stimuli that are most relevant to achieving our current goals and/or to performing the task at hand. The term 'attention' is used to describe those processes that give rise to a temporary change (often enhancement) in signal processing" Available at: http://www.scholarpedia.org/article/Crossmodal_attention"

[169]"The eye is the sense of separation and distance, whereas touch is the sense of nearness, intimacy and

The heightened sensation depends on an increased sensibility, focus and awareness of the hands moving, searching, and what it touches in the environment. According to Lundborg (2014), this condition is explained as: "the interaction of our senses becomes especially obvious if one sense is temporarily or permanently defective or absent" (p.103). Altogether, due to this "interaction of [remaining] senses" (LUNDBORG, 2014, p.103), this perception of how the hands moving in the dark is also a response for the "feedback" from the surrounding environment. In addition, the interrelated hearing function reverberating the auditive sounding cues, guiding the motor, tactile, movements[170]. On the other hand, if there is an overly pronounced visual focus, the other senses, such as hearing and touch, may end up in the background. It is because the capacity of the brain is not enough (see Lundborg, 2014, p.989).

The hands and fingers can accomplish seemingly unimaginable and stunning deeds, and as such deserves to be enhanced as wonders related to what the human body is capable of. Today, billiards of dollars are spent to develop artificial life–AI, just to prove the ability to "imitate" a human being. I prefer, on the contrary, not least through this work, to advocate the fantastic life mechanisms of a real human being.

Therefore, I think it is valid the hypothesis that in piano playing the sensory system also WANTS to investigate. It is like a remnant from birth, develops during childhood and remains, throughout life, as a constant exploration and experimentation in the world.

The goal so far has been to define and exemplify the senses from a general interpretative positioning but also related to a musical context. We can now confirm that the senses are intrinsically included in the process. As part of an inevitable procedure, which just happens due to our sensory memories as the very starting point for all types of perception, the touch of the fingers, feeling the keys at the keyboard, how the kinesthetic, proprioceptive, and interoceptive functions in the body assists while interpreting the music. What is interesting, is how Buzsáki (2006, p.46), describes this visual detection of the observer. He described and related to a computer screen with dots randomly spread and how the brain searches for a meaning, to see and to form figures. According to Buzsáki (2006), a huge number of options is theoretically at hand; to interpret many dots (on a computer screen) as meaningful, it is up to the observer to find the forms. In reason of this, we could ask how this process of constant interpretation

affection. During overpowering emotional states we tend to close off the distancing sense of vision; we close our eyes when caressing our loved ones. Deep shadows and darkness are essential, because they dim the sharpness of vision and invite unconscious peripheral vision and tactile fantasy" (PALLASMAAA, 1994, pp.45-46).

[170]"The Hand and the Brain From Lucy's Thumb to the Thought-Controlled Robotic Hand" (LUNDBORG, 2014).

influences the formation and the storage of, and in relation to long-term memories and abilities to memorize.

(Somato) Sensory Systems

We feel and perceive sensations originating from outside and inside our body via our senses[171]. The brain uses information from the external senses (exteroception) and from the internal senses (proprioception and interoception) to create thoughts, feelings, behaviors. Senses which relate our internal, inner sensations or "feelings (…) sent from the body to the brain are called enteroception or interoception" (BARKER, BREWER & MURPH, 2021, p.1). When interpreting music, they relate to how the synesthetic impact of senses in this process occurs. We all have this "sense of signals". Its function is to indicate by informing the brain via a certain signal system what we feel, internal, inside our body, like to feel one´s own heartbeat (BARKER; BREWER; MURPH, 2021, p.1).

Thus, the way how we understand (our) emotions, might be related to each person´s responses to interoceptive signals. The ability to be aware of internal signals might also differ among people. It is suggested that the approach to how decisions are made, arise from the interoceptive sense (BARKER; BREWER; MURPH, 2021, p.6) which are of importance in an interpretative process.

Other types of sensory information are "Exteroception - reception of information from outside body, E[i]nteroception - reception of information from inside body, Proprioception - reception of information about "self"' (ÅRHEM, 2015). These receptors[172] (proprioceptors) in muscles, tendons, and joints, together with organs in the vestibular system, create "the sense of balance and spatial orientation for the purpose of coordinating movement with balance" (ÖZDAMAR, 2021, p.330). The organs relevant for the vestibular system are parts related to

[171]"The somatosensory system has by far the largest number of receptor types of any of the primate sensory systems, including mechanoreceptors, chemoreceptors, nociceptors and thermoreceptors. Sherrington (1900) differentiated interoception conceptually from exteroception (sensory inputs activated from outside the body), proprioception (sensory inputs that relate limb position), telereception (sensory input from a distance: vision and hearing), chemoreception (taste and smell), thermoreception (temperature) and nociception (sensory inputs activated specifically by physically damaging or threatening stimuli). He categorized nociception and thermoreception with the sense of touch as aspects of exteroception. A century later, Craig (2003a, b) suggested to enlarge the term interoception and included small-diameter sensory input from the whole body, not only from viscera, muscles, joints and teeth but also from the skin, the largest organ of the body. In this conceptual framework, nociception and thermoreception are aspects of interoception, not of exteroception, because they report aspects of the physiological condition of the body conveyed by small-diameter sensory fibres and the spinothalamic pathway to the interoceptive cortex. Interoception is defined as "The sensory representation of the physiological condition of all tissues and organs of the body" (Craig 2015; Strigo and Craig 2016)" (DONKELAAR et al, 2020, p.173).

[172]Available at: https://www.cs.cmu.edu/~hgeyer/Teaching/R16-899B/Papers/Burke07Brain.pdf

the auditive system and eye-movements, as bodily posture. Consequently, since human senses participate in music practice, how can these sense functions, considered as a sensory system, also be included as concepts to be explored and defined as a "multidimensional interaction of our minds" (ÖZDAMAR, 2021, p.325) in the investigation between interpretation and memorization?

Sensory Memories – a Prerequisite for Interpretation

The reason why we constantly interpret (SOVERAL; ZURLETTI, 2019, p.ix; BUZSÁKI, 2006), a biological prerequisite for living, is due to the unconscious process[173] based on sensory memories[174]: "Senses are transducers from the physical world to the realm of the mind where people interpret the information, creating their perception of the world around them"[175]. These are categorized into haptic (tactile), echoic (hearing) and iconic (seeing). The echoic sensory memory lasts longer than the iconic sensory visual memory.

Perhaps it is because of evolutionary reasons, that when you hear a sound (from an external source) you cannot go back in time and hear it again (unless, as nowadays, you have recording capabilities). This contrasts with when you look at something, there is often an opportunity to "look again" at a target.

The sense of touch and audition together form: "an inner true picture of the environment" (LUNDBORG, 2014, p.76). Consequently, to present a true picture of a musical environment the tactile sensibility in between senses in collaboration are necessarily an inevitable part in the process. Biological as well as physical as well as spiritual, since: "The tactile sensibility gives 'eyes' to the hand, creating the ability to produce an inner true picture of the environment through the act of touch" (LUNDBORG, 2014, p.76).

Haptics

The "touch", deriving from the Greek word aptesthe (to touch), was developed into today´s "haptics" implying the former concept: "active" (LUNDBORG, 2014, p.72), "when

[173]Available at: https://www.simplypsychology.org/sensory-memory.html

[174]"During every moment of an organism's life, sensory information is being taken in by sensory receptors and processed by the nervous system. Sensory information is stored in sensory memory just long enough to be transferred to short-term memory (…) Sensory memory allows individuals to retain impressions of sensory information after the original stimulus has ceased" (Wikipedia).

[175]"The sensory nervous system is a part of the nervous system responsible for processing sensory information. A sensory system consists of sensory neurons, neural pathways, and parts of the brain involved in sensory perception. Commonly recognized sensory systems are those for vision, hearing, touch, taste, smell, and balance" (Wikipedia).

sensitivity and motor functions work together actively exploring objects" but there are two ways to touch as "passive" or "active" (pp.71-72).

> Music fruition and performance therefore present a well-defined framework in which to study basic psychophysical, perceptual, and biomechanical aspects of touch and proprioception, all of which may inform the design of novel haptic musical devices (PAPETTI & SAITIS, 2018, p.2).

Playing piano constitutes a haptic reality due to a "touch screen" (piano keys) that produces sound when the skin of the finger touches or presses a key. The term "haptic" that the tech giants have now taken hold of, is launching interactive "touch" products, as if it were something new. At the same time, the ancient evolutionary ability of the hands to leave an imprint on the brain itself in various cortices appears when playing the piano and other instruments. Research has clearly visualized these processes through brain scanning (fMRI, etc).

In line with Keleman (2014), I see as identical to how a utopic declaration for a manual entitled "how to interpret music":

> The hand is a cueing organ that teaches the cortex via the tactility and kinesthesia of motor action. The hand is a small body in dialogue with the cortex and has an important relationship of self-knowing that cues action. The life of the body is the life of action and feeling. The life of the body is the conversation with itself as well as with the world. (…) The way the body speaks to itself from the outside to its inside and from the inside to the outside is through its hands as much as it is through speech or facial expressions. (…) The hand is an organizing organ, turning inherited behaviour into differentiated acts that form new anatomic-behavioral-spatial time gestalts, which generate maps of expressions and experiences in the cortex. (…) The hands, like the face and the body´s postural muscular emotional expressions, form a language of communication between the body and itself and the world around it (KELEMAN, 2014, n.p.).

In this description, the hand becomes an extension of one's own self with its own identity. Not least, this self-hand-awareness then also creates a basis for various deliberate and non-deliberate actions, which in a musical context is called to have an ability to create musical meaning. i.e., to interpret.

In school we learn most about the five senses: sight, smell, touch, hearing, taste. More seldom we talk about proprioception (movement) and vestibular sense (balance), which in all, are senses used when we interpret our environment[176]. Hence, music interpretation involves more than these senses, as highlighted by some authors:

[176]Available at: www.7senses.org.au

"music is a whole brain experience, with numerous intertwining and interacting neural networks" (HODGES & THAUT, 2019, p.8).

"Numerous and widespread brain regions are involved in processing music. Because infants and individuals without formal music training can process melody, harmony, and timbre successfully, musicality is clearly a natural ability of the human brain" (HODGES & THAUT, 2019, p.8).

"An integrated, multisensory view of music processing involves auditory, visual, somatosensory, vestibular, and motor systems" (HODGES & THAUT, 2019, p.8).

Playing Piano – A Multisensory and Multimodal Activity

What does a pianist hear, or choose to listen to during the process of interpretation? What is the difference between to listen, or to hear? Since everyone knows that a musical score cannot reasonably reproduce exactly how the musician should play, questions arise such as:

> what principles govern slurring and phrasing? How are the embellishments to be realised? Are dotted rhythms to be played exactly, or assimilated - e.g. to triplets? In the absence of specific indications to what extent are the pedals to be used? To answer such questions the performer need not be a scholar, but he must be able to recognise and make judicious use of sound scholarship (CONE, 2005, p.244).

Is it an act of conscious, deliberate will, or is it based on unconscious[177] decision-making? Can something identify if the tactile-bodily based process (NICHOLAS et al, 2019) is "unconsciousness"? Anyone (without being a neuroscientist) can see the human senses[178] (audition, touch, vision, and the sixth sense[179] – proprioception[180]) constitute inevitable underlying parts of each piano performance – regardless of "level".

Making music, playing piano, elaborating, and calibrating movements and sounds can be understood as an equal interpretation of the self. Through the mixing of auditive, tactile and

[177]Available at: https://www.vocabulary.com/dictionary/unconsciously
[178]Available at: https://news.ki.se/a-new-look-at-our-sixth-sense-the-sensory-link-between-our-movement and-motor-control
[179]"fantasy, imagination;" that sixth sense, "the power of conceiving and divining the beautiful" (CHRISTIANI, 1886, p.13).
[180]"Proprioception: Sensory functions that transduce stimuli received by proprioceptive receptors in joints, tendons, muscles, and the inner ear into neural impulses to be transmitted to the central nervous system. Proprioception provides sense of stationary positions and movements of one´s body parts, and its important in maintaining kinesthesia and postural balance" (MeSH, 2023). Svensk MeSH, Karolinska Institutet, NIH, National Library of Medicine. Available at: https://mesh.kib.ki.se/term/D011434/proprioception

visual multisensory processes, and as such, unfolding recognition of all types of memories; autobiographical as well as subliminal.

Seen from an interpretative point of view, as well how the memorization process occur, different technical and musical positions must be taken. Although these decisions are based on different degrees of awareness, this could mean that the interoceptive sense, as well as exteroception and proprioception, should be included in the investigation, since all the performative steps hypothetically must be linked to some sort of stances as musical choices.

The bodily motor systems, therefore, input physical impact since piano playing requires highly technical demands and positionings in relation to pure mechanical[181] aspects.

Proprioception

As stated, Charles Sherrington (1906), developed the concept "proprioception", deriving from proprius (one´s own) (ÖZDAMAR, 2021, p.330). Generally speaking, multi-sensory play involves auditory, motor, touch, tactile and visual systems. The brain summarizes relevant input from these sensations and make conclusions how to position and relate movements to and within the body, defined by Özdamar (2021, p.330) as proprioception: "information about one´s own body" (Taylor, 2013, p.932)". Exteroception and "exteroceptors" provide: "information about things external to the body" and interoceptors, which signal information about the viscera[182]" (Taylor, 2013, p.932)" (ÖZDAMAR, 2021, p.330). The hands´ "tactile receptors", due to their exposure for mechanical pressure or stimulation, is called "mechanoreceptors"[183].

In a piano playing context, the finger must develop a certain "grip" on the keyboard, as well managing all other movements that are impossible to oversee solely with the vision. For a pianoplayer this implies a gradual need to develop this proprioceptive sense, to know "where our body parts are, how we are positioned in space and to plan our movements"[184].

The senses do not only act as passive receptors for external stimuli, but they also activate the senses´ sensibility: "The senses do not only mediate information for the judgment of the intellect; they are also a means of articulating sensory thought" (PALLASMAA, 1994, p.42).

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[181]Christiani's (1886) definition of mechanic – technical aspects of piano playing.

[182]"The visceral nervous system: relating to deep inward feelings rather than to the intellect – Oxford languages; Felt in or as if in the internal organs of the body, not intellectual, instinctive, unreasoning, dealing with crude elemental emotions, of, relating to, or located on or among the viscera. Something *visceral* is felt "deep down". In earlier years it often referred to things emotional rather than physiological. 1640 and English bishop, Edward Reynolds wrote:"Love is of all other the inmost and most visceral affection."

[183]"after the anatomists who first described them, Meissner corpuscles, Merkel cell neurite complexes, Pacinian corpuscles, and Ruffini endings" (12 Touch, p.289) Available at: https://www.centropiaggio.unipi.it/sites/default/files/course/material/touch.pdf

[184]Available at: www.7senses.org.au

Consequently, when a pianoplayer presses the fingers in the keyboard, it is not only a planless move.

Understanding piano playing as "articulating sensory thought", the next level, of how to render articulation of musical meaning in interpretation, is not too difficult to reach. At least if we allow ourselves to believe in following argumentation: "We have an innate capacity for remembering and imagining places. Perception, memory, and imagination are in constant interaction; the domain of presence fuses into images of memory and fantasy" (PALLASMAA, 2007, p.67).

Kinesthetics

Kinein (to move) is based on the Greek word and linked to aesthetic – "aesthesis"[185]. The definition of Kinesthesis is described as: "Sense of movement of a part of the body, such as movement of fingers, elbows, knees, limbs, or weights"[186]. The concept of kinesthesia has been presented as perception: "mediated by receptors in muscles, tendons, joints, and skin" (Atkinson et al., 1985, p.176, apud ÖZDAMAR, 2021, p.327). According to Hildegard (et al., 1975, p.126) kinaesthesia provides "controlling voluntary movements such as reaching, grasping, and manipulating" as "feedback from the environment" (ÖZDAMAR, 2021, p.327). A concept as "manipulating" could be relevant in a didact perspective with aspects to consider more carefully, related to "experimental" positionings regarding interpretation as memorization processes:

> Sensory functions that transduce stimuli received by proprioceptive receptors in joints, tendons, muscles, and the INNER EAR into neural impulses to be transmitted to the CENTRAL NERVOUS SYSTEM. Proprioception provides sense of stationary positions and movements of one's body parts, and is important in maintaining KINESTHESIA and POSTURAL BALANCE[187].

Since our brain wants to interpret (LUNDBORG, 2014; BUZSÁKI, 2006, p.47) this includes most visibly and obvious even kinaesthetic perception[188].

To establish a proper functionality of the body, resulting in an ability to coordinate and localize oneself and one self's own body within the environment, proprioception is required.

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[185]*Ibid."*perception of movement in architecture"
[186]Svensk MeSH. Karolinska Institutet, NIH, National Library of Medicine. Available at: https://mesh.kib.ki.se/term/D007699/kinesthesis.
[187]Svensk MeSH, Karolinska Institutet, NIH, National Library of Medicine. Available at: https://mesh.kib.ki.se/term/D011434/proprioception
[188]"defined as "a sense mediated by ends organs located in muscles, tendons, and joints and stimulated by bodily movements and tensions," and "sensory experience derived from this sense" (ÖZDAMAR, 2021).

The proprioception process can be described as a communication between the body and the brain, accomplished by a system of millions proprioceptive signals, received by the brain. The nervous system is thus activated in a never-ending interaction. The active sensors underlying this process are called: proprioceptors and are spread out in the whole body (HO, 2019). Consequently, since the senses audition, touch, and vision stimulate the brain as sensory response, this impact will be handled simultaneously as the brain combines these proprioceptive signals (HO, 2019). Therefore, during playing piano, these activities must construct a massive activity for the brain.

The brain as a unit communicates with the outside world through the somatosensory apparatus (NICHOLAS, et al., 2019) and as such is adapted by evolution. So, once again the hand is clarified, *per se*, as an embodied, speaking, instrument, combining all the senses related to music making.

DISCUSSION

After an extensive literature review, I will continue now addressing the question that has triggered this research: how can it be demonstrated that a musician makes some use of memorization as auxiliary to interpretation? We saw that memorization is a complex process involving memory models and systems consisting of sensory memory, short-term memory, working memory and long-term memory. Fulfilling this survey helped to identify common factors and features related to memorization. In addition, I have found measurable technical variables and musical elements that have an impact on interpretation in musical performance. In addition, we also grasped how the senses can influence this process. It is good, even though, to recall some elements so far considered.

When I started this research, I thought it would be easy to find materials that combine memorization and interpretation, because it is an important part of pianists' daily activities, whether in terms of performance, teaching, and learning. However, it soon became explicit that there was a large body of research in each area but separately. When I applied the descriptors “interpretation”, “interpreter”, “memory” and “memorization” in the search engines, a huge number were found, but related to the field of linguistics. When I added “music” there were only a few search results available.

I had the intuition that both areas should interact. Two such indispensable areas as music interpretation and memorization could not just go unnoticed, as they constitute two of the most important foundations in piano playing, historically, as well as in the present.

However, neither of these few sources (search results) demonstrate any direct and mutual connection between music memory and interpretation. The low number of texts is confirmed in the following statement: “The absence of information on memory for music and its interplay with interpretation is notable” (CHAFFIN; IMREH; CRAWFORD, 2002, p.24).

After having identified this gap in the literature, I proposed the hypothesis that memorization, can be used as a strategy in music interpretation. Some findings were consistent with this investigation´s hypothesis: “Expert performance requires automatic skills. Art requires creativity and freedom of choice (…) Memorization is central to this process” (CHAFFIN; IMREH; CRAWFORD, 2002, p.23); “experimenting with instrumentation, memorization techniques, metaphor, and theatrical intention are effective ways of developing interpretations” (HUANG, 2004, p.1); “the hearing memory helps to distinguish a correct interpretation from an incorrect one or correct tuning” (Gordon, 1997; Pecenka & Keller, 2009 apud HERRERA; CREMADES, 2014, p.217); “analytic memory (…) making it possible to understand how the

elements that bring music together (…) structured to give the musical work a sense of completeness (…) facilitating *its* memorisation and interpretation (Aiello, 2003, apud HERRERA; CREMADES, 2014, p.217).

In addition, Herrera & Cremades proposes that kinesthetic and vision have shown to influence music learning. More than 70 years ago, Rubin-Rabson (1950) described how visual pre-processing of the music (score) before playing improves the practice of the musical material. A recent study related to visual memorization in contemporary music shows similar results: "liberating myself from the very precise details and open myself to be expressive with the piece" (FONTE et al, 2022, p.7). Other findings based on the multimodal functionality of the senses, Watson (2006), termed as: "mentally hearing the music when reading the score" (p.536). A connection he explained as: "interpretation of the score in terms of an internal representation of sound" (p.536).

Other reports I found (comparable to my own experiences) strengthened the hypothesis that an interpretation procedure must have been somehow affected by certain outcomes linked to the strategies of memorization: "deep knowledge of the music, improved listening abilities, freedom, and improved communication and expressivity" (FONTE et al, 2022, p.7). This must mean that (at least some) methods of memorization enable expressiveness.

Another topic to investigate was Chaffin et al (2002, p.23), claiming that automaticity is required for improved (better) performance. Nevertheless, the disadvantages of "automation" (CHRISTIANI, 1886; MATTHAY, 1913), are presented in the literature. Why is the concept of automaticity equated with mechanical playing, and later a prerequisite for artistry? In this respect, my research work has led to the fact that the concept of automation reflects two important components of the memorization process that also affect the interpretation work.

First, the explanatory neuroscientific models (visualized in figures 6 and 7) demonstrates that strengthening of synapses shape memory, a result of learning and knowledge. This means that everything that is played (regardless of *how*) will be "memorized" in one way or another – at least muscularly. Perhaps then the other sensory functions are more influenceable, precisely depending on how attention and conscious influencing processes are designed?

Second, since a process of memorization indicates a longer detour, it implies increased *time* to design, focus and reflect. Imagined musical ideas can be tested, mentally practiced before (uncontrolled) muscle memory takes over.

This means that the pianist in the memorization phase can actively take advantage of the benefits of automation (neuroscientific strengthening of synapses). In this way, the

memorization can lead to the construction of new (conscious) choices of interpretation patterns. Thus, the interpretation is made visible through the memorization strategies.

Muscle memory is usually described as originating solely from the hand and fingers. But eye movements are also musculature that we can literally direct where we want. It can therefore also be used as a muscular memorization technique linked to specific “cues”. For example, at each starting note of a melodic phrase decide to look at the highest note of the right hand, naming it by name, and which function in the chord, and, at each ending melody note, to look at the left hand and repeat the same procedure. Just one strategic example, how to “cue” yourself to “remember” by using motor and visual muscle memory.

So, depending on how much (or little) we practice “knowing”; *what* will be the next chord, *how*, each hand moves; *when* the phrase changes direction, the more confident we will be in our memorization techniques. Consequently, motor, vision and hearing can also be experienced and practiced as controlled processes, via planning, thinking and feeling.

In line with a pianist's knowledge of the characteristics of each sense, a heightened focus can design various “cues” to clarify stances (chord progressions, fingering, positions, harmonies, etcetera). If the pianist decides on a visual focus: the keyboard, a key, a specific finger, the selected one will receive the most attention. It can thus be modeled and developed more “efficiently” (also in terms of *imagery*). An intentional focus increases the awareness of this specific mind relation to that “cue”. A certain feeling will/might arise and result in increased memorability. Correspondingly, when focusing on a specific auditory “cue”, hearing only certain notes, distinguished among the others, the whole musical texture can be transformed into a sudden new musical awareness. Identical scenarios arise if the pianist offers the tactile apparatus an enhanced focus.

In this way, awareness can come and go, mix between levels of mindfulness, active affect, and total neutrality, and from there observe interpretive fluctuations.

This is how a conscious approach (corporeally, bodily, or cognitively, mentally, in various combinations) to memorization will affect the creation process. Differentiation causes a musical depth. As such, its effects affect different perspectives and layers in the music, like a three-dimensional sound spectrum. It also identifies how the neuroscientific concept: “cross modal attention” can be adopted as a concrete strategy in memorization.

As opposed to the interpretation merely 'becoming' 'something', which may not have been intended, even if it could accidentally be good, here we can identify memorization as a forum for the interpretation of 'manipulation'. In this way, memorization shows how easily the music can become more transparent, just by working with different sensory focuses.

Perhaps it can be argued that this is part of ordinary practice, which has now been repeated a few times. But to get away from the belief that memorization is a mysterious process, what additional factors affect the ability to learn to apply different memorization models? And which more of these characteristics can be linked to the development of music interpretation?

Aristotle argued: “it is necessary to know what the things are that are being talked about before performing demonstrations on them” (Aristotle apud WHITAKER, 2007, p.214). With this advice in mind, I approached the previous three chapters. This implies, therefore, that we need to know what things, or objects of study, are being debated before trying to carry out demonstrations on these.

It is through the identification of all the components, technical variables and musical elements that the interpretation process relates to the memorization process. It happens both practically, performed and through verbally formulated think-aloud protocols. Knowing “what it is” can also be described as strengthening synapses in the brain. This step involves a kind of automation, a form of “brain chunking”. Here, space is freed up for deepened hearing, touch and sight. Then the senses, in search of experiences, can seek further innovation and therefore continuously interpret the 'surroundings'. We can call this format: evolutionary bodily imagination. It is the language of hands. The hands as a link between memories that construct memorization. Also, the link to our call center - the source for 'talking'. A prerequisite for expressing oneself, “speaking” and “communicating”. This is proof that memorization as learning based on bodily memory experiences is also a way of interpreting music. That is, if the pianist is permissive and reflexive towards the senses' exploration of the musical landscape.

Thus, based on the logic of Aristotle, the extensive information that emerged from the survey helped to better define the subjects and, consequently, to comprehend why they came to exist in the music realm. In this way, highlighting memorization, interpretation, and senses, we comprehend that in “the act of demonstrating that something is, we also learn what it is, and so discover both simultaneously” (WHITAKER, 2007, p.220).

To clarify the gap, the literature review has clearly demonstrated (see figure 4) that interpretation involves a larger interpretative part where the interpreter must “create” something. In this context, to fill the “gap”, Feldenkrais (1990), definition will be applied, as part of the “missing link”, between interpretation and memorization: “Awareness is consciousness together with a realization of what is happening within it or of what is going on within ourselves while we are conscious” (FELDENKRAIS, 1990, p.50).

"No matter how literal the performer wishes to be, they are obliged to make some decisions" (HAYNES, 2007, p 105), the work for an interpreter: "always presents itself to the sign's recipient in the form of an interpretative decision" (SOVERAL; ZURLETTI, 2019, p.ix).

But this "filling" the gap also requires creativity: "interpretation entails the agency of an interpreter who is more than a decoder, even a creative one" (KRAMER, 2011, p.21). According to Wittgenstein: "When we say, 'Every word in a language signifies something,' we have so far said *nothing at all*" (KRAMER, 2011, p.21). This reinforcement of how "to play", and "to say" something, then "*vom Greifen zum Begreifen* (from prehension to comprehension)"[189] (REYBROUCK, 2021, p.xiv), suddenly makes sense. Again, we can find a deeper meaning in the etymology, where "touch" links the concepts, that the meaning of the hand relates to "understanding", via the early Latin form of "comprehension", as *prehendere* (to catch, to capture).

It cannot be emphasized enough how often it is mentioned that a musical score is inadequate and imprecise, undefined, and never sufficiently described: "Musical notation is always "under-determined; imprecise and incomplete in one way or another (…) No practical notation has been (or has been devised to be) comprehensive or precise" (HAYNES, 2007, p 105). However, in the same line of reasoning, we can claim that to learn and to play by ear, interpreting a "sounding" score, is also not precise, since there is always an openness for the musician to interpret. Some "interpret" more easily from written signs, and others from auditory "signs", or from tactile signs, like braille. Also, regarding memorization, from which "source" the memorization process starts from.

It is in this gap we identify a pianist as the decisionmaker where the meaning is left to the self´s own imagination.

Defining memorization as part of imagery corresponds in this context to an (imagined) inner "reality". Fantasizing about the music, initiated (without external aids) by hearing, touching, seeing, feeling, it becomes a state of mind. If this ability is trained, because the brain works at lightning speed, the possibility of moving freely (freer) between the different parts of the music also increases. In this way, the pianist can be anywhere, imaginary, in the "score",

[189]"Music is an elusive art. Sounds disappear while they are sounding, which makes it difficult to come to grips with them. Music, therefore, has been called the most intangible of all arts. Yet to understand music, it is necessary to make sense of it, and sense-making is an act of comprehension, which has etymological roots in the Latin verb *prehendere* (to catch, to capture). Comprehension, as an act of understanding, thus has a tactile dimension as suggested by the Jewish-German philosopher Cassirer in his famous expression *vom Greifen zum Begreifen* (from prehension to comprehension). This analogy holds *a fortiori* for a vibrational art as music, with sounds that impinge upon our body and our brain. As such, it is common sense to say that we are "touched" by the music, both in a literal and figurative sense" (REYBROUCK, 2021, p.xiv).

depending on attention, which more easily develops the awareness of part and whole in the music.

Playing the piano, with the body as the main component of this imaginary toolbox, is then reframed as an inherent haptic desire for discovery. This multimodal nature of the senses takes care of the rest, i.e. the interaction processes between the senses: that hearing, and touch go hand in hand, as does sight and hearing, as well as how touch affects emotion, and vice versa, etc.

By naming the music's components, implies to be able to start and stop anywhere in the music. Then the automation of the muscle memory of the hand and fingers (as well as muscles in the eyes and ears) can be trained accordingly. This results in that thought, feeling and mind have time to work together for sensitivity, balance, nuance. Also, to describe in words to oneself, the whole of the music, and its parts, becomes an aspect of security. From there grows the courage to dare both to express and even more to try how to develop musical interpretations.

It can thus seem as if the answers to how the music can be interpreted cannot be found anywhere else than within and through one's own memories, i.e. regardless of the initial "source" (by score, by ear, by braille). Not least from the perspective of the bridging collaborative process of the senses´ multimodality. This "creation of something" is often described as the "meaning" of the music, the expression, but also, being described as something "personal", from without "the self", or as the artistic, the "art". However, it is never explicitly stated what, how, why, or not even exactly when, this "making of meaning" is to be designed with all the musical features and factors involved.

The gap hereby identified by this research, i.e., the lack of expressive number of research explicitly linking music interpretation and memorization, will hereby also be linked to the concept of "power of imagination". This connection had also been suggested by Shinn (1898) more than one hundred years ago, that he described as connected to an inner mental platform. This inner "base" can be interpreted in a multivariate of ways and even if it might seem far-fetched to even adopt this concept, we cannot close our eyes for the fact that to use one´s own imagination requires power. To believe, in varying possibilities of expression in line with the sensitivity of the senses. Of course, this stage includes an in-depth knowledge of the interaction and functions of the senses. It seems to facilitate the possibility of feeling confident in one's own expressive ability.

Although, Shinn (1898), links the human feature "power" as its epitaph, what is also confirmed in Knuuttila & Sihvola (2014), here power is equated with a self-defining, self-assuring attitude towards music interpretation, established by the process having memorized

music. One might think, there should not be any ambiguity in that, since presented already over 100 years ago, but to repeatedly enhance piano playing as a self-reverberate activity, imply a never-ending cultivation of the sensitivity and interdependence of the senses and memories.

As Osborn (1948) claims, the concept "*habit of effort*" (OSBORN, 1948, p.24), as a main part of how to build creativity, or as: "The more you rub your creative lamp, the more alive you feel" (OSBORN, 1948, p.16), and: "A person can make himself *grow* by making his creative spark *glow*" (OSBORN, 1948, p.16, which all shows how to form and identify a "degree of creative imagination" (OSBORN, 1948, p.22).

Another way to think about imagination or phantasy, translated into an academic context, is "reflexivity". According to Bolton (2010): "*Reflexivity* is finding strategies to question our own attitudes, thought processes, values, assumptions, prejudices and habitual actions, to strive to understand our complex roles in relation to others" (p.13). Or, we could also say, that to know the music is as creating it, building it up from scratch, to assume the role of composer. This is some of the main tasks for a pianist – if a successful memorization will happen. It is about how to know not only in the motor, using muscular memory, but also as a linear story, as a TED-talk to be told for one´s own self while playing. One variant, is this verbal manner to keep one´s thinking on track and a way of "cueing" the parts together in a thoughtful way.

The suggestion is merely to *know* what happens in each part of the music. This control-managing-system, the contact with, and ability to, how to follow one´s own self´s thinking, as a "reflexivity", has to be practiced slowly to acquire a sort of mental storage. Therefore, a mental – and bodily "mind map" will serve here as the definition of the strategy for memorizing.

Memorization is presented as: "To memorize is to know" (FRIEDRICH, 1950, p.40), or "[to] know the music in every detail" (WINSLOW, 1949, p.16). Possibly they refer to the inner feeling of being aware of knowing something which caused a sense of autonomy and self-governance. Memorization described from the field of psychology, relates to the division of memory based on four phases[190]: "recollection, recall, recognition and relearning"[191] (DUNSBY, 2001).

[190]"Contemporary psychology normally identifies four different types of memory: recollection, recall, recognition and relearning (see also Psychology of music, §II, 4). Whereas recollection relies on cues (of which musical notation is an assemblage), recall is a totalizing act, and 'eidetic' or complete memory is a common experience of music among professionals, even though the memory of any perception, however 'complete', is not of course the same as the original perception itself. Recognition, whether cued or not, brings to us the belief that something is familiar (and this sense of familiarity may have a basis in experience or may — as in the case of the so-called 'déjà vu' — be in all likelihood illusory), whereas relearning, which is found to be easier than learning, rests on actual familiarity to build memory in yet a different way" (DUNSBY, 2001) available at Grove online: https://doi.org/10.1093/gmo/9781561592630.article.42568

[191]see also Psychology of music, §II, 4

Correspondingly, Monteverdi included *memoria,* based on "the five classical rhetorical principles"[192] (MAZZOLA, 2011, p.12), as a part of the musician's work concerning "affects of the artist's musical person or inducing such in the audience" (MAZZOLA, 2011, p.12). Despite, it is merely about: "a matter of finding the necessary information in long-term memory when it is needed (Bousfield, 1953; Mandler & Pearlstone, 1966; Tulving, 1962)" (CHAFFIN; IMREH; CRAWFORD, 2002, p.205).

If a musical performance becomes "better" by being memorized, and furthermore, depends on the musical interpretation, then the relevant points of contact must be able to be defined. In Lisboa et al (2015), Bryant (1986), Chaffin, Imreh, Crawford (2002), memorization processes are analyzed, and the components of music are broken down, and built up, as a "mind map". In this format memorization can be designed as a strategy to interpret, based on how to enhance the "know-how". It is logical to realize that the more you know about something, the easier it is to practice, which we also touched on as a tangible (physical and psychological) sensation.

What also emerged in this investigation is that there is a neuroscientific perspective linking memorization as a strategy in music interpretation. This is based on processes demonstrable by brain research, such as long-term work with music, i.e. repeated practice of different parts that creates a form of automation.

If memorization can be spoken of as extended practice, which means "automation" of (for the music) current movement patterns, using either practical playing or using "power of imagination", this relaxation can instead free an extended mobility, a freedom: "freeing resources" for other brain pathways (somatosensory and auditory) to affect a "superior musical performance" (LOTZE et al, 2003, p.1817).

Even if such findings are most often applied to "experts" compared to "amateurs", each person has walked that path, from having been a beginner at some point. Although, it is clear, regardless of "level": "learning and memory are correlated with increased brain plasticity and structural modifications"[193] (TOWNSEND, 2017, p.27). Therefore, it is important to highlight

[192]"The breakthroughs of the human perspective of performance can be situated with Claudio Monteverdi's work in 1600, where performance is recognized as either expressing affects of the artist's musical person or inducing such in the audience. But the work has no essential individuality in this regard; it represents general categories of affect. These are transmitted in the framework of general rhetorics, more specifically according to the five classical rhetorical principles: 1.inventio (the arguments), 2.dispositio (the articulation), 3.elocutio (the communicative wording of thoughts), 4.memoria (memory for performance), 5.pronuntiatio/actio (the actual physical performance)" (MAZZOLA, 2011, pp.12-13).

[193]"In the realm of cognitive neuroscience, research confirms the impact of elaborative rehearsal on long-term memory by identifying neural markers specific to rehearsal that would predict later recall of information (Davachi, Maril, & Wagner, 2001). Artistic activities provide an enjoyable and motivating form of naturally spaced and elaborative rehearsal" (TOWNSEND, 2017, p.13).

the understanding of the functions and reflect about how even a "beginner" can experience himself as an "expert", to use imagination and to have time to develop few and small moments, as significant but still automated and creating space for "interpretation".

One might believe that complex movements, being able to play "20 notes per second" (BROWN; ZATORRE; PENHUNE, 2015, p.60), require more "attention" in the brain, and therefore take up more space, more "gigabyte" regarding "cortical activation". However, research shows the opposite. The more "expertise" in music (and even in athletic activities, as a specific article refers to), the more complex sensorimotor processes involving different senses at the same time, the more the brain "knows", how to deal with the task, the more material undergoes a process similar to "chunking", i.e., with the result that it becomes more "compressed" (less space in brain), both motorically and mentally (with automation). A solid work, based on practice processes in long-term memory, generates less (!) neural activity: "reported weaker cortical activity in professional pianists as compared to musically naïve subjects with similar motor areas" (CALMELS, 2019, n.p.). This proposal is based on: "difference in energy usage in apparently identical neuronal computations" (CALMELS, 2019, n.p.).

A similar conjunction, since memorization requires extensive motor practice is read in Shinn: "With regard to muscular memory, I believe, technically speaking, a piece can be said to be securely memorized only when it has passed below the plane of consciousness" (1898, p.25). This statement can be updated considering modern neuroscience by comprehending if the space in the brain is "freed up", there is more room to be devoted to "imagination", "creativity" and "ingenuity". Another way to present Shinn´s (1898) example is: "an activation decrease pattern recorded in motor performers has been interpreted as a gain in neural efficiency. Less investment of neural energy is required after intensive and extensive motor training" (CALMELS, 2019, n.p.).

The contradiction appears in that a cortical thickness[194] increases[195] and cortical activation decreases: "a consensus seems to have been reached on the directions of alterations in cortical

[194]"music training was associated with cortical thickness development in the premotor and primary motor cortices is not surprising given that both regions contribute to the control and execution of movement. It is posited that the premotor region plays a particularly important role in the preparation and sensory guidance of movement, both of which are key characteristics of music training. In the same way, the supplementary motor area is thought to play a role in the planning and coordination of movement, again key skills in music production (…) brain areas that play a critical role in inhibitory control, as well as aspects of emotion processing". Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4254594/

[195]"According to our results, playing the piano does not only prevent age-related brain thinning, but can even cause a CT [cortical thickness] increase in certain brain areas in older adults. We have demonstrated that playing an instrument is an effective stimulator for cortical plasticity, which lasts into aging—more than 50 years after the sensitive period(s) of musical training". Available at:

thickness (increase) and in cortical activation (decrease)" (CALMELS, 2019, n.p.), which happens because: "practice-related changes occur (…) greater cortical thickness and grey matter are exclusively registered within the auditory system in musician" (CALMELS, 2019, n.p.).

But it also emerged that memorization can allegedly become static, if it is performed mechanically, without thought (as Christiani,1886, suggested) and reflection, even if the music is learned according to all the rules of the art. Therefore, we can state that a further "strategy" is always needed to overcome obstacles regarding the resolution and prevention of difficulties in reaching one's own inner imagination.

If there was no doubt that everyone had an ability to memorize, (or to interpret for that matter), there would be no need for teachers, literature or research in the field . Like tutors for academic (creative) writing, coaching is needed for academic (creative) memorizing (or interpretation). Nevertheless, I believe I have found demonstrable evidence in this research process that neurobiologically proves that everyone possesses this intuitive power.

The obstacles observed by the authors are, in general, related to a difficulty in describing in words the complex processes by which music interpretation, memorization, and musical performance are held together. Gradually, it also dawned on me, the importance of training, trust, and relying on bodily processes, the inner hearing, which directly controls muscular processes, and vice versa.

There is also a lack of a comprehensive and unified research platform that simply describes the extensive interdisciplinary processes that the above areas encompass. Therefore, the senses can be said to constitute an ever-present didactical "toolbox" in line with suggestions by Järnerot & Veelo (2020), to challenge habits. In this sense, Jaëll's (1897) fingerprints, Dichler's (1990) numbers, Clyne's (1977) sentics, and Ibes (2001) "thousand layers" exist as aids for pianists to set up in Kolb's et al (2013) learning cycle (Figure 25):

https://nyaspubs.onlinelibrary.wiley.com/doi/full/10.1111/nyas.14762

Figure 25: the cycle of learning (KOLB et al, 2013, p.35). Here applied as a template for interpretation and memorization. Depending on how the circular variables are combined, in which directions, different degrees of (experimental) results are obtained.

Although the literary sources confronted have certain similarities, nowhere is memorization *explicitly* emphasized as a strategical approach to interpretation, neither why, nor how. Due to the results developed in this investigation I can now build up my own methodological approach which provides support for reaching the goals.

Aesthetic Dimension

Gradually, while studying memory, its functions, and related memorization strategies, it became clear that aesthetic perspectives seldom apply to the memorization process itself: "[memory] domains involving aesthetic demands have rarely been studied (CHAFFIN; IMREH; CRAWFORD, 2002, pp.23-24). Therefore, as part of this discussion, aiming to build and present arguments to define the goals of this investigation, the appearing elements, outlined features and factors, will be suggested to be included as (at least) three "aesthetic" concepts to investigate: 1) "think-aloud protocol" (Laske, 1977, apud BRYANT, 1986), 2) a (wider) concept of "touch" (REYBROUCK, 2024), and 3) "phantasy"[196] (MARCUSE, 1955).

[196]"Phantasy plays a most decisive function in the total mental structure: it links the deepest layers of the

These three concepts might seem opposites, but on the other hand, they are in line with Kant´s (1724-1804) called "aesthetic dimension", which Marcuse (1955) defines as: "the medium in which the senses and the intellect meet. The mediation is accomplished by imagination, which is the 'third' mental faculty" (MARCUSE, 1955, p.179).

In this context the interpreter represents the medium, as demonstrated (Chap.1) via Colonomo's (1992) model (WILCOX & SHAFFER, 2005). In addition to the interpreter´s activity of (physically) creating a sounding realization (of music) it is also intended to soundly explain (*interpretatio*, from Latin) and create meaning (Eggebrecht, 1967, apud DANUSER, 2015). What Eggebrecht clarifies in this context is the discovery of an explicit intermediate phase which he calls "the act of translation" – here interpreted as "the gap". In other words, a process of recreating the music. Interesting, because the result of my research sees even more the concept of memorization as a possible filling of this interpretive gap.

Assuming a pre-conversion of parameters of interpretation and senses and memorization has been carefully studied, the medium (interpreter) using "intellect", implies the "think-aloud" phase, the linear cognitive controlling stage. Furthermore, the "intellect" as the meeting point with the "senses", shows the reciprocal dependence on and the knowledge of how the senses practically articulate implemented "thoughts".

The medieval way, how one approaches one's own mindful ability (as the only possibility) to remember, has led me to believe that today we may not be making enough use of the possibilities that our body is equipped for. Neither when it comes to how we (not) discuss and think, or fantasize, based on what (in the music) we should remember.

Consequently, the linking using "imagery" illustrates an enhanced (personal) cognitive and emotional mental security that creates an environment of creativity and desire to explore.

The conclusion of this ongoing discussion is then that the area seems too unexplored. Precisely in view of the richness with which the senses are equipped and how the expressive possibilities of music are nevertheless closely connected with these.

Based on multiple findings from the literature, it can be detected similarities in line with Marcuse (1955), how a pianist is described like a "medium" [the memorizing interpreter], using "senses" (touch) and "intellect". This brings back what was presented as "imagination". A concept already discussed as:

unconscious with the highest products of consciousness (art), the dream with the reality" (MARCUSE, 1955, p.140).

> the powers of sense, fantasy, imagination, estimation, particular opinion and memory are substantially the same and that they differ from each other only in definition. So all these powers are substantially the same as the common sense and have the same organ, but they differ in definition. (*Lectura in librum De anima*, ed. Gauthier, II.26.2 (441) (KNUUTTILA & KÄRKKÄINEN, 2014, p.136).

Transforming this description into a memorization process, results in, a discovery of, and how, to sort out parts of music – a deconstruction (JOURDAIN, 1998), to reconstruct its constituent parts into a memory. A "mind map" using "thought, experience [memory] and the senses" – in line[197] with Schleiermacher (1768-1834) and Dilthey (1833-1911) saying: "we can analyze the process of understanding only in the process of production"[198] (TAPPER, 1925, p.347).

An analysis that also aims at the (memorizing) musician. To adapt, to take the time to (endure), to be touched, to be affected by different expressions of emotion that are already built into the music. But also, once discovered, can be (re)interpreted based on one's own experiences.

Similarly to Tapper (1925), when he speaks of a production process, Jourdain (1998) formulates memorization as something to be reconstructed. His memory strategy means an initial deconstruction of the building blocks of music.

Casals also uses the word "reconstruction" (DREYFUS, 2020, pp.181-182), although he refers this concept to interpretation. There, Casals highlights the importance of sensitivity, in relation to creative, sensory phases of the composer's state of mind.

The examples state the obvious, that both phases, memorization and interpretation, correlate with each other, as interactors. Like Casals's approach, seeing interpretation as an approach to the intrinsic essence of music, as using emotional intelligence, to understand "the other", via music's universal codes, Jourdain's description of music's building blocks may nevertheless contain identical processes.

In both cases, it is via the music's features and factors that we can understand both theoretical and analytical processes, as well as being able to meet "a person's" inner world behind it.

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[197]"The Imagination of the Poet: Elements for a Poetics," focusing on the subsection, "An Attempt to Explain Poetic Creativity Psychologically." Available at: https://dlcl.stanford.edu/events/lost-classics-wilhelm-dilthey-imagination-poet

[198]"the Strukturzusammenhang, the interpreter re-creates in himself the original process of creation in the author. The object of interpretation is to understand the whole from its parts, from individual words and their connections. To understand any part of a work, however, presupposes the understanding of the whole. Dilthey is aware of this difficulty. But even though the whole be understood through re-experience - Dilthey calls it nacherlebendes Verstehen - such understanding would always remain subjective" (TAPPER, 1925, p.347).

In other words, we round off, as we started this investigation (Introduction), with the concept of "self-other understanding" and "community"[199] (SILVERMAN, 2023, n.p.). In this way, memorization can be a strategy to increase in depth, via the components of music. The understanding of the meeting between minds, i.e., an interpersonal relationship building. Albeit via emotional transfer and immersion, almost "virtually" (sound wave-wise) constructed, thanks to tactility and sense functions. Overall, an in-depth learning of human possible expressive abilities linked to instrument and body and imaginary ability that develops interpretive expressive possibility.

Although, these descriptions have a clear neuroscientific basis, where also the imaginary ability can be a link via "performance cues" to remember: "Auditory and motor imagery tasks often require musicians to actively retrieve music from long-term memory, such as familiar melodies, and maintain that information in working memory (Halpern and Zatorre, 1999; Herholz et al., 2008)" (BROWN, ZATORRE, PENHUNE, 2015, p.65).

Furthermore, the concept of "expectancy" is a similar indication that memorization affects interpretive trade-offs: "Auditory–motor expectancies may thus help expert musicians' retrieve music from long-term memory, plan ahead, control actions, and adapt to auditory feedback during a performance" (BROWN, ZATORRE, PENHUNE, 2015, p.65).

But what could be more precise than the definition: "aesthetic dimension", channeling expressions of reconciliation between nature and freedom, or like a: "recognition of phantasy (imagination) as a thought process with its own laws and truth values" (MARCUSE, 1955, p.141). In that case, a musician (pianist) can be called a mediator[200], or "translator" (Chap.1) – without thereby including an underestimation of a potential "listener". It is merely about reciprocity and meeting, in an expressive, resonant reality, for which one perhaps could say that emotional intelligence is required, or at least can be developed.

Thus, within and from one's own self, a meaning-maker, who, via experiences and memories, using the all-encompassing "touch", sensory functions released, combining intellectual and imaginary musical creation: defined as mental imagery[201] (KÜSSNER;

[199]See: Music Matters a Philosophy of Music Education (Blog, 2023). Available at: https://www.musicmatters2.com

[200]"In this mind/matter relationship, the human body can be seen as a biologically designed mediator that transfers physical energy up to a level of action-oriented meanings, to a mental level in which experiences, values, and intentions form the basic components of music signification. The reverse process is also possible: that the human body transfers an idea, or mental representation, into a material or energetic form. This two-way mediation process is largely constrained by body movements, which are assumed to play a central role in all musical activities" (LEMAN, 2008, p.xiii).

[201]"When mental images in two or more modalities are formed and experienced simultaneously or in succession, this is what we refer to as *multimodal mental imagery*. For instance, when we hear *and* see a musical performance in our mind, this is multimodal mental imagery—regardless of whether an external

TARUFFI; FLORIDOU, 2023). As Marcuse (1955) phrases: “The artistic imagination shapes the “unconscious memory”’ (p.144). According to Manfred Clynes (1990): “Casals often talked about “freedom with order”, “fantasy with order” as guiding principles, in music and otherwise” (p.38). During this research I have also noted, arising perspectives suggesting that by processing memory enhances tool for how individual´s approach judgements, how to decide, thus affecting abilities in relation to creativity and imagination (HOFFMANN, SCHMIDT & PLONER, 2022, p.3).

Since the senses are inescapable parts of nature, sense integration can be helpful as a developed strategy in interpretation through the memorization process. Thus, we can already conclude that the phase of “relearning”, here defined as a phase that constructs a “variation” of what was learned: “whereas relearning, which is found to be easier than learning, rests on actual familiarity to build memory in yet a different way” (DUNSBY, 2001).

Reinterpreting something, in another form, is a kind of creation. In addition, previously accumulated experience is used. A memorization phase would thus generate a deepened variation, as how regular repetition (even if apparently unreflect) will still be colored by new experiences.

Here we can detect a result which is based on a fact where enhanced knowledge and understanding (neural consolidation, new connection between synapses), to have the sensation of knowing something, how just that feeling creates “creativity”. Even if it is not explicitly outspoken that this explicit freedom caused an enhanced “creativity”, one must have the ability to also try to *interpret* what a pianist means when saying: “the theories make us free in a way” (FRIDELL, 2009. p.208).

It can be interpreted as when we feel that we can do something and have control (in a positive sense), the body's own curiosity to “discover” can be released more loosely, which can provide a prerequisite for creation, i.e. based on evolutionary physiology.

Also is stated: “It is a standard recommendation to students to divide a piece into sections for practice on the basis of its formal structure (Hughes, 1915; Lehrer, 1988; Matthay, 1926; Sandor, 1981; Shockley, 1986). Structure is so important because it is the key to memorization as well as interpretation” (CHAFFIN; IMREH; CRAWFORD, 2002, p.205). So, by that we can assume the relevance of the analytical memory. This could serve as a state where extra space is offered in the brain, since the structure is processed, to be filled with content of *imaginative* art, however we can reflect upon: “there is no evidence that higher education

stimulus (such as music) is present or not” (KÜSSNER; TARUFFI; FLORIDOU, 2023, p.3).

induces creative power. For one thing, colleges almost ignore the subject of imagination" (OSBORN, 1948, p.24).

Descriptions from performers telling they feel "free" as interpreters must imply that a sensation of accomplishment as some kind of security has been achieved that support this freedom. To have predetermined something imply a phase of decision-making, which then is constructing knowledge. A learning process is about experience and as such it relates to stored memories, but also how to form new memories, a progression of strengthened synapses in the brain, as we have seen figures (Chap.2).

In that perspective, just by raising Fridell´s (2009) example, we can draw the conclusion that, any type of decisions that are made regarding how the music can be interpreted, can provide a scenario of enhanced freedom. But, if we analyze this again, how can a pre-decided concept create freedom? How can something tend to be free if already decided?

If we can hear up to 400,000 different frequencies[202], then we should also be able (depending on the range of the instrument) to produce the same variety, as Jourdain (1998) said: "All in all, the physics of musical instruments fortuitously matches the biology of our ears" (p. 43). As we can sense a grain of sand under a fingertip, even feel a hair on our skin, and next moment press with all our muscle forces, moving a heavy stone (LUNDBORG, 2014), so can even this immense range of various levels of power affect the contact with the keys.

Since we now know that our brain is developed for language (regardless of which sense function) and thus considers a hand as well as a mouth as having the same prerequisite for language (WILSON, 1999) i.e., they do both talk. Consequently, also pianists, use a variant of "language signing", the hands with its fingers pressing keys to make sounds.

Just *knowing* this, is an enhanced interpretative and memorizing tool to count on, not least based on the understanding of the hands´ ability to "talk", *per se,* in parity with demonstrated sensibility ("feel a hair on our skin").

The vision assists us in searching for meaning, by interpreting what there is to see. Based on previous knowledge and experiences our vision forms a picture that makes sense to us. But if we deliberately interfere in these sensorium process, we can change our interpretation by means of our thought-processes, how we think, and *feel,* not least with the body, where concepts

[202]"Our range of hearing is from 20 to 20,000 Hertz and so wide that we can tell the difference between about 400,000 different frequencies. Of course, there are many more frequencies that even people with perfect hearing simply cannot hear, because they fall outside our hearing range". Available at: https://www.tritonhearing.co.nz/blog/hearing-and-hearing-loss/human-hearing-in-comparison-1/

such as attention, focus and discrimination tend to alter our perception and association chains. This maintains familiarity with Dreyfus (2020) referring to C.P.E. Bach (1756): "Where is the evidence of emotive experience? "*Man sieht und hört es ihm an*" – "One sees and hears it in him."' (p.169). By controlling (or observing) the eye, finger, and hand muscles, or not just doing as usual, instead creating new patterns, can affect both memorization and interpretation. The literature taught us that focus affects us neurologically.

The most common denominators for creativity, according to Samuel A Malone is "to create something that did not exist before; to see new connections"[203] (MALONE, 1998, p.75). Alex F. Osborn (1948) emphasizes especially the phrase: "the degree of one´s creative power does not depend upon a degree. This point is stressed because self-confidence is one of the keys to increased creativity" (p.27). Osborn, perhaps one of few presenting himself as: "my hobby is imagination" (p.xi).

The topic "phantasy" is related to philosophical ideas presented by Marcuse (1955) that music, and its features related to "phantasy", refers to all ours "sense of loss", due to the since a long time ago broken ties to nature. In this context, we cannot avoid referring to Snowdon et al (2015) whose research on (animal and human) sound, derived from evolution, an emotional social and communicative linking, as a starting point for music, as a reason why we can be influenced tangible. What Marcuse (1955) solution refers to, is that we in music, by listening and playing, retake that loss by using imagination: "a thought process with its own laws and truth values" (MARCUSE, 1955, p.141). Thus, it can be a possibility to use memorization as a process to access one´s (also subliminal) musical (as autobiographical) memories. Because the process of relying on one's memories (or as the saying: jog your memory!) inevitably touches long-term memories and areas of the brain that link to past experiences.

Similar thoughts, replacing "phantasy" with "imagination" leads us into today´s research of music imagery (TERRY; WILLIAMON; AKSENTIJEVIC, 2011; KÜSSNER; TARUFFI; FLORIDOU, 2023). Despite a growing scientific interest related to music and imagination (KÜSSNER; TARUFFI; FLORIDOU, 2023), the concept of "imagination" *per se,* appears, as "invisible" in a music curriculum, at least seldom found explicitly "in written" in the syllabus. This, even if the subject as such is claimed to constitute a present and inevitable part of teaching and learning in music education, under the more applied concept: "creativity".

Against this background, I cannot see anything but that the source behind what constitutes (how to put together different musical variables for) interpretation is based on various types of

[203]In the original: "Kreativitet är att skapa något som inte fanns förut; att se nya samband".

imagery, imagination, fantasy, or named as self-creativity. In a music interpretative context, one must reflect over how much of our former stored memories constitute the basis for musical ideas. Or if it just happens, due to "phantasy", a dichotomy outlined accordingly: "James (1890) distinguished between *reproductive* and *productive imagination*; more recent accounts use the terms *memory imagery* and *imagination imagery* (Gracyk, 2019)" (KÜSSNER; TARUFFI; FLORIDOU, 2023, p.2)

> Phantasy is above all the "creative activity out of which flow the answers to all answerable questions"; it is "the mother of all possibilities, in which all mental opposites as well as the conflict between internal and external world are united"[204] (MARCUSE, 1955, pp.147-148).

In this respect, a memorization process is like putting together a puzzle. Although, hypothetically, it contains a palette of possibilities, with even "mental opposites". Choosing among musical sounds within the current music sphere, in a way that also consciously allows for "conflicting" creations, according to Marcuse (1955).

Consciously interpreting, during the act of memorization itself, i.e. enables a state of reflection, since the very purpose is that everything must be remembered, a necessary initial overall stance (RUBIN-RABSON, 1950). This means that memorization provides a state of "slow-motion", with a gradual development of knowing, as Hughes (1915) said: "I *know* that I know every note" (p.597).

A similarly described strategic incorporation of memories constitutes both security and an overview. Thus, a prerequisite to be able to gradually design the musical interpretation "improvisationally". To be able to reach this stage "by heart" then corresponds to how imagination as creative unlimited possibilities give us several answers to various interpretive questions (MARCUSE, 1955). Using memorization as a process and prerequisite for complete freedom through the expressive possibilities of the senses.

"Current research is considering imagery use for functions including developing and enhancing expressivity during practice and performance, assisting with learning and memorizing music" (TERRY; WILLIAMON; AKSENTIJEVIC, 2011, p.351) but also: "it has been suggested that informal practice that is aimed at enjoyment may contribute to expressivity in performance (Sloboda, 2000)" (BROWN, ZATORRE, PENHUNE, 2015, p.74).

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[204]"*Psychology o f the Unconscious,* transl. Beatrice M . Hinkle (London: Routledge and Kegan Paul, 1951), pp. 13-14. In Edward Glover's excellent analysis makes a further discussion of Jung´s work unnecessary. (New York: W. W. Norton, 1950)" (MARCUSE, 1955, p.147-148).

Therefore, memorization could be compared more closely to music imagery, and vice versa, as a mentally prepared musical "thought". Even if music is handed over filled with instructions by the composer, it is still intended to be shaped and interpreted. But also, it needs to be highlighted that the bodily memories are a part. The haptic functions to which focus must be further applied also when "imagining" a musical phrase. Too much focus is put on an often-impossible task, to "think" about everything. Instead of "doing" and put emphasis how to learn to deliberately reflect with the body, as "bodily imagery" – equated with "mental imagery".

Not only authors, but also pianists admit (empirically based) that muscle memory, despite its assisting and inevitable reliable property of "automaticity", can still be experienced as "unreliable" as a memorization strategy if it is not combined with other forms of memory and its strategies. If not, the result can lead to: "instilling fear and insecurity in the pianist. They taunt the performer: "I'll bet you don't know the next note!" (DICKINSON, p. 2009, p.271).

But evidence for playing "by ear" is substantiated in neuroscientific findings. Since inner hearing is directly controlling motor skills[206] (WATSON, 2006, p.536), these inner "thought" processes are important evidence. If inner hearing based on a memorization process controls the motor, this means that experimental inner hearing can generate different types of interpretations.

The conclusion is that an imaginary internal representation of how the music might sound, corresponding to internal musical ideas, results in a real-sounding soundscape. Evidence that memorization (based on the view that memorization is a form of an imaginary "mind map") is a strategy in music interpretation.

But, again, it is also about training sensitivity and trust in one's own body's abilities and reactions, its know-how and (evolutionary) built-in musical-emotional suggestions.

The Memorization Process should have, precisely because it presupposes its own inner "ownership" of the player, greater opportunities to create room for action and to find its own inner "voice". According to O´KEANE (2021): "individual experience that gives each person a highly individualized memory map, an imprint, and that´s very unique to them"[207], a state that can also be described as the ways "experiences are changing neural networks by both adding

[206]"Activity in the motor cortex occurred in the region controlling a finger just before the note it would have played was sounded and so it mirrored the activity that would have been required for playing. No such response was seen in a control group of similarly experienced singers who were not pianists. This type of connection would undoubtedly support the ability to play music by ear" (WATSON, 2006, p.536).

[207]O´KEANE, youtube (2022): How we make memories and how memories make us – with Veronica O'Keane. Available at: https://www.youtube.com/watch?v=TZMYvnL8dfI

and pruning synapses" (Kolb & Gibb, 2011, p. 268)" (HODGES, 2019, p.27). These observations point to how imagination can develop interpretation via memorization.

Imagery

I*magery* refers to a mental state with an inner experience of sight, hearing, and touch, "physical skill", or kinaesthetic. A practice of thinking, feeling, imagining, similar fantasizing. The difference is that imagery differs from perception, which is based on stimuli of a physical nature: "[v]isual mental imagery is 'seeing' in the absence of the appropriate immediate sensory input, auditory mental imagery is 'hearing' in the absence of the immediate sensory input, and so on" (KÜSSNER; TARUFFI; FLORIDOU, 2023, p.1). I*magery* also involves the ability to understand and reproduce by using these neural networks and in the process called: "cognitive or imaginary rehearsal of a physical skill without overt muscular movement (…) used to create or recreate an experience that is similar to a given physical event" (Connolly & Williamon, 2004, p. 224) (KÜSSNER; TARUFFI; FLORIDOU, 2023, p.1).

"Mental practice refers to the use of imagery as opposed to the physical or motor skills used in physical practice" (MIELKE; COMEAU, 2019, p.196). Scientific literature approves the advantages of mental practice: "benefits of mental practice for musicians at any level of proficiency, even young students and beginning musicians (Freymuth, 1993)" (MIELKE; COMEAU, 2019, p.197). Beneficial outcomes are: "developing and enhancing expressivity during practice and performance, assisting with learning and memorizing music" (CLARK; WILLIAMON; AKSENTIJEVIC, 2012, p.351), which also older authors refer to (MATTHAY, 1913; HUGHES, 1915; RUBIN-RABSON, 1950, among others).

Mielke & Comeau (2019) accomplished terminology of mental practice in music performance lists: "covert rehearsal", "mental practice", "mental imagery", "motor imagery", "music performance", "silent rehearsal", "auditory modeling", "aural modeling", "auditory imagery", and "aural imagery" (p.198).

At present, scientific findings about (mental) *imagery* (KÜSSNER; FLORIDOU; TARUFFI, 2022) (visual, auditive, tactile/kinaesthetic) have unfolded links to a deeper understanding of memory processes *per se*. That piano playing in fact demands a complex cognitive apparatus is understandable. But just approaching the functional progress of human memory, aiming at a conceptualization of how the senses work together, also linked to music

interpretation, made me more than once reconsider my possibilities of completion, based on frequent doubts like "you must write a thesis that you are able to write" (ECO, 1977, p.8).

In other words, the process of interpretation is shaping the music, which can obviously be done as an exercise at the instrument, "practical practice" ("PP"). But it can also be treated as "mental practice" ("MP"). Therefore, the best results are achieved when there is a combination of performance and mental training (Iorio et al, 2022).

According to Endestad et al (2020), it is possible to find similar neuronal activations whether imagining or listening to a melody, described as: "consistent with the widespread idea that imagery uses the same neural substrate of perception (Kosslyn, 1980, 1994; Zatorre et al., 1996; Halpern and Zatorre, 1999; Pearson et al., 2015)" (pp.16-17).

Moreover, the authors proposed a link between mental practice as a strategy for music memorization which cultivates performance[208], in an interesting manner which demonstrates that the more the long-term memory (LTM) is used, the less (!) the neural activity can be traced in the brain[209], i.e., the brain "chunks" the information, and "frees" space: "experts require lower levels of effort, perhaps because the relevant neural network has become more efficient, than the less experienced or the novices" (ENDESTAD, et al, 2020, p.17).

It must be clarified that memorization as *learning* implies the development of knowledge and experiences that are tangibly visible in the brain's various cortexes (HAWKINS & AHMAD, 2016; WANG & AGIUS, 2018; KANDEL, 2000; RÖSCH, 2013), nevertheless, it functions as a kind of "chunking" in the brain as well. That is, what is "chunked" in a sheet of music, only clarifies what is correspondingly "chunked" in the brain, which has positive consequences for the entire movement apparatus, i.e., coordination and calibration of sensorimotor skills and the multisensory and multimodal functions of the senses.

The incredible thing is that even these imaginary processes can be demonstrated, visible in the brain, in identical centers as the real physiological ones (ENDESTAD et al, 2020), described as: "Imagined movement was shown to induce activity in many of the same brain areas – e.g. motor cortex, cerebellum, parietal cortex – as did executed movement, "underlining

[208]"Indeed, musical ''mental practice'' (Coffman, 1990) is well known as an effective tool for enhancing memorization of music and refining performance (e.g., Driskell et al., 1994; Halpern et al., 2004; Highben and Palmer, 2004; Holmes, 2005; Lotze and Halsband, 2006; Cahn, 2008; Gregg et al., 2008; Keller, 2012; Halpern and Overy, 2019)" (ENDESTAD, et al. 2020).

[209]"Lower neural activity in experts may seem paradoxical but it may be a hallmark of expertise (in musicians: Jäncke et al., 2000; Krings et al., 2000; Koeneke et al., 2004; but also in sport athletes: Naito and Hirose, 2014). That is, long-term training sharpens the relevant neural networks and dampens or filters irrelevant or noisy activity (Milton et al., 2007), so that the network becomes more efficient and uses lower activity or fewer dedicated units for its operation" (ENDESTAD, et al. 2020).

the concept" according to the authors "that motor imagery shares the same neuronal substrates as executed movements"'[210].

Thus, in the same way we know that muscle memory is gradually strengthened and automated (depending on the degree of repetition), which results in the pianist's freedom of making movements, becoming more flexible, plastic, and adaptable. So also, an imaginary act can be strengthened, i.e. if a pianist trains both the auditory, tactile, and visual memory of a piece of music, and not least to structurally analyze, to intellectually "think" through the whole music and be able to "verbalize" the process, this internal "work" will also give demonstrable results, literally and figuratively, in body and mind.

Empirically, we can detect and experience these processes, illustrated by to "know" when something is difficult, and we "feel" when we start to learn, and we can say with certainty when we know. In a neuroscientific perspective, a similar state can be found described as: "long lasting extensive hand skill training of the pianists leads to greater efficiency which is reflected in a smaller number of active neurons needed to perform given finger movements" (BANGERT & ALTENMÜLLER, 2003, p.2).

As Mielke & Comeau (2019) state: "The current lack of clarity and consistency in the terminology of mental practice in music performance creates a disruption in this research development" (p.197). In addition, there were no consequence regarding the terminology "use of synonyms (multiple terms), which were used interchangeably" (p.197) why they also related their claim based on Bailin & Grafstein´s (2016) findings: "Because vocabulary is the most important factor affecting comprehension" (MIELKE; COMEAU, 2019, p.197).

If so, of course this statement is extremely important for this entire research, with reference to the "think-aloud protocol" (Laske, 1977, p.20 apud BRYANT, 1986, p.44). In addition, after further investigations about "verbalisation"[211], the related findings pointed to Ericsson et al (1993): "a technique, using think aloud concurrent or retrospective verbal

[210]Source: musician science (blog): Available at: https://www.musicianscience.org/index.php/professional-musicians-display-more-focussed brain-activation-than-amateurs-during-performance-real-or-imaginary/

[211]"the inner speech that results provides a means of mental control that can be used to implement plans and strategies (Reisberg 1992, p. viii; Rubin 2006) (...) The important role of inner speech in mental control has been noted by many psychologists including Pavlov, Watson, Vygotsky, and Piaget (...) The process of directing and monitoring our own mental operations in this way may be responsible for uniquely human qualities of conscious experience (Dennett 1991)" (CHAFFIN, LOGAN, BEGOSH, 2009, p.357).

[211]"Rehearsing a mental instruction in working memory broadcasts it throughout the nervous system, automatically activating other systems and coordinating their activity"(Barrs 1988)" (CHAFFIN, LOGAN, BEGOSH, 2009, p.357).

[211]"As we noted above, this ability can be used for mental rehearsal or to recover if the associative chain of a memorized performance breaks" (CHAFFIN, LOGAN, BEGOSH, 2009, p.357).

protocols to trace out cognitive processes, in a review of experimental cognitive psychology" (CHARNESS, 2021, p.131). The concept showed to demonstrate: "[t]hink aloud instructions (…) for building theories of human problem-solving (e.g., Duncker, 1945), were given strong impetus by Neweel and Simon´s (1972) *Human Problem Solving* tome" (CHARNESS, 2021, p.132). Suddenly, another field emerged, which interlinked all various concepts that was found in the literature, although in slightly altered formulations, some found in Charness (2021) referring to Herbert Simon´s book (1984/1993): *"Protocol Analysis: Verbal Reports as Data"* (CHARNESS, 2021, p.131).

A practical implementation is to say out loud, "thinking-aloud", to "act" and "verbalise" and beforehand plan and to employ for all levels and ages playing piano. My own experience has shown that if these "protocols", a concept used by Bryant (1986) is applied, but not only for the pianist practising alone, but specifically if talking and describing the memorized music for others, the memorization process will be even more reinforced, which was exemplified in a music example, by Hugo Ribeiro (Chap.2).

I found interesting to compare this experience to Gordon's findings (1990) that there is a difference related to focus and projection when the performer needs to play in front of an audience, compared to while playing alone, for one´s own self. This may sound obvious, since it is experienced by most artists that playing by heart in the practice room works easily, but not so easily on stage, in front of others. Then a similar approach should be able to be applied to "describing" one's music with words, in parallel with playing, and explicitly be allowed to practice this in front of others.

Therefore, I believe that the strategy "verbalization" could also be useful as a practical memorization training, in a format applied as a workshop in group. To offer students (learners) regular "memorization practice" with an experimental approach in a real-life situation, together with classmates or colleagues. Otherwise, applied (group) practice in the process how to memorize is consequently hindered, since rarely used as an explicit tool aimed at teaching. Neither, it is the main topic in "masterclasses", with the purpose to "test" different memorization methods in front of (and together) with others.

Since we have learned that the sight is a dominant sense, a unilaterally (visual) focus (on a score) means that the pianist´s ability to focus on hearing and touch might be "reduced", in accordance with the concept "cross-modal attention".

Hereby the pianist´s ability to pay attention to the circular reverberating and sounding "output and input process" decreases regarding: 1) what the somatosensory mind and body "wants" to "articulate" (based on long-term, and subliminal memories) and to: 2) deliberately

“change” the focus in-between the senses. Once aware of those functions (cross modal attention), it could be a possible didactical tool for interpretation and memorization (experimental approach to closing the eyes, certain aural or tactile focus, etc), also while (practicing) playing “by heart”.

As one of the outcomes of this study, I intend to develop a curriculum and syllabus for an experimental memory lab based on Kolb's (2013, p.35) learning cycle (Figure 25) based on experiences, reflections, thinking, imagination and actions in interaction with unfolding sensory sensations.

Such a process might even imply playing “erroneously”, before getting used to simultaneously describe, thinking aloud, verbalise the music, and meanwhile to apply in action. Since “correctness” characterizes most areas related to education system perhaps such a procedure is rarely ok to use as a tool (not least in higher education). Although it is never good to play “wrong”, due to created neural “pathways”, difficult to later erase – but the mental deliberation *per se*, the sensation of not being “punished” if playing “wrong”, might increase a sensation of boosted courage with resulting creativity.

I have adopted in classes, letting students describing their music memorization as if they are giving a TED-talk. This exposure, oral presentation based on *imagery*, about the format of the music, as precisely as possile, actually resulted in an enhanced state of memorization. In this sense, the music once memorized, is neither available visibly as in the score to be followed with the eye, or hearable as a music recording attended by the ear, nor to be felt as by the fingertips touching a braille-score. The memorized music is then incorporated inside the self and transformed into an internal mind-map.

The literature review also pointed to a general approach among authors, it is that memorized music increases performers´ ability to play musically with an enhanced expressivity. Arguments for this are merely based on that without the score the eyes are freed from the stand and sheet music which allows the performer to also communicate better with the audience.

The Mind Map

To think and talk aloud, to hear and see in the mind´s eye, cannot occur without a certain number of memories, which are used in the processes of memorization. On the other hand, the more we present something, we create new memories and understandings depending on how we speak, and how we hear ourselves speak. In the literature we find concepts such as “think-

aloud"[212] (NOUSHAD, et al, 2023), and protocols (BRYANT, 1986), delineated out of memory research as a tool to assist the performer in the process of how to memorize better. However, what is intended, is as Hughes (1915) described that the notes are pronounced loudly, regarding the musical landscape, to its bits and essence.

A "verbal protocol" seems only to describe the form and the theoretical foundation of the "order" in the music, like Snyder (2001) refer to as orienting oneself. But by "verbalizing" the pianist also increases the "self-hearing", literally and figuratively, since self-hearing *is* related to the theoretical structure of the music, even as a so-called "intellectual" or "thought"-process linked to analysis. This is because, during time, since music once could be noted down in signs and scores, the idea was, and still is, for the performer who wants to memorize and play by heart, merely a format for the music to be learnt and remembered. We all too often forget this detail. So, the format in which music can be preserved, unless only committed to one´s memory, is this "extended mind"[213], if a score.

As already shown in this research, the main purpose has not been to focus on the music by primarily studying sheet music *per se* (which is perhaps most common with more western art music related piano music, to which area I belong). Instead, the goal has been to broaden the perspectives, and focus largely on how to analyze, identify, understand, and implement different types of behind lying storage processes for the music in the memory.

Vision already appears as the (main) common (perhaps unreflect) denominator in relation to music interpretation. Those types of investigations related to "vision" are widely spread[214]. Already Venable (1913), argued: "Therefore the first necessity for the student of music is, Learn to read! And the second? Learn to read! And the third? Learn to read!" (p.2) – which is a still

[212]"The think-aloud (TA) method studies cognitive processes and decision-making strategies by having people voice their thoughts while performing a task or solving a problem (Ericsson and Simon Citation 1980). Ericsson and Simon's theoretical stance for the think-aloud approach is based on the distinction between working and long-term memory. This theory states that concurrent reasoning occurs in working memory, which is a cognitive system of limited capacity that temporarily holds information for immediate processing (Atkinson and Shiffrin Citation1968)" (NOUSHAD et al, 2023, p.1).

[213]"Clark and Chalmers present a thought experiment to illustrate the environment's role in connection to the mind. The fictional characters Otto and Inga are both travelling to a museum simultaneously. Otto has Alzheimer's disease, and has written all of his directions down in a notebook to serve the function of his memory. Inga is able to recall the internal directions within her memory. The argument is that the Only difference existing in these two cases is that Inga's memory is being internally processed by the brain, while Otto's memory is being served by the notebook. In other words, Otto's mind has been extended to include the notebook as the source of his memory. The notebook qualifies as such because it is *constantly and immediately accessible* to Otto, and it is *automatically endorsed* by him. They also suggest Otto's notebook should be considered an extension of himself; the notebook in a way becomes a "fragile biological limb or organ". Available at: https://en.wikipedia.org/wiki/Extended_mind_thesis

[214]Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6787282/

common approach. Perhaps, I limited myself in this regard, as I continuously and daily live by, and learn from written notes. Instead, I wanted to embrace a different approach.

Therefore, I was caught by other approaches, such as the "think-aloud protocol" Bryant (1986) refers to (Chapter 2 On Memory). For a pianist a way to identify (via memorization) a "self-hearing", what to express . Bryant (1986) presented "think-aloud protocol" as a practical suggestion on how to memorize. Her chart instructions (pp.98-116) described how to build up an internal memory map and how to verbally describe the sequence of events in the music. She found that the group that received a lecture about human memory system memorised better than the group without a lecture[215]. What literature describes as tools for remembering the music, strategies to memorize are: "safety net", "mind map"[216], "think-aloud", "action–", and "verbal protocol", which could as well be part in a big [internal/visual] "mind mapping"[217] (MALONE, 1998, p.67).

Thus, it seems clear, the impact of the "verbal protocol" on "teaching", for it works as a mode for enhanced knowledge, which is a common approach. I use myself, asking students to "verbally describe" what they do, "so their own ears hear what they say out loud", or to pretend you are practicing, memorizing, interpreting in front of a group of students, acquiring your knowledge. This, in certain way, reinforce the claims that mind maps increase the flow of ideas and imagination, flexibility, increased ability to associate with an overview of connections and consequently also the possibility to "rearrange" the map.

The process of memorization, to play heart, largely consists of designing an internal "mind map", i.e., breaking down the components of music into comprehensible units, "cues" (BRYANT, 1986), or as developed via into "performance cues"[218] (CHAFFIN et al, 2002). A

[215]One of the first authors studied related to memorization, was Dorothy Bryant (1986). Her research was constituted by two control groups (wind players) with the purpose to memorize. Before the task was accomplished, one group was offered a seminar, a brief overview and presentation about the functions of human memory systems. The second group received no such instructions. The result demonstrated how just mentioning the presence of memory (and senses) increased the participants´ (in the study) ability to memorize, compared to the others. It might have a simple explanation, to claim the result (BRYANT, 1986) as merely based on highlighted *attention,* on the own body, and its adjacent sensory tools.

[216]"a mental map of the piece that allows them to keep track of where they are as the performance unfolds. The map provides landmarks where they can restart the performance if necessary (Chaffin *et al*. 2002, Chapter 9)" (CHAFFIN, LOGAN, BEGOSH, 2009, p.353).

[217]Translated from Swedish: "Mind mapping helps us gather information in a way that encourages new associations (...) The structure of mind maps makes it easier for us to come up with ideas, integrate information and discover syntheses, connections, combinations, relationships and associations between the ideas" (MALONE, 1998, p.67).

[218]"Performance cues point to different types of memory according to which aspect of the music they address. *Structural* cues are critical places in the formal structure, such as section boundaries. *Expressive* cues represent musical feelings, e.g., excitement. *Interpretive* cues refer to musical gestures, such as changes of tempo or dynamics. *Basic* cues point to motor memory for critical details of technique, e.g., a fingering that sets the hand up for what follows. Musicians are likely to agree on the musical structure of a piece" (CHAFFIN, LOGAN, BEGOSH, 2009, p.360).

characteristic tool for memorization discovered among authors is about "planning", how to create an internal "mind map" (CHAFFIN, et al 2009). Also, the word "power" for memory functions is used as well as how addressing the action itself: "power of mentally translating into sound" (SHINN, 1898, p.4). Thus, a focus set on a mind-rich system where inherent structures are intended to be understood ("mentally") to be used practically, while memorizing.

And as the body speaks, articulated through the senses (PALLASMAA, 1994) we can detect a concept consisting of mental and bodily "thinking", regarding how to memorize and interpret, as part of a cognitive process.

Thus, when this "mind map" is built up in the memory, via different forms of "thinking", both bodily as well as mentally and intellectually, then, what else than the imagination, the "imagery" or "phantasy", based on former experiences or memories, can fill this gap – saying the unsaid, which wants to be said? In other words, this is also called "artistry", which also raise perspectives related to individuality and personality, where functions of art are seen as: "another person, with whom we converse" (PALLASMAA, 1994, p.47).

Memorizing – Genesis to Interpretation (and Vice Versa)

First, if we clarify that memory, de facto, starts from "sensory memories", also from a historical perspective where the connections between the senses and imagination, movement, body, and memory were described as follows:

> the senses, that is, vision, hearing, taste, smell and touch, and with these athagil, which the Greeks call fantasy, and furthermore, that the spirit which is in the middle ventricle operates cogitation, cognition, and foresight, and the spirit which is in the posterior ventricle operates motion and memory. (Costa ben Luca, *De differentia spiritus et animae*, 275–282) (KNUUTTILA & KÄRKKÄINEN, 2014, p.134).

Those sensory memories, after first being interpreted via various stages of both unconscious and conscious processes, are then organized, reshaped, and stored as short- and or long-term memories, linked to both our mental and physical capacity. Like the title: "Theories of Internal Senses" (KNUUTTILA & KÄRKKÄINEN, 2014, p.130), a phrase based on Aristotle, describes:

> four kinds of powers which distinguish particular things: first the common sense, next the imagination, next the cogitation, and last the memory. He regarded memory as the most spiritual, then cogitation, then imagination and last the sensory powers. (Averroes, *In Aristotelis De anima* III.6 (415–416) (KNUUTTILA & KÄRKKÄINEN, 2014, p.136).

As demonstrated, external stimuli (perception) can affect our senses, alternatively that we ourselves, through our imaginary ability, also feel, hear, and see, for our inner ear, “in the mind's eye”, or as “a feeling”, or as we say: “we are “touched” by the music, both in a literal and figurative sense” (REYBROUCK, 2021, p.xiv).

Also, Wilson (1999) states: “the hand is involved from the beginning in the baby’s construction of visuomotor, kinesthetic, and haptic representations of the world and the objects in it. This is a profoundly important role for the hand, whose importance in both cognitive and emotional ontogeny cannot be overstated” (p.323). This leads us into the perspective of sense of self, the memorizing interpreter, or vice versa, the interpreting memorizer:

> Contrary to our intuitive understanding based on personal experience, perceptions are not direct copies of the world around us. The information available to sensory systems at any instant in time is imperfect and incomplete. So perceptual systems are not built like physical devices for making measurements, but instead are built to perform inferences about the world. Sensory data should not be thought of as giving answers, but as providing clues. The brain, for example, is where seeing happens; it is the brain that figures out what the clues mean. Thus visual perception is a creation of the brain. It is based on the input extracted from the retinal image. But what is seen in the “mind's eye” goes far beyond what is presented in the input. The brain uses information it has extracted previously as the basis for educated guesses — perceptual inferences about the state of the world[219] (KANDEL et al, 2013, p.446).

From this we can understand that: “Sensory data should not be thought of as giving answers, but as providing clues”[220] (KANDEL et al, 2013, p.446), and the question is then to what extent our sense of self affects the interpretative perspective, pinpointing: ”By linking the past with the future, our memories define our sense of identity” (BUZSÁKI, MCKENZIE, DAVACHI, 2022, p.187).

The Self

One conclusion is that with an enhanced “automaticity” in piano playing, the potential thereby increases to be able also to perform these creative interpretation methods, which are also based on imaginary creative ideas. Formulated in reverse, it would be called: to have the opportunity to fantasize and create interpretive variations, a prerequisite is that the piano playing flows. But can this really be true? Does it matter whether you “know” everything perfectly, since as soon as you start playing at the piano tones are created, i.e. as music?

[219]Available at: https://archive.org/details/PrinciplesOfNeuralScienceFifthKANDEL/page/n496/mode/1up?view=theater
[220]*Ibidem*

A challenge is to become aware of balancing imagination, inner (self-) hearing, in relation to not let “muscles” “take over”. If motor memory shows any technical limitations, it can hinder interpretive (imaginary) experimentation This happens due to muscular memory and its immediate construction generating neural patterns in motor cortex. Or perhaps it can be the other way around? That the body interprets “better” – if listened to?

That is why a gradual awareness of the *self* as decision-maker, can be delineated. To adopt the “thinking-aloud” concept by Ericsson and Simon (1993): “a) to speak all thoughts, even if they are unrelated to the task; b) to refrain from explaining the thoughts; c) to not try to plan out what to say; d) to imagine the participants are alone and speak to themselves; and e) to speak continuously” (NOUSHAD, et al, 2023, p.2). To “say” everything out loud as means of detecting sensory sensations, as perception and/or as outcomes resulting from imagery.

Today, “thinking-aloud”, “TA”, Noushad et al (2023, p.3) refer to as: “prior to the task, as this provides participants with the confidence necessary to verbalize their thoughts (Ericsson and Simon, 1993)”. Thus, seemingly if implemented as a practice process, it might provide better self-esteem and security. The challenge of simultaneously think and talk, is based on a certain cognitive limitation: “the energy required to execute each individual task limits the number of tasks that can be performed concurrently (Schaefer 2014)” (NOUSHAD et al, 2023, p.3).

Consequently, a link to Miller´s (1955) description of 7±2, how much one can hold in memory. The advantage of “chunking”, as a variant of automatization, is in a “think-aloud”-context described as: “a well-rehearsed task requires less cognitive effort (i.e. automatic processing) than a novel task (i.e. controlled processing)” (NOUSHAD et al, 2023, p.3).

Here emerge even more variables of “automation”, presented as the opposite of “controlled”. Consequently, even if the former refers to something well-rehearsed. It must have initially developed due to a “controlled” sequence of events - intended to be carried out during the process of memorization.

This is precisely according to the process of memorization. If it is designed in line with “controlled-processing”, would in that case constitute an initially demanding cognitive load, to then be automated, however - after a slow strategic development in line with think-aloud, and a “self-growing” ‘I’, daring to explore techniques to interpret.

Since the performing pianist is both performer and audience at the same time, the process (Introduction, Figure 1) can also be described as the performing pianist being both performer and audience at the same time.

To be an interpreter implies a calibration in relation to a continuous balance between sounding output and input. The role of memory is clarified as an ever-present influencing reverberating factor. Like an alternative variant of Reybrouck's (2024) description of self-touch, Mazzola (2011, p.58) illustrates the instrument (an "interface") and pianist in collaboration:

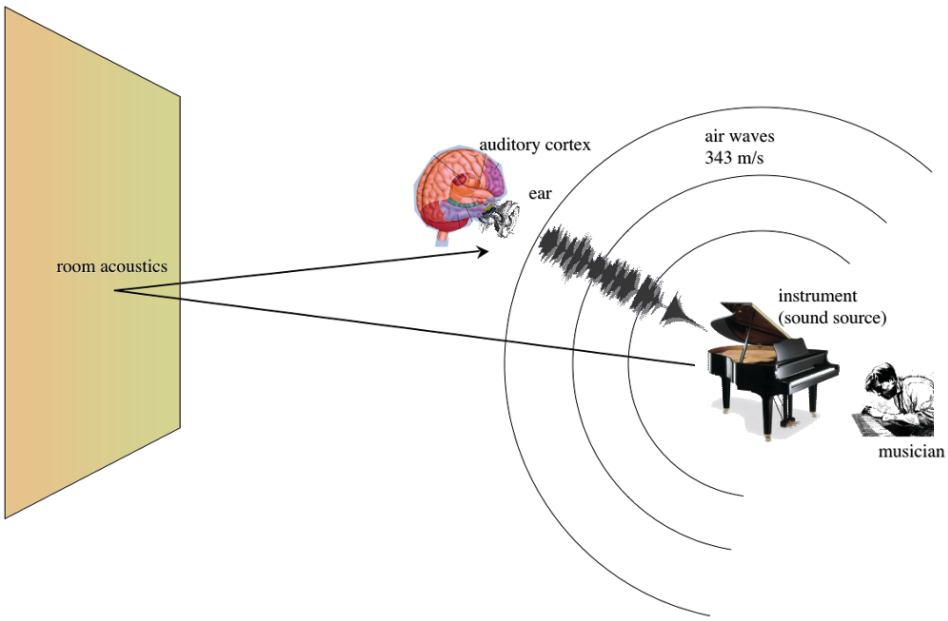

Figure 26: my understanding and development of Mazzola (2011, p.58), as a stage referring to the development of a performing person's *sense of self* which occurs in a circular reverberation process.

The illustration (Figure 26) unfolds a (desired) outcome, as a circular reverberating process. It implies an understanding and development of a person´s *sense of self*, having in mind Alf Gabrielson's assertion that "the performance of music brings with it the possibility to test boundaries (2011, 207)" (SWART, 2016, p.118). Thus, the approach to musical interpretation, analyzed within, or related to aspects of memory and memorization, could enter a more justified "therapeutical" phase of curiosity.

A playing pianist hears, feels, experiences produced music as an "answer", a "reverberation", of the "self". Also, a state establishing an existence of the *other.* The *other*, implies the composer´s music. A memory of another person´s *self.* The performer redresses another person´s *self.* When an explicit memorizing process occurs means an act of communication. A level of shared emotional intelligence[221] calibrating evolutionary related universal sounds.

[221]"The ability to understand and manage emotions and to use emotional knowledge to enhance thought and deal effectively with tasks. Components of emotional intelligence include empathy, self-motivation, self-awareness, self-regulation, and social skill. Emotional intelligence is a measurement of one´s ability to socialize or relate to

Thus, an increased probability to deliberate musical actions. As well as sprung out of expectations, also, forming a basis for expectations. Consequently, a platform as an experimental approach for music making, with a sender and a receiver; one´s self – and/or an external listener.

While the use of sensory information responds to received sensory stimuli, also the opposite occurs. Deliberately created affects are caused by musical manipulating of senses, playing piano. Those interpretative decisions can then be addressed as taken directly from sensory (memory) input. The phase to attentively *work* with the senses musically can be described as how to "work" within the working memory, i.e., to use and repeat short term memories, to enhance musical elements.

A result of this procedure is that those short-term memories develop into stored long-term memories. If playing piano by heart, those can be brought back when needed. But this "enciphering" of short-term memory into long term memory requires some reorganization in a coding-manner that the pianist instantly can find the required items.

Since "neuroscience can now explain many processes involved in the making of a musician" (SWART, 2016, p.129) I imagine a near future where exchange of experiences with neuroscientific findings would imply a more profound platform based on an explicit and experimental hands-on-practice. A possible effect which even could affect methodological and didactical aspects in the overall realm of piano playing[222]. It means that the senses, the touch of the fingers with the music can turn out to be a visualized link, to the cooperation between the hemispheres of the brain. "That said, emotional memory is still one of the deepest and least understood types of memory (Sacks 2008, 217)" (SWART, 2016, p.122).

Music interpretation has been investigated in aspects of creativity (Lisboa et al.; Payne; Barros et al.; Wise et al.; apud HÉROUX, 2018, p.1) but still it seems as if the question has not been answered: "Why do expert musicians working from the same score create different musical interpretations? During individual practice sessions, what happens that allows each musician to produce significantly different interpretive results?" (HÉROUX, 2018, p.1).

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others" (MeSH, 2023) Svensk MeSH, Karolinska Institutet, NIH, National Library of Medicine. Available at: https://mesh.kib.ki.se/term/D056348/emotional-intelligence

[222]"It is essential to be fully aware of the distinction between descriptions of how brain work and "think" (Calvin 1996; Pinker 1997) and prescriptions and recommendations on how to teach. As Gardner (1999, p.60) has stated: "We could know what every neuron does and we would not be one step closer to knowing how to educate our children," since decisions in education are built upon value judgments. Science, however, delas with mindful theories, explanatory models, and empirical observations with no immediate link to educational values" (PARNCUTT & MCPHERSON, 2002, p.79).

But surely the same applies if musicians learn to play the same piece of music, regardless of whether the interpretation process is based on a "by ear" or tactile "braille" model? Nor will they play identically, interpretively? Nevertheless, opinions are expressed, as Silverman (2007) stresses, and discusses the missing (educational) link *if,* (still) all pianists "sound the same" (p.112), thus causing stress inside academia (among those who are concerned) regarding how to proceed, to identify which are these absent tools for teaching interpretation in a manner that which lives up to all the fine descriptions of what interpretation is and should be, not least regarding memorization.

We know that long term memory (LTM), firstly, uses already familiar material, and mainly reacts on incoming stimuli which seems familiar, which then give signals to the performer, a sensation of recognition. In this sense, we can understand the impact of the LTM, since by using what is already familiar will create a deepened sensation of security (and even a maintained identity).

However, this evolutionary-based preferences, that our LTM unknowingly reacts and "chose" in line with "recognition", as a loop, *can* be analyzed as an inhibitor, for not "daring" to break the comfort zone. This, even if it just concerns how to "dare" to form a musical phrase differently than what is already "familiar", and "heard", "listened to", "incorporated" as the only correct and righteous version.

But research also shows that unexpected sounds and novel musical rhythmic, melodic, and harmonic correlations can thrill the LTM to such an extent that the memory will be activated, as highly increased "attention", which we know causes the STM very likely to be rehearsed, which leads to LTM.

Suddenly, to think about music interpretation this way, i.e., as a form of self-hearing, and not only as how to pragmatically approach the correct realm of which era the music belongs to, which century, or style, if the ornament must start from above or from under, the pianists own memories, and process of *how* to memorize, might take part, as a tool, in a tool-box. To do so, the next level of self-hearing, which is a form of internal sensation of the own´s self, hearing, touching, feeling, will be explored in a format related to how to verbalize this procedure.

But not only aspects of "verbalization" will be described, but thereafter, also how a personal development, using memorization as a tool for an exploration of music interpretative decision-makings, can challenge what is seemingly "familiar", which thus can be an extension of the internal "self", turning into "self-growing", through music.

The hand and the touch of the senses constitute the unifying link between interpretation and memorization by combining intellect and emotion aiming a music performance.

Piano playing appears as an immediate physical and muscular activity, but literature about interpretation often describes the importance of how to create “meaning”: “The ability to ‘‘hear’’ with the ‘‘mind’’s ear’ or ‘‘thinking in sounds’’ (Combarieu, 1907) and ‘‘replay’’ virtual music with the ‘‘inner voice,’’ could assist the making of creative compositions” (ENDESTAD et al, 2020, p.3).

Consequently, it then requires a wider outlook, which includes to exceed, or challenge the usual “interpretive” regulations which, for better (or worse), have an inhibiting effect on a pianist, not least with a background in a frequently occurring (inhibiting) educational structure based on doing “right or wrong”.

As described, I learned how certain methods relate to memorization, but did not know why and for what reasons I reached certain states of sensation such as increased contact with the essence of music. Judging by how the authors here clarify how to use the musical material in a way like a mind map, as a way of organizing the content, (see figure Bryant; Chaffin; Lisboa) also gave me ideas how to use imagination in a constructive way. This *know-how,* I have now been able to identify and describe throughout an interdisciplinary format based on this literature review.

CONCLUSION

Some researchers have demonstrated that playing and memorizing involves multisensory and multimodal activity since the senses work together. Jensenius (2007), for instance, uses the following figure to illustrate this multi-level process:

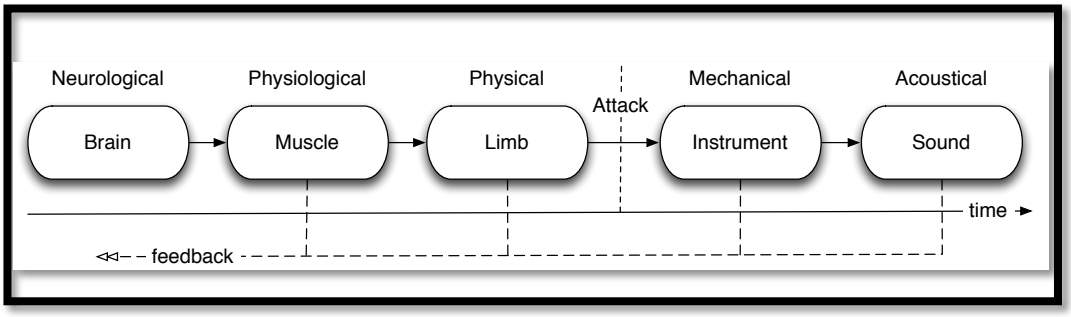

Figure 27: chain of cognitive process and multimodal feedback. Source: Jensenius, 2007, p.24.

As the Figure 27 shows, there are many common denominators involved in both memorization and interpretation process in piano playing. However, it is important to understand that the process is cyclical and with implicit feedback. These overlapping dimensions could give rise to a gap within the gap, i.e., a deepening of the constituents of imagination and fantasy; the "touch" and "verbal protocol" of the senses. Everything includes thought activation and bodily interaction, which is also called embodied cognition:

> Cognition is embodied when it is deeply dependent upon features of the physical body of an agent, that is, when aspects of the agent's body beyond the brain play a significant causal or physically constitutive role in cognitive processing"[223] (WILSON & FOGLIA, 2011, n.p.).

Overall, there is a reflexive reflexivity that is required to be able to carry out the essential work related to the design of a mental mind map, but still connected to a bodily embodied map.

We have learned that the brain is developed for language independently if it is verbal or gestural. Helen Keller's testimony is one of much evidence of the body's intelligence. Concepts such as cross modal attention and cross modal perception are only one piece of the puzzle in the complex structure that this entire subject area includes.

[223]"In general, dominant views in the philosophy of mind and cognitive science have considered the body as peripheral to understanding the nature of mind and cognition. Proponents of embodied cognitive science view this as a serious mistake. Sometimes the nature of the dependence of cognition on the body is quite unexpected and suggests new ways of conceptualizing and exploring the mechanics of cognitive processing" (WILSON & FOGLIA, 2011, n.p.).

Therefore, as discussed in Chapter 3, haptics plays a significant role in the memorization process. Hands and fingers against the keyboard constitute a decisive part of the piano playing since during this act the memory is activated by the touch. Jaëll (1897) argued that this haptic memory deserves a deeper study so that the teachers do not limit themselves to describe it as a "muscle memory" or "motor memory". Considering the precision and sensitivity that only the fingertips have (see Chap.3), and the musical experiences it generates, we can assume that more "haptic" memorization techniques should be developed and identified[224].

Perhaps Errol Garner statement (see Introduction) could be restated as "when I play, I don't think". It could be a result of a developed 100% reliance on his own embodied memorization system, which is elaborated, and which can be elaborated in various ways. You can wonder "what" decides within us? How is this process related to decisions, effect the result, for the performing pianist as both "maker" and "listener" to oneself? But if "music is subconsciously transformed into bodily sensations", as Pallasmaa (1994, p.48) claims because of: "When experiencing a structure, we unconsciously mimic its configuration with bones and muscles" (PALLASMAA, 1994, p. 48), it is nevertheless quite a task to learn to develop different memorization techniques in line with the sensibility of each sense.

There is a sort of consensus regarding the principles of memorization, which is what produces the "best" result based on all senses working together. In the memorization process, we can work with the mind map or, as demonstrated, use different mind models as didactic aids. In order not to stare blindly at the conceptual sphere of thought, we have other tactile, aural, and visual tools. It is not only when the music is memorized and then played "by heart" the musical interpretation is settled, it happens continuously.

Regarding the implementation of a strategy, one can say the level of comprehension of the general memorization process goes in line with what kind of adjustment the performer is prepared to undergo in the practice room. The way the pianist chose to expand the mixture between practice performance and mental performance will increase the abilities of how to commit a musical material to one´s memory.

This inference is corroborated by Bryant (1986), who claims that memorization, in the model she advocates, is an elaborated extension of practice, and Winslow (1949), who argues that: "Music educators and psychologists, too, are acknowledging memorization as an important aspect of musical mastery. Memory work is no longer regarded merely as a stage technique or mental stunt but as a basic function in the total learning act" (p.15).

[224]"Why Is There So Much More Research on Vision Than on Any Other Sensory Modality?" HUTMACHER, Fabian, 2019. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6787282/

Moreover, the outcome of this process also depends on what and how we focus on while playing, practicing, performing, interpreting (and, consequently, when memorizing):

> Memory thus influences attention by shaping what is heard and how it is heard. For instance, 'the brain becomes less receptive to rhythms that are not listened to' (Honing 2011, p.129). Forgetting, related to not paying attention and to not encoding material for memorisation, is thus essential to the very process of perception (ODENDAAL; LEVÄNEN; WESTERLUND, 2020, pp. 364-365).

Consequently, this rarely thought of, nor mentioned, concept of "forgetting" contributes as a significant factor in the entire memorization process: "Attention to structure serves the double purpose of preparing both the interpretation and the retrieval structure. Indeed, the two are not readily separable" (CHAFFIN; IMREH; CRAWFORD, 2002, p.210).

After having demonstrated the importance of memorization, it is at least odd to find comments from performers and teacher considering memorization something static, old-fashioned, as an unreflective unconscious repetitive mechanical activity based on imitation, such as: "memorization definitely has many valuable uses, fostering critical thinking is not among them" (FACIONE, 2020, p.5). However, as the several sources here investigate have shown, even the five concepts Facione (2020, p.5) lists as integral parts of the cognitive activity constituting "critical thinking" ("interpretation, analysis, evaluation, inference, explanation, and self-regulation") are also inevitable features of the process of memorization.

Yet memorization is based on playing "by ear". The source, the "inner score" (the mind map) from which the pianist starts is an internal idea or way of thinking, which we have seen is based on the functions of the different senses. Not least the body has its own sensory system and (evolutionary) reasons for discovering and explore sounds, and surfaces (haptically). This tactile sense (as the key resistance, for instance), combined with auditive memory, is explained by Goebl, Bresin and Fujinaga (2014), based in Galembo's research, in this way:

> Galembo (2001) showed that conservatory professors were unable to discriminate between three grand pianos by listening only, which they previously ranked according to their quality and from which they indicated to be able to easily hear the differences in sound. However, when they played them blindly (without visual feedback) and deaf-blindly (without visual and auditory feedback), they could keep them well apart (GOEBL; BRESIN; FUJINAGA, 2014, p.2839).

Therefore, we can identify the link between memory, or playing "by heart", and the body, or tactile senses. In this way, it is stablished a connection between performance practice and mental practice, where mind and body interact, and memory is heightened.

Memorizing a lot of musical material takes space and focus, but once the process is completed, we achieve a feeling of accomplishment, a state that Malone (1998) argues is a prerequisite for enabling or attaining moments where creativity enters. The capacity of chunking is what allows this process. The act of grouping parts, allows the brain to free space, since a lot of material is grouped into smaller units that are easy to remember (BROWN, ZATORRE; PENHUNE; 2015). The chunking procedure was exemplified in Chapter 2.

The result of this chunking process can be interpreted as to have the opportunity to add extra musical material, and/or, to fill "the gap", the missing link between the music and the personal individual contribution. This aspect can also be understood as a form of imagination and add something else to the already given musical structure.

After having memorized the music, other aspects are to be considered: what kind of interpretative decisions were taken (see Chaffin et al: "cues"[225] interpretive, expressive, emotional, analytic etc.)? Was the manner to interpret changed once the memorization process was finished, and the music was about to be played? After all, we can say a greater familiarity with the music was obtained, and this familiarity will facilitate further memorization processes. In this respect too, it can be claimed that memorization constitutes a strategy in music interpretation, i.e., based on accumulated, experiences. Since anything that is repeated will easier enter the LTM so even new unfamiliar musical patterns once repeated and gradually memorized will undoubtedly increase the pallet of musical variables - even if even if they are formed by unconscious "automation". Although the conditions for applying memorization as a strategy in musical interpretation increase significantly if the memorization process takes place consciously in parity with specified concepts such as focus, attention and emotional activation.

1.How can memorization be used as a tool for building an interpretation?

To clarify how the proposed hypothesis of this research demonstrably confirms that memorization is a strategy in music interpretation, step one consists of the claim that a first insight into the subject itself is needed. In this context it is understood as: knowing *what,* that

[225]"Performance cues point to different types of memory according to which aspect of the music they address. *Structural* cues are critical places in the formal structure, such as section boundaries. *Expressive* cues represent musical feelings, e.g., excitement. *Interpretive* cues refer to musical gestures, such as changes of tempo or dynamics. *Basic* cues point to motor memory for critical details of technique, e.g., a fingering that sets the hand up for what follows. Musicians are likely to agree on the musical structure of a piece" (CHAFFIN, LOGAN, BEGOSH, 2009, p.360).

something is, that is, considering the piano as an interactant, a work consisting of a pianist, music, and an instrument.

In line with Feldenkrais´ (1990, p.50) definition of "awareness": "a realization of what is happening within it", this first phase reflects knowledge about *what* relations exist between the *technical variables,* as a key term, related to the forming and development of music interpretation, and its relation to memorization. For the sake of simplicity (due to the multi epistemological areas within music) this stage will here be called a state of objectivity, which concerns areas such as acoustics, biomechanics, and physics.

A second phase reflects aspects of knowledge about what processes exist between the key concept of musical elements related to the formation and development of memorization and music interpretation. This stage can be called a state of subjectivity, how one consciously approaches past experiences and memories. But as already argued by Christiani (1886), without *thought,* any music can sound *mechanical,* and unmusical. As an automatic automaton. Consequently, the importance of thinking during the interpretation should then be related to the process of memorizing, preventing the music not to (automatically) become "unmusical".

Christiani's (1886) claim means that thought is decisive for expression, i.e., an unavoidable part of musical interpretation. If interpretation is counted as an inevitable part of making meaning when creating music, then the presence of a "thought" would form part of the evidence to ensure expected results. Thus, it is suggested that a successful memorization strategy involves the presence of a "thought".

Once this premise is understood (the impact of thought), the second part, step two, of Feldenkrais' (1990, p.50) statement makes sense: "what is going on within ourselves". That is to say, the pianist learns to be able to increase the awareness of different types of thought processes, which can both relate to interpretation and memorization.

This definition of "thought" in relation to today's state of knowledge will be identified here as the connection between cognition and emotion, body, and mind (IMMORDINO-YANG & DAMASIO, 2007). Thus, based on an interaction between body and mind, as the concept embodied cognition. Or, referring to Pallasmaa (1994): "articulated sensory thought", applied in a playing piano context, how explicitly the senses are connected to our thoughts.

So, in line with Feldenkrais's (1990) theory of awareness, there is an opportunity to pictorially visualize the process. By applying Colonomo's (1992) model of an interpreter processing a "non-linguistic message" (WILCOX & SHAFFER, 2005, p. 31) it can be described how memorization constitutes a strategy in music interpretation.

In this context, the model's eight steps (Figure 4) illustrate a gradual progression of awareness, as the state called for by Feldenkrais (1990, p.50). At the same time, a memorization work is identified, where it also appears that each step in the interpretation chain can be connected to the functions of the senses, memories and different positions related to decision-making.

As the key to also understanding the actual event itself, the course of events, it is about what kind of insight and how it stands in relation to both cognitive and emotional decision paths (see IMMORDINO-YANG & DAMASIO, 2007). Overall, it is, as Aristotle argues, having knowledge of the individual parts concerned (interpretation, memorization, senses) and their respective functions, individually and together.

Not least Bryant (1986) showed that only through increased knowledge and awareness of the very existence of both musical and human memory, the ability to memorize increased. To then also link this to a broadened insight into how character traits linked to technical variables and musical elements can be used as both analysis tools and practical companions during the performance itself by adopting: “think- aloud”, “verbal protocol” and “action protocol”, (Laske, 1977, apud BRYANT, 1986).

We can now better identify internal strategies in line with decision-making in music interpretation, which also clearly appeal to memorization processes.

Even if music is filled with instructions, it still lacks explicit details on how to construct an interpretation. Due to a memorization strategy an interpretation can, be made visible. The way the stances are made conscious, how musical texture gradually becoming coherent, means that the transparency of the pianist's interpretative influence increases.

Memorization is like constructing a mental algorithm. Depending on what, how and when commands are applied, the result will be accordingly. It can be done focusing on vision, by ear, or by braille, or combining all senses. An initial overview of the whole demonstrates the music´s features and factors. The process occurs mainly by identification of technical variables and musical elements. Once classified, included parts are broken down into manageable and comprehensible items.

By adopting certain commands presented in the literature: “performance cues”, “think-aloud”, “action protocol”, “starting tones”, etcetera, the strategical organizing regards how to reconstruct musical thoughts, emotions, and bodily sensations. The chunking procedure gradually build a manageable mind map. A corresponding sense of “knowing” increases the ability for how to command bodily preparation connected to desirable interpretative musical outcomes.

Pianists aiming to develop personal touch and individuality in the performance can benefit of mental practice. By adopting imagery in each phase of the memorization, music can be interpreted, shaped and performed in endless manners. Such an arrangement offers interpretative abilities to motor, auditory, visual, emotional, linguistic and analytic memory in collaboration with the practical process aiming to play "by heart".

The highlighting of "talking" to oneself raises awareness to one´s "listening" to inner thought patterns. Such a description of ongoing events increases the pianist´s influencing possibilities, i.e., affecting meaning and sense function, presence and focus.

Enhanced learning how to think not only increases possibilities of awareness. It also strengthens the self as a decision-making co-pilot. The relationship between "hemispheres" heightens mental and bodily communication paths. It identifies differences between random and unreflective interpretation decisions such as "happenings" ("hearing habit" or "muscle memory"), or the contrary, oral descriptions in parallel with practical demonstrations on the piano.

The effect of "thought" expansion while memorizing in combination with possible manipulations of each sense increases the pianist's awareness. These forming of tools intensifies the role as a decision maker. A feeling of security grounded on an in-depth exercise is confirmed in neuroscientific studies where memory (Figures 6 and 7) is equated with knowledge, learning and experiences.

The parameters specified for short-term memories to be transformed into long-term memory: "consolidation of long-term memory storage occurs through repetition of information (Kandel, 2006; Hardiman, 2003, 2010)" (TOWNSEND, 2017, p.6). Long-term memories lie as a platform and reference template for future interpretation. The more the use of working memory, the more memorization and learning music processes are connected. Some attention can here be drawn to risks of overly casual "decision-making" primarily based on habit or familiarity. If memorization only takes place and is contained within the framework of already learned norms and cultural structures, such as security, interpretive innovation can hardly be discerned.

Hence, concepts such as fantasy and imagination are mentioned as decisive factors. To get there in a memorization perspective, to seek to fill this gap of interpretation, can therefore be understood as extended awareness vis-à-vis the sensibility of the senses.

Thus, to achieve and build the automaticity required for real creation, a decision-making via memorization strategy is emphasized. This is also applicable to how a pianist relates to the music interpretation. It is the acquisition of knowledge in all relevant areas *per se* that broadens

perspectives. Memorization increases the ability for analytical and practical coordination of a musical process.

In a “chunking” (7±2) process (MILLER, 1955) larger objects are transformed into smaller units. It frees up space to focus on sensory feedback. Suggested input and output reduce the workload for brain and body creating a form of “automation”. This opportunity heightens sensitivity and enable emotional affects in a circular self-touch process.

Due to experimentation with the instrument's mechanics (Figure: IBES, DICHLER, CLYNES, JAËLL) acoustical and physical actions transformed into biomechanical phenomenon cause unexpected musical contrasts. It primarily occurs due to initial manipulating of “thought decision”. A “doing” affects finger pressure on the keyboard causing certain dynamics and nuances. Still, given that a strategy of the “whole” and its overview of “parts”, the act reinforces a conscious musical restructuring.

The literature shows how something well-known (usually) appeals to a positive feeling. Thus, having transformed (using focus, attention, rehearsal, repetition) the unknown into the known, clarifies multifaceted properties of musical elements as transformative variables, for possible creations of change. A result based on cause happening consequence means awareness of one's own influencing factor. An inner security and self-esteem generate an external musical performance in similar parity.

The more the music is memorized, the stronger the specific “synaptic connection” becomes. Each practical action carried out, in which way a note, a melody, or how differentiated a chord will be played, is decisive for and affects (automatically) the type of interpretation that is created. Imaginary processes also activate the corresponding motor and sensory centers in the cerebral cortex. Literally, a neurological impression is created. Memories that are repeated generate a type of memorization process. It consequently affects the music interpretation – a process also made up of memory structures.

Regardless of if the memorization takes place based on an unaware or unreflective nature, the hypothesis is confirmed. Memorization is a strategy in music interpretation. But as is usually agreed, when talking about memorization in music, it refers to a *deliberately* devised strategy. It is above all this approach that generates a profound strategy in music interpretation: the connection where memorization provides greater opportunities to influence the musical course of events.

2. How can we learn to remember and play music by heart?

Memory includes different types of “touch”: kinesthetic, auditory, and visual. Overall, comprehensive cognitive, emotional and bodily processes (e.g. perception, interoception, haptics) are represented. As essential for memory processing additional factors relate to concepts such as analytical or intellect. Thinking and speaking, in words, movements and gestures, are indispensable working steps for how feedback and definition of experiences can be connected to musical forms of expression. The more clearly their functions and forms of interaction become apparent, the easier different memorization strategies can be worked out.

Just as we are touched by music, a pianist also needs to capture all the steps that lead to a similar product, albeit in reverse. It is only through this close work that both small and large parts can be chiseled out in a way that enables a memory construction.

If the goal is to play by heart, we must be committed to our memory. This “commitment” determines what is important to remember, and what can be forgotten. The description of memory, its systematics and models, is based on crucial neurobiological functions: sensory memories (haptics, echoic, iconic). Although this primary process (linked to interpretation) is thought to occur unconsciously, it is of utmost importance to memories. The name itself describes connections between memory and the senses. The latter constitute basic building blocks and supporting sub-functions in the memorization work. In parallel, memories relate to matching parts of the music being interpreted.

Remembering music requires that the learning takes place in a controlled and co-creative way. The pianist's challenge, when handling and manipulating short-term memories into long-term memories, is to seek to engage and develop corresponding (musical) parts within the self. The deeper the impressions are made (i.e. depending on *how* the musical design is intended) the more clearly the memories emerge. This means that it is precisely at this moment that the opportunity to influence the design of music interpretation is greatest. The effect on the memory that enables reproduction becomes palpably noticeable.

Actively practicing a memorization dialogue (cognitive, bodily, emotional) is one of the most important conclusions. It also clarifies how awareness (mindfulness) is a prerequisite for sustainable memorization that works, performing by heart. Regardless of playing alone with a piano or in a concert hall with an audience, I claim the statements in the literature as true: the more the memory is used, the stronger the soul (can) become. It increases self-confidence and strength to trust oneself.

Furthermore, memory, as a bodily "touch", is represented only in a single fingerprint, directly related to cognition and emotion via the amygdala and hippocampus transforming data: "a bodily-tactile memory trace that codes for all aspects of a personally experienced episode" (NICHOLAS et al, 2019, p.39). If emotions (IMMORDINO-YANG & DAMASIO, 2007; and feedback (PANADERO & LIPNEVICH, 2022), are crucial for learning, and, since self-perceived memories have a decisive emotional significance: "subjective personal events that contain powerful emotional significance to stay part of our autobiographical memory" (NICHOLAS et al, 2019, p.39), this should affect the learning how to remember.

We learned that memorization involves the development of knowledge and experiences tangibly visible in the brain. That is, what is "chunked" in a sheet of music, only clarifies what is correspondingly "chunked" in the brain. Its positive consequences for the locomotor apparatus increases coordination and calibration of sensorimotor skills and the multisensory and multimodal functions of the senses.

Thanks to the chunking process, lesser neural activity can be traced in the brain, i.e. the brain "frees up" space (ENDESTAD, et al, 2020, p.17). Provided that the memorization process takes place constructively and purposefully in accordance with the suggestions given in the literature, a practical implementation is possible that can be paralleled with the popular concept of "critical thinking" in academia.

3 a) What strategies are suggested in the literature to better memorize a piece of music?

Overall concepts, applicable to what in this study are called technical variables and musical elements, are: "familiar patterns such as scales, arpeggios, rhythmic motifs, and more complex aspects of the overall structure of a piece such as tonality, meter, and style (Theiler & Lippman, 1995)" (IORIO, et al, 2022, p.239). All these concepts must be included in the process to be processed.

Regarding different strategic approaches, Shinn (1898) speaks of the "intellect"; Christiani (1886) terms it "thought"; a hundred years later described by Bryant (1986) as "analytical"; where Iorio et al. (2022) refers to concepts of cognition. When it is gradually transformed into, and experienced as knowledge, a feeling of cognitive and emotional "knowing", corresponding "pieces" are created in the brain. If it is also coordinated as bodily "doing", we can talk about "automation" – "bodily chunking". That is, the state of not having to think about exactly every placement, movement or change of position.

But to build secure memorization, it is usually suggested how a bodily (motor) memory (due to muscles) should be linked to various forms of analysis; analytic and structural, combined with think-aloud methods. A concept that is better considered to “respond” to the experience of “control”. A mind map thus constructed without the need for “external” reminders (music score, a recording, braille) resembles “metacognition”. This clarifies the result of a “controlling” construct in the memorization phase. Although seemingly contradictory, meaning, also being able to let go of control.

The delegation of control based on specific “cues” linked to information in the music, is considered as sensory sensing functions, with subsequent interpretation positions. In a (slow) memorization phase one's ability to also influence the interpretation increases. A gradual building of automation of the motor memory occurs due to an improved perception of sensory feedback. A prerequisite to elaborate and manipulate a desirable interpretation. A moment also to better pay attention to and experience music events. If combined with “mental practice” (Bangert & Altenmüller, 2003, apud WATSON, 2006, p.537) it is promoted as a compelling possibility to reshape interpretive choices.

As pointed out, imagery, or “mental practice”, the early 20th century concept, monkeys solving problems by thinking - without practical trials (Kohler, 1925, apud IORIO, et al, 2022, p.230), develops an inner sense of musical ideas: “to 'see' and 'feel' physical movements (...) without engaging in physical performance” (Ross, 1985, apud IORIO, et al, 2022, p.230). This practice of directing oneself via linguistic processes linked to structure (IORIO et al, 2022), by speaking and verbalizing strategies (BRYANT, 1986) is also helpful.

A memorization process that approximates sensory perception based on repetition, rehearsal, focus and attention increases awareness in a way like how Pallasmaa (1994) described the senses as articulated thoughts. Therefore, the understanding of a body that is also “speaking”, corresponding to “spoken language”, as Wilson (1999) advocated, is deepened.

To increase the conditions for awareness of the process, a guidance for practical implementation is proposed via didactic models (KOLB et al, 2013). There, cognitive “think aloud”, emotional, and sensory-“touch”, are combined with imaginary and thoughtful aspects in a matrix. To calibrate the body's conditions related to the characteristics and factors of the music constitutes a real prerequisite for a profound and conscious implementation of memorization. Once applying memorization as a reconstruction, whole-part-whole (JOURDAIN, 1998) into the format of a mind map (MALONE, 1998), the six-point strategy by Rubin-Rabson (1950), is also identified. As such, it is still one of the most functional procedures in the construction of a multi-faceted toolbox for memorization.

3b) How are the processes of memorization and interpretation related to each other?

Interpretation and memorization share identical relationship to sensory memories and senses, as multimodal and interactive concepts. Although, kinesthetic, auditory and visual are included in teaching and learning as natural didactic interpretative tools, this connection is nevertheless rarely mentioned in interpretation, in the same explicit way as in memorization. Although, based on its seemingly efficient approaches, the concept memorization seems to show a more in-depth processing. Memorization models are also based on neurobiological and psychological denominators. The phases of memorization consist of identification of parts and reconstruction of the whole. It is also described as "extended practice".

Therefore, benefits and clearer touch points with suggested memorization strategies illustrated (LISBOA et al, 2015; CHAFFIN et al, 2002), can be applied more tangibly in interpretation. The gains are also made by adopting the structures and variables for memorization. For example, using "protocols" (BRYANT, 1986), where abbreviations in memorization such as M (melody), R (rhythm), D (dynamics) etc., can develop structure also in interpretation. By specifying "start and end tones" in relation to a certain type of emotion can be applied in interpretation as "performance cues".

It is also concluded that memorization models are the basis for different types of analysis. It deepens musical understanding. Since meaning making is the foundation of interpretation internal reasoning connected to a mind map also form an exercise for the interpreter. Since beneficial to all levels, regardless of age (Freymuth, 1993, apud MIELKE; COMEAU, 2019, p.197) its connectedness between memorization, practice and performance contribute to increased expression (CLARK; WILLIAMON; AKSENTIJEVIC, 2012, p.351).

The way how short-term memories are processed and repeated in working memory, constantly in relation to stored long-term memories, in this phase, the creation of music as a meaning-making activity, is described as a prerequisite for manipulation of the music (IORIO et al, 2022, p.232). This possibility for processing (manipulation) of the music, i.e. interpretation, is based on the memorization method defined as extended practice strategy.

Likewise, the process refers to how one goes into the depth of different musical interpretation possibilities. Specific multiple palettes of decision choices are made clear by the fact that in memorization the material is processed in different orders, as preparatory training to remember, with the goal of reproduction.

Depending on focus and attention "offered" to each sense (hearing, touch, sight) with different degrees of controlled awareness, it affects what is thought, felt, experienced, heard, or

seen. This approach increases the possibility of applying the concept of “self-touch” (REYBROUCK, 2024). The illustration of a sounding result (Figure 26) thus resembles the “echo” Schnabel (1988) referred to from the expressive possibilities of the self.

As Christiani (1886) advocated, it is the use of “thought” like an interpretative tool that prevents memorization from becoming an unreflective mechanical activity. Via input and output based on the music's features and factors, the technical variables and musical elements are made conscious. In-depth knowledge of the sensibility of the senses (Figures 20-25) touch (feeling, hearing, sight) shows in reflection and thinking. In Colonomo's (1992) model “non-linguistic message” (WILCOX & SHAFFER, 2005) memorization *de facto* strategically influences the entire interpretation process.

The releasing of the notes requires courage, patience and preparation. It is a heightened combination of the thinking of the senses. An inherited mammalian trait in line with the ubiquitous sensitivity of the senses. The evolution of the human hand, after the 375-million-year-old fish, “Elpistostege watsoni”, combined with evolutionarily developed sounds, the ancient communication system, animal species in between, as glue for social togetherness, contact and expression (SNOWDEN et al 2015). Haptics is based on the body's evolutionary and natural inherent characteristics for discovery. Maybe even a function that can be confused with concepts like creativity and imagination?

In other words, there is neuroscientific evidence for how interpretation and memorization are connected via the activation of older parts of the brain, the amygdala and the hippocampus: “Key components of this system, such as the amygdala—responsible for emotional processing—and the hippocampus—integral to memory consolidation—become activated during musical exposure” (TOADER et al, 2023, n.p.). Simply a transformation of the pianist into an aesthetic medium. Hence the now generally valid thesis that music is a universal language.

4) How do the senses interact during the process of memorization and interpretation within the context of the piano repertoire?

Senses are related to interpretation and memory. Sensory sensitivity develops corresponding to the sensitivity of the respective senses. As exemplified: fingers can feel the touch of hair, ears can perceive thousands of frequencies, eyes can create patterns of everything it sees. Thanks to the senses, we can also hear, feel and see inside ourselves via imagery. The

senses affect the body, thought and emotion and vice versa. In principle, our entire emotional register is written down, corresponding to symbolic language in the vocabulary of music.

The greater the understanding and knowledge of what senses are, and how senses work, the clearer the interactive and multimodal functions of their interaction in memory and interpretation emerge.

Memorizing, performing, and interpreting music involves the influence of sensory functions: “well-executed memorized performance depends on the integration of the information coming from different memory systems” (IORIO et al, 2022, p.239). As we know, the memory systems are based on the senses.

A visual interpretation of a score can be described as a “mental rehearsal” (WATSON, 2006, p.536). Shinn (1898) imposes the “ear” as responsible for remembering, as the continuous analytical evaluator of the musical interpretation: “through the progress of a piece, a constant criticism of its tone, rhythm” (pp.4-5). The hands, like the mouth, are different kinds of “sounding” signs, although similar. Both are speaking and expressing as from an identical language source in the brain (WILSON, 1999).

The evolutionary built-in properties of the senses result in a constant preparation for extended exploration of musical sounds. Any interpretation that is performed, the brain in collaboration with body, automatically form a potential toolbox of creativity. Existing sensory memories as the “genesis” of interpretation similarly designs memories for constructing memorization. Certain insights increase awareness and reflection considering how the interpreter approaches the “non-linguistic message” (Colonomos (1992) apud WILCOX & SHAFFER, 2005). Heightened questions such as: What do I “say” when I “talk” (with my hands in the keyboard)? What interpretation do I memorize?

Memorizing is also exhausting. Shinn (1898, p.5) describes memory as “one of our great primary intellectual powers”, which he claims: “manifests itself through the various senses”. This illustration of a meeting point where senses and intellect meet (MARCUSE, 1955, p.179) accomplishes the “third' mental faculty (MARCUSE, 1955). Here, again, a pianist as the medium, in a meeting with “the other”.

To “speak” with hands, memorizing and developing inflections, hints of emotional states, moods of expressive “cues”, thus functions as a means of developing attention to senses. Increased presence achieved through further questions such as: what is required, in terms of how to use the senses to perform music as meaningful; to become aware of one's interpretive choices; to what extent must the fundamental grammatical basis be embodied in an interpreter?

Multisensory and multimodal functions of senses in memorization and interpretation are defined in neuroscience. Hence, playing “by ear” is a variant of *mental imagery*, derived from, and directed by, inner hearing which activates motor cortex (WATSON, 2006, p.536). Imagination of movement patterns has been shown to activate its corresponding (motor) cortex, like how inner seeing, to “mentally hearing the music when reading the score” (WATSON, 2006, p .536) links visual imagery to hearing, and, auditory cortex (Lotze et al. 2003 apud WATSON, 2006, p.537) is activated by visual imagination – in case the hands are simultaneously activated like playing “air piano”.

In all, proof how “fantasizing” about music interpretation generates conclusions that sensory interactions influence, is influenced by, and based on, memory constructions. And the other way around. In other words, three concepts indisputably linked. Memory models that refer to touch, hearing and sight thus also form the basis of musical interpretation. The hypothesis that interpretation can develop after applied memorization strategies clarifies the significant focus of the senses.

Sequences of events that are said to be necessary for memorization also favor interpretation. The intrinsic properties of music clearly relate to both memorization and interpretation where the senses entirely form a common platform. The functions and use of the senses are therefore best described as a toolbox for exploring musical possibilities.

The “gap” is hereby identified. The clarification of analysis and structure contributes in different ways to memory construction. Although the boundaries between theoretical and practical aspects can be blurred, the senses are nevertheless an opportunity to additionally combine all kinds of building blocks in music interpretation. Even though, the problem of interpretation refers to this re-creation of a gap, the filling of a void. One way to circumvent the gap, to fill the void, is to instill the multifaceted learning strategies and perspectives that the memorization process offers. That is, when frameworks related to memorization take place, the process is equally applicable, albeit inversely, as an interpretive model.

Additional ancient “evidence”, Descartes (1596–1650), describing a hand as: “‘the outer brain’”; and Kant (1724–1804), “‘an extension of the human brain’, a link between body and soul” (LUNDBORG, 2014, p.51), claiming our hands as our constant executor. An indirect (centuries-old) evidence, yet applicable to Erroll Garner's ability to “memorize”, to play “by heart”, based on (dependent on) embodied cognition. As also, neuroscientifically proven, how inner hearing controls hands and fingers (WATSON, 2006). Therefore, evidence of how multimodal features and sense factors in a memorization model can be used as a strategy in interpretation.

This awareness of auditive inner “speaking”, linked to motor skills (or vice versa) when hands and fingers, individually and together manipulate a relation to keys at the keyboard. Remarkable is how the human hand one and its fingers, regardless of age, continuously explores handling of piano keys linked to broadened spectrums of audition. Yet these functions are almost always related solely to the development of young children. As Alf Gabrielsson's statement, music as a test for boundaries (SWART, 2016, p.118) the hand in piano playing is a constant interpretation of the self's boundary-setting. That is, independent of age, the senses are reflected in the piano repertoire, and can be manipulated towards designing the musical “putty” that links memorization and interpretation.

5) What can be presented as evidence that better performance is related to better memorization of music?

Since memory work was considered to strengthen the soul as early as the Middle Ages (Giordano Bruno, 1582, apud FOER, 2011), it is no surprise to hear how memorizing music also improves musical performance (CHAFFIN et al, 2002; GINSBORG, 2004; LISBOA et al, 2015; FONTE et al, 2022). Now there are also explanations, neuroscientific ones, that explain why: “Playing from memory reduces the cognitive load of performance and allows greater attention to be paid to the judgment of the sound produced” (WATSON, 2006, p.536).

Here the whole essence of the concept of memorizing music seems to be explained, based on factors such as: 1) reduction of cognitive functions - which is a paraphrase of “chunking”, which enables: 2) “automatization”, which: 3) frees creation thanks to the expanded senses´ possibility of interpretation in relation to haptics, hearing and sight. In other words, an opportunity to create.

The bottom line is how best to learn to trust your memory by developing an inner dialogue. A continuous abstract thinking, “mental practice”, is used, and if combined with action and execution the procedure is described as: “an effective tool for enhancing memorization of music and refining performance (e.g., Driskell et al., 1994; Halpern et al., 2004; Highben and Palmer, 2004; Holmes, 2005; Lotze and Halsband, 2006; Cahn, 2008; Gregg et al., 2008; Keller, 2012; Halpern and Overy, 2019)” (ENDESTAD, et al. 2020).

But to first define what “a better performance” entails, the description of music (emotion, melody, harmony and rhythm) provides an initial clue. Depending on *how* these technical elements and musical variables are organized and coordinated, it is usually determined what is

considered a “better” performance. As hypothesized, it has now become clear that memorization is an important part of this work, which can develop the interpretation.

In this study, a “better” performance is equated with a “better” interpretation of the music. As described, this presupposes an interpreter who handles eight (8) steps proposed in a pedagogical model (Colonomos, 1992, apud WILCOX & SHAFFER, 2005). This implies a transformation of a “source message” to a “target source”, passing a stage of “non-linguistic” meaning. The more aware (i.e. 'awareness' here interpreted according to Feldenkrais's (1990, p.50) description) the interpreter is of the sequence of events, from the original source's “source message” to the final goal, the “meaning” of the interpretation increases.

“Meaning” in this context then means "better". That is, to give the music its proportional inherited value based on the original source. The interpreter has a significant role in influencing these eight steps, each of which is clearly influenced by (long-term) memories. This defines how experiences (memories) influence interpretation that improves better performance - and conversely, interpretation can be a stage where memorization and interpretation meet.

The functions of memory and understanding how attention, focus, and repetition of short-term memory (STM) are processed and converted to long-term memory (LTM), the components of music are strategically defined. In parallel, inherent timbres and nuances can be manipulated, resulting in emotional as well as cognitive trade-offs, expectations and surprise of sonorous outcomes of varying degrees of contrasts.

It appears that the task and sensitivity of the senses can be used as a means, method and goal for work referring to being able to notice and take in information about both musical interpretation and memorization. Another neuroscientific explanation is how attention and focus change neural circuits (SCHUMAN-OLIVIER et al, 2020). An experience that can be empirically felt on different levels. The condition thus depends on different degrees of presence (mindfulness) which continuously affects emotional involvement, a result of “call and response”, within the pianist's own self.

In other words, the manner of the interpreter correlates with the type of sensory discrimination (focus) the music is attended to, with how memorization techniques are applied and with what result the music can be remembered. Specifically, it must be recalled, how attention and focus are rewarded as one of the most important characteristics of memorization, together with repetition. But also, a “well-executed memorized performance” is said to be based on “integration of the information that comes from different memory systems” (IORIO et al, 2022, p.239). As the memory systems are based on different senses, a “better” performance of

the music is similarly equated, based on the description (Chap.1) of “feedback” (PANADERO & LIPNEVICH, 2022) as a learning process through self-listening.

As indicated, a goal in music education is how music can create meaning, to express oneself and experience musical expression. The concept of music interpretation is therefore a part of precisely being able to improve the performance (regardless of level) in accordance with the previous purpose. This is practiced through an increased sensory presence and close relationship with each sense (Chap.3). Sensory concepts (Chap.1) as part of music interpretation, are based on audition, such as self-hearing (GIESEKING & LEIMER, 1972); kinaesthetics, the implementation of multiple aspects of “touch” (JAËLL, 1897); and “vision”, where different approaches of “seeing” can develop analytical variables linked to interpretation (FRIDELL, 2009). In the conduct of how memorization can be linked to interpretation in relation to the performance, the contributing senses generates greater opportunities, regarding the importance of consciously searching for expressiveness in music, which Lussy (1892) described as “nuances” (GREEN, 1994).

As a performer of music, it is also part of the pianist's responsibility towards the composer to maintain a respectful and empathetic approach to the content, form, and structure of the music. Since the composer takes care of the design of a composition, it is the pianist's challenge to decode and design a musical interpretation. But different forms of patent (copyright and creative commons) linked to different products involve obligations and commitments for users. But unlike infringing copyright or engaging in plagiarism in essay writing, it is not a “crime” for a pianist to engage in “creative making” in music interpretation—it is a necessity. Provided that it happens within the usual norms and character traits (that pianists rarely violate). The task of interpreting and constructing a musical interpretation thus aims to fulfill goals and purposes, to find and recreate the music's inherent essence.

But since it is not possible to precisely identify how light or heavy each individual finger should be balanced against the surface of the key, how the mutual relationship between the various fingers should be weighted, how far down each key should be pressed, how little or how much the keys should then be followed in an upward direction, to form some musical meaning – that is the pianist's own, solitary challenge.

Thus, we can conclude that the term “better memorized music” in this context means a deepened learning process in accordance with proposed methods. The work is based on a careful and thorough study of the components of music, both small and large, and how they fit together. The process leads to an overall understanding of the whole: “the process of

memorization leads to a better understanding of the piece and therefore a more musical and meaningful performance" (Benward, 1950, apud BRYANT, 1986, p.3).

So, using memorization as a strategy based on as many of the proposed models as possible, a procedure can be applied that acts as a mega-toolbox. It relates not only to each pianist's disparate personality and disposition, but also to multivariable evolutionary neurobiological, cognitive, emotional, and bodily systems.

It is specifically the time aspect, and which strategic prototypes that are constructed to make the music memorable (and interpretable). Decisive for whether memorization can be said to be successful and function as an internal strategic mind map for the construction of the interpretation phase, is that the interpreter must be prepared with the opportunity to accurately highlight and angle the music in the various formats that are desirable.

Of interest is how the neural influence on focus and attention can contribute to heightened presence and experience of the senses. Overall, this function also seems to affect sensitivity and sensibility which also increases expressiveness and opportunities to develop expressiveness to create meaning in the music, i.e. interpret.

In summary: "increases in liking are associated with improved memory and improvements in memory are associated with increased liking" (STALINSKI & SCHELLENBERG, 2012, p.15), indicates that the in-depth work of memorization as a strategy is also on par with this claim. Even if something is foreign and new at first, memorization as a process can therefore increase both understanding and connection. This also increases the likelihood of emotional activity, which is said to improve both personal commitment and conditions for "safety". As a contributing cause, this (positive) habit generates an experiential platform of creativity, via a cognitive, bodily and emotional "space" to discover new interpretations.

Finally, I want to repeat the statement: "informal practice that is aimed at enjoyment may contribute to expressivity in performance (Sloboda, 2000)" (BROWN, ZATORRE, PENHUNE, 2015, p.74), can fit as an overall framework in the memorization procedure and music interpretation. Not least because for me practice and memorization are equated with interpretation, a state that combines creation and learning. A stage of "happiness" because of feeling secure within freedom.

A first step is to practice music in a way that brings a pianist to a certain level, which can be called "ordinary practice". In the second step, the practice process also passes through memorization in line with presented suggestions. This implies structured phases with emphasis on, and enhanced knowledge about the senses, including to construct a mind map. Since in this

second level it is added more information than merely practicing, we can here use the concept: "extraordinary practice". This step aims at deeper level of knowledge (than merely practicing), with the purpose to play by heart. In such a condition, a "focused" and thus "concentrated" phase will simultaneously increase the sensibility of senses and the probability to an enhanced ability to interpret.

Thirdly, in neuroscience, enhanced learning, and knowledge, is closely related to strengthening of synapses and neural consolidation (Figures 6-7) and can as such be visually seen in the brain using brain scanning techniques. This implies certain processes that also decrease cortical activation (less neural energy) which supposedly bring space for adjustment of movements, finer calibration of coordination's and synchronization between the touch and sounds and musical ideas. This sensation we can feel when we "know" something better. In this third step, when playing by heart, many musicians (inclusive myself) can witness on that they play "better", which also authors have claimed.

Fourth, if we analyze this, looking at the music *per se*, transmitted from a composer to a performer, we can state that a music score is undetermined and vague. Therefore, it is a "gap" for the performer to fill with "something", often called "meaning", and a "reason" for why that an "interpreter" can be considered a "medium". Once playing "by heart", having stated that the ability to play is freer and "better", memorized, must imply that also the interpretation has become "better". The learning and knowledge, which has resulted in a freer and more "automatized" learning, must imply that the space for interpretation will increase. When memorizing, then seems to be a process where the own internal responsibility to "commit to one´s memory" is a conscious and aware approach, where the range of the senses´ sensibility can be profiled in each part of the memorization process, more than in ordinary practice.

Fifth, since the senses are the starting point for interpretation, and that without interpretation, no memories, and without memories we cannot interpret. In that sense, there is no doubt that there are definable correlated parts within these two areas. Stored memories can be stated as a strategy for interpretation – and vice versa as each concept influences the other. That sensory memories[226] are crucial for elements related to long-term memory deepens even

[226]"Sensory memory is a mental representation of how environmental events look, sound, feel, smell and taste. It includes a long-term component useful for such activities as recognizing a color or a familiar voice. However, most vivid details of sensory memory seem to fade quickly. Based on a long history of research, this chapter examines defining characteristics of sensory memory, reasons to study it, techniques to examine it, and theories of sensory memory forgetting. This memory is especially important for a scientific understanding of consciousness, for an understanding of individual differences, and as a control in understanding conceptual aspects of memory". Available at: https://www.sciencedirect.com/science/article/abs/pii/B9780123705099001728

more the interest in how the connection between interpretation and memorization are linked and influenced by the different sense functions.

Sixth, therefore, if it is already based on neuroscientific findings that everything we do is memorized in body and mind in different ways, described as learning consolidation, one could directly argue from this point of view that memorization forms the basis of interpretation, i.e., concrete facts.

Seventh, we also found that everything is "touch" in one way or another.

It needs to be specified, that we now talk about a sense of "security" and "non-security" in aspects of how to interpret and play music, which most musicians are familiar with, both in teaching and performing, which could be exemplified as, students asking: "is this allowed", "is this not too much", "do I dare to express so much?" This, inhibition, to start to do something [play music] based on a main thought about what is "correct" or not, functions as an effective creativity-killer (MALONE, 1998), and as such, it will consequently, not open space for an internally exposure of one´s own musical memories, neither it will promote a state of imaginary ways of how to proceed when interpreting, performing music.

Thus, a *self*-circular process starts and continuous, since the more "memories" of how to create personal "enjoyment" that are collected, the more can also the senses sensibility acquire somatosensory calibration in line with the desired (remembered and memorized) sounds. This means that we, as also Zeki (2001) and Jaëll (1897) state, by practicing music and memorizing, indirectly can "study" our own internal process.

Therefore, this know-how, can also be a tool for how to understand even the memory-part related to our "reptile-brain", or amygdala, how and why, it functions as it does, and how it both can be part as a "blessings and the curses" (JÄRNEROT & VEELO, 2020, p.65), in regards of what we know and can link our own emotional system to our individual traits as tools for "self-growing" as pianists. Here "mechanical routines" illustrates how something positive can come out of (mechanical) stability. That routines and habits can be a possible source for creating the conditions to feel secure, to be "openminded and prepared to innovate their practices" (p.65).

Another topic that has followed this investigation is the often-highlighted area: "autobiographical memories", that has been mentioned and reflections on to what extent so called "personal memories" are part of the process of interpretation. And, if it as such even relates to memorization, an interesting notion was found: "musicians tended to produce memories of the musical and technical structure of pieces rather than personal memories" (Cuddy et al, 2014 apud BAIRD; SAMSON, 2015, p.224). Interesting to follow up, to what

extent “personal memories” form part of the interpretive process and how they are detectable in the “musical and technical structure”. Would it mean that the content of the music is so complex, that it easily musicalizes our own memories, when we play, but also those of others, via the music we hear?

Unfortunately, not enough space was given to develop this further, although that was my intention from the beginning. But the knowledge of the evolutionary characteristics of the hand and other senses, designed by nature to constantly “interpret”, may play a more important role in the understanding of both how memorization and interpretation can interact.

Since a process of music memorization ever since Shinn (1898) points out the importance of and understanding of how to use memory models connected to the finger, the ear, the eyes, and the intellect, validated even today, the interaction of the senses (and knowledge) is clarified considerably more than is normally emphasized when it comes to music interpretation.

This is an important result that emerged in this survey. Only the insight into the exploratory investigative nature of the senses, if they are allowed to develop sensibility, and are paid attention to, depending on the amount of time repetition and rehearsal is allowed, generates new long-term memories. Thus, gradually new interpretative networks are built up, to which both incoming and outgoing sensory stimuli are compared and calibrated.

Since interpretation is formed, or rather, *interpreted,* depending on previous experiences, i.e. memories, consequently also in memorization, emotional experiences are also activated in different ways: “When we love a piece of music, it reminds us of other music we heard, and it activates traces of emotional times in our lives. (Levitin, 206, 192)” (SWART, 2016, p.116). If, our relations to our personal and individual past (autobiographical memories) could be further “accessed” maybe in line with what Federn (1952) called: “ego boundary development” (SWART, 2016, p. 117).

With this investigation´s objectives in focus we can state, how Leonard Bernstein´s phrase: “when I teach, I learn, when I learn I teach”[227], can be transformed into another phrase: when I remember, I learn, when I learn I remember – i.e., emphasizing how a memorizing process can enhance interpretation. Both concepts are in one way, or another connected to processes of “feedback”: “Thus, memory is influenced by what is being processed and how it is processed” (STALINSKI; SCHELLENBERG, 2012, p.1). By recalling Clyne's (1990) concept: “natural design”, defining the sense of touch:

[227]Youtube: Teachers and Teaching by Leonard Bernstein (1:20). Available at: https://www.youtube.com/watch?v=_lvgPUpaumM

> Meaning-sensitive filters are inherently built into the biologic system, so that some, in fact most, dynamic forms tend to be ignored, but others have specific emotional meaning - rather like the 'innate release mechanisms' described by ethologists (CLYNES, 1990, p.25).

I claim that this research has convinced me how our given touch sensitivity applied as memorization, can be a strategy in music interpretation.

In conclusion, I want to honor the touch sensitivity of the finger. Therefore, I share a poem: *Människans händer* (Human Hands), written 1971 by the Swedish writer and Nobel laureate, Harry Martinsson[228], in the poem-collection *Dikter om ljus och mörker* (Poems about Light and Darkness), published in Lundborg (2014, pp.68-69):

The experience of hands is tactile.
Their life among things is manifold,
filled with silent contents.
They do not hear, but sense vibrations.
They do not see, but know how it is in dark cellars, when velvet is to be valued they are there,
and silently they test the grindstone and the scythe's edge. No need to let the edge bite down.
With a light touch they feel the steel's sharpness.
How have they found time to collect all their fine experiences of wool and gravel, of down and steel,
of smooth surfaces and prickly thistle-heads, of supple talcum and of every kind of flour. Their range is immense
from shiny silk to coarse sacks,
from rough files and graters
to the smooth nails of the new-born
and the touch-shine on everlasting flowers.
They live in the land of feeling where touch is everything
and where the mystery of touch is the bridge between nerve and soul. But they find their limit in the scales of the butterfly's wing[229]

Similarly, Pallasmaa's (1994) claim that: "Homogeneous light paralyzes the imagination in the same way that homogenization eliminates the experience of place" (p.46), is applicable even to a memorization process. That is, depending on the extent to which sensibility is used, the process is related to the multifaceted nature of sensory functions. The richer and more nuanced the musical interpretation becomes depends, therefore, on whether and how the memorization strategy has been applied and characterized by the imaginary expressive possibilities of the senses.

This research was motivated by my experiences and intuitions as a pianist. Although intuition is not yet a foundation for scientific research, I tried to base most of this investigation

[228]The Swedish author Harry Martinsson, awarded The Nobel Prize in Literature, 1974, for: "writings that catch the dewdrop and reflect the cosmos". Available at:
https://www.nobelprize.org/prizes/literature/1974/martinson/facts/
http://harrymartinsonitiden.blogspot.com/2007/03/martinson-och-nya-medier.html
https://www.nobelprize.org/prizes/literature/1974/martinson/article/
https://www.nobelprize.org/prizes/literature/1974/martinson/poetry/

[229]Source: The hand and the brain: From Lucy's thumb to the thought-controlled robotic hand. Translation from Swedish to English by Judith Moffett and Lars-Håkan Svensson (LUNDBORG, 2014, pp.68-69).

on personally experienced incidents, from memorizing and noticing how my interpretative ability increased. I have tried to bring up evidence, claims, and results in line with what I have learned from the literature, although I still “feel” that what I have read and learned, my accumulated knowledge, does exceed my ability to put into writing all my unfolding findings. In any case, this is what I achieved in this work.

REFERENCES

ALTENMÜLLER, Eckart; SCHNEIDER, Sabine. Planning and performance. In: Susan Hallam, Ian Cross & Michael Thaut (Eds.). *Oxford Handbook of Music Psychology.* Oxford: Oxford University Press, 2008.

ARISTOTLE. *On Memory and Reminiscence.* (350 B.C.). Translated by J.I. Beare. Originally published in Ross, W. D. (Ed.). The works of Aristotle, Vol., 3, Oxford: Clarendon Press, 1930. (from Christophar Green's Classic Collection).

ATKINSON, R. C., & SHIFFRIN, R. M. Human memory: A proposed system and its control processes. In: K.W. Spence (Eds.). *The psychology of learning and Motivation: Advances in Research and Theory*, Vol., 2, London: Academic Press, 1968, pp. 89-195. Available at: https://app.nova.edu/toolbox/instructionalproducts/edd8124/articles/1968 Atkinson_and_Shiffrin.pdf

AZEVEDO, Frederico A. C.; CARVALHO, Ludmila R. B.; GRINBERG, Lea T.; FARFEL, José Marcelo; FERRETTI, Renata E. L.; LEITE, Renata E. P.; FILHO, Wilson Jacob; LENT, Roberto; HERCULANO-HOUZEL, Suzana. Equal numbers of neuronal and nonneuronal cells make the human brain an isometrically scaled-up primate brain. *Journal of Comparative Neurology,* 10 April, 2009, pp. 532-41. Available at: https://pubmed.ncbi.nlm.nih.gov/19226510/

BAIRD, Amee; SAMSON, Séverine. Music and dementia. In: Eckart Altenmüller, Stanley Finger, François Boller (Eds.). *Music, Neurology, and Neuroscience: Evolution, the Musical Brain, Medical Conditions, and Therapies.* Progress in Brain Research, Elsevier, Vol., 217, 2015, pp. 207-235. Available at: https://www.sciencedirect.com/bookseries/progress-in-brain-research/vol/217/suppl/C

BANGERT, Marc & ALTENMÜLLER, Eckart O. Mapping perception to action in piano practice: a longitudinal DC-EEG study. *BMC Neuroscience,* 4:26, 15 October, 2003. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC270043/pdf/1471-2202-4-26.pdf

BARKER, Melissa; BREWER, Rebecca; MURPHY, Jennifer. What is Interoception and Why is it important? *Frontiers for Young Minds,* 9:558246, 30 June, 2021. Available at: https://kids.frontiersin.org/articles/10.3389/frym.2021.558246

BEACH, Frank A. *Karl Spencer Lashley 1890—1958. A Biographical Memoir.* National Academy of Sciences, Washington D.C., 1961. Available at: https://www.nasonline.org/publications/biographical-memoirs/memoir-pdfs/lashley-karl.pdf

BEARE, J.I. On memory and reminiscence Aristotle (ca. 350 b.c). *Annals of Neurosciences,* Vol., 17 (2), April, 2010, pp. 87-91. Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4116998/

BELFI, Amy, M; JAKUBOWSKI, Kelly. Music and Autobiographical Memory. *Sempre: Society for Education, Music and Psychology Research, Music & Science,* Vol., 4, 1 September, 2021, pp. 1-5. Available at:

https://journals.sagepub.com/doi/10.1177/20592043211047123?icid=int.sj-full-text.citing-articles.14

BERNARDI; Nicolò Francesco; SCHORIES Alexander; JABUSCH. Hans-Christian, COLOMBO, Barbara; ALTENMÜLLER, Eckart. Mental Practice in Music Memorization: An Ecological-Empirical Study. *Music Perception: An Interdisciplinary Journal*, Vol., 30, No. 3, 1 February, 2013, pp. 275-290. Available at: https://www.jstor.org/stable/10.1525/mp.2012.30.3.275

BISHOP, Ryan. The Force of Noice, or Touching Music: The Tele-Haptics of Stockhausen´s "Helicopter String Quartet". *SubStance,* Vol., 40, No. 3, (Issue 126), 2011, pp. 25-40. Available at: https://www.jstor.org/stable/41300213

BOLTON, Gillie. Reflective Practice: An introduction. *Reflective Practice: Writing and Professional Development.* SAGE Publications, Third Edition, 2010, pp. 3-24. Available at: https://uk.sagepub.com/sites/default/files/upm-binaries/32441_01_Bolton_3e_Ch_01.pdf

BRICARD, Nancy; WOODS, Sherwyn, M.; Memory Problems for Musical Performers. *College Music Symposium*, College Music Society, Vol., 18, No. 2, Fall, 1978, pp. 102-109. Available at: https://www.jstor.org/stable/40373972

BRODOEHL, Stefan; KLINGNER, Carsten M.; WITTE, Otto W. Eye closure enhances dark night perceptions. *Scientific Reports,* 5, 27 May, 2015. Available at: https://www.nature.com/articles/srep10515

BROWN, Rachel M.; ZATORRE, Robert J.; PENHUNE, Virginia B. Expert music performance: cognitive, neural, and developmental bases. *Music, Neurology, and Neuroscience: Evolution, the Musical Brain, Medical Conditions, and Therapies.* Progress in Brain Research, Elsevier B.V., Vol., 217, 2015, pp. 57-86. Available at: https://www.sciencedirect.com/science/article/abs/pii/S0079612314000223?via%3Dihub

BRYANT, Dorothy. *The effect of special memory instruction and guided analysis on the memorization efficiency of college brass players.* Thesis submitted at University of Oklahoma, 1985. Available at: https://shareok.org/handle/11244/5340

BURWELL, Kim. *The meaning of Interpretation: an investigation of an area of study in instrumental lessons in Higher Education*, 2003. Available at: https://s3.eu-west-2.amazonaws.com/assets.creode.advancehe-document-manager/documents/hea/private/investigating-instrumental-tuition-interpretation_1568036817.pdf

BUZSÁKI, György, Rhythms of the Brain. *Oxford University Press*, 2006. Available at: https://neurophysics.ucsd.edu/courses/physics_171/Buzsaki%20G.%20Rhythms%20of%20the%20brain.pdf

BUZSÁKI, György; MCKENZIE, Sam; DAVACHI, Lila. Neurophysiology of Remembering. *Annual Review of Psychology*, Vol.,73, January, 2022, pp. 187-215. Available at: https://www.annualreviews.org/doi/pdf/10.1146/annurev-psych-021721-110002

CALMELS, Claire. Neural correlates of motor expertise: Extensive motor training and cortical changes. *Brain Research, HAL open science,* 2019, n.p. Available at: https://insep.hal.science//hal-02269037v1/document

CHAFFIN, Roger; IMREH, Gabriella & CRAWFORD, Mary. *Practicing Perfection: Memory and Piano Performance*. Lawrence Erlbaum Associates, Publishers Mahwah, New Jersey, London, 2002. Available at: https://www.taylorfrancis.com/books/mono/10.4324/9781410612373/practicing-perfection-roger-chaffin-mary-crawford-gabriela-imreh

CHAFFIN, Roger; LOGAN, Topher R. & BEGOSH, Kristen T. Performing from memory. In: Susan Hallam, Ian Cross & Michael Thaut (Eds.). *The Oxford Handbook of Music Psychology.* Oxford: Oxford University Press, 2009, pp. 352-363. Available at: https://production.wordpress.uconn.edu/musiclab/wp-content/uploads/sites/290/2013/10/OxfordHandbookofMusicPsychologyChapter-332.pdf

CHARNESS, Neil. Contributions of K. Anders Ericsson to Experimental Cognitive Psychology. *Journal of Expertise*, Vol., 4, No.2, June, 2021, pp. 131-143. Available at: https://www.journalofexpertise.org/articles/volume4_issue2/JoE_4_2_Charness.pdf

CHMIELECKI, Konrad. The Concept of Ocularcentrism & Photographic Models of Vision. From the Perspectives of Software Studies and Cultural Analytics Methods of Social Media Images and the Consumer Society Theory. *Studia Medioznawcze*, tom 22, Nr. 3 (86), 2021, pp. 962-994. Available at: http://cejsh.icm.edu.pl/cejsh/element/bwmeta1.element.desklight-348b2b4e-e173-4ae8-9ef3-edbb217ef947/c/Chmielecki_ost.pdf

CHRISTIANI, Adolph F. *The Principles of Expression in Pianoforte Playing*. New York, Harper & Brothers Franklin Square, 1885. Available at: https://archive.org/details/principlesexpre00chrigoog/page/n7/mode/1up

CLARK, Terry, WILLIAMON, Aaron; AKSENTIJEVIC, Aleksandar. Musical imagery and imagination: The function, measurement, and application of imagery skills for performance. In: David Hargreaves, Dorothy Miell, Raymond MacDonald (Eds.). *Musical Imaginations: Multidisciplinary Perspectives on Creativity, Performance, and Perception*. Oxford University Press, 2012, pp. 351-365. Available at: https://www.researchgate.net/publication/261529611_Musical_imagery_and_imagination_the_function_measurement_and_application_of_imagery_skills_for_performance

CLYNES, Manfred. Expressive microstructure in music, linked to living qualities. In: Johan Sundberg (Ed.). *Studies of Music Performance.* Papers given at a seminar organized by the Music Acoustics Committee of the Royal Swedish Academy of Music. Royal Swedish Academy of Music, No. 39, 1983, pp. 76-186. Available at: https://www.speech.kth.se/music/publications/kma/papers/kma39-ocr.pdf

CLYNES, Manfred Mind-Body Windows and Music. *Musikpädagogische Forschung,* 11 Quellenangabe/ In: Pütz, Werner (Ed.). *Musik und Körper*. Essen, Die Blaue Eule, 1990, pp. 19-42. Available at: https://www.pedocs.de/volltexte/2014/9261/pdf/AMPF_1990_Band_11_Clynes_Mind_Body_Windows.pdf

CLYNES, M. Sentic cycles: The 7 passions at your fingertips. *Psychology Today*, May, 1972, pp. 59-60, 68, 70, 72. Available at: https://www.rebprotocol.net/senmanfredclynes2.pdf

CLYNES, Manfred. *Sentics: The Touch of Emotions.* A doubleday Anchor book. Anchor Press, Garden City, N.Y., 1977.

CONE, Edward. The pianist as critic. In: John Rink (Ed.). *The Practice of Performance. Studies in Musical Interpretation.* Cambridge University Press, 2005, pp. 241-253.

COOK, Nicholas. *Beyond the Score: Music as Performance.* New York: Oxford University Press, 2013. Available at: https://api.pageplace.de/preview/DT0400.9780199357437_A23606966/preview-9780199357437_A23606966.pdf

COOK, Nicholas. Beyond the Notes. *Nature,* Vol., 453, 26 June, 2008, pp. 1186-1187. Available at: https://www.nature.com/articles/4531186a

DAHLITZ, Matthew. Guide To The Brain – Brain-Body Connections. *The Neuropsychotherapist,* Vol., 5, Issue 6, 31 March, 2017. Available at: https://www.neuropsychotherapist.com/guide-to-the-brain-brain-body-connections/

DANKERT, Ritske. *Using Actor-Network Theory (ANT) doing research.* Blog, 30 November, 2011. Available at: https://ritskedankert.nl/using-actor-network-theory-ant-doing-research/

DANUSER, Hermann. Execution–Interpretation–Performance: The History of a Terminological Conflict. In: Paulo de Assis (Ed.). *Experimental Affinities in Music*. Leuven University Press, 2015, pp. 177-196. Available at: https://www.jstor.org/stable/j.ctv2bctk7.12

DAUGHERTY, James. Why Music Matters: The Cognitive Personalism of Reimer and Elliott F. *Australian Journal of Music Education,* 1996, No.1, 1996, pp. 29-37. Available at: https://cmed.ku.edu/private/daugherty.html

DICHLER, Josef. *Der Weg zum Künstlerischen Klavierspiel*. Lehrbücher des Musikunterrichtes. Verlag Doblinger Wien München, 1990.

DICKINSON, Stefanie. A Multi-Level Approach to More Secure Memorization. *College Music Symposium,* College Music Society, Vol., 49/50, 2009, pp. 271-283. Available at: http://www.jstor.org/stable/41225253

DONKELAAR, Hans J. ten; BROMAN, Jonas; DOMBURG, Peter van. The Somatosensory System. *Clinical Neuroanatomy,* 2020, pp. 171-255. Available at: https://link.springer.com/chapter/10.1007/978-3-030-41878-6_4

DREYFUS, Laurence. Beyond the Interpretation of Music. *Journal of Musicological Research,* Vol., 39; NOS. 2-3, 2020, pp. 161-186. Available at: https://www.tandfonline.com/doi/epdf/10.1080/01411896.2020.1775087?needAccess=true

DUNSBY, Jonathan. Memory, memorizing. In Grove Music Online, 2001, Accessed: 07 November, 2022. Available at:

https://www.oxfordmusiconline.com/grovemusic/display/10.1093/gmo/9781561592630.001.0001/omo-9781561592630-e-0000042568

EATOUGH, Virginia; SMITH, Jonathan A. Interpretative phenomenological analysis. In: Willig, C. and Stainton-Rogers, W. (Eds.). *Handbook of Qualitative Psychology*, *2nd Edition.* London, UK: Sage, 2017, pp. 193-211.
Available at: https://eprints.bbk.ac.uk/id/eprint/16386/

ECO, Umberto. *How to Write a Thesis.* Translated by Caterina Mongiat Farina and Geoff Farina. The MIT Press Cambridge, Massachusetts, London, England, Massachusetts Institute of Technology, 2015.

ENDESTAD, Tor; GODØY, Rolf Inge; SNEVE, Markus Handal; HAGEN, Thomas; BOCHYNSKA, Agata; LAENG, Bruno. Mental Effort When Playing, Listening, and Imagining Music in One Pianist's Eyes and Brain. *Frontiers in Human Neuroscience*, 15 October, 2020, pp. 1-23. Available at:
https://www.frontiersin.org/articles/10.3389/fnhum.2020.576888/full

FACIONE, Peter A. Critical Thinking: What It Is and Why It Counts. *Measured Reasons LLC, Insight Assessment*, 2020, pp. 1-31. Available at:
https://www.researchgate.net/publication/251303244_Critical_Thinking_What_It_Is_and_Why_It_Counts

FEBRES, Gerardo; JAFFE, Klaus. Music viewed by its entropy content: A novel window for comparative analysis. *PLoS One*, 17 October, 2017, n.p.
Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5645004/

FELDENKRAIS, Moshe. *Awareness Through Movement. Health Exercises for Personal Growth.* Arkana, Penguin Group, 1990.

FLEISHER, Leon. The Inner Ear: An Interview with Leon Fleisher. In: Paulo de Assis (Ed.). *Experimental Affinities in Music*. Leuven University Press, 2015, pp. 168-176. Available at:
https://www.jstor.org/stable/j.ctv2bctk7.11

FOER, Joshua. *Moonwalking with Einstein: The Art and Science of Remembering Everything.* Penguin, 2011.

FONTE, Vera; PIPA, Luís; WILLIAMON, Aaron; LISBOA, Tania. Memorising Contemporary Piano Music as Described by Professional Pianists. *Music & Science,* Vol., 5, January-December, 2022, pp. 1-15.
Available at: https://journals.sagepub.com/doi/epub/10.1177/20592043221132932

FREDRICH, Frank. Are Sight Reading and Memorizing Related? *Music Educators Journal,* Vol., 37, No.2, Nov., – Dec., 1950, p. 40. Available at:
https://journals.sagepub.com/doi/abs/10.2307/3387340

FRIDELL, Ingemar. *Talk on Musical Interpretation. Visual Tools for Perceived Dynamics and Points of Gravity.* Thesis submitted at Malmö Academy of Music, Lund University, 2009. Available at: https://lucris.lub.lu.se/ws/portalfiles/portal/3027158/1502560.pdf

GABRIELSSON, Alf & LINDSTRÖM, Erik. The influence of musical structure on emotional expression. In: Patrik N. Juslin & John A. Sloboda (Eds.). *Music And Emotion: Theory and research*. Oxford University Press, New York, 2008, pp. 223-248. Available at: https://academic.oup.com/book/53643/chapterabstract/422151224?redirectedFrom=fulltext&login=false

GIESEKING, Walter & LEIMER, Karl. *Piano Technique.* Dover Publications, INC, New York, 1972.

GILE, Daniel. Effort Models. In: Franz Pöchhacker (Ed.). *Routledge Encyclopedia of Interpreting Studies.* Associate editor: Nadja Grbic´, Consultant editors: Peter Mead and Robin Setton, Routledge, Taylor and Francis Group, 2015, pp. 135–137.

GINSBORG, Jane. Strategies for memorizing music. In: Aaron Williamon (Ed.). *Musical Excellence: Strategies and techniques to enhance performance.* Oxford Academic Press, 2004, pp. 123–141.

GIULIA, Carletti. To the Root of Interpreting. Blog, 18 February, 2014. Available at: https://wordsofnona.com/en/blog/totherootofinterpreting/

GLOOR, Valentin & COESSENS, Kathleen. 'Association': A Way of Artistic Experimentation That Can Expand Interpretation Possibilities. In: Kathleen Coessens (Ed.). *Experimental Encounters in Music and Beyond*. Leuven University Press, 2017, pp. 127-134. Available at: https://www.jstor.org/stable/j.ctt21c4sbm.16

GOEBL, Werner; BRESIN, Roberto; FUJINAGA, Ichiro. Perception of touch quality in piano tones. *The Journal of the Acoustical Society of America*, 136 (5), November, 2014, pp. 2839-2850. Available at: https://www.researchgate.net/publication/267933118_Perception_of_touch_quality_in_piano_tones

GORDON, Edwin, E. Roots of Music Learning Theory and Audiation. University of South Carolina, *Scholar Commons,* Chicago: GIA Publications, 2011, pp. 1-60. Available at: https://scholarcommons.sc.edu/cgi/viewcontent.cgi?article=1000&context=gordon_articles

GORDON, Edwin E. Audiation, Music Learning Theory, Music Aptitude, and Creativity. *Suncoast Music Education Forum on Creativity*, 1989, pp. 75-81. Available at: https://files.eric.ed.gov/fulltext/ED380341.pdf

GREEN, Michael D. Mathis Lussy´s "Traité de l´expression musicale" as a Window into Performance Practice. *Music Theory Spectrum.* Oxford University Press on behalf of the Society for Music Theory, Vol.,16, No. 2, Autumn, 1994, pp. 196-216. Available at: https://www.jstor.org/stable/746033

GUELL, Francisco & CAMINA, Eduardo. The Neuroanatomical, Neurophysiological and Psychological Basis of Memory: Current Models and Their Origins. *Frontiers in Pharmacology,* Vol., 8, 30 June, 2017, pp. 1-16. Available at: https://www.researchgate.net/publication/317825117_The_Neuroanatomical_Neurophysiological_and_Psychological_Basis_of_Memory_Current_Models_and_Their_Origins

HALLAM, Susan. Professional Musician´s Approaches to the Learning and Interpretation of Music. *Psychology of Music*, Vol., 23, 1995, pp. 111-128. Available at: https://journals.sagepub.com/doi/10.1177/0305735695232001

HAWKINS, Jeff & AHMAD, Subutai. Why Neurons Have Thousands of Synapses, a Theory of Sequence Memory in Neocortex. *Frontiers in Neural Circuits*, Vol., 10:23, March, 2016, pp. 1-13. Available at: https://www.frontiersin.org/articles/10.3389/fncir.2016.00023/full

HAYNES, Bruce. *The End of Early Music: A Period Performer's History of Music for the Twenty-First Century.* Oxford and New York: Oxford University Press, 2007.

HÉROUX, Isabelle. Creative Processes in the Shaping of a Musical Interpretation: A Study of Nine Professional Musicians. *Frontiers in Psychology*, Vol., 9, 8 May, 2018, pp.1-17. Available at: https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2018.00665/full

HERRERA, Miriam; CREMADES, Roberto. Memorization in piano students: A study in the Mexican context. *Musicae Scientiae,* Vol., 18(2), 2014, pp. 1-16. Available at: https://www.researchgate.net/publication/266968230_Memorisation_in_piano_students_A_study_in_the_Mexican_context

HO, Bernice. The Mysterious Sixth Sense of Humans: Proprioception. *Scientific Harrovian.* 'Science and the senses'. Harrow International School Hong Kong, 2019-20, pp. 20-23. Available at: https://issuu.com/harrowhongkong/docs/scientific_harrovian_issue_v_compressed

HODGES, Donald A. Music Through the Lens of Cultural Neuroscience. In: Michael H. Thaut & Donald A. Hodges (Eds.). *The Oxford Handbook of Music and the Brain*. Oxford University Press, 2019, pp. 19-41.

HODGES, Donald A. & THAUT, Michael H. The Neuroscientific Study of Music: A Burgeoning Discipline. In: Michael H. Thaut & Donald A. Hodges (Eds.). *The Oxford Handbook of Music and the Brain*. Oxford University Press, 2019, pp. 3-16.

HOFFMAN, Martina; SCHMIDT, Alexander; PLONER, Christoph J. Musical expertise shapes visual-melodic memory integration. *Frontiers in Psychology*, 24 October, 2022, pp. 1-13. Available at: https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2022.973164/full

HOU, Yingying; SONG, Bei; HU, Yinying; PAN, Yafeng; HU, Yi. The averaged inter-brain coherence between the audience and a violinist predicts the popularity of violin performance. *NeuroImage,* Elsevier Inc, Vol., 211, 1 May , 2020, pp. 1-11. Available at: https://www.sciencedirect.com/science/article/pii/S1053811920301427

HUANG, Aiyun Yaiyun. Perspectives on music interpretation: Instrumentation, memory, metaphor, and theatrical intention. Thesis submitted at University of California, San Diego, 2004. Available at: https://www.proquest.com/openview/c743ebe775959ac662b0b2a4eddfdc78/1?pq-origsite=gscholar&cbl=18750&diss=y

HUGHES, Edward; Musical Memory in Piano Playing and Piano Study. *The Musical Quarterly*, Vol., 1, No. 4, October, 1915, pp. 592 – 603. Available at: https://www.jstor.org/stable/738068

IBES, Willem (Wim). The Physics and Metaphysics of Piano Playing: Twelve Fundamental Principles. *Music Faculty Publications,* 8, June, 2010, n.p. Available at: https://digitalcommons.csbsju.edu/music_pubs/8

IMMORDINO-YANG, Mary Helen; DAMASIO, Antonio. We Feel, Therefore We Learn: The Relevance of Affective and Social Neuroscience to Education. *Mind, Brain, and Education,* Vol., 1, issue 1, 2007, p. 3-10. Available at: https://onlinelibrary.wiley.com/doi/10.1111/j.1751-228X.2007.00004.x

IMMORDINO-YANG, Mary Helen & FISCHER, Kurt W. Neuroscience bases of learning. In: V. G. Aukrust (Ed.). *International Encyclopedia of Education, 3rd Edition, Section on Learning and Cognition*. Oxford, England: Elsevier, 2009, pp. 1-14. Available at: https://www.researchgate.net/publication/288359530_Neuroscience_Bases_of_Learning

IORIO, Claudia; BRATTICO, Elvira; LARSEN, Frederik Munk; VUUST, Peter; BONETTI, Leonardo. The effect of mental practice on music memorization. *Psychology of Music*, Vol., 50, Issue 1, January, 2022, pp. 230-244. Available at: https://journals.sagepub.com/doi/10.1177/0305735621995234

JAËLL, Marie. *Le mécanisme du toucher – L´étude du piano par l´analyse expérimentale de la sensibilité tactile.* Armand Colin et C[ie], Éditeurs. Librarires de la Société des Gens de lettres, Paris, 1897.

JAYNES, E.T. Physiology of Piano Playing. *The Physical Basis Of Music,* 1994, pp. 601-624. Available at: https://bayes.wustl.edu/etj/music/m6p.pdf

JENSENIUS, Alexander Refsum. ACTION – SOUND. Developing Methods and Tools to Study Music-Related Body Movement. Thesis submitted at Department of Musicology, University of Oslo, 2007. Available at: https://www.researchgate.net/publication/224927614_ACTION_--_SOUND_-_Developing_Methods_and_Tools_to_Study_Music-Related_Body_Movement

JOHNSTON, Ian H. Interlude 2, The Piano. *Measured Tones: The Interplay of Physics and Music*. Institute of Physics Publishing Bristol and Philadelphia, Second edition, 1989, pp. 74-85.

JOURDAIN, Robert. *Music, The Brain, And Ecstasy. How Music Captures Our Imagination*. Avon Books Inc. New York, 1998.

JUSLIN, Patrik N. Communicating Emotion in Music Performance: A review and a theoretical framework. In: Patrik N. Juslin & John A. Sloboda (Eds.). *Music And Emotion: Theory and research*. Oxford University Press, 2008, pp. 309–337. Available at: https://academic.oup.com/book/53643/chapterabstract/422151245?redirectedFrom=fulltext&login=false

JÄRNEROT, Anna; VEELO, Nicole. ”Kunskap i 3D” – techne, episteme och fronesis, presenterat som samspelande dimensioner. In: A. Løhre & A. B. Lund (Eds.). Studenten skal bli lærer: Kunnskap, identitet og profesjonsutvikling, 2020, pp. 65–84. Oslo: Cappelen Damm Akademisk. Available at: https://www.researchgate.net/publication/340961649_Kunskap_i_3D_-_techne_episteme_och_fronesis_presenterat_som_samspelande_dimensioner

KANDEL, Eric R. – Facts. NobelPrize.org. *Nobel Prize Outreach AB*, 20 January, 2023. Available at: https://www.nobelprize.org/prizes/medicine/2000/kandel/facts/

KANDEL, Eric R. The Molecular Biology of Memory Storage: A Dialogue Between Genes and Synapses. *SCIENCE,* Vol., 294, Issue 5544, 2 November, 2001 pp. 1030-1038. Available at: https://www.science.org/doi/10.1126/science.1067020

KARTOMI, Margaret. Concepts, Terminology and Methodology in Music Performativity Research. *Musicology Australia,* Vol., 36, Issue 2, 14 November, 2014, pp. 189-208. Available at: https://doi.org/10.1080/08145857.2014.958268

KELEMAN, Stanley. Touching And Being Touched: The Hand As A Brain. *The Neuropsychotherapist eMagazine - Science Informing Therapy,* 6 January, 2014, n.p. Accessed 28 February, 2024. Available at: https://www.neuropsychotherapist.com/touching-and-being-touched-the-hand-as-a-brain/

KHARICHEVA, Dina Vladimirovna; BIGLER, Lyudmila Voldemarovna; BAIDALINOV, Sergei Nikolaevich; ZHILINA, Anna Valeryevna; MELESHKINA, Elena Anatolyevna. The role of musical hermeneutics in the formation of a culture of interpretation in performers. *Humanities & Social Sciences Reviews,*Vol., 8, No. 2, 27 May, 2020, pp. 130-135. Available at: https://mgesjournals.com/hssr/article/view/hssr.2020.82e16

KNUUTTILA, Simo; KÄRKKÄINEN, Pekka. Medieval Theories of Internal Senses. In: Simo Knuuttila & Juha Sihvola (Eds.). *Sourcebook for the History of the Philosophy of Mind. Philosophical Psychology from Plato to Kant.* Springer Dordrecht Heidelberg New York London, Vol.12., 2014, pp. 131-145.

KOLB, David A.; KOLB, Alice Y. The Kolb Learning Style Inventory 4.0: Guide to Theory, Psychometrics, Research & Applications. *Experience Based Learning Systems Inc.,* January 2013, pp. 1-233. Available at: https://www.researchgate.net/publication/303446688_The_Kolb_Learning_Style_Inventory_40_Guide_to_Theory_Psychometrics_Research_Applications

KRAMER, Lawrence. Language. *Interpreting Music.* University of California Press, 1st ed., 2011, pp. 20-45. Available at: https://www.jstor.org/stable/10.1525/j.ctt1pnchw

KRATUS, John. Orientation and Intentionality as Components of Creative Musical Activity. Reports – Descriptive (141) Journal Articles (080). *Research Perspectives in Music Education*, No., 2, Fall, 199, pp. 4-8.
Available at: https://files.eric.ed.gov/fulltext/ED363524.pdf

KRIVENSKI, Maria. *Making Sense Of 'Classical' Musical Performance At University: An Ethnographically-Informed Case Study of A Community of Practice.* Thesis submitted at University of Sheffield. December, 2018. Available at: https://core.ac.uk/reader/223235600

KULINSKI, Jacquelyn; OFORI, Ernest Kwesi; VISOTCKY, Alexis; SMITH, Aaron; SPARAPANI, Rodney; FLEG, Jerome L. Effects of music on the cardiovascular system. *Trends in Cardiovascular Medicine,* Vol., 32, Issue 6, August, 2022, pp. 390-398. Available at: https://www.sciencedirect.com/science/article/pii/S1050173821000700?via%3Dihub

KÜSSNER, Mats B; TARUFFI, Liila; FLORIDOU, Georgia A. (Eds.). *Music and Mental Imagery.* Sempre Studies in The Psychology of Music, Routledge Taylor & Francis Group, 2023.

LASKE, Otto E. Music, memory and thought: Explorations in cognitive musicology (monograph) Ann Arbor, microfilm, Univ of Pittsburgh music dep., 1977.

LATOUR, Bruno. On Actor-Network Theory: A Few Clarifications. *Soziale Welt,* Vol., 47, No.4, 1996, pp. 369-381. Available at: https://www.jstor.org/stable/40878163

LATOUR, Bruno. On using ANT for studying information systems: a (somewhat) Socratic dialogue. In: Chrisanthi Avgerou, Claudio Ciborra, and Frank Land (Eds.). *The Social Study of Information and Communication Technology: Innovation, Actors, and Contexts*. Oxford, 2004. Online edition Oxford Academic, 31 October, 2023, pp. 62-76. Available at: https://academic.oup.com/book/52363/chapter-abstract/421267894?redirectedFrom=fulltext&login=false

LEECH-WILKINSON, Daniel. Classical music as enforced Utopia. *Arts & Humanities in Higher Education,* Vol., 15(3-4), 2016, pp. 325-336. Available at: https://www.researchgate.net/publication/305276956_Classical_music_as_enforced_Utopia

LEHMAN, Lotte. *More than Singing. The Interpretation of Songs.* Translated by Frances Holden. Dover Publications, INC. New York, 1985.

LEMAN, Marc. *Embodied Music Cognition and Mediation Technology.* The MIT Press Cambridge, Massachusetts London, England, 2008.

LEPPERT, Richard. Music "Pushed to the Edge of Existence" (Adorno, Listening, and the Question of Hope). *Cultural Critique,* No. 60, Spring, 2005, pp. 92-133. Available at: https://www.jstor.org/stable/4489211

LERCH, Alexander; ARTHUR, Claire; PATI, Ashis; and GURURANI, Siddharth. An Interdisciplinary Review of Music Performance Analysis. *Transactions of the International Society for Music Information Retrieval,* 3(1), 2020, pp. 221-245. Available at: https://www.researchgate.net/publication/346025588_An_Interdisciplinary_Review_of_Music_Performance_Analysis

LISBOA, Tania; CHAFFIN, Roger; DEMOS, Alexander P. Recording thoughts while memorizing music: a case study. *Frontiers in Psychology*, Vol., 5, 23 January, 2015. Available at: at: https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2014.01561/full

LONG, John A; CLOUTIER, Richard. The Unexpected Origin of Fingers. *Scientific American,* a Division of Springer Nature America, Inc., Vol., 332, No., 6, 1 June, 2020, pp. 46-53. Available at: https://researchnow.flinders.edu.au/en/publications/the-unexpected-origin-of-fingers

LOTZE, M; SCHELER, G.; TAN, H.-R. M.; BRAUN, C. and BIRBAUMER, N. The musician's brain: functional imaging of amateurs and professionals during performance and imagery. *NeuroImage,* Vol., 20, Issue 3, November, 2003, pp. 1817-1829. Available at: https://www.sciencedirect.com/science/article/abs/pii/S1053811903004683

LUNDBORG, Göran. *The Hand and the Brain. From Lucy's Thumb to the Thought-Controlled Robotic Hand.* Springer-Verlag, London, 2014.

MAIRS, Rachel. Egypt. In: Franz Pöchhacker (Ed.). *Routledge Encyclopedia of Interpreting Studies.* Associate editor: Nadja Grbic´, Consultant editors: Peter Mead and Robin Setton, Routledge, Taylor and Francis Group, 2015, pp.137–138.

MALONE, Samuel A. *Kreativ Handbok i Hjärneffektivitet Gymnastik.* In the original: Mind Skills for Managers. Translated to Swedish by Inge R.L. Larsson & Kjell H. Waltman. Richters,1998.

MARCUSE, Herbert. *Eros and Civilization. A Philosophical Inquiry into Freud.* Beacon Press Boston, 1955

MATTHAY, Tobias. *Musical Interpretation. Its Laws and Principles, and their Application in Teaching and Performing.* Boston Music Company, 1913.

MAZZOLA, Guerino. *Musical Performance. A Comprehensive Approach: Theory, Analytical Tools, and Case Studies.* In collaboration with Sara Cowan; I-YI Pan; James Holdman; Cory J. Renbarger; Lisa R. Rhoades; Florian Thalmann; Nickolai Zielinski. Springer-Verlag Berlin Heidelberg, 2011.

MCCRAE Robert, R. Music Lessons for the Study of Affect. *Frontiers in Psychology, Vol., 12,* 29 November, 2021. Available at: https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2021.760167/full

MCPHERSON, Gary E; BAILEY, Michael; SINCLAIR, Kenneth E. Path. Analysis of a Theoretical Model to Describe the Relationship among five types of Musical Performance. *Journal of Research in Music Education,* Vol., 45, No.1, Spring, 1997, pp. 103-129. Available at: https://www.jstor.org/stable/3345469

MEYER, Leonard. *Emotion and meaning in music.* University of Chicago Press, 1956.

MIELKE, Susan; COMEAU, Gilles. Developing a literature-based glossary and taxonomy for the study of mental practice in music performance. *Musicae Scientiae,* Vol., 23(2), 2019, pp. 196-211. Available at: https://journals.sagepub.com/doi/abs/10.1177/1029864917715062

MISHRA, Jennifer. Playing from Memory. *American Music Teacher,* Vol., 65, No. 6, June/July, 2016, pp. 12-16. Available at: https://www.jstor.org/stable/26385978

MORGENSTERN, Dan. Errol Garner, Master of the Keyboard 1981 complete album notes. *1981 Book of the Month Records 81-5403.* Media Collections, Texas State University. Available at: https://media.music.txst.edu/morgenstern/morgenstern-grammys/garner.html

MORTENSEN, John J. Playing Beyond the Notes: A Pianist´s Guide to Musical interpretation, by Deborah Rambo Sinn. *College Music Symposium. Exploring diverse perspectives,* Vol., 53, 3 June, 2013. Available at: https://symposium.music.org/index.php?option=com_k2&view=item&id=9698:iplaying-beyond-the-notes-a-pianist's-guide-to-musical-interpretation-i-by-deborah-rambo-sinn&Itemid=125

NETTL, B. Ethnomusicology. In: Grove´s Dictionnary, 2001, n.p.

NEUHAUS, Heinrich. *The Art of Piano Playing.* Translated by K.A. Leibovitch. Kahn & Averill. London, 1993.

NICHOLAS, Jude T.; JOHANNESSEN, Annika M.; NUNEN, Trees van. *Tactile Working Memory Scale – A Professional Manual.* Nordic Welfare Centre. TB Printsolutions, Västerås, Sweden, 2019.

NOUSHAD, Babu; GERVEN, Pascal W. M. van; BRUIN, Anique B. H. de. Twelve tips for applying the think-aloud method to capture cognitive processes. *Medical Teacher,* 10 December, 2023, pp. 1-6. Available at: https://www.researchgate.net/publication/376396007_Twelve_tips_for_applying_the_think-aloud_method_to_capture_cognitive_processes

ODENDAAL, Albi; LEVÄNEN, Sari; WESTERLUND, Heidi. The Mnemonist's legacy: on memory, forgetting, and ableist discourse in twenty-first-century inclusive music education. *Music Education Research*, Vol., 22, No. 3, 2020, pp. 360–370. Available at: https://www.tandfonline.com/doi/full/10.1080/14613808.2020.1759518

O´KEANE, Veronica. "A Sense of Self – Memory, the Brain and Who We Are, 2021. Available at: https://www.youtube.com/watch?v=cGDDPT96GM8

OSBORN, Alex. *Your Creative Power. How to Use Imagination.* Charles Scribner´s Sons, New York, London, 1948.

O´TOOLE, John; BECKETT, David. Making a Start. *Educational Research: Creative thinking and doing.* Oxford University Press, 2010. Available at: https://www.researchgate.net/publication/328419149_Educational_Research_Creative_thinking_and_doing

PACE, Ian. New Music: Performance Institutions and Practices. In: McPherson, G. & Davidson, J. (Eds.). *The Oxford Handbook of Music Performance.* Oxford, UK: Oxford University Press, 2022. Available at: https://openaccess.city.ac.uk/id/eprint/25924/

PALLASMAA, Juhani. An Architecture of the Seven Senses. In: Steven Holl, Juhani Pallasmaa, and Alberto Pérez-Gomez (Eds.). *Questions of Perception: Phenomenology of Architecture.* Architecture and Urbanism Publishing Co Ltd, Tokyo, 1994.

PALLASMAA, Juhani. *The Eyes of the Skin. Architecture and the Senses.* Wiley-Academy, a division of John Wiley & Sons Ltd. TJ International Ltd, Padstow, Cornwall, 2007.

PANADERO, Ernesto; LIPNEVICH, Anastasiya A. A review of feedback models and typologies: Towards an integrative model of feedback elements. *Educational research Review,* Vol., 35, 2022, pp. 1-22. Available at: https://www.sciencedirect.com/science/article/pii/S1747938X21000397?via%3Dihub

PAPETTI, Stefano; CHARALAMPOS, Saitis. Musical Haptics: Introduction. In: Stefano Papetti & Caitis Charalampos (Eds.). Musical Haptics, Springer Open, 2018.

PARNCUTT, Richard; MCPHERSON, Gary E. *The Science & Psychology of Music Performance. Creative Strategies for Teaching and Learning*. Oxford University Press, 2002.

REN, Yiren; BROWN, Thackery, I. Beyond the ears: A review exploring the interconnected brain behind the hierarchical memory of music. *Psychonomic Bulletin & Review*, 18 September, 2023. Available at: https://link.springer.com/article/10.3758/s13423-023-02376-1

REYBROUCK, Mark. *Musical Sense-Making: Enaction, Experience, and Computation. Sempre Studies in The Psychology of Music*. Routledge, 2021.

REYBROUCK, Mark. Music Listening as Kangaroo Mother Care: From Skin-To-Skin Contact to Being Touched by the Music. *Acoustics,* 6 (1), 1 January, 2024, pp. 35-64. Available at: https://www.mdpi.com/2624-599X/6/1/3

RUBIN-RABSON, Grace. The Psychology of Memorizing. *Music Educators Journal,* Vol., 36, No. 3, January, 1950, pp. 22 - 23+45. Available at: https://www.jstor.org/stable/3388606

RÖSCH, Harald. Memories leave their traces. *Max Planck Research,* 2, 2013. Available at: https://www.mpg.de/7426068/F001_Focus_020-026.pdf

SCHOTT, G.D. Penfield's homunculus is shown with an outline which encompasses the area of cortical representation. *Journal of Neurology, Neurosurgery & Psychiatry,* 1993, pp. 329-333. Available at: https://jnnp.bmj.com/content/56/4/329

SCHUMAN-OLIVIER, Zev; Trombka Marcelo; LOVAS, David A.; Brewer, Judson A.; VAGO, David R.; GAWANDE, Richa; DUNNE, Julie P.; LAZAR, Sara W.; LOUCKS, Eric B; FULWILER, Carl. Mindfulness and Behavior Change. *Harvard Review of Psychiatry,* Nov/Dec, 28(6), 2020, pp. 371-394.
Available at: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7647439/

SHINN, Frederick G. The Memorizing of Piano Music for Performance. *Proceedings of the Musical Association,* Vol., 25, 1898, pp. 1-25. Available at: https://www.jstor.org/stable/765150

SILVERMAN, Marissa. Musical interpretation: philosophical and practical issues. *International Journal of Music education*, Vol., 25, No.2, 2007, pp. 101-117. Available at: https://journals.sagepub.com/doi/10.1177/0255761407079950

SINHA, Divya; RAMACHANDRAN, H.; LOBO, A. The Effect of Mindful Music Listening on Attention. In: Uttamkumar S. Bagde (Ed.). *Current Trends in Life Sciences*. *Trends in Life Sciences.* LAP LAMBERT, Academic Publishing, GmbH & Co. KG. Saarbrücken, Germany, 2013, pp. 105-114.

SMENTEK, Lidia. The Music of Physics. In: Ernie Malamud (Ed.). APS Forum on International Physics, *The American Physical Society,* 2011, pp. 21-22. Available at: https://higherlogicdownload.s3.amazonaws.com/APS/5850cbf5-d2ca-4fe3-9812-9b34f575294f/UploadedImages/Documents/march11.pdf

SNOWDON Charles T.; ZIMMERMANN, Elke; ALTENMÜLLER, Eckart. Music evolution and neuroscience. In: Eckart Altenmüller, Stanley Finger, François Boller (Eds.). *Music, Neurology, and Neuroscience: Historical Connections and Perspectives,* 2015, pp. 17-34.

SOVERAL, Madalena & ZURLETTI, Sara, (Eds). *Performance Analysis: A Bridge between Theory and Interpretation.* Cambridge Scholars Publishing, 2019.

STALINSKI, Stephanie M; SCHELLENBERG, E. Glenn. Listeners Remember Music They Like. *Journal of Experimental Psychology: Learning, Memory, and Cognition.* American Psychological Association. 20 August, 2012, pp. 1-17. Available at: https://www.utm.utoronto.ca/~w3psygs/StalinskiSchellenberg2012JEPLMC.pdf

STOJOWSKI, Zygmunt. The Evolution of Style and Interpretation In Piano Literature. Eds: Maja Trochimczyk and Joseph A. Herter. *Polish Music Center.* No year. Available at: https://polishmusic.usc.edu/research/publications/polish-music-journal/vol4no1/piano-literature/

STREET, Eric. Bridging the Gap Between Sight Reading and Memorizing. *American Music Teacher*, published by Music Teachers National Association, Vol., 37, No. 2, November/December 1987, pp. 32-33. Available at: https://www.jstor.org/stable/43544122

SWART, Inette. New developments in neuroscience can benefit the learning and performance of music. *Muziki, Journal of Music Research in Africa,* Vol., 13, Issue: 1, 28 September, 2016, pp. 113-136. Available at: https://www.tandfonline.com/doi/abs/10.1080/18125980.2016.1182386

TAPPER, Bonno. Dilthey´s Methodology of the Geisteswissenschaften. *The Philosophical Review*, Vol., 34, No.4, July, 1925, pp. 333-349. Available at: https://www.jstor.org/stable/2179376

TOWNSEND, Kayla G. From STEM to STEAM: the Neuroscience Behind the Movement Towards Arts Integration in K-12. *University Honors Thesis.* Bachelor of Science submitted at Portland State University, 2017. Available at: https://pdxscholar.library.pdx.edu/cgi/viewcontent.cgi?article=1475&context=honorstheses

TURABIAN, Kate, L. A. *Manual for Writers of Research Papers, Theses, and Dissertations, Chicago Style for Students and Researchers*. Revised by Wayne C. Booth, Gregory G.Colomb, Joseph M.Williams, and University of Chicago Press Editorial Staff, The University of Chicago Press, Chicago and London, 7th edition, 2007.

VENABLE, Mary. *The Interpretation of Piano Music*. Oliver Ditson Company, Boston, 1913.

VEVERKA, John A. *Interpretive Master Planning. Volume Two: Selected Essays Philosophy, Theory and Practice.* MuseumEtc, Edinburgh, 2011.
Available at: https://www.researchgate.net/profile/John Veverka/publication/322988373_Interpretive_Master_Planning_Philosophy_Theory_and_Practice_m_useums_etc/links/60649f2292851c68df487bfc/Interpretive-Master-Planning-Philosophy-Theory-and-Practice-m-useums-etc.pdf

WANG, Shentong & AGIUS, Mark. The Neuroscience of Music; A Review And Summary. *Psychiatria Danubina,* Vol., 30, Suppl. 7, 2018, pp. 588-594. Available at: https://www.psychiatria-danubina.com/UserDocsImages/pdf/dnb_vol30_noSuppl%207/dnb_vol30_noSuppl%207_588.pdf

WATSON, Alan H.D. What can studying musicians tell us about motor control of the hand? *Journal of Anatomy,* Vol., 208, Issue 4, 18 April, 2006, pp. 527-542. Available at: https://onlinelibrary.wiley.com/doi/10.1111/j.1469-7580.2006.00545.x

WHITAKER, C. W. A. *Aristotle's De Interpretatione - contradiction and dialectic.* Clarendon Press, Oxford University Press, 2007.

WILCOX, Sherman & SHAFFER, Barbara. Towards a cognitive model of interpreting. In: Terry Janzen (Ed.). *Topics in Signed Language Interpreting: Theory and practice*. Amsterdam/Philadelphia: Johan Benjamins Publishing Company, 2005, pp. 135-164.

WILSON, Frank. R. *The Hand: How Its Use Shapes the Brain, Language, and Human Culture.* Vintage Books, A Division of Random House, Inc. New York, 1999. Available at: www.vintagebooks.com

WILSON, Robert A. & FOGLIA Lucia. Embodied cognition. *Stanford Encyclopedia of Philosophy,* 2011. Available at: https://philpapers.org/rec/WILEC

WINSLOW, Robert, W. The Psychology of Musical Memory. *Music Educators Journal,* Vol., 35, No.3, January, 1949, pp. 15-16. Available at: https://journals.sagepub.com/doi/abs/10.2307/3387082

ZEKI, Semir. Artistic Creativity and the Brain. *Science. American Association for the Advancement of Science*, Vol., 293, No.5527, July 6, 2001, pp. 51-52. Available at: http://www.jstor.org/stable/3084178

ZIMMERMAN, Emily; LAHAV, Amir. The multisensory brain and its ability to learn music. The Neurosciences and Music IV: Learning and Memory. *Annals of The New York Academy of Sciences*, Vol., 1252, Issue 1, April, 2012, pp. 179–184. Available at: https://nyaspubs.onlinelibrary.wiley.com/doi/10.1111/j.1749-6632.2012.06455.x

ZLOTNIK, Gregorio & VANSINTJAN, Aaron. Memory: An Extended Definition. *Frontiers in Psychology,* Vol.,10:2523, 7 November, 2019, pp. 1-5. Available at: https://www.frontiersin.org/journals/psychology/articles/10.3389/fpsyg.2019.02523/full

ÅRHEM, Peter. *Sensory systems. General aspects.* Department of Neuroscience, Karolinska institutet, Stockholm, Sweden, 2015. Available at: https://www.kth.se/social/files/552f8dc0f276541752d1f347/KTH_Somatosensory_150410

ÖZDAMAR, Esen Gökçe. Kinaesthetic Perception and Architecture. *Barcelona, Research, Art, Creation*, Vol., 9 No. 3, 3rd October, 2021, pp. 325-340. Available at: https://www.researchgate.net/publication/350277108_Kinaesthetic_Perception_and_Architecture