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**MUSIC PERCEPTION AND COGNITION AS ACTION.
EPISTEMOLOGICAL FOUNDATIONS OF THE PSYCHOLOGY
OF PERCEPTION**

Slowa kluczowe: *perception, cognition, perceptual illusions, perception as action, ecological theory of perception*

Musical listening and understanding, perception and cognition denote a cognitive activity of the mind regarding the appropriation of the audible world. This activity depends on the sensitivity of our senses as well as on the situated, social and cultural circumstances that mould our conscious mind. The result of what we perceive reflects the perceptibility of our senses which function as the gateway into our mind. Therefore, what we perceive with our eyes depends on the bandwidth of the frequencies between infrared and ultraviolet that the retina and its photo receptors are sensitive to. Colours that physically do not exist come into our mind by an electro-physiological activation in the sensitive rods and cones of the retina. The different frequencies which the receptors are sensitive to will then be perceived (“interpreted”) as colours. Other lower frequencies will be perceived by tactile sensation as temperature (microwaves). Only mechanical frequency bands between 20 and 20.000 Hz can be processed by the hair cells in the inner ear and will be perceived as sound.

Therefore, the world we perceive is a construct of our mind and is different from other beings according to the sensitivity of their particular receptors. Consequently, the world of bees, dogs or frogs is different according to their sensory apparatus. Outside ourselves we cannot experience how the world “really” appears.

With this limitation we must accept that our view of the visible and audible world is determined by the biological and physiological conditions of our senses. What we hear or see depends on the capacity of our senses, and furthermore by the cognitive structures within the physiological conditions of how the brain processes auditory stimuli, and finally it also depends on the social and cultural conditions of the envi-

ronment we are rooted in. Through this, all incoming information will be dynamically stored and processed in a highly complex non-linear manner.

Perceptions and illusions

If we look at the literal meaning of the term perception, it refers to the Latin root “percipere, perception” (to get something) and indicates the first step in the process of cognition (*Erkenntnis*). The German term “*Wahrnehmung*” adds another nuance to the meaning while indicating that we accept something to be actually true or real (*wahr*). What and how we perceive relies on focused attention and calls for a mental activity by which sensorial data are absorbed and processed by the brain’s neural mechanisms. To recognize *something to be something* we need to integrate new information into already acquired information and to ascribe meaning to a mere sensorial input.

Simple sensorial reactions are designated as sensations (*Empfindungen*) that are based on subjective impressions. An expressive vocalization or an articulated instrumental tone do not need to be recognized as something (e.g. as an F# of an oboe) for evoking a strong emotional content which then stands for the meaning of that sound. Mostly, the subjectively experienced quality of a sound appears to represent a trait of the acoustic phenomenon itself, although it is only grounded in the mental state of the recipient (listener). This subjective quality of the experience appears as a real phenomenon of the perceived sound which makes its qualia.¹ Qualia are immediate reactions to an excitation by a sensorial stimulus without any reference to a semantic meaning. In contrast, recognition (*Wahrnehmung*) calls for a conscious cognitive act that will lead to the cognition of something to be something which means to integrate a percept into an already existing mental structure or representation.

When talking about music listening, we normally do not differentiate between both modes of sensation and cognition. We rather distinguish between concentrated focused hearing, incidental hearing, superficial hearing as an accompaniment to other primary activities (musical wallpaper), or emotional immersion into sound as an acoustic stimulant. In many cases, we cannot decide about what to listen to because music is part of the environment (supersonic sounding). All of this calls for different stages of attention.

A crucial question remains open when we attentively listen to music: how do musical phenomena reach our perceptive mind? Sensualism (John Locke, 1632-1704) acted on the assumption that everything that is represented in the mind needs to be first acquired through the senses. The central doctrine of sensualism reads: *nihil est in intellectu quod non fuerit in sensu*.² By this, every mental state must be traced back to a primary sensorial stimulation and the transmission through sensory channels. On the other hand, it is also true that one can only apprehend what is already represented in the mind. We only recognize a march or waltz when these types match what is already mentally represented.

This addresses an epistemological problem of *identity and difference*, i.e. how external phenomena that are different from one’s own can be assimilated so that what is different can be integrated into the identity and becomes identical. But this leads to the

¹ Thomas Metzinger, ed., *Bewusstsein. Beiträge aus der Gegenwartsphilosophie* (Paderborn: Schöningh, 1996).

² John Locke, *An essay concerning human understanding* (Aalen: Scientia Verlag, 1963), II, 1, 2.3.

general problem of how we can perceive what is different from identity since we generally can only perceive what is already installed and developed by sensorial data in our neural net. To suspend this aporia we have to acknowledge that music perception is deeply rooted in practical sensorial experience, but sensualism alone cannot offer a solution to the philosophical problem of identity and difference in perception and cognition. Here, it is important that the percipient needs to invest in mental activities to give meaning to the sound which comes from prior experience and cultural knowledge. Therefore, cognitive psychology turns its focus from the object of perception to the recipient and the internal processes of adaptation.

The fact that mental activity constitutes what is recognized through perception becomes evident in visual illusions. When we look at the graph in Fig. 1, perfect parallel horizontal lines are reproduced on the retina, we do not recognize parallel lines, but irregular shifts instead. The bend of black and white squares affects skewed lines that do not have a physical equivalent; they are generated in the mind because of the different processing of light and dark contrasts in the visual cortex.

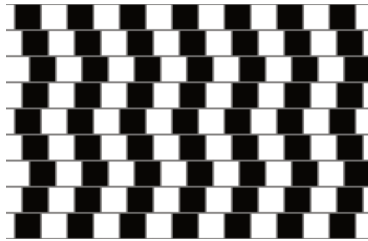


Fig. 1. Visual illusion (*café wall illusion*). The horizontal lines are exactly parallel, but are perceived as lines with skewed shifts

Source: Wikimedia, access 10.07.2019, commons.wikimedia.org/wiki/File:Caf%C3%A9_wall.svg

We find a similar situation when the music generates the illusion of an endless descent as in Bach's *Brandenburg Concerto No. 3* (Fig. 2) where the bass line is performed in a way that we hear a continuously descending line instead of repeated scale sections. This corresponds to Maurits Cornelis Escher's endless stairs (Fig. 3).

The image shows a musical score for the bass line of Bach's *Brandenburg Concerto No. 3*. The score is written for a single bass line (Vcl. (Cb.) e Cemb.). It consists of several measures of music, with a large arrow pointing to the right, indicating the direction of the perceived descent.

Fig. 2. J.S. Bach, Allegro from *Brandenburg Concerto No. 3* (BWV 1048)
Source: Neue Bach-Ausgabe, (Kassel: Bärenreiter 1987), 15, 16

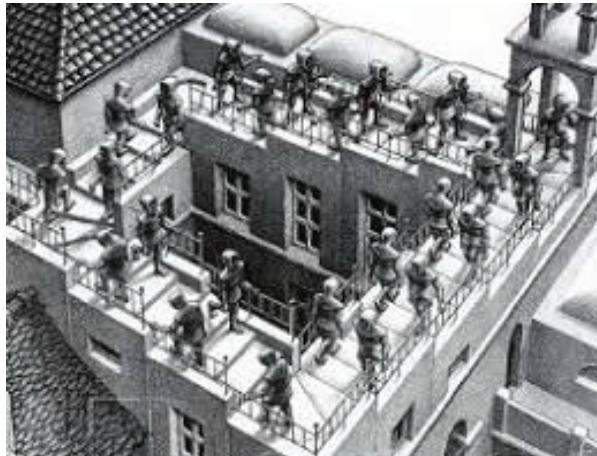


Fig. 3. M.C. Escher, *Treppauf – Treppab* (lithograph, 1960)
Source: Panoptikum, access 10.07.2019, www.panoptikum.net/m-c-escher/

Composers sometimes “play” with such psychological phenomena and compose a musical structure which does not correspond with the aural perception. One of the most prominent examples is the introduction to the Finale of Tchaikovsky’s *6th Symphony* (Fig. 4). The experienced melody results from an interpolation of the two violins and of viola and violoncello. The auditory mind connects the small intervals between both parts and generates the impression of a simple tune that every listener (and even player) hears. However, this particular melody does not exist in the score, but only in the listener’s mind.

The image displays a musical score for the Finale from the 6th Symphony by P.I. Tchaikovsky. The score is written for Violino I and II, Viola, Violoncello, and Contrabasso. The tempo is marked "largamente". To the right of the score, there is a separate musical staff titled "Klangresultat im Hörerlebnis" (Sound result in the listener's experience), which shows a simplified harmonic structure of the music.

Fig. 4. P.I. Tchaikovsky, Finale from the 6th Symphony

A similar situation is presented by some works of minimal music where interlocking patterns with minimal changes cause the individually perceived melodies depending on the changing attention of the listener. In this case, the perceived musical sound differs from the notated score because the musical effect is the results of the listener's mind.

In the history of art, illusion plays an important role as *trompe l'œil*. Here, the illusion of a three-dimensional space is evoked especially in ceiling paintings. A similar type of deception of the eyes can be found in paintings by Giuseppe Arcimboldo where, fruits and vegetables are arranged in a way that the recipient reinterprets the concrete objects as parts of a face (Fig. 5). In his painting *Autumn* (1573) a mushroom



Fig. 5. G. Arcimboldo, *Autumn* (from: *Quattro Stagioni*, 1573)

Source: Wikimedia, access 10.07.2019, commons.wikimedia.org/w/index.php?curid=101707

appears as an ear, or grapes represent ringlets. The particular elements of the picture become diaphanous for new sights and interpretations. The actual portrait of the allegory “autumn” is not on the canvas, but it arises through the act of perception; the painting gives reason to a new unique perception and does not simply mirror the naturally visualized objects; it changes the perception. The quasi-objective substrate of an artwork, which is documented in a score or picture, is phenomenally different from the actually experienced perception and interpretation of the transmitted data.

Perception and action

That perception is intensely linked with action becomes manifest in everyday experience if one considers how perception acts on action control. If one intends to drive a nail into a wall, one observes and controls each particular step of the action which is a necessary prerequisite for its success. The same happens with instrumental play. The fingering – even on a mute keyboard – evokes an internal imagination of the sound; the action of the fingers incorporates the intended sound and vice versa.

Perception is, therefore, instrumentally and functionally linked with action. It seems that to a certain extent acting constitutes perception and not only functions as a byproduct of a genuine mental activity.³ Rather both modes – action and perception – have been developed simultaneously.⁴ Moreover, it can be shown that perception is not only embedded in the environment, but it constitutes it in terms of an imagined conception of the environment. This is reflected by a classic animal experiment:

Ten pairs of kittens were raised in complete darkness and were exposed to light only under controlled conditions. These determined that one group could freely move, but for some time they had to pull a carriage with a small basket with one kitten from the other group in it. After all, both groups experienced the same environment. However, the experience of the kittens of the second group was only passive. At the end the kittens of the first group exhibited a normal behavior, whereas the kittens of the second group moved like blinds, collided with objects or dropped over edges.⁵

Thus, this shows that the animals did not represent their environment just through visual perception of the particular environmental attributes, but rather by means of their own actions within the environment, which guided their perception. This also constitutes the key condition of the understanding of sensorimotor intelligence, which initiates the cognitive process in Piaget’s developmental psychology.⁶

³ Susan Hurley, “Wahrnehmen und Handeln”. In *Philosophie der Verkörperung*, eds. Jörg Fingerhut, Rebekka Hufendiek, Markus Wild (Berlin: Suhrkamp, 2013), 379-412.

⁴ Wilfried Gruhn, Madeleine Haußmann, Ulrike Herb, Cornelia C. Minkner, Katrin Röttger, Albert Gollhofer, “The development of motor coordination and musical abilities in pre-school children”, *Arts BioMechanics* 1, 2 (2012): 89-103.

⁵ According to Richard Held, Alan Hein, “Movement-produced stimulation in the development of visually guided behavior”, *Journal of Comparative and Physiological Psychology* 56, 5 (1963): 872-876.

⁶ Jean Piaget, Bärbel Inhelder, *Die Psychologie des Kindes* (Olten, Freiburg: Walter-Verlag, 1972).

In recent times, James J. Gibson founded his ecological perception theory on the affordances which are strongly embedded in the environment.⁷ Humans and the environment are seen as an inseparable unity which cannot be split into interior and exterior parts or into cognitive and motor components. His theory indicates that creatures who sense their environment and the objects of this environment act complementarily on one another. He states that what we perceive while looking at objects are not their qualities, but just proposals for action which he calls “affordances” (Gibson). This implies that the objects of perception always offer proposals for action – a trumpet for blowing, a tune for singing, a chair for sitting etc.

To go one step further, we should also ask whether listening to music calls for action or whether action or acting itself makes a constitutive element of perception which is apt to call for action and to retroact on perception. Thus, listening incorporates acting and is not only a potential result of perception but also a mode of hearing. It can express the tension or the flow of the harmony, the anticipation of a possible conclusion, or it can demonstrate or even stimulate the internal gestures of the music. By this, action becomes an equivalent approach to listening. At the same time, action opens a new educational dimension for music learning and cognition. Action, then, is no longer a mere complement to listening and playing, rather it forms an integration of higher cognitive processes, of thinking and listening, audiating and performing, since “actions are nonverbal forms of thinking and knowing in and of themselves” (Elliott⁸).

Perception and cognition

We finally need to differentiate between perception and cognition. *Perception* refers to the reception of the physical parameters of the music and its mental processing in the neural network, whereas *cognition* refers to the mental process of generating meaning. We give meaning to a sound by integrating it into the mental structure of the musical mind and its cultural imprint. Ludwig Wittgenstein pointed out in his *Philosophische Untersuchungen* (1953) that there are two different “objects” of sensual perception: the *object* which is perceived and its *meaning* or reference. This is a change of the aspect of the attentional direction (*Aspektwechsel*). “Der Ausdruck des Aspektwechsels ist der Ausdruck einer neuen Wahrnehmung, zugleich mit dem Ausdruck der unveränderten Wahrnehmung“.⁹ While perception refers to the objective aspect of receiving the sensorial data, the process of cognition has turned in the opposite direction. Now, the subjective aspect of the generation of personal meaning comes into play. The conscious mind of the recipient takes possession of the percept and gives it a meaning. This aspect of appropriation depends on experiences and expectancies which characterize the subjective code of cognition as a culture-specific and experience-driven entity.

⁷ James J. Gibson, *The Ecological Approach to Visual Perception* (Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1986).

⁸ David J. Elliott, *Music Matters. A New Philosophy of Music Education* (New York, Oxford: OUP, 1995), 55.

⁹ Ludwig Wittgenstein, *Philosophische Untersuchungen*, ed. Eike von Savigny (Berlin: Akademie-Verlag, 2011), II, XI.

Here, the recipient incorporates the given physical structure and develops it as an essential part of the self (Fig. 6).

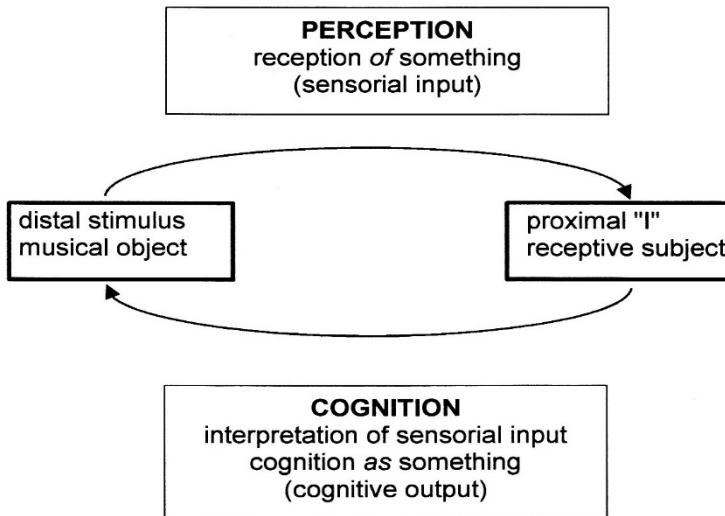


Fig. 6. The cycle of perception and cognition

Through action, the genesis of meaning and individual significance merges with embodiment. Perception and cognition as embodied cognition elucidate the process of recognition and interpretation of something to be something. Cognition, therefore, exceeds the psychological and neuro-physiological process of perception of which action makes up an essential part.

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Summary

MUSIC PERCEPTION AND COGNITION AS ACTION. EPISTEMOLOGICAL FOUNDATIONS OF THE PSYCHOLOGY OF PERCEPTION

A general discussion of the epistemological foundations of a psychology of perception will be exemplified by examples from visual and aural illusions. Based on differences between perception and cognition, the idea of perception as action is introduced and discussed in the light of modern theories of perception. Finally, a clear differentiation between perception as the sensorial input and cognition as a process that generates meaning consolidates the focus on perception and action.

Key words: *perception, cognition, perceptual illusions, perception as action, ecological theory of perception*

