TEACHING MUSIC PERFORMANCE IN HIGHER EDUCATION

EXPLORING THE POTENTIAL OF ARTISTIC RESEARCH

EDITED BY
HELEN JULIA MINORS,
STEFAN ÖSTERSJÖ,
GILVANO DALAGNA, AND
JORGE SALGADO CORREIA

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9. The Musical Object in Deep Learning

Odd Torleiv Furnes

Introduction: Redesigning Education

In 54 BCE, Caesar invaded Britain. The campaign had fought its way from Rome using horses and wooden carriages for transportation. Over a millennium later, in 1510 CE, Martin Luther travelled from Germany to Rome using the exact same technology—one that remained virtually unaltered for a further 300–400 years. If we fast forward, the variety in means of transportation today has exploded and so has the advance in all other forms of technology. The kind of education where the students are set to copy skills and facts from yesterday to handle the jobs of tomorrow has rapidly become more and more irrelevant and outdated. Andreas Schleicher, director for Education and Skills in the Organization for Economic Cooperation and Development (OECD), puts it like this: 'We live in a fast-changing world, and producing more of the same knowledge and skills will not suffice to address the challenges of the future'.[1] Such insight has forced a change in education, and the solution has been turning towards the so-called twenty-first-century skills. With these skills, we look to the future: 'We are preparing students for jobs that don't yet exist'.[2] In Norway, one answer to these challenges was to replace the national curriculum for primary, lower secondary and upper secondary education. In the new curriculum, introduced in 2020, the renewal of subjects and competencies is aimed at equipping students with the necessary knowledge and competencies to handle the unknown challenges of tomorrow. Competence, a central concept in the curriculum, is thus defined as 'the ability to acquire and apply knowledge and

1 Andreas Schleicher, 'The case for 21st-century learning', Organization for Economic Cooperation and Development, 14 June 2012, OECD Web Archive, https://web-archive.oecd.org/2012-06-14/61660-thecasefor21st-centurylearning.htm

2 Maruan El Mahgiub, 'Education: Preparing Students for Jobs that Don't Yet Exist', TEDxIEMadrid, YouTube, uploaded by TEDx Talks, 4 September 2019, https://www.youtube.com/watch?v=uGR4eJmNI90

https://doi.org/10.11647/OBP.0398.12

skills to master challenges and solve tasks in familiar and unfamiliar contexts and situations'.[3] The concept of deep learning (in-depth learning) has also been given a central place, alongside competence, in the new curriculum. There are varying definitions of the concept. Deep learning is said to provide room for the students to 'develop understanding of key elements and relationships in a subject'.[4] Other definitions are 'to learn something so well that you understand relationships and can apply what you have learned in new situations' or 'gradually developing knowledge and lasting understanding of concepts, procedures and relationships in the subject and between subject areas'.[5]

The turn towards twenty-first-century skills and deep learning represents a break with traditional pedagogy, replacing the acquisition of facts and concrete, isolated skills—often referred to as surface learning—with that of understanding concepts, seeing relationships, and applying knowledge in new contexts.[6] We can interpret this as a shift from obtaining a certain defined amount of knowledge to, instead, grasping the structure of knowledge.[7] Here, memorising isolated facts and procedures is considered of less value than understanding how the different elements are interrelated and structured. The new emphasis on structural understanding, in turn, allows for the recognition of similarities in structure between seemingly unrelated problems and challenges—a skill that enables the transfer of knowledge. This may seem a logical response to the unforeseen challenges of the twenty-first century, but there are some issues that need to be addressed. Although deep learning is partly defined as an understanding of concepts, the concept of deep learning itself is not necessarily easy to understand, and its application to the subject of music is, perhaps, even less obvious. One main objective of this chapter is to clarify how deep learning in music can be understood and facilitated.

3 Utdanningsdirektoratet, 'Core curriculum: Competence in the subjects', 2019, para 3 of 7, https://www.udir.no/lk20/overordnet-del/prinsipper-for-laring-utvikling-og-danning/kompetanse-i-fagene/?lang=eng

4 Ibid., para 6 of 7.

5 Utdanningsdirektoratet, 'Dybdelæring', 13 March 2019, para 1 and 2 of 4 (my translation), https://www.udir.no/laring-og-trivsel/dybdelaring/

6 Sawyer, R. Keith, 'Introduction: The New Science of Learning', in *The Cambridge Handbook of the Learning Sciences*, ed. by Keith Sawyer (Cambridge: Cambridge University Press, 2014), pp. 1–16. See Table 9.1.

7 Michael Schneider and Elsbeth Stern, 'The cognitive perspective on learning: Ten cornerstone findings', in *The Nature of Learning: Using Research to Inspire Practice*, ed. by Hanna Dumont, David Istance, and Francisco Benavides (Paris: OECD Publishing, 2010), pp. 69-90, https://doi.org/10.1787/9789264086487-5-en

Deep Learning	Traditional Learning
Deep learning requires that learners look for patterns and underlying principles.	Learners memorize facts and carry out procedures without understanding how or why.
Deep learning requires that learners integrate their knowledge into interrelated conceptual systems.	Learners treat course material as disconnected bits of knowledge.
Deep learning requires that learners relate new ideas and concepts to previous knowledge and experience.	Learners treat course material as unrelated to what they already know.
Deep learning requires that learners reflect on their own understanding and their own process of learning.	Learners memorize without reflecting on the purpose or on their own learning strategies.

Table 9.1. Deep learning vs traditional learning.

Musical Knowledge and Meaning

To define the concept of deep learning in music, different aspects of meaning and knowledge become central to the discussion. I will pursue two strands of reasoning: the ontological question regarding the source of musical knowledge, and the epistemological question of how we can attain musical knowledge. In terms of musical ontology, the notion of the musical object as the source of musical knowledge can be contrasted to the situated view that musical knowledge is created within the social, relational musical activity. The epistemological strand investigates our ability to perceive, process, and understand music as sound and follows the discourse between analytical or verbal (language-based) knowledge and intuitive, experiential, somatic, and non-verbal knowledge. Upon inspection, we can find signs of both an ontological and an epistemological perspective in the definition of deep learning. Following these two strands, I start with the question of musical ontology.

Source of Musical Meaning

In search of the source of musical knowledge, we cannot escape the question of meaning. Traditionally, there have been two diametrically opposite stances regarding in what musical meaning is grounded. Some believe that the source of musical meaning can be found within the musical object (for example, in the performed and/or broadcast sound in performance, or in the score as written by the composer). Others think that music is given meaning through extra-musical references. Leonard B. Meyer, in his book *Emotion and Meaning in Music* (1956), described this difference of opinion as being:

> between those who insist that musical meaning lies exclusively within the context of the work itself, in the perception of the relationships set forth within the musical work of art, and those who contend that, in addition to these abstract, intellectual meanings, music also communicates meanings which in some way refer to the extramusical world of concepts, actions, emotional states, and character. Let us call the former group the 'absolutists' and the latter group the 'referentialists'.[8]

The absolutist stance is further divided into the positions of formalism and expressionism. Formalists believe that 'the meaning of music lies in the perception and understanding of the musical relationships set forth in the work of art and that meaning in music is primarily intellectual'.[9] The Austrian music critic and formalist Eduard Hanslick (1825–1904) exemplifies this stance when stating: 'Music consists of tone successions, tone forms; these have no content other than themselves'.[10] Then, there are absolute *expressionists* who do not think that the meaning of music lies in an intellectual understanding of musical form but in the musical *experience* excited by those forms without the need for any extramusical reference. Another type of expressionism takes the view that 'emotional expression is dependent upon an understanding of the referential content of music'.[11] This gives us the following notions of musical meaning: the formalist, the absolute expressionist, and the referential expressionist. Note that Meyer describes two forms of absolutism—the formalist and the expressionist—but only one type of referentialism. He states that 'almost all referentialists are expressionists',[12] but he is not clear about an alternative to referentialism that is not directly related to expressiveness. One candidate for covering the non-expressive, referential side could be so-called conceptual art. Here, the artistic object is of less importance than the extramusical idea or concept that the spectator can detect through thoughtful reflection. Conceptual art has even been described as anti-aesthetic.[13] Another candidate, although it is not explicitly non-expressive, is the discipline of musical semiotics. In *Signs of Music*, Eero Tarasti describes the discipline in this way:

> No object or thing has any existence for us unless it means or signifies something. Music thus mediates between values be they aesthetic, ideological, or whatever—and fixed, ready-made objects. In fact, music as a sign provides an ideal case of something meaningful and communicative, and thus of something semiotical par excellence.[14]

8 Leonard B. Meyer, *Emotion and Meaning in Music* (Chicago: University of Chicago Press, 1956), p. 1.
9 Ibid., p. 3.
10 Eduard Hanslick, *On the Musically Beautiful*, trans. by L. Rothfarb and C. Landerer (Oxford: Oxford University Press, 2018 (1854)), p. 109.
11 Meyer, p. 3.
12 Ibid.
13 Arthur P. Shimamura, *Experiencing Art: In the Brain of the Beholder* (Oxford: Oxford University Press, 2013), p. 25.
14 Eero Tarasti, *Signs of Music: A Guide to Musical Semiotics* (The Hague: De Gruyter Mouton, 2002), p. 4, https://doi.org/10.1515/9783110899870

In musical semiotics, the claim is that music gains meaning through non-musical references. These non-musical references can be related to gestures, gender, biology, intertextual connotations, etc. Thus, for music to be meaningful, one must see and understand what the music signifies. Although there could be an intuitive, experiential component involved, this can be seen as a matter of conceptualising relationships between the realms of the musical and the non-musical.

With conceptual art and the conceptual side of musical semiotics, we may have completed the picture drawn by Meyer: musical meaning emerges through a) the *expressive* dimension, where the source of emotional expression is either within the musical object itself or in the referential, non-musical associations; or b) the *conceptual*, intellectual logic detected within the musical object itself or in the referential, non-musical denotations. In other words, when focusing on the musical object as the source of knowledge, meaning can arise through an intellectual and conceptual discovery of relationships between the musical elements (formalism) or through an intuitive, emotional response to the unfolding music (absolute expressionism). On the referential side, music can attain meaning through emotional reactions caused by associations between the music and non-musical objects or actions (referential expressionism) or through a more intellectual detection of a conceptual connotation between musical signs pointing to a non-musical reality (conceptual art and musical semiotics). It all boils down to whether musical meaning is reliant on the musical object or on non-musical denotations and to whether meaning emerges through emotional responses or conceptual, abstract thinking. Other disciplines that treat musical meaning as referential are sociology of music and parts of educational philosophy and music education. These disciplines provide the strongest opposition against the absolute view of art and music.

Absolutism under Attack

Formalism and absolute expressionism have been under attack from both sociological and philosophical sides. A significant voice was John Dewey, who critiqued the art object as being detached from real life. In his book *Art as Experience* (1939), he said the following:

> When an art product once attains classic status, it somehow becomes isolated from the human conditions under which it was brought into being and from the human consequences it engenders in actual life-experience. When artistic objects are separated from both conditions of origin and operation in experience, a wall is built around them that renders almost opaque their general significance, with which esthetic theory deals.[15]

According to Dewey's pragmatism, music loses significance and value when it is removed from actual life experience. We might say it also loses meaning. In an attempt

15 John Dewey, *Art as Experience* (Berkley, CA: Berkley Publishing Group, 2005 (1934)), p. 1.

to distance music and musical meaning from the musical object, Christopher Small coined the term 'musicking', which put emphasis not on music as an object but as action: 'There is no such thing as music. Music is not a thing at all but an activity, something people do'.[16] David J. Elliott and Marissa Silverman adopt a similar perspective in *Music Matters*, stating that:

> musical values are not intrinsic; they are not 'fixed-in' sonic forms or captured in notated scores. Musical values are socially assigned to sounds according to how sounds are used, experienced, and understood as being 'good' or 'right' for various purposes in musical, personal, and ethical social life. […] Musics can only be understood and experienced in relation to contexts of socio-musical contexts. From Dewey's pragmatic perspective, and from our praxial perspective, musics have meaning only in relation to, and in recognition of, distinct human aims and needs.[17]

Their term 'musics' refers to all forms of making music, and 'musicing' (Elliott and Silverman's parallel to Small's 'musicking') includes performing, improvising, composing, arranging, conducting, and recording. However, it also 'always includes listening because music makers of all kinds listen to what they do in acts of musicing and because listening is, in itself, a form of musical-social-participation'.[18] Elliott and Silverman, by stressing that listening is a part of music making and a form of social participation, seem to understate listening as an independent activity oriented towards the aesthetic properties of the musical object. This can be seen as an attempt to build a case against both the idea of a musical object and an aesthetic form of listening because both concepts have historically been ignorant of human concerns:

> […] the aesthetic work-concept defines music listening via a negative norm: to listen aesthetically is *not* to connect musical sounds to other human concerns. In the jargon of aesthetics (and 'music education as aesthetic education'), our dispositions as listeners must be 'disinterested' and 'distanced'.[19]

Elliott and Silverman may be right that the concept of aesthetics has been interpreted according to the philosopher Immanuel Kant's idea of disinterestedness, which urges the listener to 'forget' about personal interests and concerns and direct his or her attention directly towards the musical work. In 2015, when their book was published, however, the idea of 'disinterestedness' did not have a monopoly on how to define the concept of aesthetics. Furthermore, when they argue against the notion of the 'work-concept', they build their case on ideas that were more prevalent 200 hundred years ago than they are today:

16 Christopher Small, *Musicking: The Meanings of Performing and Listening* (Middletown, CT.: Wesleyan University Press, 1998), p. 2.
17 David J. Elliott and Marissa Silverman, *Music Matters: A Philosophy of Music Education*, 2nd edn. (Oxford: Oxford University Press, 2005), p. 103.
18 Ibid., p. 16.
19 Ibid., p. 67, emphasis in original.

> The elements-based work-concept of music, which reached maturity around 1800 [...] institutionalized the false but widespread assumption that 'musical meaning' resides inside musical form and exists only for listeners' intellectual contemplation, not *felt* enjoyment.[20]

They seem to make a case against both aesthetic listening and the musical object due to an association with what we recognise as a formalist notion of musical meaning. While they acknowledge that many aesthetic philosophers refer to feelings, Elliott and Silverman claim that this does not refer to actual *felt* emotions. There is some historic validity to this accusation, but the rhetoric drives them into an apparent wholesale rejection of both the musical work and aesthetics in terms of musical meaning. As a consequence of their reasoning, they arrive at a definition of music as something completely dependent on social function: 'sound is deemed to be music according to the personal, social, and cultural functions it serves'.[21]

What could be seen as an attempt to marginalise the importance of individual listening outside of the activities of music-making fits the socio-constructivist paradigm that treats meaning and knowledge production as a shared social and cultural activity. Consequently, there is less of both valuable meaning and knowledge to be found for the individual attending to the aesthetic properties of the musical object than in how we use the objects for our common good.

Traces of the perspectives described above can be found in the Norwegian curriculum. One of the core elements in music claims that 'The meaning of music is created when music is used in social contexts'.[22] Such a stance may be seen to oppose what has been considered somewhat elitist attitudes within absolutism and formalism—attitudes that, according to Dewey, render the general significance of the artistic object opaque.[23] This dissociation from art as an object does not just seem to bury the notion of absolute formalism and expressionism; it also makes us question the idea of aesthetic learning *per se*: if musical meaning is treated as a socially defined symbolic language under relativistic and pragmatic terms, what is the status of the individual's perceptual experience of music as sound? Is there nothing in the sound itself that may give rise to perceptual and emotional experiences that are not socially pre-defined, functional, or pragmatic?

Many of us have experienced so-called 'guilty pleasures'. Kris Goffin and Florian Cova describe the phenomenon like this:

> In everyday language, the expression 'guilty pleasure' refers to instances where one feels bad about enjoying a particular artwork. Thus, one's experience of guilty pleasure

20 Ibid., p. 68, emphasis in original.
21 Ibid., p. 102.
22 Utdanningsdirektoratet, '(MUS01-02) Curriculum for Music: Core elements', 15 November 2019, https://www.udir.no/lk20/mus01-02/om-faget/kjerneelementer?lang=eng
23 See, for example, Elliott and Silverman's discussion on aesthetic objects as 'highbrow', for the socially privileged, educated, and 'classy' people, p. 96.

> seems to involve the feeling that one should not enjoy this particular artwork and, by implication, the belief that there are norms according to which some aesthetic responses are more appropriate than others.[24]

In the case of guilty pleasures, is the meaning of music 'created when music is used in social contexts'? Or, how does this fit with the claim from Elliott and Silverman, quoted above, that 'Musical values are socially assigned to sounds according to how sounds are used, experienced, and understood as being "good" or "right" for various purposes in musical, personal, and ethical social life'?[25] If social values determine our norms for 'good' and 'bad' music, despite our personal and private experience, we are removing the aesthetic aspect from music listening and are left with just another social activity. The very existence of the phenomenon of guilty pleasures shows that musical meaning has more to it than just being the outcome of a socially constructed process. In fact, a guilty pleasure can be seen as a response to musical expressions that is the opposite of being pragmatic and social.

In discussions about the ontology of music wherein claims are made about the true source of musical meaning, we find that social sciences generally have rejected ideas of music as an object, of musical autonomy, and of formalism. Such ideas have been replaced with socio-cultural and pragmatic paradigms claiming that musical meaning is socially constructed. Anyone suggesting that musical meaning resides in the musical object risks being labelled as outdated or elitist. The debate around musical ontology has been rather unconstructive and has resulted in an entrenchment on both sides of the discussion. A more fruitful path to understanding the phenomenon of music and musical meaning might be found by turning to the epistemological side of things. Next, I explore what we know about our perceptual system and emotional responses to music.

The Aesthetic Experience

As we have seen, the concept of aesthetics is not considered neutral but, rather, is laden with philosophical ideas around the ontology of the arts. These range from defining aesthetics as the philosophical study of beauty and taste (via the aesthetic as a disinterested experience) to the study of art forms.[26] Let us try to refrain from arriving at an irrefutable philosophical definition of aesthetics and instead approach the aesthetic from a more basic point of view—our sensory system and emotional responses. In doing this, we are closer to the etymological origin of aesthetics, the Greek *aisthetis*, which means 'sensation and perception'. This notion is positioned in contrast to *noesis*, which refers to intellectual knowledge. The following gives an overview of

24 Kris Goffin and Florian Cova, 'An empirical investigation of guilty pleasures', *Philosophical Psychology*, 32/7 (2019) (p. 1129–55).

25 Elliott and Silverman, p. 103.

26 T. Munro, et al., 'Aesthetics', *Encyclopedia Britannica*, https://www.britannica.com/topic/aesthetics

the basic elements of the biological or innate side of sensation and perception as well as the mechanisms involved in our emotional responses to the perceptual input.

Sensation

The sensation of seeing, hearing, or smelling is caused by external stimulation of our sense organs. Even if the dictionary entry of 'sensation' refers to a mental process,[27] much of our experience of sensation can be ascribed to physical factors and processes. In the case of hearing, the anatomy and physiology of our auditory pathways[28] define what we are able to detect from the incoming fluctuations in sound pressure that hits our outer ear. Due to both the structure of our head and to how our outer and inner ear are constructed, the hearing abilities of humans differ from those of animals.[29] The basilar membrane in the cochlea has a tonotopic organisation, meaning that different parts of the membrane have different physical sensitivity corresponding to different sound frequencies. The physical construction of the human basilar membrane defines our hearing range from 20 to 20000 Hz. We also find that the membrane has a limited resolution for simultaneous frequencies: two pitches that appear at the same time within the same critical band[30] will interfere with each other, creating the sensation of beating or roughness. This is referred to as 'perceptual dissonance'.[31] Perceptual dissonance can be naturally produced by the close frequencies that occur, for example, in a bear growl, a rockfall, or in a thunder roll. It has been found that experiencing perceptual dissonance is linked with a brainstem reflex[32] that makes us alert or afraid, something that has served us well in trying to survive in a threatening environment. Perceptual dissonance occurring in music can trigger the same reflex.

After the sound waves have been registered as frequencies and converted into electric signals in the cochlea, the electric signals are sent up the cochlear nerve into the brain where it is further processed in the auditory cortex. Although there is not a clear-cut division between the two, we may refer to the physical process happening in the cochlea as sensation and the psychological processing done in the brain as perception.

27 'Sensation', *Merriam-Webster Dictionary*, 2022, website, https://www.merriam-webster.com/dictionary/sensation

28 James O. Pickles, 'Auditory pathways: anatomy and physiology', *Handbook of Clinical Neurology*, 129 (2015), 3–25, https://doi.org/10.1016/B978-0-444-62630-1.00001-9

29 Kerry M. Walker, Ray Gonzalez, Joe Z. Kang, Josh H. McDermott, and Andrew King, 'Across-Species Differences in Pitch Perception are Consistent with Differences in Cochlear Filtering', *Elife*, 8 (2019), https://doi.org/10.7554/elife.41626

30 'Critical band', *APA Dictionary of Psychology*, online edn, 19 April 2018, https://dictionary.apa.org/critical-band

31 Albert Bregman, *Auditory Scene Analysis: The Perceptual Organization of Sound* (Massachusetts: MIT Press, 1990); David Huron, 'Tone and Voice: A Derivation of the Rules of Voice-Leading from Perceptual Principles', *Music Perception*, 19/1 (2001), 1–64, https://doi.org/10.1525/mp.2001.19.1.1; Ernst Terhardt, 'The Concept of Musical Consonance: A Link between Music and Psychoacoustics', *Music Perception*, 1/3 (1984), 276–95, https://doi.org/10.2307/40285261

32 Patrick N. Juslin, *Musical Emotions Explained: Unlocking the Secrets of Musical Affect* (Oxford: Oxford University Press, 2019).

Perception

Our auditory environment is created by numerous sources. A main task of perception is to organise and interpret the auditory signal and group the sensory inputs into separate and coherent streams according to their respective sources. This is done through a combination of bottom-up and top-down processing. Albert Bregman, author of the book *Auditory Scene Analysis*, describes the difference between the bottom-up and top-down processes like this:

> Primitive grouping is considered a 'bottom-up' process because it operates on the perceptual data at the input or 'bottom' of the perceptual-cognitive system [...]. Bottom-up processing involves only the immediate present (echoic and short-term memory). This is in contrast to 'top-down' processing that usually operates on the data after primitive grouping has taken place, and involves long-term memory. The grouping that is the result of top-down processing with long-term memory constitutes the second kind of grouping effects, called 'learned' or 'schema-driven grouping effects'.[33]

When Bregman is talking about primitive grouping, he refers to the 'laws of perceptual organisation' outlined by the German gestalt psychologists Kurt Koffka, Wolfgang Köhler, and Max Wertheimer at the beginning of the twentieth century. The theory 'stresses that we perceive the environment with respect to its inherent organisational and relational properties, and that we tend to perceive holistic, cohesive, meaningful forms'.[34] To sort the sensory input into coherent and meaningful groups, perception operates according to laws like proximity, similarity, symmetry, good continuation, and closure. They all follow the fundamental law of Prägnanz: 'Of several geometrically possible organisations that one will actually occur which possesses the best, simplest and most stable shape'.[35] Bregman demonstrated that the laws of gestalt perception also apply to auditory grouping: 'They include such things as frequency proximity, spectral similarity, [and] correlations of changes in acoustic properties'.[36] The factors involved in auditory grouping follow the assumption that sounds have a physical source and that the task at hand is to determine things like the location, movement, size, and origin of the sound's source. We find, for example, that sounds which start and stop at the same time, come from the same direction, and are similar in timbre and pitch are assumed to come from the same physical source and are, therefore, grouped into the same auditory stream. The laws or principles of gestalt perception have also been demonstrated within musical perception and have played a major role in the theories

33 Bregman, p. 32.
34 Michael W. Eysenck and Mark T. Keane, *Cognitive Psychology: A student's handbook* (Philadelphia: Psychology Press, 2000), p. 26.
35 Kurt Koffka, *Principles of Gestalt psychology* (London: Routledge, 1999), p. 138.
36 Bregman, p. 401.

of researchers like Leonard B. Meyer, Eugene Narmour and E. Glenn Schellenberg.[37] We shall not go into detail on these theories but just give a few examples of some of the basic principles for grouping in music:

- sequential pitches that are close in time, frequency and timbre group together and form motives and melodies;
- pitches that appear simultaneously group together and forms a single harmony;
- simultaneous melodies moving in the same direction with similar intervals and pitch-duration (homophony, correlation of changes) are perceived as one 'thickened melody';
- simultaneous melodies moving in opposite direction with different intervals and pitch-duration are grouped into separate streams and perceived as independent melodies (counterpoint).

The fundamental principle in auditory perceptual grouping is that it is object-oriented. The same goes for grouping in music perception. The difference between auditory perception of natural sounds and music is that music does not originate from a single source but from multiple sound sources that usually correlate on one or more auditory dimensions. When there is no such correlation, we might be experiencing aleatoric music, or something that we would have trouble categorising as music. Due to the correlation between different sound sources on different dimensions, music has been compared to the mythological 'chimera', a creature which was a lion, a goat, and a snake in the same body. Elvira Di Bona has described this phenomenon in music as 'chimericity':

> It is the property of hearing as a unified whole a melody or a harmony that does not belong to any single sound source but instead consists of the assembling of melodic or harmonic fragments coming from different sources. Chimericity is not reducible to the low-level audible properties of pitch and loudness; it is cognized at the perceptual level thanks to the auditory mechanism of primitive grouping.[38]

The chimericity of music may be seen as a product of the combination of low-level, bottom-up grouping and top-down, learned patterns. When there is low-level 'evidence' of multiple sound-sources that, to a greater or lesser degree, correlate and create compound and multidimensional patterns, we are 'forced' to interpret these as one multidimensional object. The factors involved in sensation and perception point to the fundamental task of interpreting sensory input so that we can detect objects in

37 Eugene Narmour Meyer, 'The Top-down and Bottom-up Systems of Musical Implication: Building on Meyer's Theory of Emotional Syntax', *Music Perception*, 9/1 (1991), 1–26, https://doi.org/10.2307/40286156; E. Glenn Schellenberg, 'Simplifying the Implication-Realization Model of Melodic Expectancy', *Music Perception*, 14 (1997), 295–318, https://doi.org/10.2307/40285723.

38 Elvira Di Bona, 'Hearing chimeras', *Synthese*, 200/3, 257 (2022), 1-20, https://doi.org/10.1007/s11229-022-03721-y

our surroundings. This is also a fundamental aspect of auditory perception and is a necessary factor in music perception as well. What we have seen seems to undermine Small's statement quoted earlier: 'There is no such thing as music. Music is not a thing at all but an activity, something people do'.[39] We might not talk about sounds *as* objects, but we certainly associate sound *with* objects. The difference between *seeing* a lion and *hearing* a lion, for example, is barely a philosophical one: both forms of sensory input make us conclude that 'it is a lion'. As visual perception is oriented at identifying objects in our surroundings, so is auditory perception. What is special about music is that it is perceived as a multidimensional object, or a chimeric 'thing'.

So far, I have dealt mainly with the so-called bottom-up aspect of primitive grouping. We shall turn to research on our emotional responses to music, where other bottom-up as well as top-down aspects of learning play a prominent role.

Emotional Mechanisms

In *Musical Emotions Explained*, Patrik N. Juslin gives a broad review of research on musical emotions. One main focus is a set of evolved mechanisms that account for music-evoked emotions. The overview of the mechanisms presented below will cast light on the discussion of whether musical meaning is reliant on the musical object or on non-musical denotations in terms of emotional experience.

Brainstem Reflex

As touched upon earlier, brainstem reflexes can be caused by dissonant sounds. Juslin suggests that this is because 'sensory dissonance is suggestive of "danger" in a natural environment'.[40] Brainstem reflexes can also be caused by sounds that are very sudden, loud, or have a fast or accelerating tempo.

Rhythmic Entrainment

It is assumed that we are equipped with perceptual rhythms that can entrain to rhythmic patterns in our environment.[41] This entrainment can affect our inner bodily rhythms (for example, the heart rate) as well as result in visible, synchronised bodily movement. Entrainment to slow rhythms can be a source of a feeling of calmness, while entrainment to fast rhythms can induce excitement and heightened arousal, and in general can being in 'sync' with music be a source of pleasure.[42]

39 Small, p. 2.
40 Juslin, p. 267.
41 Mari Riess Jones and Marilyn Boltz, 'Dynamic Attending and Responses to Time', *Psychological Review*, 96/3 (1989), 459–91, https://psycnet.apa.org/doi/10.1037/0033-295X.96.3.459
42 Juslin, p. 283.

Contagion

When we spend time with someone who is uplifted and happy, we may feel uplifted, and when a person smiles at us, we find it very hard not to smile back. This kind of emotional contagion can also happen through conversations with people who are sad or depressed. It is assumed that our tendency to mimic the expressions of feelings stems from our ability for emotional empathy. This mimicry not only involves a visible physical reaction but also a mirrored emotional response. We do not only automatically react to visible cues like a smile but also to the character of the human voice. Research has shown that the same effect can be found through music. Music with a slow tempo, dull timbre, and with low pitch and sound level may be experienced as sad, while music with a bright timbre, high pitch, fast tempo, and strong sound level tends to be experienced as happy.[43]

Evaluative Conditioning

If you often spend time at a friend's house and they always play a certain kind of music in the background, hearing this music outside of this context may bring back the good feeling associated with being with your friend. This connection often occurs outside of our awareness. Juslin explains:

> Evaluative conditioning refers to a process whereby an emotion is aroused by a piece of music just because this stimulus has been paired, repeatedly, with other positive or negative stimuli, which are not necessarily logically connected to the music in any way.[44]

Thus, contrary to the first three mechanisms, evaluative conditioning may create an emotional response to music that has little to do with the actual musical content. Because evaluative conditioning belongs to our subconscious procedural memory of learned associations, we are often unaware of the link between a stimulus and an associated emotional response, and we may not be able to explain why we have a certain feeling when hearing a specific piece of music.

43 Ibid., p. 187; Patrick N. Juslin, and Erik Lindström,'Musical Expression of Emotions: Modelling Listeners, Judgements of Composed and Performed Features', *Music Analysis*, 29/1-3 (2010), 334–64, https://doi.org/10.1111/j.1468-2249.2011.00323.x

44 Juslin, p. 304.

Episodic Memory

As with evaluative conditioning, episodic memory also involves an association between a stimulus and memory. The difference between the two mechanisms is that, in episodic memory, the association is made with a specific memory. In the case of music, if we hear a song during our first kiss, hearing the same song years later may invoke the memory of that specific kiss. As with evaluative conditioning, a positively valenced episodic memory 'infects' our emotional response to the associated music. We can also have strong episodic musical experiences that make us remember a specific context; when thinking of the context, we can relive the specific episode and the emotional musical experience.

Visual Imagery

We have the ability to imagine scenes that have never happened. We do this by combining memory fragments of things we have experienced, seen, or heard about. Visual imagery involves a process where the listener invokes emotionally laden inner images while listening to music. Juslin refers to three different ways in which images come about: 1) 'Mental imagery may occur when listeners conceptualise the musical structure through a non-verbal mapping between the metaphorical "affordances" of the music and image schemata grounded in bodily experience'.[45] A melody gradually rising in pitch may for example invoke the image of flying higher and higher. 2) Imagery invoked by myths or knowledge about the creation of the music (for example, 'Tears in Heaven' by Eric Clapton or Mozart's Requiem[46]). 3) The listener creates images based on how the music appears to comment or mirror certain aspects of the listener's current life experience. This happens through a metaphorical projection based on musical structures.

Musical Expectancy

Juslin refers to musical expectancy as

> a process whereby an emotion is aroused in a listener because a specific feature of the music violates, delays, or confirms the listener's expectations about the continuation of the music. Every time you hear a piece of music your expectations are raised, based on music you have heard before.[47]

45 Juslin, p. 331; George Lakoff and Mark Johnson, *Metaphors we live by* (Chicago: University of Chicago Press, 2003).

46 Clapton wrote 'Tears in Heaven' in memory of his son, Conor, who died tragically at the age of 4. When Mozart was commissioned to write a requiem mass, he had deteriorating health. He was convinced that he wrote the requiem for his own funeral.

47 Juslin, p. 344.

Juslin leans on Leonard B. Meyer's theory of emotional arousal based on inhibited or delayed expectations. According to Meyer, musical expectation is a product of a) primitive perceptual processes, which are the aforementioned gestalt laws of perceptual organisation, and b) expectations based on learned 'schemata'. These schemata include aspects like tonality and structural regularities in specific genres.

Consequences for Discussions on Aesthetics and Musical Meaning

Together with perspectives from sensation and perception, the factors involved in creating musical emotions cast light on our discussion on aesthetics and musical meaning. Contrary to what we have learned about the perceptual and emotional mechanisms involved in an aesthetic experience, Elliott and Silverman, among others, choose to downplay the importance of listening to music as sound. One reason for this can be found in their opposition towards absolutism, as with Elliott and Silverman's attack on the aesthetic work-concept. By associating aesthetics with formalism, intellectualism, and elitism, they seem at the same time to make a wholesale rejection of aesthetics in music education. Instead of seeking musical meaning through an aesthetic attention to the sounding object, they understand musical meaning as something solely socially constructed. This is reflected in the statement referred to earlier: 'Musics can only be understood and experienced in relation to contexts of socio-musical contexts'.[48] Based on what we have learned about emotional mechanisms like evaluative conditioning and episodic memory, there is an obvious problem with giving social context an exclusive role in defining musical meaning; the emotional mechanisms that emphasise social context can create an emotional response that stands in opposition to both the innate and schematic responses that take their input from the sounding object (brainstem reflex, rhythmic entrainment, contagion, visual imagery,[49] musical experience). In accordance with Juslin, emotions stemming from contextually dependent mechanisms 'are not necessarily logically connected to the music in any way'.[50] Hence, when Elliott and Silverman discourage taking an aesthetic attitude towards music and claim that music can only be understood in relation to a socio-musical context, their account of musical meaning is not only flawed but could turn out being musically irrelevant.

The seven emotional mechanisms discussed above work in an interrelated manner where bottom-up, primitive processes meet top-down, learned, schematic processes. Together, they create a rich, compound emotional musical experience. To account for this, we should strive to take a broader, synergistic approach when trying to

48 Elliott and Silverman, p. 103.

49 This is a compound mechanism, but the aspect of perceptual affordance in this mechanism points to a strong element of a bodily anchored metaphorical projection that is shared across individuals, and to a certain extent across cultures.

50 Juslin, p. 304.

understand the nature of musical meaning and knowledge. The late American music educator Bennett Reimer upheld the importance of taking a synergistic position in music education philosophy. In *A Philosophy of Music Education*, he quotes Paul G. Woodford and his thoughts about this matter:

> What gets many contemporary critics and theorists into trouble, I think, are their monolithic and dogmatic assertions that all authority is arbitrary and, therefore, suspect, and that absolutely everything is socially constructed [...]. A more reasonable proposition is that we are both processes and products of some complex, even chaotic, mix of biological nature and lived experience.[51]

We know that in the workings of perception, bottom-up and top-down processes interact in the attempt to organise sensory inputs, and we know from the overview of emotional mechanisms in music that both innate and learned factors are involved in creating what we perceive as emotional, meaningful musical experiences. When we assign social construction exclusive rights to define musical meaning, we have a problem.

Although Reimer asks for a synergetic approach, due to a long-lasting view where listening is treated as valid only as a subsidiary of performing and making music,[52] he seeks to bring attention to the importance of aesthetic listening. In fact, he considers the construction of musical meaning as primarily originating from an aesthetic engagement which produces musical feeling:

> Experiencing music as an 'affecting presence'—as a source of meanings gained through feeling—is a primary end of being involved with music [...] musical feeling becoming musical meaning. Music immerses us in the raw reality of feeling—its naked, subtle, exquisite truth, the truth of conscious being. This accounts for its charm and joyousness, and also its profundities and awesomeness—the entire spectrum of aware undergoing. That primal experience of the affecting presence of sounds is what I call 'knowing within' music.[53]

When we turn to the aspect of deep learning in music, we shall bring with us the perspective given by Reimer: it is the affecting presence of sounds that allows for 'knowing within' music.

51 Paul G. Woodford, qtd. in Bennett Reimer, *A Philosophy of Music Education: Advancing the Vision*, 3rd edn. (London: Prentice Hall, 2003), p. 75

52 Ibid., p. 110.

53 Ibid., p. 186.

Towards a Deeper Understanding of Music[54]

Structure of Knowledge

The concept of deep learning refers originally to computers and machine learning where the attempt has been to 'mimic the human brain'.[55] Ed Burns, Kate Brush, and Alexander S. Gillis compare deep learning to how a toddler learns the meaning of the word 'dog':

> Deep learning is a type of machine learning and artificial intelligence (AI) that imitates the way humans gain certain types of knowledge. […] Deep learning enables a computer to learn by example. To understand deep learning imagine a toddler whose first word is *dog*. The parent says, 'Yes, that is a dog,' or, 'No, that is not a dog.' As the toddler continues to point to objects, he becomes more aware of the features that all dogs possess. What the toddler is doing, without knowing it, is clarifying a complex abstraction: the concept of dog. They are doing this by building a hierarchy in which each level of abstraction is created with knowledge that was gained from the preceding layer of the hierarchy.[56]

Christian Janiesch and colleagues describe the essence of the process involved in deep learning like this: 'machine learning seeks to automatically learn meaningful relationships and patterns from examples and observations'.[57] This is similar to what psychologist Keith Sawyer describes as one aspect of deep learning: 'Deep learning requires that learners look for patterns and underlying principles'.[58] It is interesting to note that the American psychologist, Jerome Bruner, already back in the 1960s stressed the importance of students gaining an understanding of the structure of a subject matter:

> Grasping the structure of a subject is understanding it in a way that permits many other things to be related to it meaningfully. To learn structure, in short, is to learn how things are related.[59]

Ironically, this is analogous to what Michael Schneider and Elsbeth Stern, fifty years later, describe as the need for a paradigm shift in education today: 'from the amount of knowledge to the structure of knowledge'.[60] We have seen that the perspectives taken in the new curriculum resemble this, where an interpretation of the concept of deep

54 Parts of the discussion are elaborations and developments of some of the perspectives presented in my book about deep learning in music: O. T. Furnes, *Dybdelæring i musikk - musikalsk forståelse gjennom sansning, følelser og begreper* (Oslo: Universitetsforlaget, 2022).

55 IBM, 'What is Deep Learning?', IBM website, n.d., https://www.ibm.com/topics/deep-learning

56 Ed Burns, Kate Brush, and Alexander S. Gillis, 'Deep Learning', *Tech Target Network* website, 2023, https://www.techtarget.com/searchenterpriseai/definition/deep-learning-deep-neural-network

57 Christian Janiesch, Patrick Zschech, and Kai Heinrich, 'Machine Learning and Deep Learning', *Electronic Markets*, 31/3 (2021), 685–95.

58 Sawyer, p. 4.

59 Jerome Bruner, *The Process of Education* (Boston: Harvard University Press, 1990), p. 7.

60 Schneider and Stern, p. 71

learning is to 'develop understanding of key elements and relationships in a subject'.[61] Another aspect involved in definitions of deep learning is that of conceptual learning: 'Deep learning requires that learners integrate their knowledge into interrelated conceptual systems'.[62] An equivalent to this in the Norwegian national curriculum is 'gradually developing knowledge and lasting understanding of concepts, procedures and relationships in the subject and between subject areas'.[63]

If we try to translate all of this to the teaching of music, some will be opposed to deeper learning in music as something that seems to place emphasis on a formalistic and intellectual approach to musical understanding—a conceptual and theoretical knowledge of musical structure. Since Reimer sees musical feelings as the key to 'knowing within' and to musical meaning, he does not support conceptual learning as an end in itself. He does, however, emphasise the role played by 'knowledge about' and 'knowledge why' to enhance 'knowing within'.

> All those learnings (knowing about and knowing why) serve a purpose—the purpose of enhancing the quality of the direct engagement with the sounds of music themselves—of knowing within music. Knowing about and knowing why are means. The end is enhanced knowing within music (and knowing how) in direct, immediate musical experiences.[64]

Knowledge can enhance the perceptual sensitivity,[65] and we know that learned schemata interact with bottom-up, sensory inputs, so when Reimer claimed that knowledge can provide for a richer musical experience, he was on to something. Accordingly, if the aesthetic experience can be enriched and deepened through knowledge, conceptual understanding becomes a factor in musical meaning: 'Teaching for musical meaning requires the use of language as a means to enhance musical experience'.[66]

Deep Learning through Aesthetic Attending

The emphasis on conceptual understanding and learning structure by educators, psychologists, and researchers like Bruner, Sawyer, Schneider, and Stern turns attention toward the key elements in music as a source for acquiring a deeper understanding of music. In terms of conceptual learning, this should not be approached through memorising definitions but can be achieved through implicit learning. This kind of learning involves a process of 'acquiring knowledge about the structure of the environment without conscious awareness, or the non-intentional acquisition of

61 Utdanningsdirektoratet, Core curriculum: Competence in the subjects.
62 Sawyer, *The New Science of Learning*, p. 4.
63 Utdanningsdirektoratet, 'Dybdelæring', para 1 and 2 of 4.
64 Reimer, Bennett, *A Philosophy of Music Education: Advancing the Vision*, 3rd edn (London: Prentice Hall, 2003), p. 187.
65 Rasha Abdel Rahman and Werner Sommer, 'Seeing What we Know and Understand: How Knowledge Shapes Perception', *Psychonomic Bulletin and Review*, 15/6, 1055–63, https://doi.org/10.3758/PBR.15.6.1055
66 Reimer, A Philosophy of Music Education, p. 257.

knowledge about structural relations between objects or events'.[67] One kind of implicit learning of concepts is described by cognitive linguists such as Mark Johnson and George Lakoff as part of their theory on embodied cognition.[68] One aspect of this is that meaning arises from bodily experience and is a prerequisite for conceptual understanding: 'Meaning traffics in patterns, images, qualities, feelings, and eventually concepts and propositions'.[69] Johnson further emphasises the bodily component of meaning: 'Meanings emerge "from the bottom up" through increasingly complex levels of organic activity'.[70] Furthermore, he warns against intellectualising conceptual learning:

> I will be using the terms embodied meaning and immanent meaning to emphasize those deep-seated bodily sources of human meaning that go beyond the merely conceptual and propositional. Structures and dimensions of this immanent meaning are what make it possible for us to do propositional thinking. But if we reduce meaning to words and sentences (or to concepts and propositions), we miss or leave out where meaning really comes from. We end up intellectualizing human experience, understanding, and thinking, and we turn processes into static entities or properties.[71]

Inherent in the theory of embodied cognition, as laid out by Lakoff and Johnson, is the role metaphors play in translating bodily experience into conceptual understanding: 'Our ordinary conceptual system, in terms of which we both think and act, is fundamentally metaphorical in nature'.[72] Given that 'metaphor is understanding and experiencing one kind of thing in terms of another',[73] understanding key elements and relationships in music need not be an intellectual and formalised enterprise but can be accomplished through experience translated into images or everyday concepts. The emotional mechanism of visual imagination described earlier is an example of a metaphorical projection from music to visual objects and actions. Juslin explains that 'mental imagery may occur when listeners conceptualise the musical structure through a non-verbal mapping between the metaphorical "affordances" of the music and image schemata grounded in bodily experience'.[74] Thus, in terms of understanding the key elements in music, we can perceive pitch as a physical location in altitude, rhythm as a horizontally moving object, dynamics as the size of an object, or melody as a movement in vertical and horizontal physical space. When listening to the music

67 J. S. Freund, 'Learning', in *Encyclopedia of Gerontology*, 2nd edn., ed. by James E. Birren ([n.p.]: Elsevier, 2007), https://doi.org/10.1016/B0-12-370870-2/00106-2

68 George Lakoff and Mark Johnson, *Metaphors we live by* (Chicago: University of Chicago Press, 2003).

69 Mark Johnson, *The Meaning of the Body: Aesthetics of Human Understanding* (Chicago: University of Chicago Press, 2007), p. 9.

70 Ibid., p. 10.

71 Ibid., p. 11.

72 Lakoff and Johnson, p. 3.

73 Lakoff and Johnson, p. 4.

74 Juslin, p. 331.

as one multidimensional object, elements like melody, rhythm, dynamics, and timbre interact in creating rich visualisations of imaginary scenes.[75]

The American philosopher Jerrold Levinson talks about aesthetic attending and appreciation of music and our tendency to hear music as movements:

> we hear motion or movement, of an imaginary or perhaps metaphorical sort, in music: we hear music rising, falling, soaring, plunging, expanding, shrinking, advancing, retreating, rushing, lingering, trudging, leaping, swelling, subsiding, and so on.[76]

Descriptions such as these can be used both to describe gestures both as expressions of musical content and meaning. Levinson even compares aesthetic appreciation to a kind of 'latent dancing':

> musical understanding is itself essentially a kind of latent dancing, whereby one moves with musical movement, but on a psychic or imaginary plane.[77]

Using language to describe music as gestural movements gives us access to our intuitive experience of music and musical expressions. Through metaphorical descriptions, we can communicate both musical movement, expressions, and perceived emotional content (note that there is a difference between perceiving and feeling emotional content).[78]

The Musical Object as a Metaphor

Our discussion has shown that there are ample reasons for talking about music as an object and that this is not an intellectualised, formalised, isolated object deprived of real-life significance. On the contrary, the musical object, as we have discussed here, is essential both to sensation, perception, and emotion and to the construction of musical meaning. Furthermore, if deep learning is to understand key elements, see patterns and relationships, and to acquire a conceptual understanding of the subject's basic structures, then attending to the musical object, its expressive qualities and its multidimensional construction, seems central to a deeper knowledge and an enhanced experience of music. Talking about music as a metaphorical object in terms of size, speed, gestural expressions, etc., we gain an increased understanding of the musical multidimensional object as well as of our perception and interpretation of the music. Both in music education and in artistic research, this kind of aesthetic attention and conceptual interpretation builds knowledge of music, not primarily as a scientific,

75 For a more in-depth description of possible metaphors for musical movement and structure, Steve Larson's book *Musical Forces: Motion, Metaphor, and Meaning in Music* (Bloomington: Indiana University Press, 2012) is a suggested starting point.

76 Jerrold Levinson, *Musical Concerns: Essays in Philosophy of Music* (Oxford: Oxford University Press, 2015), 23, https://doi.org/10.1093/acprof:oso/9780199669660.001.0001

77 Ibid., p. 29.

78 Juslin.

formalised object, but as a human expression of ideas and emotions of real life expressed through a metaphorical multidimensional object.

A scientific description of the musical object and its expressed content should therefore be grounded both in the intuitive experience and on experiential and metaphorical descriptions of perceived force, size, and gestural movements. This would help us keep music research and discourse relevant to human experiences. Furthermore, with this as the foundation, when we extend musical research to investigate social and cultural impact, and social construction of musical meaning, we are grounded in an embodied, aesthetic approach to music as sound. A grounding of musical discourse in the embodied, aesthetically perceived, also allows for extending the concept of aesthetics to pragmatist or relational aesthetics, and gives added meaning to concepts like 'musicing', or even the idea of conceptual art.

Understanding the musical object as emerging from our attempt to interpret our auditory surroundings, constructed through gestalt perception, perceived emotional content and as a movement of gestural expression, leaves little room for old accusations; this object is not elitist, intellectual, or opaque to general significance. On the contrary, attending to the musical object in the way described in this chapter, provides for an embodied and aesthetic experience that is perceived as meaningful. Furthermore, when our aesthetic attending is done with an awareness of the movements and gestural, expressive qualities of the different interrelated musical dimensions, we gain a deeper understanding of the structure of music as a multidimensional object. Through language, first with metaphorical descriptions and later with musical terms and concepts, our conceptual understanding of music deepens. Verbal descriptions may in turn enhance our perceptual discrimination and give added depth to our aesthetic experience. This approach answers to definitions of deep learning given in the Norwegian national curriculum: develop 'understanding of key elements and relationships' or 'understanding of concepts, procedures and relationships'.[79]

Deeper Learning in Music for the Future

With deep musical learning, we do not associate 'aesthetics' with a philosophical discourse but with our sensations in meeting with the unfolding musical object together with an attempt to verbalise and conceptualise this experience. This resembles one central point in Chapter 12 in this volume, where Helen Julia Minors encourages us to break down the barriers between critical analysis and performance, and to see aesthetic understanding and performance as integrated curricular elements. The presented perspective on deep learning in music, with its emphasis on combining aesthetic awareness with verbal conceptualisations, may also be one way to remedy Stefan Östersjö's concern regarding the need for to artistic research to enable movement

79 Utdanningsdirektoratet, 'Core curriculum', para. 3 of 4.

'between different forms of knowledge [which] is a factor in artistic research that remains in its infancy'.[80]

Deepening our aesthetic awareness together with conceptual insight provides us with important tools for lifelong learning, including the ability to reflect upon our perception and performance. This has been emphasised by Eva Georgii-Hemming et al.: 'Reflection is at the core of lifelong learning and linked to action'.[81] The aspect of lifelong learning is also a central point for Minors when she emphasises 'self-awareness, self-assessment, self-learning and self-branding'[82] as important outcomes of a curriculum that combines aesthetic awareness with critical reflection. Furthermore, with a deepened aesthetic understanding we will be better equipped to meet new and unfamiliar musical expressions, not with judgement, but with curiosity and interest. This can serve as a means for intercultural understanding and assist in reducing Western cultural hegemony in higher music education, a central theme in Sarah-Jane Gibson's chapter, Chapter 11, in this publication.

When discussing lifelong learning and the challenges of the twenty-first century, we need to take the increasing influence of artificial intelligence (AI) into account. We already have AI-powered tools for musicians and producers that can serve as guidance—for example, in practice or mixing. We also see that AI is capable of both composing, producing, and playing sound. The AI output can serve as a starting point for creative discovery or generate a complete musical output on its own. AI already surpasses humans in storing knowledge, and the latest trends in AI research attempt to equip machines with emotions—something that can be tracked in the recent call for abstracts within the theme 'Emotions and Artificial Intelligence' by the journal *Frontiers*. Here we find that the research 'intends to help in the creation of future AIs that are more responsive, empathetic, and intuitive in their interactions with humans'.[83] While this might seem disturbing to both artists and others, we can assume that this 'empathy' at best is recognition and mimicking of human emotions, not actually feeling them. Facing a future where AI is infiltrating our society, our responsibility both as artists, researchers, and teachers for the coming generations involves working along three main strands: 1) While artificial intelligence might surpass humans in 'hard', factual knowledge, we should not fall to the temptation to off-load all cognitive tasks to artificial intelligence and to blindly follow its instructions. Doing this could result in reducing our conceptual understanding of the world around us, including music. Therefore, we need to deepen our embodied conceptual understanding of the

80 Stefan Östersjö, 'Art Worlds, Voice and Knowledge: Thoughts on Quality Assessment of Artistic Outcomes', *Online Journal for Artistic Research*, 3/2 (2019), p. 71, https://doi.org/10.34624/impar.v3i2.14152

81 Eva Georgii-Hemming, Karin Johansson, and Nadia Moberg, 'Reflection in Higher Music Education: What, Why, Wherefore?', *Music Education Research*, 22:3 (2022), 245–56, https://doi.org/10.1080/14613808.2020.1766006

82 Helen Julia Minors in Chapter 12 of this volume

83 *Frontiers*, 'Emotions and AI', call for submissions, para 2 of 5, https://www.frontiersin.org/research-topics/56458/emotions-and-artificial-intelligence

structure and inner workings of music as a tool for creative and artistic expression. 2) Machines might be able to mimic human emotions. However, unlike machines, humans have the ability to express actual felt emotions. Thus, upcoming composers and musicians should go beyond reproducing and mimicking genres and expressions of others and turn to an aesthetic awareness and deeper understanding of the music. This allows for making personal aesthetic interpretations that can result in subjective, creative, and artistic expressions of felt emotions. 3) Although artificial intelligences are superior in collecting data and imitating reality, they do not do well in interpreting data in a larger context. This is partly because machine learning systems do not have access to the world of physical, social, and cultural interactions like we do. This should be an incitement to see our role as artists in a broader context as interpreters and communicators of human emotions, relationships, cultures, values, concepts, and ideas. This is where we tap into concepts like 'musicking' and 'relational aesthetics' discussed in this and other chapters in this book.[84]

Since deep learning, as I have discussed it here, seeks to deepen our conceptual understanding, aesthetic awareness, and expressive abilities, it may provide the foundation for lifelong learning for students, artists, researchers and teachers facing both known and unknown challenges throughout the twenty-first century.

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84 See Chapter 10 and Chapter 12.

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