Learning: On the Multiple Facets of a Colloquial Concept

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Several terms in colloquial language are used without a clear definition. However, we all associate something specific with the term being used and apply it to various situations. One such term is undoubtedly the concept of learning. We use the word innocently and become aware of its divergent meanings and its attribution to different disciplines only when we start to think about a specific aspect. As Augustinus said when reflecting on time: everybody knows intuitively what it is, but when we are asked to explain or define it, we get into trouble: "Quid est ergo tempus? Si nemo ex me quaerat, scio; si quaerenti explicare velim, nescio" (Augustinus).

Learning is always associated with action. In infancy and early childhood it is based entirely on concrete actions that involve the whole body, whereas later in life one can replace real actions by imagined actions (actions in preparation), or by abstract cognitive operations (Piaget 1947). However, there is a strong and necessary basic connection between thinking (learning) and acting (doing), and there is a particularly distinct association between auditory and sensorimotor brain activities. Normally, learning is accomplished by doing something or changing a pattern of action. This terminates in new mental representations. However, before embarking on a discussion of the neural conditions, we will first review the everyday usage of the term "learning" in various contexts.

Learning refers to a process of acquiring something new that is not completely new, but which is new within the individual range of possibilities. We call it learning when we acquire or refine a skill that we have not yet developed. The skill might belong to practical abilities and habits as well as to thinking and understanding. Through learning, something has changed within actions, thoughts, or habits. Therefore, learning is always associated with behavior and relates to attitudes that remain relatively stable and that appear as a consequence of an interaction between the subject or organism and the environment, but not as a result of other influences (illness, drugs, psychic states, etc.). However, this classical behavioristic definition includes observational processes only, and ignores structural changes within a personality.

Biochemical processes are considered when we look at learning from a neurobiological point of view. All apparent or hidden behavioral changes ultimately are caused by biochemical changes in the information transmission on the molecular level of synaptic connections (see Figure 1). The function of synapses is to propagate or inhibit the chemo-electrical signal transmission. Learning, then, refers to the establishment of new, or to the extension of already existing, neural connections and the building of networks where information is represented. To develop new networks, the synaptic exchange must be modified (strengthened or inhibited). Here, synaptogenesis and transmission speed are important factors in mental growth. Furthermore, the interaction of neurons and networks by synchronous firing is also most relevant for this process.

From a neurobiological perspective, it might happen that no behavioral differences appear in two learning groups, yet a brain scan reveals significant differences regarding the strength of activation and the connection of brain areas (Gruhn 1997). Therefore, two subjects may show exactly the same results in a cognitive or behavioral test, i.e. they have both learned something, however the learning itself can be quite different because of verifiable changes in the internal structure of the synaptic connectivity.

Figure 1
The synaptic gap with pre-synaptic vesicles that perform the exchange between neurons

If we are going to describe learning in terms of everyday life, we recognize a divergent applicability dependent on the many functions and purposes of learning. One learns a foreign language so that one may become able to communicate with other people, to exchange information, and to fulfill daily needs. However, when we learn an instrument, we call it "to play" an instrument. This embraces all motor activities (posture, finger movement, etc.), musical dimension (articulation, intonation, ear control, etc.), and cognitive abilities (reading skills, notation, theoretical knowledge, etc.). What we learn when we learn refers to different issues that culminate in a new or differentiated ability (mastering the instrument) or knowledge (reading a bass clef or notating a minor scale), and extend the base for further experiences. To sum up, learning embraces the acquisition of practical and theoretical knowledge, ability and experience.

How do we acquire new abilities and extend our knowledge? This normally happens through experience, sometimes by mistakes (trial and error), or most usually by taking lessons from a specialist. For this purpose, institutions like schools, training courses, camps, evening classes, etc. have been established where individuals with a special expertise guide and instruct those who want to learn something (car driving, foreign languages, instruments, chess, painting, etc.). However, those who attend a choir or participate in leisure time facilities do not see themselves as learners; rather, they want to have fun and to join with others in communal activities.

Just this brief and incomplete survey reveals that we cannot strictly separate learning from other activities that include or initiate learning. In many everyday situations, learning is not intentional, it happens incidentally, whereas in a foreign language class or in instrumental instruction one attends consciously with the goal and explicit intention of learning something new.

In a first approach we can point out that learning affects behavior (but is not behavioral in essence), and contains the acquisition of knowledge, ability, and experience. This happens in various areas of different kinds of public institutions, daily life, or simply by doing something. When young boys on the beach of Copa Cabana watch the older ones playing football, they join in and play with them, or imitate what they saw from watching their strategies. In this way, they learn all kinds of tricks and techniques of football, and, at a later stage, they will probably become champions. This is the most typical method of social learning in a life situation with and from others that is not primarily intentional because people do it for fun, not for learning reasons. That is, it happens implicitly and incidentally, whereas learning by imitation is normally conscious and intentional; the violin teacher tells his student to watch and imitate his actions e.g. when teaching the vibrato. This can also be done quite explicitly when the teacher verbally explains and demonstrates the hand, finger, and arm movements. Contrariwise, a teacher can just demonstrate the sound of a violin tone with and without vibrato and ask for the reproduction of those sounds. What normally happens is that a pupil wants to produce the vibrato as others do. The teacher can then follow up on the pupil's initiative and encourage him/her to imitate the vibrato—which leads to the risk that the student will find a physiologically inappropriate or musically weird solution. A solid teaching strategy with step-by-step exercises can be more efficient and successful. This indicates that learning mostly (or always?) tends toward achievement: one can master something that was not achieved before learning.

To sum up the second approach, we realize that learning can be implicit or explicit, verbal or procedural, intentional or incidental. Mostly, real world learning, i.e. learning in daily life and real situations, applies a mixture of all. Most of what we have learnt (such issues as walking, talking, balancing, singing, etc.) is acquired incidentally, but is always connected with practice! A small child learning to walk falls down repeatedly, but does not give up, and stands up again; the child needs to fall down so that the body can learn by proprioceptive feedback how to balance, so that s/he is finally able to walk independently.

It appears that learning happens naturally and incidentally in many daily situations, but it always requires practice to automatize the particular trajectories, even though we may connect to it and acquire it in a joyful play-situation. All of this needs to be stored or represented in the mental organization of the brain. Memory comes into play here. Very often—especially in schools—learning is equated with memorization, which means that we need to keep in mind what we once acquired.

We will now explore the function of the body and the brain, and their relationship to learning. We will focus here on the interaction of learning with general intelligence and memory, with joyful play and permanent laborious practice, and finally with movement and embodiment (see Figure 2).

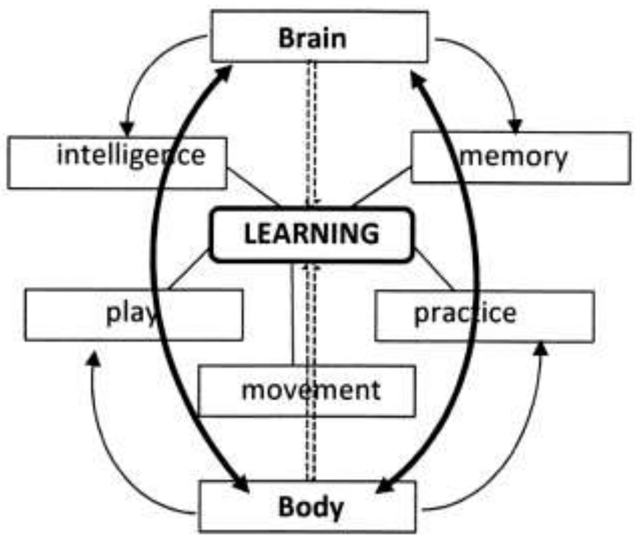

Figure 2
Brain-body-interaction, with different dimensions contributing to the learning process

1. Learning and General Intelligence

We can define intelligence as the genetic disposal of human mental abilities, which are normally measured by intelligence tests (IQ-tests). Intelligence, of course, plays an important role in learning because a higher cognitive potential will lead to faster processing and better results (higher scores) in learning tasks. Intelligence can be seen as a measure that explains differences in human mental ability (Deary 2000; 2001).

Two contrasting theories or paradigms are under debate: intelligence as one big attribute reflected by high (> 100), medium (100), or low (< 100) IQ, or, on the contrary, intelligence as a bunch of different abilities based on special linguistic, mathematical, sportive, musical, etc. skills as ascribed by Howard Gardner to the phenomenon of "multiple intelligences" (Gardner 1985; 1999). If we go along with Gardner, it is clear that not only cognitive aspects account for intelligence and that everybody develops his/her own intelligence profile: one with a higher linguistic, others with a higher mathematical, bodily-kinesthetic, or spatial capacity. That might explain why one person can easily and quickly learn to play the violin while others cannot, while others are much better at solving abstract mathematical problems, etc. However, intelligence in terms of Gardner's theory is not related strictly to cognitive capacities, but is widely equivalent to aptitude, which describes a potential based on a genetic disposition.

If we follow Ian Deary, who focused on different factors that account for the individual differences in mental ability, we need to identify those factors that affect intelligence. For this, Deary hypothesizes a general factor of intelligence (g-factor). This is a statistical construct that is effected by several cognitive brain factors such as perceptual organization and comprehension, the capacity of the working memory, and mental processing speed (see Figure 3).

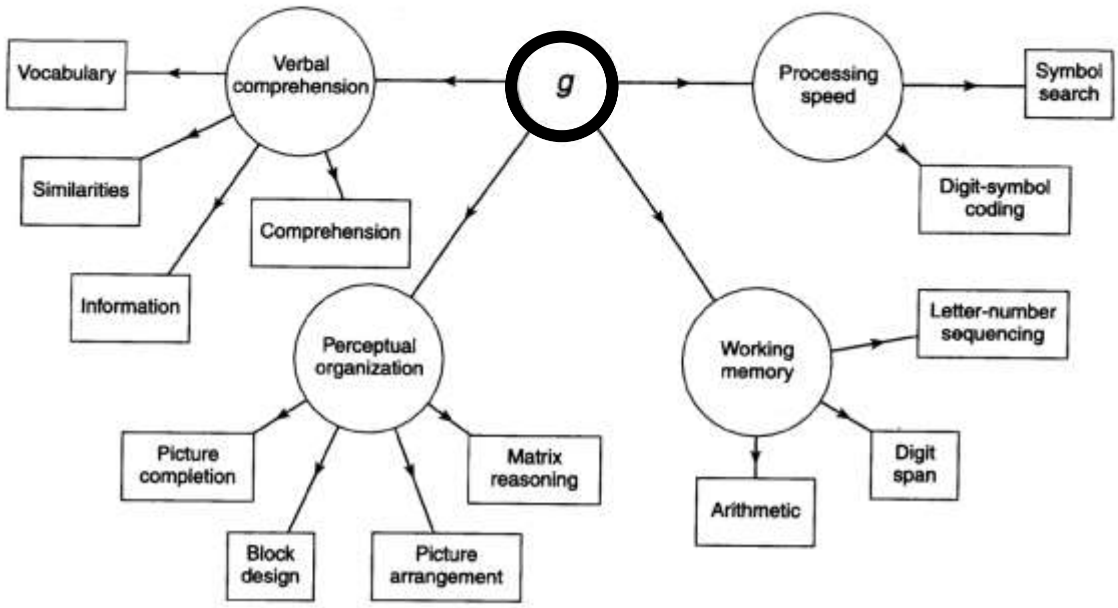

Figure 3 Hierarchy of factors contributing to ability test scores with the general (g-) factor on top and related mental factors around (from Deary 2001, 3)

Mental speed is genetically determined and cannot be trained. It depends on the synaptic connectivity and the degree of myelination that produces an electrically insulating layer, the myelin sheath around axons, which causes a higher speed of signal conduction. Subjects with better (higher) mental speed do better (more efficiently) in cognitive tasks. This, in the end, also means that higher mental speed as a core factor of general intelligence provides a better prediction of success in learning (Gruhn, Galley, et al. 2003). Although intelligence is not part of learning per se, it does enhance and support learning strategies in many different areas—one of which is also music and instrumental learning.

2. Learning and Memory

In a colloquial sense, we often equate learning with memory. Learning in the academic subjects of a school curriculum calls for memorization of facts and data. Learning, then, is associated with (verbal) knowledge acquisition. Here, it is helpful to realize that Gardner has broadened the validity of the term "intelligence" toward areas that are not based only on cognitive abilities. As we have seen, the working memory is a relevant factor of general intelligence (Figure 3) and therefore functions in learning as well. Although learning cannot be equalized with behavior and memory (as is often the case in daily life), working memory is important for all musical activities when we remember, plan, execute, and monitor our musical performance. And reversely, musical practice reveals an overall positive association with visuospatial and verbal (auditory) working memory (Bergman Nutley, Darki, et al. 2014).

Musical working memory is also involved in the specific and peculiar form of internal musical thinking. This develops during the transition from figural to formal representations (for these terms see Bamberger 1991; 2013). The development of mental representations includes the ability to create connections between perception and musical conceptions. We relate a perceived musical element (a pattern, piece, tune, sound, etc.) to an already familiar element and compare to see if it is the same or different. The internal thinking or musical audiation (Gordon 1993) relies on the capacity of the working memory. The bigger it is and the faster one can retrieve information from it, the more one will succeed in making connections and developing new associations. This is a prerequisite for any problem-solving strategy as well as for learning as a process to generate meaning. Thus, learning enables us to recognize something to be something, and to generalize this meaning for accessibility in other, similar situations.

To sum up, learning is not simply an accumulation of knowledge in the memory, but memory is a key factor in the process of developing mental representations and making new connections between already established representations.

3. Learning as Play

When we refer to "playing" music, what does it mean and where does it come from? When a child wants to learn trumpet, we call it "playing the trumpet." Behind the linguistic usage, there is a common understanding of the function of music learning and music performance as play because it shares some commonalities with ordinary play that involve high commitment and pleasure.

In everyday life, the term “play” denotes the opposite of “work”—that results from effort and strain. Work in general starts from a clear purpose and guarantees economic survival or even prosperity. Therefore, it is hard, but useful, not always enjoyable, but necessary. On the contrary, play in general as well as musical play is always or predominantly joyful and satisfactory. It is full of intention and meaning to the players, but it is free of concrete utility, practical application, and is independent of praise. It is self-evident and free of external purpose. In learning, success is a much better motivation than easy and exuberant praise. Children do not play in order to receive praise, but for their own satisfaction. Play follows rules, but these rules organize the common activities and have no other goal beyond that; they are self-evident. As opposed to work, which terminates in a factual result or an achieved product, play is best accomplished as a process of doing something that is a goal in itself. Both activities, play and work, can be social and communal, but can be performed also by one person alone. Therefore, play as a self-evident process terminates best in what Csikszentmihalyi has called “flow,” which describes a state of autotelic experience by which a person is highly focused on an activity, fully concentrated, intrinsically rewarded, emotionally involved, so that (s)he seems absent-minded and out of real time (Csikszentmihalyi 1997).

It seems obvious that musical and ordinary play share many commonalities. However, how does learning fit into this concept? Learning is an activity undertaken to acquire new knowledge or abilities. Sometimes, it is also real work with high commitment and continued practice. However, learning in a life context—like play—often happens without intention or any immediate or useful purpose. When we learn a new song just by listening to it many times, we learn and memorize it without the intention to do so, but quite incidentally. When children find a drum or an object that they can use as a drum, they explore rhythms and experience new sounds just by imitating other children. Incidental learning is always implicit learning with minimal attention to and awareness of the actual process. By this, one learns a large number of habits and skills without formal instruction. These kinds of activities beyond formal settings share incidental learning with play. Therefore, play modes can be integrated into learning arrangements so that learning is somehow similar to play and shares its modalities for a while. One learns an instrument by playing it. Learning the instrument turns into instrumental play.

4. Learning through Practice

However, learning cannot remain in that play mode. Musicianship and mastery depend on personal commitment and continuous and sustained practice over a longer period of time. Only through practice can proficiency succeed. Musical performance with an instrument calls for a maximum of spatial and temporal fine-motor precision that can only be gained through training on a daily basis (Jabusch & Altenmueller 2014). Learning to play an instrument correctly requires precise motor coordination of arm, hand, and finger muscles. As expert research has demonstrated (Ericsson, Krampe, et al. 1993), this can be mastered through deliberate practice. There are bio- and neuro-physiological conditions that need to be taken into account. The supplementary motor area in the brain (SMA) saves complex motor programs that are automatized in cooperation with the basal ganglia. This neural network needs to be trained, it does not develop automatically. The training is sometimes hard and arduous, but it can also become highly satisfactory when the training is accompanied by high motivation and “intrinsic fascination” (Sloboda & Howe 1991).

Practice, therefore, is a constitutive part of learning; there is no learning without practice because a new ability, knowledge, or attitude needs to be consolidated by use and repetitive application. Synaptic connections that are the first reason for behavioral change will disappear without repetitive use ("use it or lose it"). In a pedagogical context, teachers must take care that practice does not become mechanical repetition. Although this supports precision, it abolishes musical joy, personal satisfaction, and musical expression. Accordingly, we cannot separate learning from practice, but practice alone does not necessarily lead to learning in a comprehensive sense.

5. Body and Embodiment: Learning by Movement

We started with the brain and its function for intelligence. Now, the examination of the different dimensions of learning terminates at the opposite pole: the body and embodiment of music learning. It is not the brain and not the hand or the fingers alone that learn to play an instrument, it is always the entire person with body, mind, and brain. Therefore, corporeal aspects of learning are crucial (Gruhn 2012).

Musical performance and musical understanding are always embodied. We need a body to execute musical thoughts vocally or instrumentally, and we understand the type and emotion of a musical performance by the inner implementation of the musical gestures that enable a performance and determine its character (Godoy & Leman 2010; Gruhn 2014). We understand a march or a dance, sad or happy music by an internally imagined performance of the respective gestures.

Furthermore, especially in early childhood learning, there is no separation of cognition from bodily experience. Infants' perception is excelled by a coenesthetic quality (Spitz 1965) that refers to a holistic way of perception and experience. Here, the entire body represents one of the senses. The cry of a baby is not merely an acoustic phenomenon, but an expression of the body and soul in all its dimensions. Consequently, we can only access the brain of a person by his/her body. The proprioceptive interaction between body and mind is the entrance door to the brain, and affects and changes the neural structure on the synaptic level of information propagation (see Figure 4).

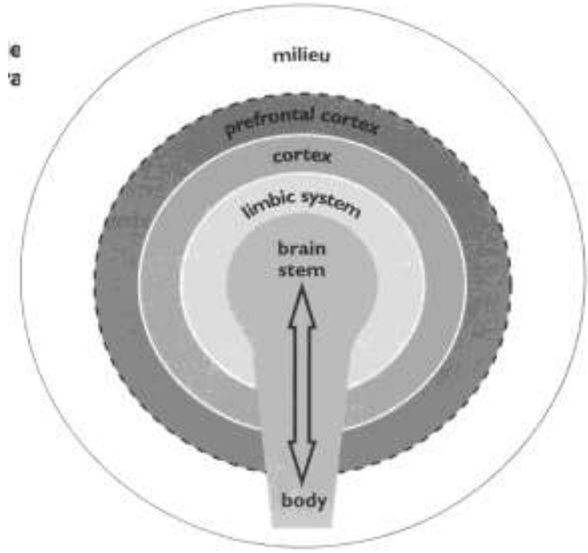

Figure 4
The three layers of brain evolution (brain stem, limbic system, and cortex) and their interplay with the body in human cognitive development (with permission of G. Hüther)

Any musical experience is perceived primarily through the body. Therefore, it can be expected that the body itself is part of the learning system. This was observed in classes where children with good motor coordination were those with higher scores in a music aptitude test. This was confirmed by a biomechanical investigation of the interaction between motor control and coordination, and musical abilities in preschool children (Gruhn, Haußmann, et al. 2012). Additionally, brain research has addressed the question of how music and brain interact on a neuronal level. It has been shown that beat perception in musical rhythms involves the motor areas in the brain (Chen, Penhune, et al. 2008; Grahn & Brett 2007), which confirms a vital interaction between musical pulse and motor perception.

The aforementioned studies demonstrate that music and movement are interrelated. Children learn with their bodies; and the body functions as the transfer machine to cognition and mental representations (Gruhn 2010). The embodiment of music and the learning of a musical instrument, as well as music as an acoustic phenomenon that shares many aspects of communication and expression with language, represent two sides of the same coin: embodiment and learning are inseparably connected. This calls for a much stronger curricular and methodical integration into the teaching of music.

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The preceding reflections on the colloquial use of the concept of learning manifest many associations and overlaps with other domains that share some commonalities, but are also distinct and need to be differentiated clearly. Learning as an activity to acquire knowledge and abilities is complex in its many associations. In the context of educational sciences, one can distinguish between different types and modalities, levels and functions of learning. Our reflection of basic understandings is intended to shed light on the various transitions from a narrowly defined concept of learning to other related aspects. We can think of the term itself as a core that has become worn at its edges. This opens up the term toward absorbing new ideas and determinations that may enrich our understanding of teaching and learning.

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